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## The Decade Past and the Decade Ahead

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# The *Várzea*: The Decade Past

**Christine Padoch and Angela Steward**

## Introduction

In December 1994, almost 12 years to the day before the meeting on *The* Várzea*: The Decade Past and the Decade Ahead* was convened in Manaus, the first international conference devoted entirely to the topic of the *várzea*, entitled *Diversity, Development, and Conservation of the Amazon* Várzea took place in the city of Macapá. Although the Manaus meeting largely focused on the future, to better understand the path ahead it is instructive to remember where we have passed before. Looking back at the 1994 conference provides a convenient entry point.

In 1994 several ambitious and complex integrated conservation and development efforts in *várzea* environments were underway in both Brazil and Peru: the most prominent of these were at located in Mamirauá (at that time it was the Mamirauá Ecological Station; the Mamirauá Sustainable Development Reserve was not created until 1996), and in the Pacaya-Samiria National Reserve in Peru. There were as well a number of large and important research efforts focused on *várzea* issues that brought teams of prominent researchers to leading Amazonian research institutions, such as the Museu Paraense Emilio Goeldi in Belém, INPA (Instituto Nacional de Pesquisas da Amazônia) in Manaus, and to IIAP in Iquitos. In addition, several smaller but no less active efforts that featured various combinations of research, training, conservation, outreach, and education focused on communities and their fishing and farming, fauna, forests, and agroforests in and around Macapá, Belém, Santarém, Marajó, Manaus, Tefé, and up into Peru around Iquitos and elsewhere. The Macapá conference was convened in response to these efforts, major and minor, in the *várzea*. It provided an opportunity to assess the progress of these projects as well as more generally to evaluate the state of *várzea* research, conservation, and development. For the community of *várzea* researchers it was a chance to meet, exchange ideas, rethink approaches, and form new collaborations, as well as to reach out to the general public, the press, and policymakers. The broader objective of the event was to focus attention on *várzea* environments and communities that were substantially different from those of the *terra firme* that were, and still are, attracting a good deal of the world's attention at the time.

Reflecting the work of many *várzea* researchers of the time, an overarching theme of the 1994 meeting was the prevalence and importance of heterogeneity in the *várzea*: social, physical, as well as biological, and the implications of this diversity for research and management and for effective policy making. Linked to the heterogeneity issue was a discussion of scale, both spatial and temporal, including appropriate scales for management, conservation, and control over resources on the *várzea*. In some cases this took the form of discussions of community versus state control, common property, and open access. Related also to these issues was a strong emphasis on the necessity for crossing disciplinary and/or sectoral boundaries to achieve more effective management as well as more relevant research. Another common theme was the "anthropogenic Amazon," especially the "anthropogenic *várzea*," i.e., a strong emphasis on the role of people and Amazonian societies in transforming and enriching *várzea* landscapes. And finally, again reflecting the needs of the integrated conservation and development projects and other *várzea* research and conservation efforts, the many ways and many levels on which links needed to be forged between research, management, conservation, and policy making was a prominent and common concern at the meeting.

Each of these five cross-cutting issues was broadly applied to consideration of the more specific topics: fisheries, forestry, conservation, soils and river dynamics, and the management of land resources. These topics were the five headings under which presentations at the meeting, and later the book that resulted from the conference, were organized. The volume entitled Várzea*: Diversity, Development, and Conservation of Amazonia's Whitewater Floodplain* brought together most of the presentations and discussions of the Macapá meeting and now offers a window into what were the major foci of research and conservation efforts of that time. Many, if not all, of these issues stand out as continuing concerns of research, conservation, and development in *várzea* environments. In hindsight, a number of important issues were either underrepresented or ignored at the time of the planning and/or implementation of the Macapá meeting in 1994, as well as in the resulting volume, again largely reflecting contemporary research emphases. Gaps that particularly stand out include:

1. Demographic shifts in the *várzea*, especially urbanward, and circular rural-urban flows, which in 1994 – as now – were very important trends. These and other demographic and economic and policy changes, especially the importance of new sources of income for families living in the floodplains and/or exploiting *várzea* resources, did not receive the attention they merited at the Macapá meeting.
2. Common property management of resources figured in discussions of fisheries, but little was featured on the peculiarities, complexities, and change in land tenure in the *várzea* and their effects on the use of resources and the fate of communities.
3. Areal coverage of the basin was quite uneven. Upriver areas, other than the Pacaya-Samiria Reserve, were little discussed, and little was said about *várzea* areas in countries other than Brazil and Peru. Then as now there were very important changes occurring in some of these highly dynamic regions. Immigration flows, land use changes, as well as intensification of the exploitation of timber, fish, and other resources in these neglected regions demand attention.

The years following 1994 have been characterized by great changes in the Amazon *várzea*. Advances in *várzea* research, conservation, and development, and the impacts of broad social, economic, and political forces have added to the understanding and appreciation of the complexity and heterogeneity of *várzea* environments and cultures. Here we provide a very brief outline of several of these major changes and their implications for future conservation and development and research initiatives in the Amazon *várzea*. The discussion is not meant to be a comprehensive review, but rather provides a lens through which the case studies in this book can be read. We review several of the broad political, social, and economic processes that have prevailed in the Peruvian and Brazilian *várzea* over the last decade. Some of these are discussed in far greater depth in the chapters that follow; many are only now being examined comprehensively by researchers.

## Social, Political, and Economic Changes

### *Brazilian Várzea*

Over the past decade numerous national-level political shifts and policy reforms have changed the Brazilian Amazon, bringing both new opportunities and challenges to *várzea* communities. The first of these changes was the decentralization of the Brazilian government. Under government restructuring policies following 1988, the northern Amazonian territories, including Amapá and Roraima, which once fell under the jurisdiction of the federal Brazilian government, were made member states of the federation. With this change, judicial power and financial resources were distributed to state and municipal governments (Kingstone 1999; Souza 1997). In many ex-federal territories, reorganization resulted in the creation of state school and health posts in many *várzea* communities. This change also created rural public sector jobs that resulted in improved public services in many rural areas (IBGE 2007). At the same time, however, decentralization has meant that administration of rural extension and development programs now falls under the jurisdiction of young state governments. To date, *várzea* farmers in ex-federal territories report the weakening of extension services and rural development programs following this shift. In Amapá, rural extension agents explain that limited funding and lack of trained personnel have made it difficult for the young states with limited financial resources to deliver adequate services in rural areas. Local development agencies in states like Amapá continue to suffer from difficulties such as geographic isolation and high transportation costs (RURAP 2004).

Decentralization has also coincided with the emergence of new social movements and networks in the *várzea*. One of the most important events has been the establishment of local chapters of the national rural workers unions (*Sindicato dos Trabalhadores Rurais*) in new *várzea* communities. Throughout Amazonia, union leaders have informed farmers of their rights to retirement, disability, and widows' pensions offered through the *Instituto Nacional do Seguro Social* (INSS),

Brazil's social security institution. In regions where the union movement has been strong, the effect has been to bring stable monthly incomes to retired and aged *várzea* residents (women, 55 and men, 60), whose livelihoods depend on natural resource management (Schwarzer 2000). Research results from the Brazilian Amazon estuary, in the municipality of Mazagão in Amapá, indicate that the rural pension program has increased economic security as well as community perceptions of well-being, and represents today the most secure source of income for a significant portion of rural *várzea* households (Steward 2008).

Several national campaigns aimed at alleviating poverty in Brazil's poorest regions have also brought benefits to many *várzea* communities. National social welfare programs, such as the *Bolsa Escola* and later *Bolsa Família* programs, offer stipends to poor families with school-age children (Rawlings 2005). These federal initiatives have been widely implemented across the country and have reached rural *várzea* communities – in particular those located close to regional cities (Steward 2007). Federal social welfare programs have additionally been supplemented by state and municipal programs also offering cash assistance to poor families. Research from the estuary of Brazil has shown that two communities (87 households) were receiving income from eight different social welfare programs (Padoch et al. 2008; Steward 2008).

The three changes outlined above – decentralization and public job creation, the establishment of a rural pension program, and new social welfare policies – have brought new sources of income to *várzea* communities. In contrast to wages earned from the sale of forest and agricultural products, wages, pensions, and welfare payments are earned on a monthly basis. While little research has been conducted on the effect of these programs on patterns of resource management and biodiversity in the *várzea*, preliminary studies from the Amazon estuary indicate that these programs have had significant impacts. In the state of Amapá, research shows that many farmers invest retirement pensions in their properties to increase the economic productivity of the household forests, fallows, and house gardens in their landholdings (Steward 2008; Padoch et al. 2008). Research has also shown that because families earn cash on a more regular basis, many have given up the production of subsistence crops such as corn, beans, and manioc in annual fields, and are purchasing cheap staples such as manioc flour and rice imported from southerly states in Brazil to sustain their families. At the same time, farmers are increasingly orienting their productive activities toward crops such as açaí and fruit crops with a strong local market. While fish and game are still common protein sources in these study communities, income from government sources is increasingly used to purchase chicken and beef in greater quantities to meet household food needs (Steward 2008).

Two additional changes have fostered positive social and economic transformation in *várzea* communities across Brazil. Along with forming local chapters of the rural workers union, in many *várzea* communities residents have created community organizations, such as women's associations, farmers' associations, and residents' associations – many of which are recognized in Brazil as grassroots organizations (McGrath 2000). Formation of these civic groups has allowed many rural isolated *várzea* communities to gain visibility and support from national and

international NGOs and government organizations. With NGO status, community groups can apply for funds for community projects to support rural development. While the goals of these diverse groups vary greatly, most aim to improve health and education services and promote economic development. Community-level organizing has thus rendered previously isolated *várzea* communities visible on a regional, national, and often international scale. This shift represents another way in which the *várzea* has become further integrated into a global political and economic system (Almeida 2002).

A final change fostering rural development has been state and federal programs aimed at electrifying vast rural areas across Brazil. In 2004, the Lula government established a national program entitled *Luz Para Todos* (Light for All), with the ambitious goal of bring electricity to all rural areas in Brazil. Following the federal government's initiative, state governments have also launched rural electrification programs. In the state of Amapá, the state-funded *Luz para viver melhor* (Light to Live Better) has brought electricity to *várzea* communities in close proximity to urban centers. Electrification in these areas has brought immediate benefits to *várzea* dwellers. Residents are able to store perishable foods and thus economize on household labor. In addition, electricity provides the potential for new means of post-harvest food processing and finishing. With electrification, many *várzea* residents began to conserve frozen fruit pulp to sell in the off-season and thus earn a higher price per unit (Steward 2008). Improved communications have also facilitated community organization efforts. With access to information regarding market prices of forest and agricultural products, farmers are no longer at the mercy of middlemen who in some *várzea* areas have historically underpaid farmers for their products. While these important advances have been made in Amapá, most *várzea* communities in areas such as the Amazon estuary remain to be reached and serviced with rural electrification programs.

The Brazilian government launched a national agrarian land reform policy in the early 1970s (Kay 2000, 2007). Information regarding new land tenure laws has been slow to reach *várzea* communities. Over the last decade, union and community leaders have brought this information to rural communities. Because of this influence, a larger number of *várzea* households have been able to obtain legal tenure. In addition, some communities have opted to secure "communal" and household land rights. Over the last decade a large number of conservation units have also been created by the state and federal government. While the aims of these conservation units vary, most are based on the premise of forging sustainable development in *várzea* communities through the careful management of *várzea* resources.

The above changes – land reform and distribution, community management, and the creation of new conservation units – illustrate that today more than ever the tenure situation in the Brazilian *várzea* is increasingly complex. In some areas of the *várzea*, a formal and legible land tenure system is in place, where independent farmers own titles to their properties. In other cases, communities manage resources together, defining the terms of their use locally, and are the legal occupants of these spaces. This complex and heterogeneous land tenure situation needs to be carefully considered in future conservation and development initiatives in the Brazilian *várzea*.

## *Peruvian Várzea*

Broad social, economic, and political forces have also had impacts on the Peruvian *várzea*. The recent history of Peru, from the mid-1980s through the mid-1990s, has been fraught with violence attributed to the guerilla movement known as Shining Path (*Sendero Luminoso*) and drug traffic and production (Kay 1996–97, 1999; Kuner 1997). While guerilla violence was concentrated in the highlands, and in particular in the Huallaga Valley, stretching over the Departments of Huánuco and San Martín, acts of violence and sabotage spread into neighboring departments of Ucayali and Loreto in the central lowland Amazon, causing disruption in *várzea* peasant communities along the Ucayali, Huallaga, and Marañon rivers. Over the last decade, drug traffickers have continued to transport large quantities of cocaine along the tributaries of the Marañon and Ucayali Rivers, through an array of Amazon routes across the Brazilian and Colombian borders (Kay 1999).

Violence attributed both to the illicit cocaine trade and to the Shining Path movement has had a significant impact on the livelihoods of rural people living in several *várzea* regions. Violence and the threat of violence spurred migration, causing villagers to seek refuge in other communities and cities in several parts of the Ucayali and Loreto regions. The violence created by Shining Path and drug trafficking, as well as repression of these problems, has impeded the evolution of civil society organizations in the *várzea*. Incipient rural organizations were destroyed and the instability and uncertainty have made it difficult for communities to form farmers' unions, associations, and cooperatives.

When Alberto Fujimori was elected president in 1990, his government implemented a series of neoliberal economic reforms. As in Brazil, the policies called for economic austerity and decentralization. One great consequence of Fujimori's economic policies in the *várzea* was the demolition of the state Agrarian Banks, which since the 1960s had provided subsidies and credits to smallholder *várzea* farmers (Chibnik 1994). Research conducted in *várzea* communities near the city of Iquitos has illustrated that the loss of these state programs prompted shifts in natural resource management in *ribereño* peasant communities (Acre-Nazario 2007; Pinedo-Vasquez et al. 2002). Acre-Nazario (2007) shows that following the loss of agricultural credits and subsidies, *ribereños* shifted from agriculture to charcoal production. With the loss of subsides for agricultural production, charcoal production became more viable because it required little monetary investment. Growing local urban demands for charcoal as a cheap cooking fuel also made the activity relatively risk-free (Acre-Nazario 2007). Furthermore, and in a similar vein, Pinedo-Vasquez et al. (2002) have shown that in the greater regions of Ucayali and Loreto, farmers who once planted rice and benefited from the Agrarian Bank's credit programs now largely depend on the sale of fish in growing urban markets to earn cash income. In contrast to Brazil, the loss of supports for farmers in Peru has not coincided with new social programs to alleviate poverty and redistribute income, and thus *ribereños* and indigenous farmers in the *várzea* of Peru have remained marginalized within the nation state.

One of the most significant policy changes affecting the Peruvian *várzea* was the promulgation of new federal legislation guiding the use, management, and conservation of forest resources (Hidalgo and Chirinos 2005). The new law that came into effect in 2001 was born of a participatory process that involved discussions and debates among 15 working groups of individuals representing forest producers, government agencies, environmental nongovernmental organizations, industrialists, Amazonian native communities, and other relevant groups (ITTO 2003). The main goal of the new forestry law was to promote effective forest management through decentralized governance and oversight of forestry operations. Another goal was to increase the economic contribution of the forestry sector to the national economy. Under the new law, forests in Peru have been divided into various forest types, including production forests, forests on protected lands, forests for future utilization, community forests, and local forests. Specific land use categories are associated with each forest type; various stakeholders gain access to forest resources through concessions, permits, and official authorizations (IRENA 2003). The legislation also provided a legal framework for promoting forest certification and attempted to promote sustainable forest harvesting through long-term concessions within permanent production forests.

The legislation recognizes the multiple users of forest resources and attempts to implement a participatory and decentralized approach at governing those resources. Research has shown, however, that in practice the legislation has increased unsustainable and predatory harvesting of timber in Peru. In particular, small-scale loggers who often do not have the political power nor the financial resources to win bids for long-term concessions have turned to illegal and informal logging, often on the peripheries of legally sanctioned areas (Higaldo et al. 2005). Small-scale loggers working informally generally supply timber to growing regional cities, where demand for cheap timber has increased over the past decade. Experts have thus shown that despite the new regulations from 1999 to 2005, new forest disturbances and deforestation in the Peruvian Amazon occurred at a rate of 632 square kilometers per year and 645 square kilometers per year, respectively (Oliveira et al. 2007). Deforestation data published by government agencies indicate that 86% of all forest damage was concentrated in two regions: the Ucayali logging center of Pucallpa and along the road network that emanates from this area (INRENA 2003). In addition, 75% of new logging occurred within 20 km of legally sanctioned areas in Peru. For instance, in the central Pucallpa region, deforestation and disturbance had increased by 400% over the course of these six years (Oliveira et al. 2007).

In the face of socioeconomic marginalization, *ribereños*, who are the majority population of the Peruvian *várzea*, have become economically dependent on fish, timber, and other natural resources to make a living. As a result, forests and lakes in the Peruvian *várzea* are rapidly becoming degraded. Several lakes that were the source of fish and other food sources for *ribereños* are currently polluted and depleted. Similarly, forests located at the back of the communities, which have long provided safety nets for many *várzea* dwellers, have been lost or degraded over the last decade. The depletion and degradation of natural resources, in particular the loss of fish, game, and timber stocks, are among the drivers of migration, propelling *ribereños* to urban centers, particularly Iquitos and Pucallpa.

## Urbanization Processes and Rural Production, Peru and Brazil

The above changes have occurred against a backdrop of accelerated urbanization in Amazonia. Researchers now estimate that over 70% of all Amazonian residents live in urban centers, either in the region's historical port cities, or in new urban centers that have grown up within the last 20 years (IBGE 2007). Most of the large cities in the region, including Belém, Manaus, Santarém, Macapá, Iquitos, and Pucallpa, are situated in or at the edge of the *várzea*. The growth of regional cities is attributed to various factors, including the expansion of the public sector, state-sponsored colonization projects in both the Peruvian and Brazilian Amazon, capitalist development projects, processes of deagrarianization in the rural areas of Amazonia due to the challenges of production in an increasingly integrated and global society, the continuing lack of educational and other services in rural areas, and the growth of informal sectors in regional cities offering opportunities for urban employment (Browder and Godfrey 1997; Brondízio et al. 2002; Brondízio 2008; Padoch et al. 2008).

The effects of city growth on rural and urban *várzea* environments are now being explored (WinklerPrins 2002; WinklerPrins and deSouza 2005); one impact appears to be the creation of growing urban markets for *várzea* products (Brondízio 2002, 2008; Padoch et al. 2008). In the Amazon estuary, for instance, *ribeirinho* producers have responded dramatically to the increased demand for açaí fruits, which are required in large quantities to meet the needs of a growing low-income urban population in regional cities and booming external markets (Brondízio 2008). In Peruvian Amazonia, the growth of shantytowns has given rise to burgeoning markets for inexpensive timbers such as capirona, a *várzea* species which is increasingly dominating managed secondary forests and fallows. Growth of *várzea* cities is increasingly accompanied by significant rises in pollutants in rivers, with a negative impact on the health of both people and wildlife in the region (Pineda 2005).

## Advances in Research, Conservation, and Development: ProVárzea

The major *várzea* research and conservation projects, Mamirauá and Pacaya-Samiria, whose creation inspired the first *várzea* conference, are still generating important research, insights, and conservation experience in the *várzea*s of Brazil and Peru. Some of these advances are discussed in the papers that follow. During the past decade many other long-term and new efforts have focused on the floodplains; several are also presented, discussed, and dissected in this volume. The foremost governmental and nongovernmental research institutions have focused on Amazonia, including the Museu Goeldi, INPA, IIAP in Peru, IPAM, and IMAZON, as well as the universities of the Amazon Basin, including the Núcleo de Altos

Estudos Amazônicos at UFPa. They have also fielded a great variety of projects and programs on the *várzea* (de Casto and McGrath 2003). The most significant new institution dedicated entirely to *várzea* research, conservation, and development over the last 12 years has been the ProVárzea program launched by the Brazilian government in 2001 (ProVárzea 2007). ProVárzea is a federal government initiative funded through the Program for the Conservation of Brazil's Tropical Forests (PPG-7) and executed through IBAMA, Brazil's environmental regulatory agency. The objectives of ProVárzea combine research in *várzea* environments, sustainable development through novel approaches to natural resources management, and a decentralized, participatory approach to monitoring the use of *várzea* resources, which complements IBAMA's efforts to uphold federal environmental laws and regulations in the *várzea*. The work and many of the accomplishments of ProVárzea are detailed in contributions to this volume.

## Conclusion

Many of the changes to *várzea* environments and societies that we mention above, and many more that we have failed to point out, are the subjects of the articles, section introductions, and commentaries that follow. Some of the sections of the present volume recall the organization of the first *várzea* volume, *Diversity, Development, and Conservation of the Amazon* Várzea. The present book features chapters on the management and conservation of aquatic resources and of terrestrial resources, as well as a section on conservation and conservation units. Forestry and fluvial dynamics receive somewhat less emphasis in this book than in the first, although each topic gets some attention in a number of papers. Several of the important issues that were left unexamined in the earlier volume, however, are at least partially scrutinized and discussed here, including several examinations of demographic change and urbanization, as well as major assessments of tenure and resource rights in the *várzea*.

The contributions collected in this book are one more step in the exploration of complexity and heterogeneity of *várzea* environments and peoples in an era of great change. It is our hope that this book will inspire additional research in both the natural and social sciences from an array of perspectives and approaches, and that this information, and in particular the lessons learned from previous endeavors in conservation and development, will help inform effective policy for the Amazon *várzea*. The tireless dedication of many of the contributors to this volume to conservation and development – along with the positive movements toward sustainable development outlined in this review – leave us with an optimistic view of the future of the Amazon *várzea* as we approach the next decade.

We insist on optimism despite the fact that during this past decade the *várzea* lost its greatest champion: the great scholar and conservationist, and our friend, J. Márcio Ayres. This volume includes a special section in honor of Márcio and his work, and we dedicate this book to him.

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# *Várzea*: The Decade Past and the Decade Ahead – An Introduction

**Muriel Saragoussi**

Over the last several years, the Ministry of the Environment of Brazil has been working tirelessly to give sustainable development policy in Amazonia the visibility and importance it deserves. In the Amazon region, as in the halls of the federal government, it is recognized that Amazonia, more than any other part of Brazil, is home to the knowledge and experience necessary to show that concern for the environment and economic development are not only compatible, but go hand-in-hand in creating a better world.

We have, therefore, instituted the Sustainable Amazonia Plan (PAS) as a regional framework that recognizes the social, cultural, and ecological diversity of the region, as well as its varied histories of settlement and economic uses in order to offer – in a form that integrates all of Amazonia's diversity – development that is socially, environmentally, economically, culturally, and politically sustainable.

The concept we employ now in our public policies is that the process of policy creation and negotiation is as important a product as the final policy result. This product – whether a law, a program for public financing, the creation of a conservation unit, or other – cannot be disassociated from the process of its creation. In other words, it is important to understand who were the actors who were involved in elaboration of the proposal; what, if any, were the most important conflicts that were encountered; how an accord was finally reached; what perspectives and whose interests predominated throughout the process; and what was the final outcome. The quality of the process is essential to the quality and the other basic features of the final product, as well as to the probability of effectively implementing the specific policy.

Thus, public consultation, transparency, and social involvement have been the central tenets of our work. To recall, the four objectives the Ministry of Environment strives to achieve are: an environmental policy integrated with other government priorities; sustainable development; social participation and involvement; and the strengthening of SISNAMA, the National Environment System.

Thanks to the conscientious implementation of these objectives, at the end of 2006 we could report that deforestation in the Amazon decreased by 52% in 2 years (31% in 2004–2005 and another 30% in 2005–2006), and that 19.4 million ha of federal units of conservation were created in the areas of greatest conflict, illegal "land grabbing," and deforestation. Following in these directions, INCRA prevented

66,000 registrations of irregular rural properties that would have resulted in further illegal grabbing of public lands, and the Law of Management of Public Forests and the Limitation of Provisional Administration Instrument (ALAP) were approved for areas where critical studies are needed for the creation of conservation units.

I will not cite all of the victories or all of the progress that this vision of integrated process and policies has brought the country; but they, together with the fight against corruption and crimes associated with environmental offenses, have built a solid base upon which we can put sustainable development into practice in Amazonia.

The greatest challenges today concern how to add value to sustainably produced forest products, and how to create just relationships between those who produce and those who buy these products, and how to do all this on a scale that will be compatible with improving the quality of life of Amazonians while maintaining all ecosystem functions. To rise to these challenges in the Amazon *várzea* we need to integrate traditional knowledge on resource use and management with the body of scientific knowledge that has been generated over the last 2 decades. With these we can create effective and lawful patterns of use and management.

While we will not list all of the projects and processes supported by the Ministry of the Environment, we would like to focus attention on some of the excellent results of the ProVárzea program. The point of departure for ProVárzea is the notion that sustainable and effective public policies can arise only if all stakeholders participate in the design of these solutions. In Amazonia it is necessary to involve not only the actors representing the state, civil society, and science, but also the economically powerful, who often consider participation merely a waste of time, but nevertheless are accustomed to having privileged access to power.

ProVárzea has demonstrated both understanding and commitment to involving all stakeholder groups, including those representing the government and nongovernmental organizations, the beneficiaries, as well as the direct and indirect users, in all its presentations and discussions of the results of the studies they have supported.

Without doubt the greatest advances that have been made are in the area of cross-cutting opportunities that link environmental policies to other policies affecting the Amazon *várzea*, especially those that that further:

- Legalization of land tenure in *várzea* areas regulated by SPU, INCRA, and IBAMA, the norms and procedures having been established and processes initiated in the states of Amazonas and Pará,
- Identification of priority areas for the conservation of *várzea* biodiversity by making them available to the ARPA Project as well as to CNPT by subsidizing the implementation of future conservation units, and
- Support to IBAMA in the regulation of fishing of large migratory catfish and other species of commercial value.

In policies and legislation related to community management, participatory and community management as a tool for regulating fishing in the Amazon Basin has been strengthened. This new direction has led to the training of more than 400

people, including environmental analysts for IBAMA, state environmental organizations, NGOs, and community leaders.

The principal limitation to implementing this model is the organizational capacity of the groups involved, rather than their technical capacity. It is known that groups with a strong social base will be better equipped to resolve any technical questions. The challenge is to strengthen the ability of communities to organize and create the necessary conditions for sustained collective action. For this reason, ProVárzea has promoted organizational development using diverse strategies, but principally through the support and promotion of projects that act as catalysts of change in their regions and that generate methods and lessons that then can be replicated in other areas and regions.

In total there have been 25 subprojects supported by ProVárzea, with resources on the order of R$10 million. These have included projects on capacity building, resource management, sanitation, and product marketing. Some of the outstanding illustrations of program outputs and impacts include the following:

- In total, 115,486 people were directly affected in 32 municipalities of the states of Amazonas and Pará by ProVárzea-supported projects.
- About 100,266 ha of area in terrestrial and aquatic ecosystems are now under management. A significant portion of the managed aquatic sites employ official "Normative Instructions" in regulating community fishing accords.
- In relation to the process of supporting associations or cooperatives, new institutions were created based on ProVárzea projects and their partnerships, including one on the river São Francisco that resulted from the dissemination of a project carried out by the MOPEBAM (the Fishermen's Movement of Eastern Pará and Lower Amazonas).
- Fishermen's unions were strengthened by increasing their economic activities and promoting their important social and political achievements. It is worth mentioning that four town councilors who were elected came from the ranks of directors of the fishermen's unions of Santarém (Z-20), Juruti (Z-42), Prainha (Z-31), and Óbidos (Z-19), as did a State Secretary of Fisheries and 12 municipal health councilors.
- There was a 32% increase in the number of women occupying directors' positions in community associations supported by ProVárzea.
- One hundred and fifty six training courses were offered by projects, on subjects ranging from regional cooking for cooperative and community members, to environmental legislation, distillation and extraction of essential oils, management of lakes, and the implementation of demonstration sites for forest timber management, reaching a total of about 2,300 people.
- New management techniques were developed and improved, focused on the management and marketing of freshwater shrimp (*Macrobrachium amazonicum*); the management of stingless bees in Amazonia, (*Mellipona* spp); the extraction, processing, and marketing of essential oils of *várzea* species, such as *cumaru*, rosewood, *andiroba*, and *copaiba* – in total ten new products reached markets, generating income for local residents and communities.

Beyond supporting projects, ProVárzea tested several new models of shared management of natural resources in the *várzea* with excellent results. These included an interinstitutional monitoring system known as the Integrated Unit of Environmental Defense (UNIDA), created in Santarém in Pará State, but now being replicated in other municipalities in eastern Pará; another is the institutionalization of the Environmental Volunteers Program for IBAMA using lessons learned from ProVárzea projects, and the creation and strengthening of Municipal Councils for Rural Sustainable Development with the implementation of Municipal Rural Sustainable Development Plans.

In conclusion, it is clear that the macropolicies for Amazonia proposed and implemented by the Ministry of the Environment are solidly anchored in experiences developed by local socioenvironmental institutions and their partners. The Pilot Program for Tropical Forests (PPG-7) was one of the seeds of the Sustainable Amazon Development Plan. This advance in turn will be "fertilized" by the Amazonia Program which we are now designing to replace the Pilot Program for the ever-changing ecosystem of Amazonia.

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# Abbreviations

Preface

| | |
|---|---|
| ALAP | Limitation of Provisional Administration Instrument |
| INPA | Instituto Nacional de Pesquisas da Amazônia |
| INSS | Instituto Nacional do Seguro Social |
| MOPEBAM | Fishermen's Movement Eastern Para and Lower Amazonas |
| PAS | The Sustainable Amazonia Plan |
| PPG7 | Pilot Program for Tropical Forests |
| SISNAMA | Brazilian National Environment System |
| UNIDA | Unit of Environmental Defense |

Chapter 2

| | |
|---|---|
| BMI | Body Mass Index |
| HIV | Human Immunodeficiency Virus |
| PID | Pelvic Inflammatory Disease |
| PSA | Health and Happiness Project |
| SES | Socioeconomic Status |
| STI | Sexually Transmitted Infection |

Chapter 4

| | |
|---|---|
| ACAR | Association of Credit and Rural Extension |
| ICMS | Municipal Sales Tax |
| IDAM | Institute of Development of Amazonia |
| INCRA | National Institute of Colonization and Agrarian Reform |
| EMATER | Corporation for Technical Assistance and Rural Extension |
| EMBRAPA | Brazilian Agricultural Research Corporation |
| FUNRURAL | National Fund for Rural Assistance |
| ITERAM | Land Institute of Amazonia |
| PND | National Program of Development |
| SPVA | Superintendency of the Economic Recovery Plan for the Amazon |
| SESP | Special Public Health Service |
| SUDAM | Superintendency for Amazonian Development |
| ZFM | Manaus Free-Trade Zone |

Chapter 5

| | |
|---|---|
| IBAMA | Brazilian Institute of Environment and Renewable Natural Resources |
| MMA | Ministry of the Environment |
| PAE | Agroextractive Settlement Projects |
| SPU | Federal Patrimony Services |

Chapter 6

| | |
|---|---|
| PIN | National Integration Plan |

Chapter 8

| | |
|---|---|
| CPUE | Catch Per Unit Effort |

Chapter 9

| | |
|---|---|
| GRPU | Gerência Regional do Patrimônio da União |
| PDS | Projetos de Desenvolvimento Sustentável |
| VEA | Voluntary Environmental Agents |
| TAC | Terms of Adjustment of Conduct |

Chapter 10

| | |
|---|---|
| MAPA | Ministry of Agriculture, Livestock and Food Supply |
| RAN | National Center for Conservation and Management of Amphibians and Reptiles |
| RDS | Sustainable Development Reserves |
| RESEX | Extractive Reserves |
| SNUC | National System of Conservation Units |

Chapter 11

| | |
|---|---|
| AVV | Voluntary Environmental Agent program |
| CBD | Convention on Biological Diversity |
| CITES | The Convention on International Trade in Endangered Species of Wild Fauna and Flora |
| COPESCAL | Commission for Inland Fisheries of Latin America |
| CPUE | Calculation of Productivity per Unit of Effort |
| EIA | Environmental Impact Assessment |
| GTZ | German Technical Cooperation Agency |
| IPAAM | Amazon Environmental Protection Institute |
| IPAM | Research Institute of Amazon |
| MPR | Management Plan for the Reserve |
| SCM | Mamirauá Civil Society |
| TCA | Amazon Cooperative Treaty |

Chapter 13

| | |
|---|---|
| DBH | Diameter at Breast Height |
| NMDS | Non-Metric Dimensional Scaling |

Chapter 16

| | |
|---|---|
| ALAP | Area of Provisional Administrative Limitation |
| APA | Environmental Protection Area |
| EIA/RIMA | Environmental Impact Study |
| IAG | International Advisory Group |
| NTFP | Non-Timber Forest Products |
| PAC | Program for Acceleration of Growth |
| SDS | Secretariat of Sustainable Development |

Chapter 17

| | |
|---|---|
| ASDR | Amanã Sustainable Development Reserve |
| MSDR | Mamirauá Sustainable Development Reserve |
| SDR | Sustainable Development Reserves |

Chapter 19

| | |
|---|---|
| CNS | The Rubber Tappers' National Council |
| CNTP | National Center for the Sustained Development of Traditional Populations |

Chapter 20

| | |
|---|---|
| EXRES | Extractivists Reserves |
| PA | Protected Area |

Chapter 21

| | |
|---|---|
| CNPq | National Council for Scientific and Technological Development |
| IDSM | Mamirauá Institute of Sustainable Development |
| MCT | Ministry of Science and Technology |

Chapter 22

| | |
|---|---|
| SEMA | Environment Secretary |

Chapter 23

| | |
|---|---|
| IBDF | Instituto Brasileiro de Desenvolvimento Florestal |
| ODA | British Overseas Development Agency |
| SCM | Sociedade Civil Mamirauá |
| WCS | Wildlife Conservation Society |

Chapter 25

| | |
|---|---|
| CGBA | Comitê de Gestão do Uso Sustentável dos Recursos Pesqueiros da Bacia Amazônica |
| FASE | Federation for Social and Educational Assistance |
| UNIDA | Integrated Environmental Defense Unit |

Chapter 26

| | |
|---|---|
| AAV | Environmental Volunteer Agents |
| CAPDA | Committee on Research and Development Activities of Amazonia |
| CONTEC | Science and Technology State Council |
| FAPEAM | Fundação de Amparo á Pesquisa do Estado do Amazonas |
| FAPESPA | Fundação de Amparo à Pesquisa do Estado do Pará |
| FUNDCT | National Fund for Scientific and Technological Development |
| FUNTEC | State Fund for Science and Technology |
| IBGE | Brazilian Institute of Geography and Statistics |
| SECTAM | State Secretary for Science, Technology and Environment |
| UC | Conservation Unit |

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# Part I

# Introduction: Human Society in the *Várzea*: A History of Change and Adaptation to Contextual Uncertainties

**Richard Chase Smith**

**Abstract** Life is not necessarily easy, and certainly not predictable, for the inhabitants of the *várzea*. An analysis of the variables that determine their dynamic adaptation to the diversity implicit in the *várzea´*s aquatic and terrestrial ecosystems requires both an interdisciplinary and an historical approach. Four of the chapters in this section of the book look at external factors that challenge livelihood strategies and daily living patterns for families in the *várzea* communities: Harris looks at historic processes that formed modern *várzea* societies, Benatti at the uncertainties inherent to the tenure system for land and resources, Alencar at the impact of federal and state policy or lack thereof, and Silva at the effect of all these uncertainties and changes on the health of the *ribereño* population. On the other hand, in the fifth chapter, Costa and Brondízio remind us that the Brazilian Amazon region, and in particular the *várzea*, has been for a long time an "urbanized forest," thus adding a relatively new angle to our look at Amazonian floodplain societies. Each perspective contributes to our picture of the dynamic and uncertain nature of human life in the *várzea*.

**Keywords** Uncertainties • Adaptation • History • Livelihoods • Context

## 1 Introduction

Several years ago, towards the end of May, when the annual floodwaters were at their high mark, I attended a field course in the *várzea* of the upper Tahuayo River, a tributary of the Peruvian Amazon upriver from Iquitos. Because I had to leave field course early, I was taken by a small motorized canoe in the early morning darkness to the point from which the daily *colectivo* boat left for Iquitos.

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I decided at the beginning of the 10 hour journey to entertain myself by listing all the products that were loaded onto the boat headed for the Iquitos market. Among the products I noted down, there were staples, like rice, maize, and manioc root. There were many different fruits and vegetables coming from the gardens, like several varieties of citrus fruits, guavas and *guayabas*, as well as those from the forest, like the fruits of the *huasai, aguaje,* and *ungurahui* palms. The quantity and variety of fish species grew remarkably as we made our way down the Tahuayo River, as did the dried and fresh meat from deer, wild pigs, *agoutis,* and other animals. There were live animals as well, including chickens, ducks, a pig, monkeys, and parrots. And little by little, the roof of the boat was covered with sacks full of charcoal. By the time we entered into the rougher waters of the Amazon, I had a list of 37 different products that, in one day in the lives of these *várzea* villagers, were being taken to Iquitos for distribution to family members living there and for sale in the market. The *várzea* is truly a remarkably productive and diverse place in which to live!

But life is not necessarily easy, and certainly not predictable, for the inhabitants of this ecosystem. Four of the chapters in this section of the book look at external factors that challenge livelihood strategies and daily living patterns for families in the *várzea* communities: Harris looks at historic processes that formed modern *várzea* societies, Benatti at the uncertainties inherent to the tenure system for land and resources, Alencar at the impact of federal and state policy or lack thereof, and Silva at the effect of all these uncertainties and changes on the health of the *ribereño* population. On the other hand, in the fifth chapter, Costa and Brondízio remind us that the Brazilian Amazon region, and in particular the *várzea*, has been for a long time an "urbanized forest," thus adding a relatively new angle to our look at Amazonian floodplain societies. Each perspective contributes to our picture of the dynamic and uncertain nature of human life in the *várzea*. Let's briefly look at each of the contributions and then at the picture that emerges.

Harris shows how the historical development of *várzea* settlements and their relation with the colonial order, and later with a globalizing marketplace, have reshaped settlement patterns among the local floodplain societies. Accepting that the prehistoric pattern was likely one of complementarities of *várzea* and *terra firme* resource use proposed by Denevan (1996: 671), he concludes that this has changed significantly along the Lower Amazon (Cleary 2001), where transformations in the local economy and property relations introduced during the colonial period produced a split between the two zones. In his own words, "the balance between the zones was complicated by the inclusion of the region in world markets, the development of its own interior trade networks, and the development of a riverine peasantry focused on the floodplain."

The end of the eighteenth century brought two important changes in the Lower Amazon. In 1798, the special legislation which obliged the Indian population to work for the state, which had provided in exchange some protection for their garden sites, was revoked, leaving them as vulnerable as the local peasantry. At the same time, with prices high on the European market, cacao production became an important economic activity along the floodplain; both land grants and land grabs

produced a shift in ownership and settlement patterns, concentrating both population and production in the floodplain zones.

Harris, like many others who have observed the *várzea* and their communities, suggests that the long-term livelihood resilience among the *várzea's* residents is directly linked to their capacity to manage both its diversity and its uncertainties (Hiraoka 1985; Padoch and Jong 1990; Coomes 1992; Coomes and Barham 1999; Smith et al. 2001). He suggests that "much of this resilience is dependent on an ability to occupy floodplain land without fear of land grabbers, and to have access to nonvalorized resources."

This brings us to Benatti's contribution regarding land tenure regulation in the Brazilian *várzea*. He asks "What does the legalization of land/resource rights mean for the *várzea* and what are the steps that must be taken in order to assure legally the sustainability of the human settlements in the *várzea*?"

In Peru, contrary to the situation of the peasant and native communities, there is no specific legislation regulating procedures for formally recognizing either the existence of an estimated 2,500 *ribereño* communities in the Peruvian Amazon or their tenure rights. Only an extremely small percentage of them have any sort of tenancy security regarding their house and garden sites, communal areas, the areas used to extract forest resources, or the lakes used for fishing.[1] Today, the *ribereño* families and communities living on the *várzea* constitute the most neglected sector of the Peruvian population regarding these and certainly other basic services and protections.

Because of its seasonal flooding, the *várzea* is not a straightforward case of land ownership and titling. Benatti stresses that Brazilian law clearly separates the dominion over a resource from use rights over the same resource. For the *várzea*, therefore, the central issue is the definition of dominion over the land area that is annually flooded: who has power over those lands, and can that power be alienated to a third party?

In Brazil, as in Peru, the legislation covering these questions does not recognize the *várzea* or floodplain as a specific category of dominion. In this case, then, according to Benatti, both dominion and use rights over these land areas must be analyzed from the perspective of water rights and rights to the river/stream bed. Both the Brazilian and the Peruvian states exercise dominion over water as a public resource, as well as over all river beds, seasonally flooded forest lands, river banks, and lakes. Water rights take precedence over land rights in the case of the Brazilian *várzea*, even when the land may be flooded for only a small part of the year. This is because water is considered a limited resource in danger of becoming scarce. Therefore, it is the state, through its dominion over water resources, that exercises dominion over the *várzea* and that has the power to determine use rights.

We must remember here that state processes for the legalization of land tenure and access/use rights are extremely sensitive to their political context. From this

[1] An official register of communities shows only 16 *ribereño* communities with collective title, all located in the region of Loreto.

perspective we are faced with another series of fundamental questions that need to be asked regarding such rights in the *várzea* area: for example, who determines, and how do they determine, the priority level given and the specific environmental services subject to such priorities? And secondly, who determines, and how do they determine, the priority level given to specific social actors (local communities, large local extractive interests, powerful international extractive interests, etc.) who claim concessionary use rights over *várzea* resources?

Both questions are central to the future of the *várzea*, its resources and its people, and both questions are fundamentally political. Is the Lula government in Brazil giving first priority to the claims and sustainability needs of the rural *várzea* communities and towns, i.e., those who live on the *várzea*? In Peru, the same question needs to be asked. The Garcia government is constructing a legal framework to ensure that priority is given to foreign investors for long-term concessions (or even outright property rights) over large areas of *várzea*. These political choices reflect the political weight of each of the actors and their capacity to influence how public policy is directed. Within the Peruvian context, the *ribereño* communities are unfortunately invisible on the political stage.

Public policy is a key factor in this set of issues, as in others. Alencar looks at the impact of public policies on the recent history of population movements in the *várzea* of the upper Solimoes. She suggests four underlying factors that explain the changing settlement patterns in the upper Solimoes *várzea*: (1) changes in the systems of economic production; (2) the impact of state policies regarding the occupation of the region; (3) the growing urbanization process, especially in the context of the creation of new municipalities; and (4) the impact of certain public policies, especially recent policies seeking to guarantee sustainable livelihoods. Among these, the role of public policy, at least during the past half century, has been the dominant factor.

According to Alencar, the most visible result of the long series of projects implemented over the past 35 years by the federal, state, and municipal governments in the upper Solimoes has been the rapid process of urbanization. Similar to other parts of rural Latin America, the concentration of state investment in providing services for urban areas has increased their attractiveness for residents of the rural communities: better educational, health, and transport services, and greater access to jobs and cash, among many other reasons, have produced a steady migration towards these centers. The enormous magnetic pull that creating the Duty-Free Zone in Manaus in the late 1960s had on rural areas of the entire state of Amazonas is a case in point.

Silva undertook a study, partially presented here, in which he asks how both seasonal ecological changes as well as social-economic changes have affected the health of the rural *várzea* populations. He compares health and aging statistics from three *ribereño* communities in the state of Pará with Brazilian and international indicators.

One of the communities has participated in a long-term health program sponsored by an NGO, a fact that was to some degree reflected in its relatively higher "scores" for the general good state of health of its population. Yet, despite the lack

of formal health services, the other two communities also enjoyed relatively "good" health. This overall good health score for the three communities came as a pleasant surprise to me. I expected worse.

The most prevalent diseases in the three are those of the skin, the respiratory and digestive systems, and disorders of the eye, not unlike statistics from other parts of rural Brazil. But a second surprise comes with the seasonality of these diseases, which in some cases such as iron-deficiency anemia, may be linked, as Silva points out, to a seasonal deficiency of dietary micronutrients. Yet the relationship is not that straightforward, as the seasonal distribution of disease is not the same in each of the three communities. Once again, the seasonal flooding seems to shape even the health of the *várzea* people, but in ways we do not yet understand.

Costa and Brondízio use demographic census data as well as archival and historical sources to characterize and highlight urban demographic changes and dynamics within the floodplain region. It should come as no surprise, given the worldwide trend towards urbanization, that the Amazonian floodplain region is also experiencing faster growth in its urban population than its rural counterparts. According to the authors, the most heavily populated floodplain counties have already reached close to 80% in level of urbanization compared to 64% for the region as a whole.

However, the urbanization process in the Amazonian floodplains is by no means a recent phenomenon. Sixty-four percent of all Amazonian municipal capitals are cities created between 1616 and 1800 mostly along the Amazonian floodplains. Of the Amazon's five oldest cities, four are situated in the floodplains. We are reminded here of one of Harris' central messages: we must view the Amazon floodplain as a historical place.

However, despite the centuries of urbanization on the floodplains, Costa and Brondízio lament the deficient state of urban infrastructure and services. And yet, despite the lack of potable water, sewage systems, public transport, etc., these urban areas still fare better than the rural areas, especially in educational opportunities. This, of course, explains, in part, why they continue to attract rural migrants.

## 2 *Várzea*: The Big Picture

It is clear from the data and discussions presented here that biological diversity is not the only feature that the *várzea* residents need to factor into their livelihood strategies. The *várzea* is also a remarkably dynamic, and in many ways, unpredictable world. As many authors have pointed out, the flooding pattern is the most important environmental factor influencing this riverscape and the livelihood strategies of its inhabitants (Goulding et al. 1996; Hiraoka 1985; McGrath et al. 2008). Within this pattern, significant variations exist within and between years in the intensity, timing, and duration of the floods, influencing enormously the success or failure of the *ribereño*'s choice of livelihood strategies for that year (Smith et al. 2001).

The dynamism of this hydrologic regime is influenced largely by nonlocal factors. For example, the timing and intensity of flooding in the Iquitos area depends on the rainfall patterns in the watersheds of three major subsystems: the Ucayali, which drains the central and southern Andes; the Marañon, which drains the central and northern Andes; and, to a lesser extent, the Napo, which drains the northern half of Ecuador. Furthermore, these rainfall patterns are in turn influenced by the global phenomenon of the El Niño-Southern Oscillation (ENSO),[2] although in ways as yet little understood and subject to scientific uncertainty (Smith et al. 2001).

In addition to the dynamic flooding patterns, changes in conditions for access to capital, land, and political power, the evolution of the age-cycle in the domestic unit, the presence of external agents (state and local governments, NGOs, church-related groups), ups-and-downs in demand and prices in the market and the growing dominance of urban centers influence the shifts of economic strategy at the household level (Coomes and Barham 1999). Each of the variables that impinge on rural lives and livelihoods is embedded in broader social and natural processes that are themselves dynamic, diverse and, in most cases, rooted in the history of relationships among human populations and between them and their environment.

These relationships and interactions are complex and extremely difficult to discern and comprehend for rural people and researchers alike. Often political decisions, cultural perceptions, economic interests and other social factors well beyond the local community may influence or even determine the outcomes of household and community initiatives. Short- and long-term changes in global systems, such as the ENSO events, can have consequences at a particular place and time that science began to understand only a few years ago. Regardless of the scale, the construction and maintenance of livelihood strategies that can cope with the uncertainties of the system and are resilient in the face of change are indeed major challenges.

To survive, these communities have to adapt to the heterogeneous and dynamic world in which they live. Flexible institutions are key to the viability of management systems, which must bend with the uncertain rhythms of social life, whether they are power struggles among family groupings, or constant variations in the legal and policy framework defined in the distant national capital (Holling et al. 1998; McCay and Jentoft 1998; Mehta et al 2000; Scoones 1999).

An analysis of the variables that determine this dynamic adaptation to the diversity implicit in the *várzea´*s aquatic and terrestrial ecosystems requires both an interdisciplinary and an historical approach. One needs to look at how both people (men/women, domestic units, kin-based "clans" (Acheson et al. 1998; Smith 1997))

[2] The El Niño event refers to the reversal of the east–west warm water currents in the equatorial Pacific Ocean and the accumulation of masses of warm water along the Pacific coast of tropical South America; the Southern Oscillation refers to the total atmospheric-oceanographic changes caused by the El Niño event (Mörner 1993). Since the 1998 El Niño event, scientists have been describing the sudden reversal of the El Niño conditions in the year or two afterwards as the La Niña event.

and resources (fish stocks, forests) respond to the cyclical changes in the local environment over a period of years. At the same time, one must address the impact of the changing social composition of the *ribereño* society, as well as external forces such as regional political shifts, fluctuations in prices at the regional market, and the growing influence of urban centers. In this sense, as Harris points out, the adaptations of *ribereño* families and communities to such dynamic surroundings must be seen as an historical process over a long period of time.

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# Life is Hard, Life is Beautiful: Some Perspectives on Health and Aging in Amazonian Rural Populations

**Hilton P. Silva**

**Abstract** It is not easy to live in the Amazon. The difficulty of access to almost everything, from food to transport, makes life very hard in the vastness of the region. It has been called a "Green Hell" and a "Counterfeit Paradise," yet people have adapted to it and survived for millennia. However, despite its demands, it is also wonderful to live and work in the Amazon, one of the most pristine and ecologically rich natural places on the planet. In this chapter some aspects of health and living conditions of *caboclo*, rural peasants, in the state of Pará, are presented and discussed in relation to each other, to other Amazonian groups, to the overall Brazilian population, and to other Latin American peoples, with the aim of providing some information about how it is to live, work, and grow old in the Amazon. Data presented come from a large ongoing study initiated in 1996 contrasting the floodplain (*várzea*) and the upland (*terra firme*) areas, during the wet and dry seasons in northern Brazil. The groups investigated include people from the Caxiuanã National Forest, Melgaço, and of two communities living in the Ituqui Island, Santarém. Among other findings, the three groups present a high prevalence of undernutrition in children, and of obesity and hypertension in adults, indicative of their current epidemiological and nutritional transition, and causes for great public health concern since access to medical care continues to be one of the major challenges for the local communities.

**Keywords** Caboclos • Environment • Brazil • Health • Aging

## 1 Introduction

It is hard to live in the Amazon. The heat, the bugs, the rain, the mud, the parasites, the problems with access to transportation, basic infrastructure and communication in a geographically enormous area, the cost of everything that has to be imported,

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from food to drinking water; everything makes life difficult in the vastness of the region. It has been called a "Green Hell" and a "Counterfeit Paradise," among many other adjectives through the centuries (Wagley 1974; Goodland and Irwin 1975; Meggers 1996). Yet people have adapted and survived in the region for millennia, close to 20 million individuals at present, according to the last census (IBGE 2008). Nevertheless, despite its difficulties it is also wonderful to live and work in the Amazon. The fascination of living among hundreds of cultures, the smiles received in every house visited, the enormous diversity of wildlife, the warm, freshly brewed coffee (*cafezinho*) with *tapioca* (a type of soft bread made of manioc flour) served everywhere, the big and strong rivers which dominate everything, the different ways people see the world, the marvelous foods and fruits, the possibility of discovering something new every day, make it most often very pleasant.

This combination of hard and wonderful also makes the Amazon a fantastic place to study. For researchers, the sky covered with stars reflected in the Amazon River, the refreshing bath at night in the *igarapés*, under the huge full moon, and the eyes of the crocodiles in the distance—even though the mosquitoes don't leave any part of you unchecked—everything is memorable. The beauty is indescribable, but the work is very arduous, and sometimes dangerous. The distances are enormous, the heat during the day in the schools and houses covered with Brasilit® (amiant cement roofing sheets) or metal sheets makes you feel as if you were melting, the extreme discomfort for the urban dweller in many places, the constant, daily alternation between torrential rain and strong sun making everything damp all the time, the risk of contracting malaria and dozens of other tropical diseases. Traveling is another challenge, when crossing the "river-sea" for days in a wooden ship with hundreds of people lying in their hammocks atop one another, or on a small speedboat, just 5 meters long with a tiny 25-horsepower engine, feeling the wind in your face, the water splashing everywhere, the sun burning your back; all the time the sensation of being so small in the middle of something so immense and yet so little known. The whole majesty of nature and how much we depend on it. So wonderful and yet so hard!

For the people living there, this is reality, the human-environment challenges that researchers struggle to understand in order to help protect nature for future generations.

In this chapter some aspects of health and living conditions of *caboclo*, rural peasant groups, from Pará State, are presented and discussed in relation to each other, to other Amazonian groups, to the overall Brazilian population, and to other Latin American peoples, with the aim of providing to the general readership some information about how it is to live, work, and grow old in the Amazon.

## 2 The Study Populations

The data presented here come from a large ongoing study initiated in 1996 among three *caboclo* populations of diverse ecosystems in the Amazon basin. Most of the information comes from the 1996–1997 field seasons, which developed into a

unique databank, as investigations were conducted with whole populations, contrasting environments, and during the wet and the dry seasons, the two dominant periods of the year.

The term *caboclo* has been subject to a wide range of definitions (for detailed discussion about this issue, see Ayres 1992, and Adams et al. 2006). For this research, the term refers to the genetically and culturally trihybrid peasant populations, descendants of the Native Americans, the Europeans, and the Africans who colonized the region in the last two centuries. They have historically inhabited the rural areas of the Brazilian Amazon, occupying the floodplains (*várzeas*) and the upland (*terra firme*) ecosystems, and have in common several sociocultural aspects associated with their mixed heritage (Silva and Eckhardt 1994; Silva 2001, 2009). The detailed description of the dataset, environment, and populations has been presented in previous publications (Silva 2001, 2002a, 2009; Silva et al. 2006; Silva and Crews 2006; Silva and Padez 2006, Silva 2009). For this reason, only a brief description is presented here.

The study groups include one population from the upland and two from the floodplain areas of Pará State. The comparison of the populations from these different ecosystems is important for the development of public health programs more adequate to their specific needs. The first population investigated lives in the Caxiuanã National Forest, a protected area of 330,000 hectares covered mainly by primary tropical rain forest along with flooded forests, secondary vegetation, and nonforested areas, situated in the county of Portel (1°42′30″ south, 51°31′45″ west), 400 km southwest of Belém, the state's capital. This area encompasses a black water ecosystem in the Caxiuanã bay (MPEG 1994; Lisboa 2002). This is the least studied of the three populations. During field work (1996/1997) there were 29 houses inside the protected area, with a population of 212 people (Silva 2001). Their subsistence is based on fishing, hunting, extraction of natural products such as palm hearts from *açai* (*Euterpe olleracea*), Brazil nuts (*Bertholetia excelsia*), small scale wood extraction outside the protected area, and agriculture of manioc (*Manihot esculenta*), bananas (*Musa* sp.), sugar cane (*Saccharum officinarum*), and edible fruit trees (Silva et al. 1995; Silva 2001). A few individuals from the local families also work for wages at the Ferreira Penna Research Station of the Goeldi Museum, a field research facility inaugurated in early 1990s. The Caxiuanã group exemplifies a more traditional lifestyle, since they have only minor and sparse interactions with the market economy.

The second population is situated in Ituqui, county of Santarém (approximately 1° south, 54° west), 900 km from Belém. Most of Ituqui's population lives on an island located 3 to 4 hours downstream by boat from Santarém, on the Tapajós River, a whitewater ecosystem (McGrath 1994; Adams et al. 2005). The population is divided into seven communities. Six, including Aracampina (N = 380) inhabit the outskirts of the island, mostly the floodplain areas, and one, Santana (N = 477) is located in the mainland, but is considered historically, politically, and culturally part of the Island's group, as its population utilizes some of the same resources as the islanders. Besides fishing, the main economic activity, Ituqui populations also practice slash-and-burn agriculture and animal husbandry, in the floodplain and in the

uplands. The two Ituqui groups are representative of more transitional populations, since they are heavily involved in the market economy of the region (Silva 2001).

Overall in the three studied groups, the settlements are dispersed, with spaces of 50 m to several kilometers between the houses. Households are usually stable; that is, families live together in the same area for decades, or sometimes, people live their entire lives in the same location, since most *caboclos* have a long-term relationship with their lands either by ownership or by historical attachment (*posse*). The household may have one or several families living in the same unit, or families may work as an extended family with two or more houses occupying a contiguous area. Houses are built of wood or thatch, or bricks, or combinations of these materials. Almost invariably they are built on stilts, and have no internal showers or toilets. None has piped water or sewage, as there are no central water and sewage treatment systems in the study areas, which are similar to most of the rural Amazon (Simdamazônia 1992; Scherer 2004; Silva 2006). The majority of *caboclos* are Roman Catholic, even though the evangelical movement is growing fast. They all speak Portuguese, vote in the regional and national elections, and participate, albeit to highly different degrees, in the local politics.

Although the populations investigated live in different environments, leading to somewhat different lifestyles, they share most of their traditions, customs, and culture; as well as a similar genetic background (Santos et al. 1996; Silva 2001; Silva et al. 2001). For this reason, they were chosen as representative of the health and living conditions of contemporary Amazonian riverine populations.

All groups were investigated in the wet and the dry seasons as part of a large longitudinal investigation about *caboclos* socioecology, lifestyle, and health (Silva 2001). In the three communities, informed consent to participate in the research was obtained from all participants, or their parents or guardians, following the principles of the Helsinki Declaration and its revisions. Everyone present in the areas at the time of field research was invited to participate, and all individuals interested and their families were included.

## 3 General Health Trends

Only some aspects of the populations' health are presented and discussed here, as previous works have already reported with more detail on population structure (Silva 2002a), health and intestinal parasites (Silva 2009), growth and nutrition (Silva and Crews 2006), chronic diseases of modernization (Silva et al. 2006), and age at menarche and menopause (Silva 2001; Silva and Padez 2006).

The sample ranged in age from 2 weeks to 94 years, and everyone was individually evaluated. A total of 890 people participated in the research.

Table 1 presents the age and sex distribution of the three study populations. On visual inspection by the author, who is a licensed physician in Brazil, the majority of adult participants (>86% in all communities and both seasons) were qualitatively classified as being in "good" health, that is, they did not have major visible

**Table 1** Age group and sex distribution of the three study groups

| | Caxiuanã | | | | Aracampina | | | | Santana | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Males | | Females | | Males | | Females | | Males | | Females | |
| Age Group | N | % | N | % | N | % | N | % | N | % | N | % |
| 0–2 years | 13 | 11.9% | 15 | 14.6% | 21 | 15.8% | 17 | 11.6% | 10 | 5.1% | 16 | 7.9% |
| 3–5 years | 12 | 11.0% | 9 | 8.7% | 15 | 11.3% | 16 | 10.9% | 18 | 9.2% | 15 | 7.4% |
| 6–8 years | 8 | 7.3% | 11 | 10.7% | 16 | 12.0% | 16 | 10.9% | 26 | 13.3% | 28 | 13.9% |
| 9–11 years | 9 | 8.3% | 13 | 12.6% | 12 | 9.0% | 23 | 15.6% | 28 | 14.3% | 32 | 15.8% |
| 12–14 years | 13 | 11.9% | 8 | 7.8% | 15 | 11.3% | 10 | 6.8% | 29 | 14.8% | 22 | 10.9% |
| 15–17 years | 8 | 7.3% | 6 | 5.8% | 6 | 4.5% | 3 | 2.0% | 10 | 5.1% | 13 | 6.4% |
| 18–24 years | 10 | 9.2% | 16 | 15.5% | 6 | 4.5% | 12 | 8.2% | 16 | 8.2% | 11 | 5.4% |
| 25–34 years | 14 | 12.8% | 7 | 6.8% | 8 | 6.0% | 17 | 11.6% | 16 | 8.2% | 19 | 9.4% |
| 35–44 years | 5 | 4.6% | 8 | 7.8% | 10 | 7.5% | 11 | 7.5% | 17 | 8.7% | 21 | 10.4% |
| 45–54 years | 7 | 6.4% | 4 | 3.9% | 11 | 8.3% | 14 | 9.5% | 7 | 3.6% | 11 | 5.4% |
| 55–64 years | 4 | 3.7% | 4 | 3.9% | 7 | 5.3% | 4 | 2.7% | 6 | 3.1% | 9 | 4.5% |
| 65–94 years | 6 | 5.5% | 2 | 1.9% | 6 | 4.5% | 4 | 2.7% | 13 | 6.6% | 5 | 2.5% |
| Totals | 109 | 100.0% | 103 | 100.0% | 133 | 100.0% | 147 | 100.0% | 196 | 100.0% | 202 | 100.0% |

chronic or permanently incapacitating diseases (Ferro de Souza 1983), and the majority of children presented levels of psychomotor development adequate for their reported ages. In Caxiuanã, only 1.74% of participants (n = 3) were classified as in "reasonable" health, that is with one or more clinically observable major health problems; while one child was observed to be in "poor" health. In Aracampina, one elderly man was also classified as in "poor" health because he was suffering from both malnutrition and emphysema. In addition, two adults suffered from severe scoliosis, and 13.2% (n = 29) were in "reasonable" health in that community. In Santana, two adults were classified as in "reasonable" health (0.64%) (Table 2). This qualitative approach was later combined with a more quantitative evaluation, to provide the overall health portrait of the populations.

## 3.1 Nutrition, Growth, and Development

Nutritional status was evaluated both qualitatively and quantitatively. In terms of qualitative evaluation, Caxiuanã was characterized by the highest frequency of people in poor nutritional status (low body mass index [BMI], and the fewest in the "good" health category [54%, n = 93]). In Aracampina two people were in poor condition (1.3%), and in Santana none were. Differences during dry and wet seasons exist but were not striking (Table 2). In the wet season, Aracampina had the

**Table 2** Population health trends of the three study groups

| Variable | | Caxiuanã % | Aracampina % | Santana % |
|---|---|---|---|---|
| Aspect (dry season) | Good | 97.69 | 86.35 | 99.36 |
| | Reasonable | 1.74 | 13.20 | 0.64 |
| | Poor | 0.57 | 0.45 | 0.00 |
| Aspect (wet season) | Good | 93.95 | 99.07 | 99.58 |
| | Reasonable | 5.52 | 0.93 | 0.42 |
| | Poor | 0.53 | 0.00 | 0.00 |
| Nutritional status (dry season) | Good | 54.00 | 68.60 | 77.90 |
| | Reasonable | 41.40 | 30.10 | 22.10 |
| | Poor | 4.60 | 1.30 | 0.00 |
| Nutritional status (wet season) | Good | 56.70 | 80.30 | 75.80 |
| | Reasonable | 38.00 | 19.30 | 24.10 |
| | Poor | 5.30 | 0.40 | 0.10 |
| Alcohol use | | 19.2 | 15.3 | 15.4 |
| Smoking | | 25.2 | 8.1 | 11.0 |
| Age at menarche (years) | | 12.8 | 13.0 | 13.1 |
| Age at menopause (years) | | 49.5 | 46.7 | 46.7 |
| Abortions (% of women) | | 9.3 | 15.0 | 19.7 |

highest frequency of people in the good health category, followed by Santana and Caxiuanã. In the dry season, Santana had a higher frequency of people in the good health category, followed by Aracampina and Caxiuanã (Table 2).

According to a previous study of children between the ages of 0 and 11 years in the three communities (Silva and Crews 2006), in general there was a high prevalence of low height-for-age among the three groups. However, children from Aracampina and Santana tend to be taller and heavier than those from Caxiuanã, and when compared to the NCHS/WHO reference data (NCHS 1977), they are all shorter and lighter than the 50th percentile of the reference, but their weight-for-height is above the 50th percentile, the same trend being maintained in both the wet and the dry seasons.

Mean adult BMI of the three Caboclo populations were slightly above the averages of the NHANES II (Second National Health and Nutrition Examination Survey) international reference (Najjar and Rowland 1987). If considered strictly according to that reference, levels of combined overweight and obesity (BMI$\geq$27) were high among women in all three study areas. However, cut-off points for obesity and underweight are arbitrarily defined, and should be used with caution in populations with varying genotypic backgrounds such as the *caboclo*. In Caxiuanã and Aracampina men had similar mean BMIs, but the BMIs of women varied significantly in the wet and dry seasons, with Aracampina women having consistently higher BMIs than Caxiuanã women. The same trend was observed for Caxiuanã and Santana. Women from Santana had BMIs slightly higher than Aracampina women (Silva et al. 2006), and there was only one case of undernutrition among all the adults sampled.

Inadequate intakes of iodine, vitamin A, riboflavin, iron, and other micronutrients are important public health problems worldwide (Marinho et al. 1981; Maberly et al. 1994). One of the most common micronutrient deficiencies is iron, which affects mainly children and pregnant women (Maberly et al. 1994). Iron-deficiency anemia has been associated with reduced immune response in children, increased maternal mortality, reduced working capacity in adults, and negative effects on growth and development (Stuart-Macadam 1989; Stuart-Macadam and Kent 1992; Maberly et al. 1994; Ryan 1997).

On clinical inspection of children, signs of iron-deficiency anemia, including paleness of the skin, whitening of the eye conjunctiva, and reports of chronic weakness and tiredness, were prevalent in all three communities, ranging from 17.4% in the dry to 56.4% in the wet season in Caxiuanã. Frequencies were not statistically different between Aracampina and Santana. Among adults, women showed more signs of anemia than men. All 22 pregnant women investigated in the three groups presented clinical signs of anemia.

Few studies of micronutrient deficiencies or related clinical manifestations have been conducted in the Amazon basin (Marinho et al. 1989, 1981; Fitton 1999). Blood hemoglobin levels were not measured in this study, but a clinical evaluation of mucocutaneous characteristics and coloration indicated that children and pregnant women are frequently affected by iron-deficiency anemia. Using the mucocutaneous discoloration criteria, in Caxiuanã, Aracampina, and Santana, the prevalence of anemia is lower in the dry than in the wet season, reaching 60.5, 55.6, and 45.9%

in boys, respectively. Girls also present high rates of anemia, ranging from 52.3% in Caxiuanã to 39.7% in Aracampina during the wet season. For adults the lowest level is found among men in Caxiuanã, where only one individual showed anemia in the dry season. The highest incidence is found among women of the same community (39%) in the wet season.

An estimated 20% of men and close to 50% of women worldwide suffer some degree of iron deficiency for various reasons, ranging from severe loads of intestinal parasites to excessive menstruation in some women (Maberly et al. 1994). The levels observed for the *caboclo* are in the same range as those reported by Giugliano et al. (1981) for low socioeconomic status (SES) children in the floodplains of the Solimões river, and by Giugliano et al. (1984) for low SES children of Manaus and the Rio Negro. Among the *caboclo*, the highest rates of anemia were observed in the population whose children have the highest prevalence of helminthes (Silva 2006a).

## *3.2 Clinical Health*

All major body systems were clinically investigated in the three groups (Silva 2001). Although head lice infestation is very common among schoolchildren in Aracampina and Santana, skin disorders are by far the most prevalent infectious conditions across all populations. *Pityriasis versicolor*, known locally as *pano branco*, and other dermatitis and dermatoses, followed by scabies, are responsible for 27.4% of all complaints in Caxiuanã, 24.9% in Aracampina, and 21.1% in Santana. In general, children are more affected than adolescents and adults are the least affected (Tables 3–5).

In Aracampina there were four suspected cases of leprosy, all among adults. Two others were confirmed by the federal government surveillance system. All were males. One reported that he was treated for 2 years and cured, the other did not recall taking any medication in the past 2 years. In Santana, one man presented signs compatible with leprosy, but did not report being diagnosed previously; he was sent for follow-up in Santarém. The northern region of Brazil still presents a high prevalence of leprosy (Magalhães and Rojas 2007), which makes the possible cases of that disease among the investigated groups a cause for concern. In Caxiuanã, one case of cutaneous leishmaniosis was identified during the research; there was no leishmaniosis in Ituqui. Overall, Santana men presented more types of skin disorders than the other two groups (Tables 3–5).

One of the few other reports about skin diseases among rural Amazonian populations is that of Fonseca et al. (1975) on 4,731 children in 8 municipalities in the state of Amazonas. They showed that *Pytiriasis versicolor* (*pano branco*), is the most prevalent skin disease, with an average of 13.7% of children infected in the studied communities. All three *caboclo* groups have prevalence rates above those reported for most Amazonas municipalities and comparable to those of Tabatinga, a small city in the northern part of the state, in which 40.3% of the children were infected (Fonseca et al. 1975). The lowest prevalence among the *caboclo* was in Aracampina

**Table 3** Percent of main disease occurrences in males and females by system and age group in Caxiuanã

| Caxiuanã | | | | | |
|---|---|---|---|---|---|
| Variable | Age group (years) | Disease | % males | Disease | % females |
| *Dry season* | | | | | |
| Skin | 0–11 | Pityriasis versicolor | 40.0 | Pityriasis versicolor | 31.6 |
| | | Dermatitis | 8.1 | Skin allergies | 5.6 |
| | 12–17 | Pityriasis versicolor | 23.8 | Pityriasis versicolor | 50.0 |
| | | Dermatitis | 5.9 | Scabies | 2.1 |
| | 18–94 | Pityriasis versicolor | 5.3 | Pityriasis versicolor | 19.5 |
| | | Dermatitis/spots | 4.2 | Skin lesions | 2.4 |
| Respiratory System | 0–11 | Cold/flu | 27.0 | Cold/flu | 21.1 |
| | 12–17 | Cold/flu | 29.4 | Cold/flu | 25.0 |
| | 18–94 | Cold/flu | 18.4 | Cold/flu | 13.9 |
| | | Sinusitis | 2.6 | Asthma | 5.6 |
| Digestive System | 0–11 | Abdominal pain | 5.4 | Abdominal pain | 15.8 |
| | | Diarrhea | 5.4 | Diarrhea | 7.3 |
| | 12–17 | Abdominal pain | 5.9 | Diarrhea | 8.3 |
| | 18–94 | Abdominal pain | 7.9 | Abdominal pain | 11.1 |
| | | Diarrhea | 5.3 | Gastritis | 5.6 |
| | | Gastritis | 2.6 | | |
| Eye disorders | 0–11 | Conjunctivitis | 2.7 | Conjunctivitis | 7.9 |
| | | Allergy | 2.7 | Blurred vision | 1.8 |
| | 12–17 | NONE | | NONE | |
| | 18–94 | Pterygium | 13.2 | Blurred vision | 11.1 |
| | | Blurred vision | 13.2 | Cataract | 5.6 |
| | | Cataract | 2.6 | Pterygium | 2.8 |
| *Wet season* | | | | | |
| Skin | 0–11 | Pityriasis versicolor | 18.4 | Pityriasis versicolor | 15.9 |
| | | Dermatitis | 5.3 | Dermatitis | 4.5 |
| | 12–17 | Pityriasis versicolor | 31.6 | Pityriasis versicolor | 46.2 |
| | 18–94 | Pityriasis versicolor | 13.5 | Pityriasis versicolor | 2.4 |
| Respiratory System | 0–11 | Cold/flu | 35.9 | Cold/flu | 38.6 |
| | 12–17 | Cold/flu | 26.3 | Cold/flu | 7.1 |
| | 18–94 | Cold/flu | 18.9 | Cold/flu | 23.5 |
| | | | | Asthma | 5.9 |
| Digestive System | 0–11 | Abdominal pain | 5.1 | Abdominal pain | 6.3 |
| | | Diarrhea | 5.1 | | |
| | 12–17 | Abdominal pain | 5.3 | Abdominal pain | 7.7 |
| | 18–94 | Abdominal pain | 6.5 | Abdominal pain | 14.3 |
| | | Gastritis | 2.2 | Gastritis | 8.6 |

(continued)

**Table 3** (continued)

| Caxiuanã | | | | | |
|---|---|---|---|---|---|
| Variable | Age group (years) | Disease | % males | Disease | % females |
| Eye disorders | 0–11 | Allergies | 2.6 | Conjunctivitis | 6.8 |
| | 12–17 | NONE | | NONE | |
| | 18–94 | Blurred vision | 13.5 | Blurred vision | 8.6 |
| | | Pterygium | 8.1 | Conjunctivitis | 5.7 |
| | | Cataract | 2.7 | Pterygium | 2.9 |

**Table 4** Percent of main disease occurrences in males and females by system and age group in Aracampina

| Aracampina | | | | | |
|---|---|---|---|---|---|
| Variable | Age group (years) | Disease | % males | Disease | % females |
| *Dry season* | | | | | |
| Skin | 0–11 | Pityriasis versicolor | 20.4 | Pityriasis versicolor | 16.1 |
| | | Dermatitis | 14.8 | Dermatitis | 8.1 |
| | | | | Scabies | 8.1 |
| | 12–17 | Pityriasis versicolor | 47.6 | Pityriasis versicolor | 16.7 |
| | | Dermatitis | 4.8 | Scabies | 16.7 |
| | 18–94 | Pityriasis versicolor | 5.3 | Pityriasis versicolor | 6.7 |
| | | Dermatitis/spots | 2.9 | Dermatitis | 4.4 |
| Respiratory System | 0–11 | Cold/flu | 38.0 | Cold/flu | 35.5 |
| | | | | Asthma | 3.2 |
| | 12–17 | Cold/flu | 19.0 | Cold/flu | 25.0 |
| | | Asthma | 4.8 | | |
| | 18–94 | Cold/flu | 14.3 | Cold/flu | 11.1 |
| | | Asthma | 2.9 | Sinusitis | 4.4 |
| Digestive System | 0–11 | Abdominal pain | 5.6 | Abdominal pain | 4.8 |
| | | Diarrhea | 3.7 | | |
| | 12–17 | Abdominal pain | 4.8 | NONE | |
| | 18–94 | Abdominal pain | 2.9 | Gastritis | 11.1 |
| | | Gastritis | 2.9 | | |
| Eye disorders | 0–11 | Conjunctivitis | 15.6 | Conjunctivitis | 11.1 |
| | | Blurred vision | 6.0 | Blurred vision | 4.8 |
| | 12–17 | Pterygium | 14.3 | Conjunctivitis | 8.3 |
| | | Conjunctivitis | 9.4 | | |
| | 18–94 | Pterygium | 34.3 | Pterygium | 17.8 |
| | | Blurred vision | 8.6 | Blurred vision | 15.6 |
| | | Cataract | 8.6 | | |
| *Wet season* | | | | | |
| Skin | 0–11 | Pityriasis versicolor | 16.7 | Pityriasis versicolor | 19.0 |
| | | Pyodermitis | 1.6 | Scabies | 3.4 |

(continued)

**Table 4** (continued)

| Aracampina | | | | | |
|---|---|---|---|---|---|
| Variable | Age group (years) | Disease | % males | Disease | % females |
| | 12–17 | Pityriasis versicolor | 50.0 | Pityriasis versicolor | 71.4 |
| | | | | Dermatitis | 14.3 |
| | 18–94 | Pityriasis versicolor | 12.1 | Pityriasis versicolor | 2.4 |
| Respiratory System | 0–11 | Cold/flu | 14.8 | Cold/flu | 27.6 |
| | | | | Asthma | 3.4 |
| | 12–17 | Cold/flu | 10.0 | Cold/flu | 14.3 |
| | 18–94 | Cold/flu | 3.0 | Cold/flu | 3.9 |
| | | Sinusitis | 3.0 | Asthma | 2.0 |
| Digestive System | 0–11 | Abdominal pain | 20.4 | Abdominal pain | 27.6 |
| | | Diarrhea | 1.9 | Diarrhea | 3.4 |
| | 12–17 | Abdominal pain | 4.8 | Abdominal pain | 14.3 |
| | 18–94 | Gastritis | 6.1 | Gastritis | 3.9 |
| | | Diarrhea | 3.0 | Abdominal pain | 2.0 |
| Eye disorders | 0–11 | Blurred vision | 1.9 | Blurred vision | 5.2 |
| | 12–17 | Pterygium | 10.0 | NONE | |
| | 18–94 | Pterygium | 39.0 | Pterygium | 17.6 |
| | | Blurred vision | 6.1 | Blurred vision | 9.8 |
| | | Cataract | 6.1 | Cataract | 3.9 |

**Table 5** Percent of main disease occurrences in males and females by system and age group in Santana

| Santana | | | | | |
|---|---|---|---|---|---|
| Variable | Age group (years) | Disease | % males | Disease | % females |
| *Dry season* | | | | | |
| Skin | 0–11 | Pityriasis versicolor | 27.5 | Pityriasis versicolor | 13.5 |
| | | Dermatitis | 2.9 | Scabies | 5.4 |
| | 12–17 | Pityriasis versicolor | 25.0 | Pityriasis versicolor | 28.6 |
| | | | | Dermatitis | 3.6 |
| | 18–94 | Pityriasis versicolor | 5.4 | Pityriasis versicolor | 9.0 |
| | | Allergies | 1.8 | Scabies | 3.0 |
| Respiratory system | 0–11 | Cold/flu | 30.4 | Cold/flu | 18.9 |
| | 12–17 | Cold/flu | 7.1 | Cold/flu | 35.7 |
| | 18–94 | Cold/flu | 10.7 | Cold/flu | 7.5 |
| | | Sinusitis | 3.6 | Sinusitis | 1.5 |
| Digestive system | 0–11 | Abdominal pain | 18.8 | Abdominal pain | 23.0 |
| | | Diarrhea | 5.8 | | |
| | 12–17 | Abdominal pain | 21.4 | Abdominal pain | 14.3 |

(continued)

**Table 5** (continued)

| Santana | | | | | |
|---|---|---|---|---|---|
| Variable | Age group (years) | Disease | % males | Disease | % females |
| | | Nausea | 3.6 | Gastritis | 3.6 |
| | 18–94 | Abdominal pain | 16.1 | Abdominal pain | 11.9 |
| | | Gastritis | 8.9 | Gastritis | 6.0 |
| Eye disorders | 0–11 | Conjunctivitis | 1.4 | Blurred vision | 1.4 |
| | | Strabismus | 1.4 | Allergies | 1.4 |
| | 12–17 | Strabismus | 3.6 | Conjunctivitis | 3.6 |
| | 18–94 | Pterygium | 5.4 | Pterygium | 3.0 |
| | | Cataract | 3.6 | Cataract | 1.5 |
| *Wet season* | | | | | |
| Skin | 0–11 | Pityriasis versicolor | 23.2 | Pityriasis versicolor | 28.4 |
| | | Dermatitis | 2.4 | Pyodermitis | 7.5 |
| | 12–17 | Pityriasis versicolor | 55.2 | Pityriasis versicolor | 32.1 |
| | | | | Dermatitis | 3.6 |
| | 18–94 | Pityriasis versicolor | 16.7 | Pityriasis versicolor | 8.8 |
| | | Dermatitis | 5.6 | | |
| Respiratory System | 0–11 | Cold/flu | 14.8 | Cold/flu | 26.9 |
| | | | | Strep throat | 1.5 |
| | 12–17 | Cold/flu | 6.9 | Cold/flu | 14.3 |
| | 18–94 | Cold/flu | 5.3 | Cold/flu | 5.9 |
| | | Sinusitis | 5.3 | | |
| Digestive System | 0–11 | Abdominal pain | 8.2 | Abdominal pain | 9.0 |
| | 12–17 | Abdominal pain | 4.8 | Abdominal pain | 14.3 |
| | 18–94 | Gastritis | 5.6 | Gastritis | 2.9 |
| Eye disorders | 0–11 | Pterygium | 1.6 | NONE | |
| | | Strabismus | 1.6 | | |
| | 12–17 | Pterygium | 3.4 | Blurred vision | 3.6 |
| | 18–94 | Pterygium | 5.6 | Pterygium | 14.3 |
| | | Blurred vision | 5.6 | Cataract | 2.9 |

girls (19.0%) and the highest is in Caxiuanã boys (40.0%). As in the state of Amazonas, Pytiriasis also is the main dermatological problem among the *caboclo* from Pará.

The second most common group of diseases was composed of those of the upper respiratory system. In the dry season rates of cold/flu in the three populations were higher than in the wet season for both sexes from children to adults (Tables 3–5). Other frequent complaints were asthma attacks and sinusitis. Two cases of

emphysema were identified among elderly men, one in Caxiuanã (a 70-year-old) and one in Aracampina (an 87-year-old). One 55-year-old woman in Santana was being treated for tuberculosis. In general, although respiratory disorders affected proportionally more children than adults, when all three groups were compared to each other, more types of diseases were diagnosed in women from Caxiuanã during the wet season, and in men from Aracampina during the dry season (Tables 3–5).

The third most prevalent afflictions were those of the digestive system. Among children and adolescents, the main complaint was abdominal pain, which was often accompanied by a distended abdomen and diarrhea, especially among boys. In adults, besides abdominal pain, heartburn was a common complaint in Aracampina (4.3%). In that community, 18% of children and adults reported having difficulty digesting beef. They felt "bloated," "heavy," and "nauseated" after eating red meat. This is an interesting phenomenon that has apparently not been reported before among *caboclo* groups and deserves to be further investigated. Digestive problems, overall, were more prevalent in Caxiuanã and Aracampina children than in Santana (Tables 3–5).

The fourth most prevalent complaints were about eye and vision problems. Especially in Aracampina and Santana, purulent conjunctivitis was a major problem for children and adolescents in the dry season. In adults, pterygium and "blurred vision" were the most common complaints. Cataracts were present in men and women in all three communities, but appear with higher frequency in Aracampina. Overall, more eye and vision problems were identified in the adult population of Santana than in the other groups (Tables 3–5).

When compared to other populations, such as the low SES school children from Manaus, of which 81% have clinical indications of eye disorders (Giugliano et al. 1981), the prevalence among the *caboclo* is higher. Among adults the most noticeable eye disorder is pterygium, an overgrowth of retinal epithelial tissue associated with prolonged exposure to wind, sunlight, dust, and natural elements. The highest prevalence is observed among Aracampina males, who fish daily and are exposed to extremes of sunlight and winds. Another disease of considerable importance in the region is conjunctivitis, probably of bacterial origin. A marked seasonality characterizes the almost epidemic increase in the prevalence of conjunctivitis during the dry season in Aracampina.

## *3.3 Morbidity by Poisonous Animals and Malaria*

Accidents with poisonous animals were one of the major concerns in all three groups, and for this reason they deserve special attention from public health authorities. Poisonous snakebites were quite common in Caxiuanã, with 13.2% of adolescents and adult men having been bitten at least once. According to Avila-Pires and Hoogmoed (1997), four species of poisonous snakes are found in Caxiuanã (*Bothrops atrox*, *Bothrops brazili*, *Micrurus spixii marsiusi*, and *Micrurus leminiscatus*). In Aracampina and Santana, snake bites occur rarely, but accidents with stingrays (*Potamotrygon motoro*) happen almost daily. In Aracampina 37.5% of

adolescents and adults have been stung at least once, and some as many as ten times. In Santana, the prevalence was 10%. Local treatments for stingray stings (and often snakebites) range from dressing the wound with burned diesel oil, ground coffee or applying hot salt water, to drinking teas and infusions made with local herbs, to special prayers by the local healers (*reza*). With the exception of applying hot water to the wounded region, which is efficient for stingray stings since these have thermolabile poison, the other reported "treatments" showed no visible efficacy.

During the first field season in Santana, in 1996, an epidemic of malaria by *Plasmodium vivax* swept through the village. It was brought by seasonal workers returning home from the state of Rondônia. The index case was pinpointed among a group of men who had been working as topographers for a timber company in the jungles of that state. Within 10 days of their arrival in the village, over 21% of the population was infected. Fortunately, the epidemic was controlled in 12 days due to early diagnostic and intervention provided by the Evandro Chagas Institute/Fundação Nacional de Saúde and the research team. This epidemic was particularly relevant, as Ituqui Island was considered an area previously free of malaria. The rapid and thorough control of the cases prevented further spread to adjacent communities and the possibility of the disease becoming endemic in the region again. Aracampina and Caxiuanã did not have malaria cases during the field seasons.

Since malaria is endemic throughout the Amazon, such cases of reemergence in areas already considered free of the disease pose an extra burden on the already debilitated health of the *caboclo* and other traditional populations.

## 3.4 Oral Health

Dental and oral health have important implications in terms of nutrition and quality of life, since oral diseases and cavities can reduce the food intake due to pain, and can progress to generalized infections leading to severe illness and potentially death (Reisine 1988; Ministério da Saúde 2005). Oral health in Brazil is generally considered precarious (Tomita et al. 1996; Brasil 2004; Colussi et al. 2004). The three study populations show patterns compatible with this indication and much below the acceptable level of 50% of teeth without cavities suggested by the World Health Organization for the year 2000 (Tomita et al. 1996).

Men and women in Caxiuanã had on average more cavities in their lower teeth than their Ituqui counterparts. However, as they become older, the Caxiuanã group conserve more teeth than the Ituqui populations in their lower and upper jaws ($p<0.001$, $p<0.001$). The average number of superior and inferior teeth present were also significantly higher in Caxiuanã than in the Ituqui group for both sexes ($p<0.001$, inferior, and $p<0.001$, superior, men; $p<0.001$, inferior, and $p<0.001$, superior, women). On the other hand, more people in Ituqui than in Caxiuanã had dentures ($p<0.001$, men, and $p<0.001$, women). Comparisons of children and adolescents among populations showed that in those aged 3–5 years the number of open cavities in boys was significantly higher in Ituqui than in Caxiuanã ($p=0.02$), no other significant differences in the average number of open cavities across populations were observed.

**Table 6** Oral health characteristics of the three study groups

| Variable | Caxiuanã | Aracampina | Santana |
|---|---|---|---|
| Tooth brushing (3x/day) | 28.40% | 39.50% | 58.30% |
| Oral infections | 2.90% | 8.05% | 5.50% |
| Inflammation/bleeding gums | 5.70% | 26.30% | 5.80% |
| Toothache | 3.00% | 4.30% | 1.80% |

Oral infections were present in 2.9% of the individuals in Caxiuanã, 8.0% in Aracampina, and 5.5% in Santana; while inflammation and bleeding of gums occurred in 5.7% of people in Caxiuanã, 5.8% in Santana, and 26.3% in Aracampina. Toothache was reported in all communities, but more so in Aracampina (4.3%), than in Caxiuanã (3.0%) or Santana (1.8%) (Table 6). In Santana, 58.3% of the informants reported brushing their teeth three or more times a day, especially children and adolescents, compared to 39.5% in Aracampina, and 28.4% in Caxiuanã.

In general, cavities are more frequent in the Caxiuanã population, which is closely followed by Aracampina. However, in the Caxiuanã group more teeth are present across age groups than in the two Ituqui populations. Girls have slightly more cavities than boys at ages 0–2 and 3–5 years in all groups. This trend of females having more cavities than males is generally maintained across all age groups in Caxiuanã. On the other hand, in Aracampina and Santana boys and men have more cavities than girls and women. Additionally, the number of people with dentures in Santana is higher than in Caxiuanã, another indicator of their overall better access to health care and financial resources. The Caxiuanã group has fewer oral infections and less periodontal disease than the Ituqui group.

Complaints of toothache are more frequent in Aracampina, followed by Caxiuanã and Santana (Table 6), reflecting the prevalence of untreated cavities and access to health care in the three groups. Prevalence of cavities among the children is as high as that observed in a study of Abaetetuba children, also in rural Pará (Normando and Araújo 1990); and the prevalence of periodontal conditions in the *caboclo* is lower than that observed among children and adolescents from the city of Araraquara, a large urban center in the state of São Paulo (Dini 1997), but is similar to the average observed among rural Guatemalan groups (Hunter and Arbona 1997).

More people report brushing their teeth three or more times a day in Santana than in Aracampina or Caxiuanã (Table 6). This indicates a better level of knowledge (although not necessarily practice) of oral hygiene habits. Nevertheless, the Santana population still has a high prevalence of cavities, even though everyone interviewed knows that they should brush their teeth daily. People in Santana also have more access to tooth extractions and dental procedures than people in Aracampina and Caxiuanã. Additionally, children in Santana have more access to oral hygiene, since they have toothbrushes at school, and rinse their mouths with fluoride once a week, whenever it is provided by the nongovernmental organization Health and Happiness Project (PSA). In Giugliano et al.'s (1981) Amazonian low SES sample, 18.8% of the children had 1–2 cavities, 33.3% had 3–4 cavities, and 46.4% had 5 or more. These rates are higher than those of the *caboclos*, but when

compared to urban children of Bauru and São Paulo in southeastern Brazil, reported by Tomita et al. (1996), *caboclos* have a much higher prevalence of cavities.

## 3.5 Women's Health

There are still few studies reporting on women's health issues among *caboclo* and other rural groups in the Amazon (Silva 2001; Moura 2005; Piperata and Dufour 2007; Siqueira et al. 2007). No significant differences in mode or type of birthing were observed across the three communities. Like those investigated by Piperata and Dufour (2007), all mothers indicate that they observed the *resguardo*, a 30–40 days postpartum period in which women significantly restrict their activity patterns and dietary variety. The majority of births was through vaginal delivery and occurred at home attended only by a midwife (Caxiuanã, 100%, Santana 82%, and Aracampina, 78%). In Aracampina 2.6%, and in Santana 3.3%, of the births occurred in a hospital, but only 0.9% and 0.7% of all births were Cesarean sections, which contrasts sharply with the current overall Brazilian birth statistics, in which this country has one of the highest rates of Cesarean deliveries in the world (Gomes et al. 1999; Siqueira et al. 2007).

As reported for other rural areas of the Amazon, fertility is high among the *caboclo* women, and they start reproductive life while still teenagers (Silva 2001; Moura 2005). According to Silva (2002), in Caxiuanã, 47% of the babies are born of women 19 years of age or younger; and the couples have, on average, 5.4 live children, which is lower than that observed in other rural populations (Pereira and Baracat 2000; Moura 2005), but above the average for the Amazon region (four children per couple) and much above the national average of 2.7 children per couple at the time of field work (IBGE 1996). Of the three groups, the highest fertility is observed in Santana, with 5.5 children per couple, and the lowest is observed in Aracampina, with 5.2 children per couple (Silva 2001).

As among the women from the region of Amanã, Amazonas State (Moura 2005), in Santana, Aracampina, and Caxiuanã, most women do not practice any form of contraception other than breast feeding, and differently from women of upland farming settlements in Belterra and Santarém (Siqueira et al. 2007), rates of prenatal medical attention and surgical sterilization are very low (<5%), which confirms the fact that these women have very limited access to medical services.

Although age at menarche was not statistically different across the study groups, girls in Caxiuanã have their first menstruation slightly earlier (12.8 years) than girls from Santana and Aracampina (13.0 and 13.1 years, respectively) (Table 2). Their mean age at menarche is lower than the average for the overall Brazilian population, what may be considered an adaptive response to a highly unpredictable environment (Silva and Padez 2006). This is different from what has been observed elsewhere, where more westernized girls most often start menstruating earlier than girls from more traditional groups (Henneberg and Louw 1995). Some possible explanations for the lack of difference observed among the Caboclo girls are discussed elsewhere (Silva and Padez 2006). Nevertheless, since age at menarche is an important marker of population health, and

this has been decreasing among the *caboclo* in the last decades, this may indicate an improvement in these populations' quality of life (Silva and Padez 2006).

As a result of the small number of postmenopausal women (N = 29), average age at menopause was determined jointly for Santana and Aracampina. Menopause occurs earlier in Ituqui (mean age 46.7 years), compared to Caxiuanã (mean age 49.5 years) (Table 2).

Abortions are reported frequently in all three groups. In Caxiuanã, 9.3% of primiparous women already had at least one spontaneous abortion, in Aracampina 15.0%, and in Santana 19.7% (Table 2). Some of these abortions are possibly associated with pelvic inflammatory disease (PID) and leucorrhoea, symptoms of which are reported by about 13% of women across the three populations. The high rates of abortions in the three communities, and the apparent higher prevalence with increasing transition to a more cosmopolitan lifestyle, deserve further investigation. Cancer rates are unknown among those populations. Only 1.0% of women of reproductive age in Caxiuanã, 10.0% in Aracampina, and 13.3% in Santana have ever had a test for uterine cancer (Pap test). Most women in Caxiuanã have not heard of the procedure, while in Ituqui such knowledge is more common. This better knowledge of the Ituqui women regarding health procedures likely results from the annual visits by the "health missions" to these communities to provide medical and dental assistance. Health mission is the name given to groups of physicians, nurses, and dentists hired by the municipalities to sporadically visit these riverine communities and provide basic health care and vaccinations (Silva 2001, 2006a).

## *3.6 Conditions Especially Affecting the Elderly*

The number of elder individuals (age 65 years and older) has grown significantly in the past 50 years in Brazil, from 2.4% of the population in 1940, to 5.4% in 1996, to 8.6% in 2000 (Camarano et al. 1999; IBGE 2002). Nevertheless, there is still a very limited number of studies about rural elders in the country (Heck and Langdon 2001; Missio and Portella 2003; Colussi et al. 2004), and much less is known about the health situation of the riverine elders. In the three populations the elderly sampled consisted of 36 individuals (4.04% of the total sample); the majority are males, and there are more individuals in this category in Santana. Their main complaints include symptoms of arthritis and chronic back pain, which are reported by 17% of the participants, this being the chief complaint among the elders, especially in Aracampina. Physical "weakness" is almost universally reported, especially among the older women, and children aged 8–11 years. Other miscellaneous conditions diagnosed in adults and the elderly included psychiatric disorders, epilepsy, diabetes, heart conditions, hypertension, obesity, undernutrition, secondary syphilis, tuberculosis, bronchopneumonia, emphysema, gastritis/ulcer, respiratory and cutaneous allergies, cancer, streptococcal throat infections, strabismus, dysuria (in women), spondyloarthropathy, and joint pain. With the exception of strep throat and dysuria, which were diagnosed in all three groups, and spondyloarthropathy,

which clustered in one family from Caxiuanã, all other conditions were present mainly in Aracampina and Santana.

Several elders from Aracampina and Santana reported past hospital stays and surgeries (mainly for treatment of hernias, cancer, and physical trauma of different origins). In Caxiuanã the only hospital stays were related to treatment for snakebites.

In Brazilian urban and rural populations obesity and the associated increase in diabetes, coronary heart disease, and hypertension are becoming a major public health problem (Lotufo 2000; Silva et al. 2006; Anjos 2006). Among the *caboclo*, a subsistence base of small-scale fishing for consumption and sale and, more recently, other less physically demanding activities such as white-collar jobs (as opposed to mostly agriculture) are associated with greater fatness among women. In Aracampina and Santana, processed and imported foodstuffs likely influence the observed results, since these tend to be high in fat and salt. The daily activities of men remain physically intense in all three groups, whether they are hunting, fishing, or working in the gardens. Even though men's diets may differ among the three groups, dietary effects are likely overwhelmed by levels of activity. Among women, as in the general Brazilian population, there is a tendency to an increase in prevalence of overweight and obesity (Mondini and Monteiro 1998), a result of both lifestyle and dietary changes, which seem to be stronger in the Ituqui adult residents.

Associated with the increased prevalence of overweight/obesity, there is also a high prevalence of hypertension among the three study groups, and especially among the women (Silva et al. 2006) (Table 7). Nevertheless, in contrast to findings

**Table 7** Descriptive statistics of systolic blood pressure (SBP) and diastolic blood pressure (DBP) for the three study groups in the dry and wet seasons

| | | Dry season | | | Wet season | | |
|---|---|---|---|---|---|---|---|
| | Variables | N | Mean | S.D. | N | Mean | S.D. |
| Males | | | | *Caxiuanã* | | | |
| | SBP | 30 | 117.3 | 12.0 | 29 | 111.7 | 12.2 |
| | DBP | 30 | 73.3 | 7.1 | 29 | 69.3 | 7.9 |
| | | | | *Aracampina* | | | |
| | SBP | 28 | 116.4 | 11.6 | 27 | 113.7 | 12.7 |
| | DBP | 28 | 71.4 | 8.0 | 27 | 71.1 | 8.0 |
| | | | | *Santana* | | | |
| | SBP | 49 | 114.9 | 13.0 | 14 | 110.7 | 9.97 |
| | DBP | 49 | 69.1 | 8.8 | 14 | 74.3 | 6.4 |
| Females | | | | *Caxiuanã* | | | |
| | SBP | 33 | 110.6 | 12.9 | 28 | 112.8 | 15.3 |
| | DBP | 33 | 69.1 | 9.4 | 28 | 66.1 | 10.6 |
| | | | | *Aracampina* | | | |
| | SBP | 26 | 115.7 | 13.3 | 43 | 112.5 | 13.3 |
| | DBP | 26 | 74.6 | 6.4 | 43 | 71.6 | 7.5 |
| | | | | *Santana* | | | |
| | SBP | 54 | 108.7 | 13.8 | 28 | 111.0 | 11.9 |
| | DBP | 54 | 68.3 | 9.6 | 28 | 72.1 | 7.8 |

of other studies, especially in urban settings, there is no statistical correlation between aging and increase in blood pressure in these populations, even though some of the elderly are hypertensive. These individuals complain often of the difficulty of access to medicines and appropriate diagnostic procedures, which makes them suffer sometimes for years with bone and joint pains, hypertension, and other chronic ailments.

### *3.7 Mortality*

Even though over 70% of the participants in the study areas had birth certificates or identity cards, which facilitated ascertaining birth dates, most deaths, as in other rural areas of Latin America, were not registered. Therefore the main causes and numbers of deaths were difficult to establish accurately. This is particularly true for very young children and elderly individuals, whose deaths usually occur at home and are attributed to "fever," "diarrhea," "old age," or "stroke." During the course of the study two elderly individuals died. One was a 90-year-old man from Aracampina who had melanoma. He was bed-ridden, undernourished, slightly dehydrated, with a cold and swollen submandibular ganglia at the time of the first study visit to the community. He died 4 months later. The other was a 70-year-old man from Caxiuanã who had been diagnosed with emphysema and died of "stroke" (according to his wife's information) about 6 months after the first visit. For the young, causes of morbidity and mortality are somewhat easier to determine since, if possible, parents bring their children to the city for treatment, where a diagnosis is established by the attending physician and reported to the parents. There were no reports of deaths among children during the field seasons; however, for cultural reasons, most people avoid talking about death or its causes. For previous years, childhood deaths were recalled by the informants as being associated with "drowning," "diarrhea," and "fever," but nobody in any of the populations knew precisely how many children had died in the 5 years previous to the research.

## 4 Making Sense of It All: *Caboclos'* Health, Disease, and Socioecological Differences

In the three study groups, the high prevalence of undernutrition in children, and obesity and hypertension in adults, are causes for great public health concern. Beyond that, other diseases prevalent are those of the skin, the respiratory and digestive systems, and the eyes. These results partially reflect the main causes of morbidity and mortality in the general Brazilian population. According to a report by the Pan-American Health Organization, respiratory infections are the fourth leading cause of death among Brazilian adults, after circulatory problems, external causes, and cancer (OPAS 1990). In addition, intestinal problems are the second leading cause of hospitalization in Brazil, according to a contemporary Ministry of

Health report (Ministério da Saúde 1997). The most frequent digestive problems among the Caboclo are abdominal pain, probably associated with intestinal parasitic infections, and diarrhea, which are also among the most frequently reported diseases in Brazil (Filho et al. 1978; Ferraroni et al. 1979; Vasconcelos 1981; Ministério da Saúde 1997; Boia et al. 1999).

An additional finding, unique to this research, is digestive complaints by Aracampina and Santana residents after eating beef. *Caboclo* food traditionally has little salt, few condiments and spices, and is composed mainly of easily digestible fish. They report sensitivity to beef and acidic foods (such as the juice of the cupuaçu fruit *Teobroma grandiflora*), and complain after eating of extreme abdominal discomfort and sometimes vomiting. Whether these effects are due simply to increased stomach acid production in individuals not used to foods harder to digest, or to differential digestive patterns specific to the *caboclo*, is still unclear.

The question of micronutrient deficiency, especially iron, has been a matter of great concern in terms of public health (UNICEF 1999). In this case, rather than suggest that anemia in these populations is related solely to poor nutritional iron intake, it is suggested that parasitic loads and diarrhea also play a major role in the prevalence of anemia observed in the *caboclos*. Naturally, nutritional deficiencies cannot be dismissed as a factor, particularly since fish and manioc flour have very low levels of iron (Rocha et al. 1982; Franco 1987), and industrialized food items, which contain iron, are added to the diet mainly seasonally.

Pityriasis is the main skin problem among the *caboclos*, as in other rural populations, but leprosy should likely be of higher concern epidemiologically. An interesting finding is that the prevalence of pityriasis is lower at older ages. Since this is an infection easily transmitted, the decline in incidence with age in both sexes suggests that there has been a recent exposure among the younger *caboclo*, that adults are more protected due to better hygiene habits, or that some sort of resistance to the infection is developed as one becomes older. Further research into these hypotheses is warranted.

In relation to the eye problems, the high rates of cataracts are a cause for concern, as this is an easily treatable disease today. As for conjunctivitis, it is possible that the annual variation in the prevalence of this disease is associated with seasonal deficiency of dietary micronutrients, especially vitamins A and C, as has been reported for other Amazonian populations (Giugliano et al. 1981, 1984; Marinho et al. 1989), leading to reduced mucocutaneous resistance to bacterial infections, or to a seasonal increase in bacterial levels.

The overall oral health of the study populations corroborates the trend of Santana being healthier than the other two groups. Nevertheless, the oral health of the *caboclo* is far from acceptable, and this research shows that across different environmental and socioeconomic conditions, regardless of age groups, the oral health of rural Amazonian populations remains a major public health issue.

From a gender perspective, it is noteworthy that the Ituqui group presents the highest frequency of abortions and women's complaints associated with pelvic inflammatory disease (PID) symptoms. The incidence of abortion in Ituqui is similar to that observed among the population of the Rio Negro reported by

Giugliano et al. (1984). Uterine cancer has a high incidence in the state of Pará (57/100,000: Dr. Raimundo Gallo, the state's Health Secretary, personal communication), and PID may be associated with such cancers as well as with abortion. Furthermore, PID is often a sequela of sexually transmitted infections (STIs). The presence of PID and STIs among the *caboclo* means that the human immunodeficiency virus (HIV) might also be present among them. Additional investigations among the *caboclo* may aid establishing links among abortions, PID, and cancer, and help characterize their situation in relation to the AIDS pandemic. These issues are especially important, as cancer is the third leading cause of death among Brazilian women (OPAS 1990), and little is yet known about the prevalence of malignancies or STDs and HIV/AIDS among Amazonian rural populations (Santos et al. 1992; Silva 2002b). No cases of HIV/AIDS were reported during field work in any of the communities.

In the three groups, for most common diseases and ailments, the local healers (*benzedeiras* and *puxadeiras*) are the first resource called upon, particularly in Caxiuanã and Aracampina. In all the populations, elderly women continue to be the main depository of traditional healing practices and knowledge of many different kinds of traditional medicines. People are treated frequently with teas, home remedies, and special prayers. Small children are particularly sensitive to the "evil eye" (*mau olhado*), which can be deadly, and needs to be treated with sessions of special prayers by the *benzedeiras*. In Santana, government health agents play an important role in health promotion and maintenance, and it seems that local healers are less called upon than in the other populations, another sign of the Santana group's higher dependency on western medications and ways of life. In addition, the Health and Happiness Project (PSA) which has for several years worked with Santana to improve the health of the community, has been developing several projects, such as following the length and weight of newborn babies to help the ones with low birth weight, and teaching alternative food recipes to young mothers. It is possible that the measures developed by the PSA have had some influence on the outcome of the health indicators in Santana; therefore, some of the observed health differences among the three *caboclo* groups are likely attributable also to a combination of Westernization and improved healthcare assistance.

Seasonal changes, geographic location, and socioeconomic conditions play important roles in the differences in general health aspects observed between floodplain and upland Amazonian populations. Upon visual inspection, Caxiuanã presents overall fewer people in the "good" health category and good nutritional status than Ituqui. Additionally, more people in Caxiuanã smoke and consume alcohol than people in Ituqui (Silva 2001, 2005). Conversely, fewer women report having abortions in Caxiuanã than in Ituqui. However, when the prevalence of disease by system is considered, relationships between groups, environments, and seasons of the year appear more complex. Among the three, Caxiuanã has a higher prevalence of undernutrition overall, of skin, digestive, and eye disorders in the dry season, more respiratory disorders in the wet season, and more intestinal helminthes. Aracampina has the second highest prevalence of undernutrition overall, a higher prevalence of skin diseases in the wet season, of respiratory diseases in the dry season, and of digestive

and eye disorders and intestinal protozoans in both seasons. Santana, in general, has the lowest rate of occurrence of all diseases. Caxiuanã and Aracampina differ more in the season of their disease occurrence than in disease prevalence itself. However, the better health status of Santana cannot be attributed solely to its geographic location. Both blood pressure (Silva et al. 2006) and oral health differ between Caxiuanã and Aracampina, and more subtly than between both and Santana. These results show that floodplain groups appear to be healthier overall than the upland group in some aspects, with the reverse being true for others, composing a complex set of human biological, cultural, and environmental interactions.

Access to a more cosmopolitan lifestyle, that is, more access to consumer goods and industrialized foodstuffs, is higher among the floodplain populations, but Caxiuanã experiences fewer seasonal influences on health than Aracampina or Santana. Overall, the findings suggest an ameliorating effect of Westernization, and a secondary, more subtle, effect of the floodplain environment on the health of the study populations.

## 5 Conclusions

For most rural Amazonian populations life is very hard. Few people live to old age, dying occurs with little assistance, and death happens often without an official certificate. Work to make an everyday living is intense, and the return is often barely enough to survive until the next day. Overall, it is still difficult to find personal information, such as last name, name of grandparents, full name of parents and relatives, birth date, and even correct age among them, because a large part of the population, especially the elderly, is illiterate, and access to official documentation is unevenly distributed between the rural and the urban areas. Access to healthcare and education is extremely limited in some locations, and the result is the diseases characteristic of the epidemiologic transition still taking place in the region (Causey and Causey 1975; Silva 2006), with a heavy burden on the young children and the elderly.

Life is hard, but also beautiful, in the Amazon. Whether in the *várzea* or in the *terra firme*, like all tropical areas of the world, it is neither hell nor paradise, but a highly complex and challenging environment in which human populations have lived for thousands of years, adapting to its shifting nature. Nevertheless, with all the difficulties, current Amazonian populations continue to grow and thrive, despite their still often dramatic health situation, amidst the beauty of this highly coveted natural ecosystem.

In the past 10 years, as public health policies have started to produce a positive impact on the overall health status and life expectancy of rural Brazilian populations, a better prospect for the future starts to become possible, albeit very slowly when compared to the urban areas of the country. The creation of protected areas and the full integration of the traditional populations under the control and management of these areas, a daring proposal which started to come true with the

creation of the Reserva de Desenvolvimento Sustentável Mamirauá in the 1980s by Márcio Ayres and his team, is a powerful statement about the possibility of combining human development and quality of life with environmental sustainability. Other experiences of community involvement in the protected areas, such as the one going on in Caxiuanã, are promising. It is expected that as Amazonian populations become more empowered, and have a better education, and as more information is made available about all aspects of their lives, new and better social and public health policies will be created to help improve their health, and to care for their culture and ways of life. This will help to ensure the protection of Amazonia and its floodplains, which are among the most important ecosystems of the planet.

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# The Floodplain of the Lower Amazon as a Historical Place

**Mark Harris**

**Abstract** Following William Denevan's bluff model of riverine settlement, this chapter considers the historical role the floodplain of the Lower Amazon has played in the colonial and postcolonial history of the region. In particular, I focus on the complementarity of the floodplain and the *terra firme*'s settlement during the period of intense colonization of riverine areas. By looking at colonial land records, census data, and economic activities, I argue that the floodplain assumed a special significance in the late colonial period, which made the dual strategy on behalf of individual families neither possible nor desirable. The balance between the zones was complicated by the inclusion of the region in world markets, the development of its own interior trade networks, and the development of a riverine peasantry focused on the floodplain. The ecological complementarity was superseded by economic and political factors that happened to promote the floodplain.

**Keywords** History • Peasantry • Land • Cacau • Colonization • Cabanagem

## 1 Introduction

Since the 1980s few Amazonianist scholars have failed to enthuse about the floodplain and its flooded forests. This zeal has been perhaps tempered by William Denevan's 'bluff model of settlement' (1996), in which he argues that the prehistoric societies of the Amazon were unlikely to have been positioned on the floodplain itself. Rather they were primarily located on fringing higher ground. These lands were alongside rivers, but they were not seasonally flooded and were therefore less hazardous, and more defensible from attackers. How, after all, can the extensive areas of *terra preta* soils be explained if the floodplain was so essential? Still, the

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floodplains were a necessary part of economic life because of their fertile soils and productive lake fisheries. Denevan therefore proposes a model on based on a "dual strategy or complementarity of *várzea* and *terra firme* resource use." (1996:671).

This position is strengthened by examining modern production systems from Peruvian Amazonia, which combine the seasonal movement between flooded and nonflooded land. The apparent continuity of contemporary and historical resource management strategies is undeniable. However, the argument is established as though it were an ecological imperative, obvious to any sensible person at any time: "Bluff cultivation and forest resources provided a safety valve when *várzea* fields were destroyed by high floods" (1996:672). In this chapter, I intend to address the historical basis of this model in the Lower Amazon by looking at colonial land records, census data, and economic activities. My argument is that the floodplain assumed a special significance in the late colonial period, which made the dual strategy on behalf of individual families neither possible nor desirable. The balance between the zones was complicated by the inclusion of the region in world markets, the development of its own interior trade networks, and the development of a riverine peasantry focused on the floodplain. Let me make clear: the bluffs remained significant as settlements in the Lower Amazon, but the configuration changed. The ecological complementarity was superseded by economic and political factors that promoted activities on the floodplain.

This chapter also addresses the misperception that the once densely inhabited riverbanks of the Amazon were basically empty until the rubber boom, except for a few villages and forts. This may have been the case on the Solimões and the Rio Negro in the late eighteenth and early nineteenth centuries (though this could be contended). Denevan writes, for example, that "[b]y 1850 at most there were very few riverine Indians surviving along the Amazon and its main lower tributaries as a result of disease, slaving, fleeing to the interior forests and detribalization." (1996:672). In one sense this is true: there were no Amerindian nations along the main river. Yet the gist is that there was nobody else. There were, in fact, many Indians, survivors of the conquest, as we will see, and whites, *mamelucos*, *cafuzos*, and enslaved Africans. The floodplain was not a blank slate on which modern Amazonia printed its name. It was a historical place, just like any other (see Cleary 2001:293). What kinds of people lived there after the great tribal federations were displaced? What did they do? What does the occupation of the floodplain in colonial times reveal about the present?

These questions are inspired by Denevan's important long-term view of Amazonian settlement. They are also provoked by Hugh Raffles's natural history of the floodplain, which seeks to unravel "fluvial practice" (2002:35), and "the ability of contemporary and historical Amazonian populations actively to produce new environments" (2002:37). Raffles elegantly brings to light the ways the floodplain and its rivers have been manipulated by multiple agencies of human and nonhuman actors. These "histories of creativity," as he calls them, help understand the floodplain not just as a place that limits human life, but one that enables it, offering potential and opportunity. It is both the constraint and the promise I wish to examine here.

A note on the word *várzea*: it is a Portuguese word and means generally flat land. In Brazil it has come to mean low-lying land composed of alluvial soils at

the sides of rivers. The part which becomes seasonally flooded is known as the *várzea*, or the floodplain in English. In the Amazon it is not entirely clear when the word first started being used. I have not come across its use in archival documents from the eighteenth or early nineteenth century. Instead, *ribeira* or *ribanceira* are employed by colonial clerks and administrators. '*Varzea*' (without an accent) is used by Domingos Ferreira Penna in his work on the Lower Amazon, so it must have been in circulation in the mid-nineteenth century (1869:99, for example). There is then no *lingua geral* term for the floodplain; *restinga* (levee) is too specific. Given the abundance of other Tupi derived words for riverine features, this is a little surprising. This lack of formal specification of seasonally flooded land in the colonial era suggests that from a cultural perspective it was not perceived as a special place in itself. Essentially the term is ecological and without a social reference. In other words, the framing of inhabited environments was predominantly cultural and was shaped by the colonial context in which they emerged.

## 2 The Colonization of the Lower Amazon Floodplain, 1660s–1830s

The Lower Amazon, or *Baixo Amazonas*, is one region in the interior riverine network of Amazonia. Other major river regions include the Upper Amazon and the Rio Negro, Marajó, Tocantins, and the Belém area. The Lower Amazon roughly runs from Parintins to Monte Alegre. In colonial times, as now, Santarém lay at the hub. The image of a hub is useful, because there are major tributaries to the Amazon which more or less converge on Santarém. To the south is the Tapajós River, which leads up to Cuiabá, Matto Grosso, and the centre of Brazil. In colonial times this was a long-distance trade route of some importance (Bates 1969 and Monteiro 1994). To the north is the Trombetas River, which leads into remote forests and eventually to Guyana. Indians and enslaved Africans used this route as a preferred means of escape (Gomes 2002). To the west and east ran the Amazon River. The Lower Amazon of the colonial era can be seen as a natural gateway. All river traffic had to pass through, especially since Óbidos lay at the narrowest part of the river. Many settlers came there, Indians were forced into missions, and its floodplain land was coveted. Moreover, Mura, Maues, and Mundurucu Indians lived in relatively close proximity to colonial villages, in the maze of streams on the south bank of the Amazon River between the Madeira and Tapajós Rivers (known then as Mundurucania). As a result, the area assumed historical importance as the location of intense social and economic activity, experiencing its own wars, conflicts, and violence (Jorge dos Santos 1999). The Lower Amazon is part of what we can call traditional, pre–rubber boom Amazonia, where a riverine-based way of life is dominant and livelihoods are gained from a diversity of activities. It is the Amazonia beautifully described by Inglês de Souza in his novels and short stories, especially *O Cacualista* (2003, 'The Cacao Planter').

The colonization of the riverbank bluffs and floodplain was intrinsic to the success of Portuguese imperial domination.[1] It was known almost from the beginning of Portuguese conquest as the *rio-mar*, river-sea. The Victorian naturalist, Henry Bates, provides a good overview when he writes "The whole Amazons valley is […] covered by a network of navigable waters, forming a vast inland freshwater sea with endless ramifications, rather than a river" (1969:20). Bates also considered the Portuguese to possess a "fair knowledge" of this huge watery expanse by the early eighteenth century, about a hundred years after their expulsion of competitor Europeans and the disappearance of the large Amerindian federations on the Solimões and Amazonas (Bates 1969:117). The novelty of the size and power of the rivers facilitated, rather than hindered, the settlers in their pursuits (Boxer 1962:271).

Between the 1660s and 1740s, missions were established well into Spanish territory up the Solimões, and the Negro and Branco Rivers (Sweet 1974). Accompanying this expansion was a commercial push for both slaves and products, which linked up the riverside missions under Portuguese control in a network of production and distribution. The drive was achieved by the pioneering efforts of the pathfinders, the *bandeirantes*, or as they were locally known, *cunhamenas* (Sommer 2004). Once colonial occupation of the immense territory was officially recognised in the Treaty of Madrid in 1750, forts were built to protect the frontiers of the Empire. The forts were, however, largely symbolic; they had few soldiers and hardly any supplies, and lay in chronic disrepair.

At first the missions were the main kind of settlement along the rivers. Typically built on bluffs along the river, missionaries and *cunhamenas* forced Indians to participate in colonial life, often at some distance from their homelands. Amerindian groups such as the Tapajós and the Conduris had disappeared by the late seventeenth century. Indians who resisted colonial inclusion were deemed enemies and therefore could be enslaved when captured. Most Indian slaves were taken straight to farms in and around Belém. The forts established at Óbidos and Santarém in the 1690s started the establishment of colonist farmsteads, benefiting from the proximate natural resources.

Many of these missions, like Santarém, Óbidos, Monte Alegre, and Alenquer, remain the location of towns today—it is not clear whether they were also settlements in the pre-European period. Silves and Villa Franca were amongst the largest villages in the Lower Amazon in the eighteenth century, but now are much smaller. Parintins and Juruti, on the other hand, were insignificant and grew with the growth of river traffic in the second half of the nineteenth century. (Part of the explanation of the continued existence of places like Santarém was the ongoing presence of relatively wealthy cacao planters from the early to the late nineteenth century. These people

[1]The following sketch is concerned with the people who were a core part of colonial life—the workers, slaves, and planters. It does not address the early conquest period and any continuity it may have had with either the precolonial or late colonial era. Sources for the ethnohistorical study of the Lower Amazon can be found in Sweet (1974), Menendez (1992) and Porro (1993).

managed to maintain their activity despite the horrific violence of the 1820s and 1830s, when there was the conflict over independence and the Cabanagem rebellion.)

Apart from the military and religious conquest, Portuguese colonization of the Amazon involved the occupation of land as its central strategy. Outside the missions various kinds of farmsteads were established by Portuguese settlers and Brazilians. Basically these individuals were, economically speaking, peasants, making a living from a diversity of activities, including fishing, livestock raising, hunting, and farming. They traded their goods by transporting them to Belém rather than local markets, which were little developed in the eighteenth century. A fascinating insight into the life of this heterogeneous group of people is provided by the 1778 census of every non-Indian household in Grão Pará, its location and principal economic activity.

Taking Santarém as an illustration, we find that 56 households were listed, seven of them headed by widowed women. Twenty households were situated in the village itself, and the rest in rural areas. Araripixuna, to the northwest of Santarém, was the most populous, with 15 houses there. Some of the domestic heads shared the same family names, indicating kinship connections. This area comprised both low and high floodplain land and bluffs. Although it is not certain precisely where houses were built, it is likely they were spread out along the riverbanks, occupying both seasonally flooded and higher land. In the middle of the Amazon River, and to the north of the Santarém, was Arapary, where eight houses were detailed. This is typical *várzea* with its 'endless ramifications' of streams and lakes. Nearby, Tapará and Aritapera had five and four houses respectively, also floodplain. Paricatuba, a bluff near the opening of the Igarapé Araripixuna on the Amazon River, was the only other site mentioned, and had three domestic units. This information reveals that rural locations were generally more desired than the town. Moreover, it was the floodplain that was the preferred situation for making a living in this late colonial area. One explanation for the popularity of the floodplain was the increasing significance of cacao. Over 90% of these riverine households were listed as cacao planters.

The same residential and economic significance of the floodplain for non-Indians is found in other Lower Amazon towns. Yet there were fewer people planting cacao; more are listed 'living from their agency' (*vive de sua agencia*), i.e., they do everything. The largest 'family' by far in the Lower Amazon was headed by Manuel Correa Picanço, resident of Arapary, a widower with three married children (who worked in the local army and lived with their father), and 39 slaves. Picanço had a cacao plantation, and yet was *remediado*, able to provide enough to survive, and just above poor on the scale used. This same economic value was accorded families with no slaves and similar numbers of children. On the other hand, there were some families who had a handful of slaves and were given as poor. Nobody was described as rich.[2] Still, when the nineteenth century dawned, and cacao became ever more dominant and slaves were introduced in greater numbers, these distinctions became stronger.

[2]See Vila de Santarém, pp. 151–153 in the 'Census Tables,' Governor of the Rio Negro, João Pereira Caldas, to Governor of Pará, Martinho de Melo e Castro, 22nd June, 1785, Barcelos, AHU Pará Avulsos, Rio Negro, cx. 8, doc. 7509.

Another source which informs us about the settling of land is the royal land grants (*sesmarias*) conceded in the Lower Amazon between 1740 and 1820. Using the land register in the Public Archive of the State of Pará, it is possible to locate the sites of the grants in the region. As in the 1778 census, the actual locales are not recorded, rather place names (e.g., Paricatuba) and general region (e.g., the town of Óbidos) are described. The map below gives approximate locations based on the excellent and detailed maps by Herbert Smith (1879) and Paul Le Cointe (1911) (Fig. 1).

In total, there were 49 land grants to 45 individuals (*sesmeiros*), i.e., some had more than one. These people were the richer section of the non-Indian peasantry listed in the 1778 census, such as Picanço. They represented the local elite: they served as members on the local council and occupied military posts. As can be seen, many *sesmarias* were on floodplain areas near towns, conveniently located for communication and transport. And cacao trees lined the riverside. Those individuals who did not seek a royal land grant may have been too poor to demarcate the land and employ a clerk and a lawyer to draw up the requests. By the early nineteenth century, other prime floodplain neighborhoods were occupied, around Ituqui for example. The occupation of riverbanks, including bluffs and *várzea*, was intensifying.

However, these people had to contend for land and resources with Indians. These Indians were the survivors of the colonial offensive. By the late colonial era, they were a fraction of the preconquest total. Nevertheless, according to recent commentators (Sommer 2000; Mello e Souza 2003), their general resilience and their negotiation of Portuguese policies secured themselves positions, which belies the

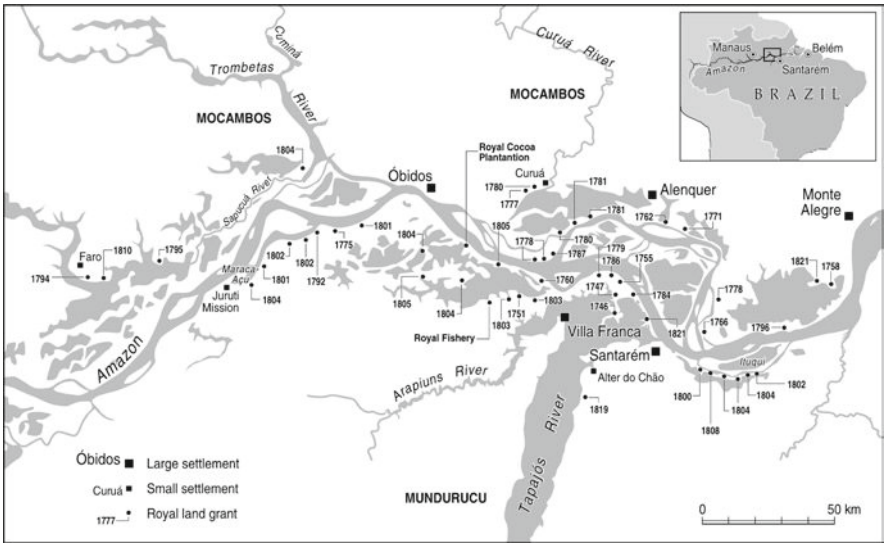


**Fig. 1** Map of royal land grants (*sesmarias*) given in the Lower Amazon (rough indications of their location)

image of the defeated and miserable relics of once dominant Indian tribes, as represented by John Hemming (1978, 1987). Like the whites and *mestiços*, they were not a homogenous group. They differed in terms of their experience of slavery, length of time in a mission, social and family position, and ethnic identity. In 1783 there were 696 Indian men, women, and children in Santarém (Sommer 2000:326). The non-Indian population for Santarém for 1778 was 328 whites and *mestiços*, and 148 slaves. In summary, Indians accounted for more than half the total (59%), the free just over a quarter (28%), and the enslaved for about an eighth (13%). These divisions were more or less the same for Óbidos and Alenquer, but Faro, Monte Alegre, Villa Franca, and Alter do Chão had higher numbers of Indians and fewer slaves and free peasants.

Portuguese legislation, known as the Directorate, between 1758 and 1798, obliged all colonial Indians to work for the state. For this reason, their main domestic residences had to be in the colonial villages, that is, the old missions situated on bluffs. This meant they could not live permanently on the floodplain, though they were permitted private gardens and temporary houses there. Indians had to grow their own food in a *roça comun*, communal garden, as well as supply soldiers (if there was a fort in the village) and passing dignitaries and their entourages. The location of these publicly-owned gardens is not known for every village in the Lower Amazon. Yet it is very probable that traditional areas of high fertility were employed, that is, the floodplain and the ancient *terra preta* sites. In Santarém the *roça comun* was to the east in the floodplain region of Maicá, on the Amazon River. It is also likely the *terra preta* soils near there were used. In Óbidos the *roça comun* was situated across the river opposite the town on the south bank, near the huge state-owned cacao plantation. One may suppose that the household gardens were not far away. This pattern of seasonal movement between floodplain, or *terra preta*, agricultural location, and bluff dwelling confirms Denevan's model. However, it was not one that would last much longer in the Lower Amazon.

The Directorate was abolished in 1798. In legislation, Indians were no longer to be treated differently from anybody else. The new policy involved the sale of publicly owned assets (except for the cacao plantation and various fisheries). Immediately, the Indians no longer had the same forms of security and protection. They were thrown together with the rest of the free peasantry and left to survive. I shall examine what happened below. This moment coincided with the expansion of cacao orchards in the Lower Amazon and an influx of settlers looking for land in prime locations—in some cases where the communal and private gardens were.

Although we might like to imagine the riverbanks as empty in the late eighteenth century, this was not the case in the Lower Amazon. Land demarcation was becoming increasingly combative (for an example in Porto de Moz, see Sommer 2000:123). And the floodplain became the locus of conflict.

This section has sought to build up a picture of different phases of colonizing the riverbanks of the Lower Amazon. Following the destruction of the Amerindian nations in the early conquest period, small missions took their place, generally on

higher nonflooded bluffs. In the vicinity, colonists settled on floodplain land in order to take advantage of Indian labor, trade, and fertile land for cacao and pasture. By 1758 this residential apartheid ended, but Indians continued living in villages rather than rural settlements. By the end of the eighteenth century the non-Indian peasantry was unevenly spread between the town and riverbank. The local elite moved into towns for administration, town councils, markets, military posts, and religious control. But the focus of their attention was their farmsteads, where they spent most of their time. There was much greater interest in the floodplain itself, especially near to villages, rather than other ecological zones, as its economic potential was more readily realized.

## 3 Economic Activities and Colonial Conflict

This next section will examine the range of activities undertaken in the colonial period and how those activities affected the social structure. Although the vast majority of people at the end of the colonial period lived next to the river, their work was not confined to that area. Seasonal collecting expeditions sought products gathered from the interior forests and up the tributaries, such as wild cacao, sarsaparilla, turtle eggs, Amazonian clove, nuts, and various resins and oils from trees, as well as lard from turtles and manatee. Trade, marketing, visiting, and participation in religious ceremonies involved travel to villages and towns, and sometimes to Belém.

Indeed, people moved constantly in search of better conditions, which could mean escaping from abusive bosses or creating new opportunities. This mobility proved very troublesome for the colonial administration. It wanted to establish vassals who practiced agriculture and were tied to the land. The archive in Belém contains many letters by bureaucrats complaining about people packing up and being absent from military or work obligations. In most cases the individuals or families would turn up a few villages away, looking for a plot of land. Such movement was quite reasonable, as skills could be reapplied and the technology was light. There may have been other reasons for moving on, which I will consider below. For the relatively wealthy, however, such mobility (unless they were a trader) was a less attractive option. It was their goal to occupy land to plant cacao trees and raise cattle. This put them in conflict with poorer neighbors whose crops were in danger of being destroyed by cattle.

The free peasantry, which included Indians after 1798, pursued their livelihoods in a mixture of ways, much as they do today. There is no record of precisely the full range of each household's production, either for subsistence or sale. In the late colonial period markets for agricultural produce in the interior were limited. There were shops for goods from the outside, such as alcohol and tools. This meant that most domestic units provided their own daily food or engaged in activities in exchange for food.

As mentioned above, the principle economic activity was the growing of cacao. Almost all cacao lands were along the riverbank. Since the 1730s, cacao had been the most significant export from the Amazon. Then, it was grown by Indians in missions, and following the expulsion of the Jesuits in 1757, production was overseen by the state, which guaranteed prices and transport. By the end of the eighteenth century, the state withdrew its control of the economy. In his study of the economic history of cacao production in the Brazilian Amazon from the time of the missions to the end of the colonial period, Dauril Alden concludes that:

> It was cacao that encouraged the settlement of the Amazon during the eighteenth century and that produced a large share of the crown's income from that region. In the long run, however, cacao may have been disadvantageous to regional growth (because it was too dependent on a single crop). Certainly it did not bring about unlimited prosperity. As with staples in other production areas, prosperity for some, such as the merchants of Belém and Lisbon, meant misery for others, including the Indian paddlers, black slaves, and many marginal orchard owners. But who the people actually were and how much they benefited from the cacao industry are questions to which answers still need to be discovered (Alden 1976:132).

What is relevant here is the agrarian characterization, and the effect of this cacao boom on local society. In the late eighteenth century, some Indians, especially the officer or noble class, had gained some standing in Pará's colonial world, and could negotiate the terms of their inclusion in it (Sommer 2000). This was the case for those with large families, who could control the labor of kinsfolk. But with the ending of the Directorate, these people lost their special status in the colonial regime and became part of a differentiated and diverse riverine peasantry. Inevitably, simmering conflicts and prejudices erupted, as pressure on land and labor supply grew.

As part of the reforms at the end of the eighteenth century (in order to introduce liberal economic practices), there was an auction (*arrematação*) of some of the state's assets. In some remote places there were few takers, owing to the lack of private capital. The Indians who had worked the land to be sold off were in no position to compete with the better off individuals.[3] This process allowed the elite to occupy the most important areas in the region. These were prize floodplain lands, suitable for growing cacao and not too low so they would flood every year. And previous users and inhabitants were pushed off the areas they had enjoyed.

In the Portuguese Empire's archives in Lisbon there is a beautiful drawing of one man's plot of land conceded in 1802 by the King. It is situated down-stream of Óbidos, on the north bank. The image shows the plot entirely covered with cacao trees, with the house in one corner. It is bordered on either side by other cacao planters. Faria, a Portuguese military officer, took early retirement in order to run

[3] José Joaquim Pereira do Lago to Governor, Alter do Chão, 10th December 1799, Arquivo Publico do Estado do Pará (APEP) cod. 575, doc. 48. See also 'Autos de demarcação da terra,' Óbidos, 19th March 1812, APEP 'Documentação Juridiciário.'

his economic interests. He also was granted another piece of land on the other side of Óbidos. His application for that *sesmaria* does not mention what he intends to do with the land; most likely it would have been to raise cattle. As it happens, neither of these plots were on old Indian lands or gardens.[4]

In the early nineteenth century the rise in production of cacao led to the increased use of African, rather than Indian, labor. From having no more than a few hundred slaves, the Lower Amazon and Tocantins areas came to have many thousands, mostly working in and around the cacao plantations. The introduction of African- and Brazilian-born slaves brought a new set of problems for the elite. According to the regional Portuguese authorities, the flight of slaves from their masters was one of the most serious problems of the late colonial period. Escaped slaves used to establish their own communities (*quilombos*) in remote places up tributaries, and would attack farms, burn houses, kill cattle, and kidnap women and other slaves. Often they were armed, and defended their homes with devices such as trenches and traps. In these ways the *quilombos* of the Amazon were no different from those elsewhere in Brazil and the Caribbean. There were some regional variations, such as the importance of Indians in helping slaves escape, the complicity of traders in supplying *quilombos*, and the network of rivers and dense forests that aided escape and obscurity.

Travellers in the early to mid-nineteenth century described the monotony of the river banks in the Lower Amazon—the stumpy, wide-branched cacao trees for leagues on end (Maw 1829; Edwards 1847:105–107). The lands where Indian peasants once had their gardens and temporary homes were progressively being taken over by land-grabbing cacao planters. Certainly this happened in Óbidos and Santarém, where Indians complained that they were thrown off the land they were working. Planters responded by saying the Indians were not using it profitably. Plots near towns on the main trunk of the Amazon River were at a premium in the first decades of the nineteenth century.

*Grilhagem* (land grabbing) is nothing new in the Amazon and takes place with each new successive economic phase. The Brazilian priest André Fernandes de Souza worked with Indians as a missionary. Writing a report to Pedro I, he stated that six kilometres above Manaus is a small river called Taroma: "At its mouth is the cacao plantation of the ex-governor José Joachim Victorio, in forming which he removed all the population, and obliged them to work on it with no other payment than a very slender subsistence, which was the principal cause of the desertion of the Indians" (Fernandes de Souza 1848). This was not an isolated incident, but indicative of a general pattern taking place. If an ex-governor was land grabbing with impunity then others were.

By 1828, a memorial from the Lower Amazon asserted that in the municipal districts of Santarém, Óbidos, and Alenquer, almost all land was covered by cacao trees.[5] The only land which remained unplanted was where the risk from flooding was too

[4]Biblioteca e Archivo Público do Pará (1904), Francisco José de Faria, R. Paraná-Merim de Maracassú, and Francisco José de Faria, districto da Villa de Óbidos, p. 54.

[5]Anonymous, 'Memória de Santarém,' 1st December 1828, Santarém, APEP cod. 851, doc. 74.

high. The other towns had cacao, but were more inclined to fishing and the making of manioc flour. As more and more land was swallowed up by cacao, smallholders were pushed out to peripheral areas further away from towns, and in between plantations, so their efforts to create viable peasant households were constantly challenged. This sheds a slightly different light on the comment by a man from Vila Franca writing in the 1820s who said that the "Indians were dispersed in the districts." They were not so much spread out as squeezed out. In the space of thirty years (1790s–1820s), the agrarian structure had become more divided: larger orchards worked by slaves, more small-scale peasant farms in the interstices and on the periphery.

The riverine way of life revolved around these rich and poor peasants and their struggles. Given the relative lack of wealth in Pará, the division between economic classes was not as great as elsewhere in Brazil in the same period. The peasantry was heterogeneous because it was composed of various kinds of people: Indians, *mestiços*, poor Portuguese settlers, freed slaves, and fugitives from justice in the other regions. Although the way of life was connected to the river, it was also based in a plot of land that provided security of residence and subsistence potential. In this way, Amazonian floodplain peasants (*ribeirinhos*) have always accessed a diverse range of environments to sustain their livelihoods, and moved across them with ease. Thus they have depended not on one or two activities but many, and often these are performed together in a coordinated fashion. Such is the skill—indeed, the imperative—of living on the floodplain.

Although the poorer peasants had diverse origins, they shared similar experiences. One critical aspect of this formation was the sense of being pushed out by the better off cacao growers who wanted more and more space to plant trees on. The Cabanagem rebellion of 1835–1840 had various causes, such as arguments over the nomination for provincial president, lusophobia, and the accumulation of oppressive demands from the outside. One cause that has not been analyzed sufficiently is the sense of grievance that some felt towards the local elite over losing their prime plots of land and thus their livelihoods. This conflict over land and resources helps explain why the Cabanagem spread into the interior of Pará and lasted so long after the fall of Belém in May 1836.[6]

## 4 Conclusion

This chapter has sketched the general development of the floodplain peasantry in one Amazonian region in the colonial era. Yet this assemblage of people was neither exclusive to this ecosystem nor homogeneous in character. Although

[6]The Cabanagem has been the subject of many studies in Brazil but few outside. See, for example, Raiol (1970); Hurley (1936a, b); Moreira Neto (1985); Paolo (1985); Salles (1992); Cleary (1998, 2003); Chasteen (2000). Some parts of the argument in this chapter are elaborated in my book, *Rebellion on the Amazon* (2010).

focused on the margins of the river, people moved between villages, towns and cities, and the forests as they pursued their livelihoods and searched for new opportunities. The occupation of the floodplain involved conflict and was contested by individuals and families. Those who made a living on the floodplain in the late colonial era were not doing so because it was second best, nor did they lack ambition or imagination. Their choices were constrained by economic options, the structure of colonial society, its ethnic and cultural dimensions, and transport availability.

One feature of the peasantry more generally is its domestic organisation; work and economic life is channelled through the household. Since they are a 'part-society' within a much larger entity, there may not be strong social connections between neighboring households. Of course, family links in the Lower Amazon did spread across domestic units, but sometimes they did not. Colonial Pará was not a structured and ethnically-integrated society with networks across residential areas, as was the case in preconquest riverine Amerindian societies. It was not possible in the colonial era, or even later, to have gardens on the floodplain and houses on the river bluffs, that is to live and work separately. Each household was required to live next to its gardens, cattle, orchards, and so on, in order to lay claim to the land and to protect it. In other words, there was good reason, in the context of the times, to live on the floodplain and suffer the hardships of the place, such as the seasonal inundation. We can see colonial floodplain peasant life as representing a hard-won adaptation to prevailing conditions, and as a complex amalgamation of traditions. As such, periodization is extremely difficult. In spite of being a singular location, the place has been subject to multiple influences at different stages, each one with its own history.

Despite this violence, this history of the Lower Amazon reveals the floodplain's significance today. Peasants living in floodplain areas are not recent arrivals; nor are they haphazardly making a living, or simply accommodating external demands. Many of them are the descendents of those who settled there in colonial times. The resilience of their livelihoods over two and a half centuries suggests an ability to adapt not only to uncertainties in the regional markets, but also to internal needs. Much of this resilience is dependent on an ability to occupy floodplain land without fear of land grabbers, and to have access to nonvalorized resources. Although the floodplain is a historical place, it is not one that exists independently. The floodplain has been incorporated into a nexus of other environments in the Amazon. Certainly it has not been possible to make a living solely from the floodplain's aquatic and terrestrial resources. The particular configuration and weighting has changed over time. The more *ribeirinhos* are prevented from exploiting a diverse range of environments, the more pressure there will be on the floodplain.

In summary, there were different interests and forms of relating to the environment. The Lower Amazon, with its valuable resources, was as contested in the early nineteenth century as it is today. The kind of historical approach advocated here has had two objectives. It aims to overcome the presentism of some social scientific

work on the Amazon. This body of work tends to see social problems as requiring technical solutions and proper management, rather than seeing them as composed of different interests and outcomes of struggles over time (see Nugent 1993 for a critique). What is more, this present-oriented perspective suffers from 'chronic emergency' diagnosis of Amazonia's ills (see Alencar et al. 2004). Each crisis produces another which has a human and environmental impact. One does not doubt the significance of increased road paving, soya farming, and illegal logging, to give three current examples. These activities are having huge effects on the region (e.g., Watts 2005). However, the discourse of crisis and ongoing devastation legitimates expert knowledge rather than local knowledge, and external intervention rather than local empowerment. The perceived urgency given to environmental problems is associated with global discourses of nature and development. Surely it is for this reason that there has been a considerable growth in nongovernmental organisations (NGOs) in the Amazon with financing from North America and Europe (Buclet 2004). Most of the NGOs propose innovative models of development, and stress local management of resources and the importance of conservation. However, Buclet (2004) has shown how they are nevertheless embedded in a social system that is imbued with traditional forms of domination and older paradigms of socioecological development. This context limits the full impact of their policies.

The second purpose of the historical perspective is to refocus on the *ribeirinhos* themselves. As lacking in ambition or desire for progress as these floodplain people appear to developers, they are nevertheless carrying out a massive historical mission. Put simply, this task is the continued employment of skills which allow for reproduction from one generation to another, representing defended positions arising from specific social situations in the flow of historical activity. The apparently effortless employment of these skills should not be mistaken for laziness, as the Amazonian elites have done and still do. Rather it is the precise maintenance of order and reproduction in a world of chaos and change that is their achievement.

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# Socioeconomic Dynamics, Public Policies, and Migration in the *Várzea* of the Upper Solimões

**Edna Alencar**

**Abstract** In recent decades, migration and movement of families toward urban centers have contributed to the demographic modification of *várzea* populations along the Upper Solimões, reducing the number of communities as well as the supply of agricultural products. This article intends to show that this demographic process is associated with both socioeconomic and environmental factors, including: (1) the relationship between changes in the system of economic production and population dynamics; (2) the policies of territorial occupation and demographic mobility; (3) the urbanization process, and creation of new municipalities; and (4) the relationship between public policies, socioeconomic dynamics, and migration, emphasizing the role of the state in the promotion of policies capable of guaranteeing a sustainable lifestyle, and social and environmental justice for the rural populations, particularly in *várzea* areas. This analysis is based on research carried out in the region among residents, municipal administrators, and segments of civil society, with the objective of supporting proposals for public policies for the *várzea*.

**Keywords** Amazonia • Migration • *Várzea* • Public policies • Social and environmental sustainability

## 1 Introduction

The colonial occupation of the Brazilian Amazon was marked by various actions of the colonial government to control the process of settlement. By controlling native populations, the colonial government attempted to impede the entrance of other

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colonizers who could pose a threat to Portuguese domination. In this sense, territorial occupation was contingent upon the colonizers' ability to maintain control of the land, including its borders, its economic exploitation, and migratory flows.

The model of population management that was implemented by the colonial government initially relied on a partnership with the Catholic Church through the activities of various religious congregations (Jesuits, Franciscans, Carmelites, etc.). They used the creation of missions and villages as a means of "civilizing" the native population and of thus gaining control over the land and its valuable natural resources. This model of management used the native population as a free labor force, exploiting them for their manpower and in particular their knowledge of the environment.

The history of the occupation of the Amazon is marked by an economy based upon the exploitation of certain natural resources that formed the predominant system of production in each period. These periods can be considered economic cycles, such as boom in the "*drogas dos sertões*" (forest products) and the "rubber boom," that share the following characteristics: (1) they are based on an extractive system of natural resource production, (2) they rest on a fragile economic base, and (3) they are marked by periods of prosperity and decline due to shifting demands for these forest products or their economic exhaustion. Each economic cycle is associated with population ebbs and flows, resulting in demographic dynamics affected as much by internal migration flows as by the immigration of people from other regions, and also by the displacement and disappearance of native indigenous populations, reflecting changes in the processes of territorial occupation and exploitation of natural forest products valued by the market.

Between the end of the nineteenth century and the beginning of the twentieth, the Brazilian Republic secured partnerships with international capital in the form of American and English companies that invested in rubber extraction. This money also financed immigration through loans to provincial governments to facilitate transportation and settlement. Since no banks existed to finance rubber extraction, large commercial houses situated in Belém and Manaus received loans from international banking agencies, and advanced money to the owners of "*seringais*" (rubber trails) to support the extraction of latex. The expansion of the international capitalist economy stimulated the process of occupation of the Amazon, generating demographic and territorial changes in the region. These migratory flows to the Amazon were provoked by broader social and economic changes that had occurred in Brazil in the north and northeast. Both unemployment and the great droughts that occurred in 1877 and 1878 spurred thousands of northeasterners to migrate to the Amazon and the southeast in search of jobs (Ribeiro 1990; Santos 1980; Weinstein 1983). This migratory flow had certain characteristics: (1) it was mainly a rural-to-rural migration; (2) it resulted in a pattern of settlement based on fluvial transport, with the formation of dispersed settlements distributed along the banks of rivers, similar to patterns of Amerindian settlement; (3) it was based on the intervention of the Brazilian state and on investment of international capital that financed the extractive industry.

Beginning in the 1940s the federal government initiated a project to promote the development of the north with a landmark speech of President Getulio Vargas

(1946) that become widely known as "The March to the West." To make this project possible the government created institutions such as the SPVEA (Superintendência do Plano de Valorizaçao Econômica or Superintendency of the Economic Recovery Plan for the Amazon), INPA (National Institute for Research on Amazônia), SESP (Special Public Health Service), and SUDAM (Superintendency for Amazonian Development), among others, and built highways to facilitate communication between the north and the south of Brazil.

In the second half of the twentieth century, the intervention of the state in settlement and population management policies became more direct through the implementation of a set of development policies aimed mainly at the eastern Amazon. This plan, known as PND (National Program of Development) was implemented in the period from 1972 to 1974. The objective of the PND was to establish guidelines for the managed settlement of the territory, and to promote the development and integration of the Amazon into the national economy. It was in this period that a new process of economic and demographic occupation occurred in the Amazon. With the construction of highways such as BR 230, the Transamazônica, and BR 163, the Cuiabá-Santarém highway, a new pattern of regional settlement emerged that was no longer based on fluvial transportation. In the westernmost region of the Brazilian Amazon, in the region that includes the valleys of the Solimões, Japurá, and Amazon rivers, waterways provided virtually all communication and transport, although there had been a failed attempt to build a railroad connecting the Madeira and Mamoré rivers to transport rubber (Oliveira Filho 1988 and Ribeiro 1990). In the 80 years since these interventions, the state is even more present due to policies for occupation of international border areas through projects such as the Calha Norte and, more recently, with the creation of nature reserves, indigenous reserves, and areas of agricultural settlement managed by INCRA (National Institute of Colonization and Agrarian Reform). Thus, with these state interventions, demands for new economic products, and the arrival of new migrants, the Amazon has urbanized and industrialized, but with serious social and environmental problems associated with demographic change in the region over the last several decades.

Considering the size of the region and its environmental and social diversity, it is necessary to view this reality from a particular perspective in order to understand how this process is unfolding. Therefore, this chapter presents an analysis of the *várzea* of the Upper Solimões, informed by studies carried out as part of the PróVárzea program (Lima 2005; Alencar 2005), which highlight the environmental, socioeconomic, and demographic characteristics of this region.

## 2 The Human Occupation of the *Várzea* of the Upper Solimões

According to narratives of the earliest travelers and colonial administrators, during the colonial era the *várzeas* were densely inhabited areas, with villages that extended for kilometers along the banks of the Amazon River (Porro 1995, 1998; Ribeiro 1990; Meggers 1987; Oliveira 1983; Alencar 2002). However, this demographic pattern in

the *várzeas* was altered by policies of colonial occupation of the Amazon implemented in the eighteenth and nineteenth centuries, including those promoting village settlement, and later those associated with the rubber industry (Almeida 1997; Loureiro 1982; Oliveira 1983). The use of the indigenous people as manual laborers in extractive activities, such as in rubber collection, led to the depopulation of riverbank settlements along major rivers through the expulsion of indigenous peoples who had traditionally inhabited river banks in both *terra firme* and *várzea* areas.

In the last decades of nineteenth century, the above scenario was altered with the arrival of immigrants from the northeast who came to the region in search of wealth and prosperity. New immigrants were sent to work on rubber plantations in the upper Juruá, Purus, and Japurá rivers. The process of immigration contributed to the expansion and settlement of the Brazilian territory, and at the same time, immigrants began to compete with the remaining indigenous peoples for land and natural resources. As the rubber trade expanded into new territories, some indigenous groups who were living along the margins of the main rivers, including the Solimões, Japurá, and Juruá rivers, and had resisted colonial occupation since its onset, were forced to migrate to remote areas, such as the headwaters of small tributaries—as was the case of the Ticuna peoples of the upper Solimões river (Oliveira Filho 1988). Many indigenous peoples were integrated into the regional population through interracial marriages and inserted in the category of *Caboclo* (Oliveira Filho 1988; Lima-Ayres1992), so that by the beginning of the twentieth century, the indigenous population was found in just a few localities.

In the second decade of the twentieth century, economic changes resulting from the decline in rubber prices, which led to the demise of the rubber industry, also had an impact on regional demographic patterns. Without the support of the rubber "*patrões*" (trading house owners or middlemen), and the large trading companies located in Manaus and Belém, many rubber tappers (*seringueiros*) had to search for other sources of income, and began to exploit different natural resources to diversify their sources of income. Thus, over the course of a year, ex–rubber tappers engaged in a diversity of production and extraction activities, including fishing pirarucu and hunting animals whose pelts were of commercial value. At this time there was an increased migration of families in search of better work opportunities. Families who lived in settlements situated on the margins of *igarapés* (streams) in the *terra firme* and made their living from rubber tapping decided to move to the banks of the main rivers to work in fishing and agricultural activities in the *várzea* (Alencar 2004a). The decline of the rubber industry affected not only those directly dependent upon rubber tapping, but also small producers who made a living selling manioc meal and tobacco. In some areas the tapping of rubber, on a smaller scale, persisted into the 1970s, when timber extraction began and later peaked in the late 1980s.

Up until the 1970s, commerce in the region was organized through a system of "*aviamento*," with the *patrão* at its center and with the great majority of the population living in rural areas. In the 1970s, with the decline of rural commerce, urbanward migration increased, leading to a marked decline in size of the rural population (Arnaud 1979, Lima-Ayres1992). This significantly altered the demographic profile of municipalities in the region. Between 1970 and 2000, the urban population of the

Amazon region grew at a higher rate than the growth rate of the total population, and at double the rate of national population growth; the percentage of the Amazonian population living in urban areas grew in that period from 35.7% to 68.2% (IBGE 2000). In regard to the rural population, IBGE (the Brazilian Institute for Geography and Statistics) data indicate decreasing and negative growth rates for this time period, attributable to the aforementioned factors.

Between the 1970s and the 1990s, diverse factors prompted *várzea* families to move to urban centers, among which we highlight the economic, social, political, and environmental changes. In the upper Solimões River, indigenous peoples who had taken refuge in *terra firme* areas at the headwaters of small tributaries moved to occupy *várzea* and *terra firme* areas along the Solimões River. This spurred conflicts involving the control of territory and the affirmation of cultural and ethnic identity. These conflicts resulted in the creation of several indigenous reserves in the 1980s and 1990s (Oliveira Filho1988; CEDI/PETI 1990; Alencar 2004b).

Until the 1990s, the economy of the region centered on timber extraction. However, with the new policies creating indigenous reserves, environmental legislation establishing strict controls on logging, and the intensification of monitoring on the part of IBAMA (Brazilian Institute of the Environment and Renewable Natural Resources), the timber industry faltered, and exports declined. Municipal districts like Benjamin Constant, Atalaia do Norte, and São Paulo de Olivença suffered greatly from these economic changes, which led to the closing of banks, the decay of commerce in industrialized goods and services, and the migration of the population to other urban centers.

With the timber industry in decline, economic activities shifted toward fishing (of catfish and other scaleless species) controlled by traders who were directly linked to companies located in Colombia. Fishing activities that developed along the Solimões River became the main economic activity for many families who inhabited the *várzea*. The productivity was greater in the period of greatest abundance of some species, like the *bagres* (several catfish species), that occurs in the Amazonian "summer." However, factors including the use of more efficient capture technologies, the use of dragnets by larger boats, the increase of the population of fishermen, and the consequent increase in fish captures led to a reduction of this formerly abundant resource. While these factors have affected demographic dynamics and settlement patterns in the Upper Solimões since the 1970s, the state has also played a major role in this process through the creation of new municipalities, with the intention of increasing regional urbanization as an important stage of the development process and of modernization.

## 3 Public Policies, Urbanization, and Migration

One of the most relevant characteristics of the recent demographic occupation of the Amazonian region is the pattern of intensifying and accelerating urbanization that is introducing deep changes in the structure of regional settlement. This contrasts with

what occurred in eastern Amazonia, where the intervention of the state in the settlement process did not encourage the implementation of settlement projects aimed at the construction of *agrovilas* or model cities. The state directly intervened through the process of territorial decentralization, which resulted in the creation of new municipalities and contributed to the population flow from rural to urban areas. Beginning at the end of the 1970s and lasting through the first half of the 1980s, the influence of the state was manifested through the actions of agencies such as ACAR (Association of Credit and Rural Extension), which was later replaced by EMATER (Corporation for Technical Assistance and Rural Extension), and currently by IDAM (Institute of Development of Amazonia); EMBRAPA (Brazilian Agricultural Research Corporation); INCRA (National Institute of Colonization and Agrarian Reform), which assisted families who had been dislocated after the creation of some indigenous reserves; FUNRURAL (National Fund for Rural Assistance); ITERAM (Land Institute of Amazonia); or through governmental programs such as POLAMAZÔNIA, which sought to introduce changes in production; and financial agencies such as the Bank of Brazil, which developed credit policies for the rural population, intermediated by the governmental agencies described above. The Armed Forces through the Brazilian Army and the Forest Battalions, in the name of securing the borders, had guaranteed to monitor settlement on the international frontiers.

But the single greatest factor of change in the pattern of regional settlement and the implementation of a policy to develop the north was, without a doubt, the creation of the Manaus Free-Trade Zone (ZFM) at the end of the 1960s. The Free-Trade Zone became a magnet for immigrants, not only for the majority of residents of the state of Amazonas seeking better conditions of life and social reproduction, but also migrants from other regions of the country. Part of this flow comprised people native to rural Amazonas State; many were former rubber tappers who had migrated previously from the northeast. The most attractive factor prompting this migratory flow was the promise of some tens of thousands of jobs generated by the Industrial District of the ZFM, an attraction that continues into the present.

In the 1980s and 1990s, migration toward urban areas continued. This time it was stimulated by urban deconcentration brought about by policies governing the creation of new municipalities, which were implemented during the military government and continued until after the Constitution of 1988 came into effect. With the creation of new cities, the pattern of regional settlement was reordered by concentrations of urban populations in cities of fewer than 50,000 inhabitants. As we showed in previous work (Alencar 2004a), none of the municipalities that form the Upper Solimões have more than 40,000 inhabitants. According to Wanderley (2001), a significant part of the rural population of Brazil lives in the rural zones of such small municipalities. But in the Amazon region the population is concentrated in cities of less than 100,000 inhabitants, and the number of cities with populations between 20,000 and 50,000 inhabitants has increased. This means that the capitals of the states that compose the Legal Amazon have continued to grow, although the main centers of the urban population today are small to medium-sized

cities. In the Upper Solimões, the decrease of the rural population is associated not only with the creation of new municipalities, but also with the process of demarcating indigenous reserves, as mentioned before. Dozens of families who did not claim membership in any ethnic group had to migrate to urban areas such as Benjamin Constant, Tabatinga, and São Paulo de Olivença (Alencar 2004a). The creation of indigenous reserves affected the economy of the region because it redefined territories and created new rules of access to their resources, mainly affecting families who had their livelihoods centered on the exploitation of natural resources such as timber.

While the economy of the municipality of Tabatinga was not focused on logging—it was rather a center of processing—it was also affected through the urbanward immigration of various families from the *várzea* and the *terra firme*. These families were placed in settlements created by INCRA, located in the *terra firme* in an area now known as "Incra." However, some families, particularly those native to the *várzea*, did not adapt to the settlement and abandoned their lots to move to the urban area or other cities, such as Manaus (Alencar 2004a, 2005).

It has been calculated that following the creation of indigenous reserves, production in Benjamin Constant fell by 70%, because a large part of the agricultural production that supplied the district came from households that had been displaced from areas that were situated within indigenous lands (Alencar 2005). The indigenous communities that remained in the reserves did not produce sufficient quantities to supply local markets. About 42 of the families who were displaced were relocated in the INCRA settlement of Cajarí, in *terra firme*. These families experienced the same difficulties adapting to a new environment as those that had left for the municipality of Tabatinga (Alencar 2004a, 2005), and they too abandoned the settlement and migrated to the town of Benjamin Constant or to Manaus.

The growth of urban areas coupled with the lack of alternatives for generating income caused serious problems for the governments of the municipalities. The municipality of Tabatinga, for example, generates one of the smallest taxable incomes in the region, insufficient to keep the administrative machine functioning, to take care of the demands of those families who had migrated from rural to urban areas, or to provide sufficient income through service sector jobs or from governmental aid. With the rise of unemployment and the lack of services in the public sector, there was an increase in crime and involvement of young residents in drug trafficking.

While the changes that spurred urbanization from the 1970s to the 1990s, including the creation of new municipalities, economic changes, and the formation of indigenous reserves, had lost some momentum by the end of the 1990s, considerable urban migration continued. Data from IBGE shows that in the period of 1991–2000, population growth rates in five of the nine states that form Legal Amazônia was -1.72%, demonstrating a process of depopulation of rural areas (IBGE 2000). As we saw, this change was largely a consequence of public policies, realized through different modes of state intervention.

## 4 Migration and Public Policies

The creation of new municipalities that occurred from the 1970s onward favored the decentralization of state power on the one hand, and on the other hand it created a type of freedom whose main characteristic was a high degree of dependency in relation to the federal government. This is because both cities and municipal districts depend on the transfer of financial resources, particularly from the federal government, but most tax revenues like the ICMS (municipal sales taxes) are generated in the cities that are state capitals. Too many municipalities are not economically or financially autonomous, except those that receive royalties from mineral resource concessions.[1] In the case of the Upper Solimões the main export product, fish, is not taxed, resulting in serious tax losses for the municipality and the population in general. The most serious aspect of this situation is the fact that it is an extractive economy based on animal resources that has negative impacts upon the environment without any financial returns.

A dependency on the transfer of resources places most municipalities at the mercy of federal government policies that come with strict restrictions, which municipal districts often cannot meet. However, at certain times, municipalities use their political power to establish alliances with representatives of state and federal powers, sometimes in the form of pacts between local authorities and other sectors of state and federal government. Through these alliances, small municipalities obtain resources to implement policies to promote infrastructure development, such as the building of schools, hospitals, or clinics.

The absence of public resources generates deficiencies in the delivery of social services, such as health and education, and in investments in infrastructure. These factors are associated with the migration of families from the *várzea* to the administrative centers of municipalities and districts. Precarious policies enacted by governments of the municipalities for rural communities clearly express the manner in which rural communities are treated, particularly *várzea* communities (Alencar 2004). One example is the granting of credit to the agricultural sector, where investments are directed toward *terra firme* communities, which are considered low risk; on the other hand, almost no credit subsidies are granted to *várzea* producers. Unfortunately, this is also a reality in other regions of the Amazonian *várzea* (Chibnik 1994).

Furthermore, the absence of policies to guarantee economic security and the ability of *várzea* families to recover from material losses (loss of crops and other assets) demonstrate the degree to which *várzea* dwellers are undervalued in society and are viewed as people who need to be transformed or modernized. Research carried out in the Upper Solimões showed that *várzea* credit policies are strictly geared toward agricultural production and most often subsidize seeds, which

[1]For additional reading on *várzea* municipalities that receive transfer of payments, see Neves (2005) for the Middle Solimões, O'Dweyer (2005) for the Lower Amazonas, and Silva (2004) for Foz do Amazonas.

frequently arrive outside of the planting season (Alencar 2005; Lima 2005). Moreover, during negotiations with *várzea* farmers, financial agencies do not account for the risk of material loss caused by environmental factors in their contracts. For example, periodic floods can result in the loss of crops, animals, and even farmers' residences. Such problems, caused by natural phenomena, occur every year; and yet the government has yet to develop an emergency fund to support families during these times—another factor encouraging rural to urban migration in the Upper Solimões.

Impartial and unequal treatment of *várzea* residents is also evident in policies promoting migration to urban centers, and to the *terra firme*, implemented by governments of the municipalities (Alencar 2005). Investments in health and education services as well as in community infrastructure, such as sanitation, water treatment, waste collection, and road building, are most often directed toward urban centers. Rural communities obtain services, such as electricity, when populations grow and there is thereby significant political power to pressure the governments of the municipalities. *Várzea* residents, on the other hand, do not always have their needs attended to nor their claims recognized, because they live in an environment considered inadequate due to its inherent unpredictability. Governments of municipalities do not invest in infrastructure to improve living conditions for *várzea* dwellers, because they believe better places to live and work exist, such as the *terra firme*. This belief reinforces Wanderley's (2001) argument made in his analysis of the rural Brazilian condition, that "the rural population is still the main victim of poverty, isolation, and political subjugation" (2001:36).

As in most small municipalities in Amazonia, in the Upper Solimões economic activity and social services are concentrated in medium and large urban centers; the situation of rural isolation is exacerbated by the absence of an adequate communication network between the rural villages and the administrative centers of the municipalities. This situation reinforces the impression held by the local population concerning the precariousness of services and resources offered to small towns, as well as a clear association between the number of inhabitants and the availability of financial resources.

Access to certain social services and material comforts, such as government aid in finding housing is absent in *várzea* communities. These services and comforts are only available for those who have some type of cash income, i.e., a minority of city residents. Therefore the great majority of *várzea* residents who migrate to urban areas continue to seek their livelihoods from *várzea* sources; they cultivate crops or extract natural resources, such as fish and lumber. In the municipalities of São Paulo de Olivença, Amaturá, Benjamin Constant, and Tabatinga, a significant number of families who live in urban areas work in the *várzea* cultivating manioc (cassava), bananas, and watermelons, or engaging in extractive activities, such as fishing (Alencar 2004a, 2005). These families tend to migrate seasonally between urban and rural spaces, a strategy that allows them to overcome the limitations of each locale: in the former, high rates of unemployment and in the latter, the absence of basic social services for the community (Alencar 2002).

According to evaluations conducted by governments of municipalities, migration to district capitals and administrative centers provides families with access to government assistance in education, health, and other public services (Alencar 2005). However, they also recognize that moving to urban areas often has a negative impact on people adapted to either *várzea* or *terra firme* rural environments.

Thus, although indirectly, municipal governments promote the exodus of *várzea* dwellers by their failure to invest in social services. Moreover, a reduction in the number of inhabitants in the rural area means a reduction in costs for the governments, associated with investments in rural zones including:

(a) Electricity: they no longer need to provide for so many *várzea* communities, nor provide fuel to keep the generators functioning;
(b) Construction and maintenance of schools: reducing the population reduces the demand for classrooms and for rural teachers; and
(c) Emergency material and financial support for the families in cases of floods and riverbank collapse.

In this last example, the government would need to bear the costs of constructing new residences in alternative locales.

Another aspect of this political situation is the incapability of municipal governments to offer quality services to urban residents. Municipalities that experienced significant urban population growth over the last two decades, such as Tabatinga and Benjamin Constant, have faced housing shortages and job scarcity. Many families are underemployed or depend on financial help from the government to survive. These municipalities had actually invested in social services for the rural population, adopting health policies and establishing schools as a way to settle the rural population (Alencar 2004a). On the other hand, the towns of Amaturá and São Paulo de Olivença stimulated the exodus of *várzea* populations to urban centers or the *terra firme*. In the city of Amaturá, migration of *várzea* families to urban centers has been occurring for a number of years, causing a reduction in the number of *várzea* communities within the last 20 years (Alencar 2004a).

## 5 Conclusions

In the Upper Solimões River area, governments of municipalities encounter difficulties implementing public policies for poverty alleviation by promoting conservation and management of the natural resources. Precarious health, education, and community infrastructure, as well as the absence of public programs to prop up the agricultural sector, such as lines of credit and policies supporting small-scale production, contribute to the vulnerability of *várzea* residents, rendering their livelihoods unsustainable. *Várzea* dwellers thus view migration as a way to access essential social services.

*Várzea* families identify the absence of agricultural support programs as one of the principal challenges facing their communities. Despite the importance of agriculture

in the region and the potential of the *várzea* to contribute to the development of this sector, residents look to extractive activities as their main source of income for a number of reasons. Agriculture is hindered by the absence of credit programs to support cultivation, lack of infrastructure to transport and market goods, and the scarcity of facilities that supply necessary equipment and store perishable produce. Productivity in the *várzea* is high; however, producers do not have adequate access to the processing, storage, or marketing infrastructure that would allow them to participate in consumer markets.

Investments in school infrastructure and professional training for rural teachers in educational centers, enabling them to teach all elementary grades in these selected community hubs, could allow for a decentralization of the demand for schooling, and some relief for the overburdened educational facilities in cities. These changes have been brought about by policies aimed at decentralizing education, transferring capacity to the municipalities; it has also come as a response to the demands of rural people to improve educational services at the level of municipalities. The creation of educational centers in rural areas would guarantee a reduction in urbanward migration. Migration threatens the social mode of reproduction when the failure to find work in the city forces some parents to return to the *várzea* to cultivate crops or to fish, while women and the children remain in the city. Such family migration to urban areas disrupts the forms of social reproduction characteristic of farming societies; elders cease to pass on traditional knowledge to children, impeding the continuity of a tradition of working the land and maintaining a relationship with the environment. The general tendency, however, is that these targeted rural communities or community hubs benefit from social services, such as education, at the expense of smaller communities that must depend on the hubs for any assistance or services.

In the area of health, difficulties in accessing medical services force *várzea* residents to make long and costly trips that may threaten their agricultural production. The creation of regional health centers could meet the demands of rural peoples and would reduce rural to urban migration. Policies to create rural health centers would help fix the rural population in place. This is demonstrated by the permanence of inhabitants in localities where services are actually offered.

Policies that aim to strengthen the productive sector need to stimulate the cultivation of products capable of earning high market prices as they move through the production commodity chain. The biggest difficulty for residents of *várzea* communities is not agricultural productivity, but inadequate facilities for storing and preserving products, a lack of credit programs to finance agricultural activities that require more expensive technologies, as well as technical assistance from competent agencies. To overcome these limitations and develop the agricultural sector, governments of municipalities need to establish partnerships with research institutions and agricultural extension agencies to facilitate access to technologies that are economically accessible and ecologically sound.

The implementation of public policies directed toward the improvement of basic social services and policies to support small-scale agricultural production could have positive impacts on the population dynamics of the Upper Solimões.

The families that live in the *várzea* know that the risk of losing their production is great, but they understand that, compared with life in the *terra firme* or the city, life in the *várzea* has advantages in terms of income generation, food production, and housing without need to pay rent. These types of analyses illustrate the ways in which *várzea* residents understand the social and environmental diversity of the *várzea*, the differences between the *várzea* and the *terra firme*, and between the *várzea* and urban areas. For these reasons, to understand the patterns of a particular way of life, the patterns that make that way of life different from life in other places, and the strategies that guarantee a life in conditions of social sustainability, is essential to the process of formulation of public policies.

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# Proposals, Experiences, and Advances in the Legalization of Land Tenure in the *Várzea*

**José Heder Benatti**[1]

**Abstract** This study is about land tenure and the use of natural resources in the Amazonian *várzea*. The main objectives of this research were to adjust and to formulate legal instruments to enable the conservation, sustainable use, and integrated management of the *várzea*. The possession and management of natural resources imply control. In other words, it is only possible to manage what is possessed, partially or totally. In the case of common property, this control occurs when a social group somehow retains some power over a determined area. The form of possession found in the Amazonian lowlands alongside watercourses is possession of lakes and pasture areas as common spaces, considering that each riparian inhabitant has a lot of land in the marsh where he develops his agriculture of subsistence and his habitation. Thus, the lot is the area appropriated individually, and the lake and the natural pasture play the role of common area. In the back of these lands, where there are fields and lakes, the use of these environments are collective. Although there is a notion of width based on the distance between properties and the limits with neighbors, the fields and lakes are considered an extension of the property's limits, not as private spaces, but collective ones; generally, there are no fences in native fields and the natural pastures are used commonly by the cattle, which are identified by each riparian family. The rights of the Federal Constitution of 1988 established new grounds for the relationship between society and environment.

**Keywords** Land regularization • Right to property • Environment • Amazon • Várzea

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## 1 Introduction

This chapter outlines questions and arguments developed from the larger research project "The agrarian question and management of natural resources in the *várzea:* an analysis for the elaboration of new legal models," which I coordinated in cooperation with the Várzea Natural Resource Management Project, a part of ProVárzea, sponsored by the Ministry of the Environment (MMA), and its regulatory agency, the Brazilian Institute of Environment and Renewable Natural Resources (IBAMA).[2] In addition to the work presented in this chapter, three additional studies on land tenure legalization and the use of natural resources in the Amazon *várzea* were carried out during the same period.[3]

The main objective of the project presented in this chapter was to develop appropriate legal instruments to enable conservation, sustainable use, and integrated use and management of the *várzea*. With this goal in mind we conducted four legal and technical studies related to the use of natural resources in the *várzea*. These works establish scientific and technical bases to facilitate the development of public policies for appropriate use, management, and conservation of natural resources in the *várzea* in the central Amazon basin.

Our efforts have been successful because, following the presentation of our findings, the federal government of Brazil legalized numerous *várzea* properties maintained and used by local people which we had previously analyzed and evaluated.

Since 2004, the National Institute of Colonization and Agrarian Reform (INCRA) and the Federal Patrimony Service (SPU), through a Technical Cooperation Agreement, created many agroextractive settlement projects on islands and in *várzea* areas. Through this initiative the federal government legalized almost 105,000 ha, allowing for the social inclusion of 9,309 *ribeirinho* families in the northeastern region of the state of Pará.

Despite these successes, important questions remain, such as: what is the meaning and significance of land tenure legalization in the *várzea,* and what future actions should be taken to assure the sustainability of *ribeirinho* occupation of the *várzea*?

Before entering into this debate, we discuss some aspects, which we consider important in regard to the questions presented above: (a) exactly what is the debate regarding the legal nature of the *várzea*? (b) who has the legal authority to legalize land tenure in the *várzea*? and (c) who should regulate the management of natural resources in the *várzea*?

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[3]The following researchers contributed to this project: José Heder Benatti (coordinador), Ana Carolina Santos Surgik, Antônia Socorro Pena Da Gama, David G. McGrath, and Girolamo Domênico Treccani.

## 2 Geography of the Amazonian *Várzea*

First and foremost in this discussion we must define the *várzea.* Amazonian rivers are subject to periodic floods, when water overflows streambeds and riverbanks, causing different degrees of flooding on adjacent lands. River margins that are periodically flooded by waters of rivers, lakes, and streams are what we will refer to as *várzea*.

Areas of *várzea* are lowland floodplains spread along the Amazon and its tributaries, varying considerably in width. *Várzea* areas may vary from 16 km in width at Itacoatiara, to 50 km at Parintins, 33 at Óbidos and 24 km at Santarém (Moreira 1977:15). Topographically, *várzea* areas can be divided into low *várzea* and high *várzea*. In the former, the land is flooded during part of the year, and is covered in pasture or forest vegetation. The latter is a more elevated area covered with forest vegetation, and flooded only during the highest reach of the flood.

The *várzea* is influenced by hydrological, climatic, edaphic, and floristic factors. Variation in these factors, and differences in the flood regime, result in different ecological characteristics and consequently, specific uses of the natural resources in each region of Amazonia.

Nonetheless, not all riparian areas are considered *várzea*. It is also possible to find areas of *terra firme* along the Amazon River. But in general, *terra firme* is found farther away from the riverbanks adjacent to low-lying *várzea* areas.

It is important not to confuse the classification of low and high *várzea* with the occurrence of different types of floods (small, medium, and high). In small floods, rising waters do not inundate the high *várzea*. Both the high *várzea* and part of the low *várzea* remain free of floodwaters. However, during a medium flood, water covers most of the high *várzea* and floodwaters connect rivers, lakes, and streams. In this situation the entire low *várzea* is submerged and only the highest parts of the high *várzea* escape flooding. During the highest floods, floodwaters even invade nearby *terra firme* areas.

In this study we consider only the *várzea* areas inundated by medium floods, i.e., all of the low and most of the high *várzeas*. The legal outlines of a system of land tenure that we propose here are restricted only to such areas.

Also excluded from our discussion are areas that pertain to the coastal *várzea*, that is, the geographic space situated in the lowest portion of rivers, where they empty into the Atlantic Ocean. This study is limited to communities in the *município* (akin in US terminology to a "county") of Gurupá in the Amazon River estuary (located downstream from the Amazon's confluence with the Xingu River); in the *município* of Santarem along the Lower Amazon (both in the state of Pará); and in the *municípios* of Parintins and Tefé in the state of Amazonas.

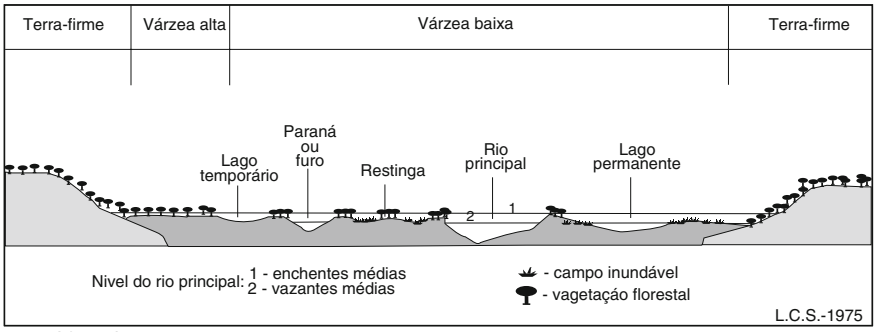
It is important to emphasize that the *várzea* is influenced by natural phenomena and comprises "a hybrid system, that involves two distinct phases, but which are linked and interdependent" (Surgik 2003:12). These phases include the period of low water (during which time the river holds the smallest volume of water) and the period of high water (when the waters overflow and cause the flooding of the river margins). We cannot understand the *várzea* without

including these two phases and, therefore, when presenting proposals to legalize land tenure and to manage natural resources, we take into account the periods of both low and high waters.

The image below shows a profile of the *várzea*, distinguishing the areas of high and low *várzea* and the corresponding vegetation types; it also shows the water levels during the period of high and low waters. The floods affect the deposition of sediments and the corresponding distribution of ecological diversity.

The physical space for which we are seeking a legal framework that would define ownership, tenure, and land use includes both the low and high *várzea*s, or what is generically termed *várzea.* These geographic areas comprise rivers, lakes, streams, other watercourses, natural levees, flooded savannas, and forests (Fig. 1). Geographically, the *várzea* is defined in opposition to the *terra firme*. Thus, it is the interrelation of diverse geographic elements and natural resources that make up the *várzea*.

However, when this natural phenomenon that is the *várzea* is analyzed from a legal perspective, it presents a different reality. The law does not address the natural phenomenon of "*várzea*" itself, but rather the environmental and social consequences of seasonal floods. In considering the legalization of land tenure what is important is to determine ownership of lands that are inundated seasonally (natural levees, lake shores and beds, ephemeral streams, and forests). Since Brazilian law considers water and rivers public goods, rivers, streams, and permanent lakes, as well as the banks of main rivers, cannot be restricted for individual use, but rather remain in the public domain. Thus, considering the issues involved in the protection and use of natural resources (water, soil, fauna, and flora) it is not whether ownership is public or private that is important, but rather the forms of access or use of those resources.[4]




Fonte: SOARES, 1977:138

**Fig. 1** Elements that compose the drainage, relief, and vegetation of the *várzea*

[4]Use must be understood in the broadest terms. Natural resources are used to sustain fishing activities, agriculture, and timber extraction. They can even be used for transportation

## 3 Definition of the Legal Nature and Ownership of *Várzea*

Based on the description above, it is possible to discuss to "whom" *várzea* areas belong. Once an initial determination of ownership of *várzea* lands is made, i.e., whether these areas are public or private, it becomes easier to discuss natural resource management issues. In this discussion, we must distinguish land ownership from the use of natural resources, because in the *várzea*, it is possible to have public land with private use of natural resources.

The first issue to be analyzed here is the legal definition of the *várzea*. Does Brazilian legislation define what the *várzea* is? Or is it a natural phenomenon that does not quite fall within accepted legal frameworks? In the latter case, a legal definition would not exist and the area would be defined in reference to natural phenomena similar to those that characterize the *várzea*. We will analyze these two possibilities.

For Treccani (2003) and Surgik (2003), Brazilian laws do not define the concept of *várzea*. In fact, we do not find any legal definition in Brazilian legislation. Vieira (1992, 1999) affirms that the *várzea* has the same legal nature as a riverbed. This author, based on Junk (1984), describes the *várzea* as composed of

> systems of riverbanks or protrusion of land that interact permanently with lakes, rivers, canals, and internal waters, in which the liquid mass that covers the land bodies during part of the year is restricted by naturally formed islands and dikes, or is simply dammed and maintained in marginal lands by the same waters of the natural stream bed during floods, thus forming alluvial ecosystems of extraordinary complexity and biological diversity. The waters that rise during flood period return to the river channel when the level of the river decreases, thus leaving evident *várzea* lands (Junk 1984; apud Vieira 1992:5).

The riverbed is defined in Article 9 of the Water Code (Decree 24643 from July 10th, 1934) as being *the surface that water covers when it is not overflowing onto normally dry ground* (emphasis added). In other words, the riverbed is an area of land usually covered by water.[5] Vieira (1992: 7) also states that the *várzea* is equivalent to a riverbed at its seasonal high-water stage.

CONAMA Resolution number 004, of September 18th, 1987 (Article 2, Letter C), defines a seasonally high-water riverbed as "an enlarged river channel or the riverbed at its highest flood stage—full during periods of annual flood."[6]

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[5] Stream beds, river beds, and channels are conduits for waters, or areas where waters run between two banks or margins. Therefore, riverbanks, being the most elevated areas of the beds, represent the portion of the streambed that contains the waters (Mendoça 1909:7).

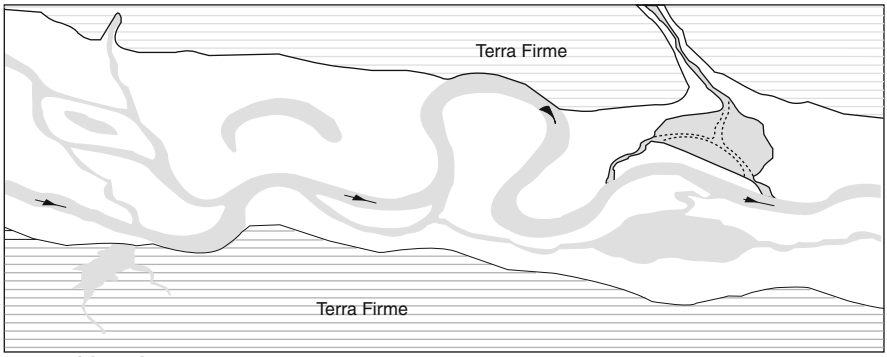
[6] Some lawyers affirm that CONAMA Resolution 004/85 was retracted with the implementation of Law no. 9985, June 18th, 2000 (Law of the System of Conservation Units - SNUC), which revoked Art. 18 of Law 6938/81. Defenders of this position argue that the revocation of Art. 18 would also make null Resolution 4/85. We defend the contrary thesis, in which CONAMA Resolution 4/85 did not follow the same faith of Art. 18 of Law no. 6938/81 and happily continues in force. Our understanding is that the CONAMA Resolution does not regulate Art. 18 of Law 6938/81; therefore it did not lose its effect. For more details see Mercadante et al. (2001).

Based on these rulings, the *várzea* would be defined as an enlarged river channel, or the riverbed at its highest flood stage. However, to analyze the question of land tenure and legalization, the *várzea* must be analyzed as two different legal elements: a water resource and an enlarged river channel/bed. To facilitate the understanding of our conception of *várzea*, see Fig. 2 below.

In the Brazilian Constitution of 1988 water is considered a public good. Law 9433/97 instituted the National Policy of Hydrological Resources and the National System for the management of Hydrological Resources. This law affirms that water is of the public domain[7] and is considered a limited natural resource in a situation of scarcity; human consumption is prioritized over animal consumption.

The constitutional determination of water as a public good has repercussions for *várzea* land tenure and ownership. The Brazilian constitution states that the Union owns, among other things, "lakes, rivers, and any water bodies in lands of its domain, or that cross more than one State, or serve as borders with other countries, or if they extend to or originate from a foreign territory." The Union also has the right to "potential hydraulic energy" (Article 20, III and VIII). According to the constitution, the State also controls "surface or ground waters, flowing or emergent waters, and those in reservoirs, in this case, according to the law, those originating from federal works (Article 26, I)."

According to Ribeiro (2003:40), "due to the new constitutional order, the waters will always be a public asset"; this is confirmed and expressed in Article 1, I, of




Fonte: SOARES, 1977:139

Álveo, leito

Calha alargada on maior do rio, lago, igarapé, paraná on furo

**Fig. 2** Composition of the *várzea* from a legal point of view

[7]The expression "public domain" is used to assign assets for public use, for use by the general population, or for restricted special use. Di Pietro (2001:531) states that "although the classification adopted by Article 98 of the Civil Code includes three modalities of assets, in relation to the legal system, only two exist," that is, State assets of public domain and State goods of private domain (*bens dominicais*), the latter being partially public and partially private.

Law 9433, which states that the water is a public property good. Therefore, no body of water can be privately owned.[8]

Since water is a public asset, the land below it, the river channel, or the riverbed at its highest flood stage, is also public. However, river waters and their respective channels (permanent or seasonal) belong to individual states when water, "in its different manifestations, does not cross federal lands or cross more than one state" (CF/88, Article 20, II), or "when water is in deposit and is not released through federal projects" (Price Waterhouse, 1989: 290; apud Ribeiro 2003: 39).

Considering this, the ownership of the *várzea* is public, and waters can be in the power of the Union or individual states, depending on who owns the water. If the waters belong to the Union, the *várzea* will be federal. On the contrary, if the water course belongs to a state, the *várzea* will be state-owned. Thus, the river channel and/or the riverbed at its highest flood stage belong to the state that also owns the water. In the case of the confluence of two or more water courses under distinct domains, the entity in possession of the greatest volume of water will be granted ownership.

## 4 Legal Instruments and the Authority to Legalize Land Tenure in *Várzea*

In this discussion, the *várzea* clearly has the legal title to the riverbed in flood or of the river, lake, stream, or other waterway at its highest flood stage; that is, it is publicly owned. Any other solution can lead to legal inconsistencies, causing us to affirm that the *várzea* is sui generis—or that specific legal conditions apply in this context. For instance, outside of the flood season when water levels are low, *várzea* lands would be designated as private, but in the high-water period, the area belongs to the public. However, the same asset, in this case *várzea* lands, cannot have two legal domains, concurrent or continuous owners.

Now that we have established a legal definition for the *várzea* and clarified its ownership, we can more easily discuss issues of land tenure and legalization. In this chapter, however, we restrict our discussion to an analysis of *várzea* land tenure and legalization in rural areas; excluded from our analysis are discussions of these issues for urban areas, including administrative centers of *municípios*, districts, towns, and villages.

The *várzea* is a public good and its resources are available for common use. Because it belongs to the public, the *várzea* is a *res extra commercium* that cannot be alienated.[9] In other words, *várzea* lands cannot be the object of legal transactions

[8]The Civil Code from 2002, in Article 1230, affirmed that "property of the ground does not include mineral deposits, mines, hydraulic energy potential, archaeological monuments, and other assets governed by special laws." While not included in the list above, the Federal Constitution and special law (Law 9433/97) excluded water from private ownership.

[9]To alienate means to transfer ownership of an asset to another person, or to transfer use and enjoyment of an asset to another person.

conducted by private parties, such as purchase and sale, donation, exchange, mortgage, pledge, contracting, leasing, or possession *ad usucapionem*, etc.

Articles 183, § 3, and 191 of the Federal Constitution assert that public property will not be acquired by seizure.[10] In this line, Article 100 of the Civil Code states that "public goods for common and special use are inalienable, as long as they pertain to the public as prescribed by the law."

Nonetheless, land use and access to natural resources can be granted through different types of public contracts, including those that grant authorization of use, permission of use, cession of use, concession of use, concession of real rights, and superficial rights. In the cases realized thus far by the federal government, legalization and access to resources has been granted through the concession of rights.

In the case of private ownership of public goods, land ownership is never transferred to the individual, but allows for resources and land to be used according to contract. Transfer of use is granted through concession contract, which is a written document that delegates power to the grantee, defines the object of use, indicates the geographic limits of the area in use and the period of use, and establishes the rights and duties of the grantees (Meirelles 1993:343).

The concession contract has the following characteristics: it is bilateral, gratuitous or incurring charges, nontransferable[11] and realized *intuita personae.* Transfer of public property for private use is granted by means of a contract[12] which depends on a previous ruling of the executive or legislative power, and is granted for a predetermined period.

Law 9636/98, Article 18, II, enumerates possible beneficiaries, gratuitously or in special conditions, of Union property: people or legal entities, in cases of public or social interest, or of economic benefit to the nation.

Therefore, the *várzea* pertains to the Union or to states with usufruct rights transferred to occupants through administrative contracts (concession contracts). As long as the environmental interests of the society are maintained, the rights of social groups to engage in nonpredatory use also will be assured.[13] Thus, while the adequate use of the area exists according to contract, and the contract remains viable, use rights can be granted to occupants' heirs. But if there is a breach of contract due to modification of use, land returns to the domain of public administration.

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[10]In a similar work, we find Article 102 of the Civil Code affirming that "the public goods are not subject to "*usucaption"*.

[11]Commutable is exchange or replacement used in onerous contracts or occurs when there is substitution of one form of payment for another.

[12]To grant is to give or confer something with or without compensation. A grant is an agreement that creates a right of any description other than the one held by the grantor. In Brazil a grant is the permission to use public property.

[13]In the case of land tenure legalization for an individual family property or community properties, the concession contract also serves to assure means of traditional organization of the favored social group.

Whatever the motive is for ending the contract of use—breach of contract or interest of parties—previous concession holders have the right to compensation for improvements to the area and work carried out on the land, just as in a relationship of occupancy.[14] In the event of damage to the environment, the responsible party will be penalized civilly and criminally for these acts, in addition to having their contract rescinded, since it is no longer legally sanctioned.

The concession contract includes a use and management plan for the area in question,[15] approved by the public agency in charge governing this zone.[16] The contract is guided by a natural resource management plan, and includes clauses for rescinding use rights in the case of environmental damage. A public legal entity authorizes gratuitous use to the local population, stipulating against damage to natural resources, in accordance with the management plan issued by an authorized environmental agency. The management plan is therefore an integral part of the transfer contract. It is the responsibility of the granting legal entity to supervise the use of resources and assure the fulfillment of the conditions stipulated in the contract and management plan.

To regulate land tenure in a granted area, the concession contract can be signed by a legally recognized residents' association that represents all inhabitants in a particular area. The contract can call for a collective or an individual system of land use, as long as all community members approve a single use and management plan for the area.[17]

In sum, land tenure regulation is based on a concession contract, as *várzeas* areas belong to the public, where property cannot be transferred to private parties, "making null, therefore, all and any registration of private property" (Treccani 2003:15).

The legalization of land tenure is designed to reify or make concrete state ownership (when it refers to conservation units, marine, and *várzea* land) on lands within

[14] An exception to this rule may occur if the concession contract explicitly indicates *ribeirinhos* will not be paid for improvements in the following situations: (a) when the grantee is given diverse use rights in the contract; (b) if a breach in contract occurs; (c) if the grantee rescinds the contract, or if the area is not adequate to provide the means to sustain his/her activities, (d) in the case of environmental damage, transfer of use rights (with the exception of inheritance) or violation of the management plan.

[15] The natural resource use and management plan is a written document developed by residents of the area in question, with the intention of defining social and economic activities elaborated in the *várzea* areas to be legalized under land tenure laws.

[16] At the present moment, to legalize land tenure of Union properties (see Memorandum 167/01 GEAES/GEAPN and Memorandum 10/02 GEAES/SPU), the interested party must direct his/her request for a concession contract to the Regional Federal Patrimony Service (GRPU) or the Secretary of Federal Patrimony (SPU) of the Federal Patrimony Service (SPU), along with other documents and information. The order must be followed with a preliminary proposal of the activities to be carried out in the area or a summary of proposed use. In our proposal, the plan of use will be substituted for the preliminary proposal, because it has the same function, that is, to inform the agency of how the interested party intends to use the public good.

[17] The advantage of developing a unique use and management plan for a concession area is that it facilitates the management of this area, as well as the resolution of possible disputes over natural resources.

the limits of the area to be regulated. Only through the legalization of land tenure is it possible to secure land ownership and the use of natural resources. In the case of traditional populations and *ribeirinhos*, the law seeks to legalize the existing occupation of land and resources.

The land tenure legalization process must take into account two basic premises:

(a) the ecological integrity of the *várzea* environment (ground, flora, and water resources); and
(b) different agricultural and forest management patterns; in other words, different forms of occupation and use of the natural resources.[18] Land tenure legalization for traditional or *ribeirinho* populations cannot simply consider land used for agricultural activities, in other words, *restingas* (natural levees). To obtain economic and ecological sustainability of the *várzea* areas, the *restingas,* savannas, lakes, and rivers must all be considered.[19]

For these reasons, land tenure legalization in the *várzea* must respect the ways in which resident *ribeirinhos* use natural resources. Legal guidelines that inform land tenure policies must consider the interests of diverse actors and account for differences in natural environments, as was demonstrated in the studies of McGrath (2004) and Treccani (2003). In these studies three categories of rural property were identified, according to their use of natural resources and the size of landholdings:

(a) medium and large rural property (individual possession more than four fiscal land units);[20]
(b) small rural property (individual possession four fiscal land units or less) plus the common area (pasture and community [communal] lakes);[21]
(c) common property or communal area (area of *restingas*, pastures, and community lakes).

The procedure of land tenure legalization is the same for all these classes and respects the particulars of appropriation and use of the natural resources. However,

[18]For a complete debate on land occupation by traditional communities and its repercussions on legislation, see Benatti (2003).

[19]In *várzea* areas the area of land occupied by individual families is limited in depth by lakes and other bodies of water; its lateral limits are well defined. This spatial division assures that all families have access to the four main environments of the *várzea* (running water courses, natural levees, natural savannas, and lakes). This arrangement must be recognized and upheld, since it assures the viability of household economies in the *várzea* (McGrath 2004).

[20]Fiscal Land Units (MF) are set by INCRA and are defined by the laws of each Brazilian *município*, according to Article 4 of Decree 8485, from May 6th, 1980.

[21]McGrath (2004) indicates that a large percentage of rural properties in the *várzea* measure less than one MF; that is, less than 3 ha. However, when land tenure legalization includes natural levees, communal pastures and lakes, the total area per family exceeds the MF. Therefore, these areas cannot be classified as insufficient for a family's subsistence (also called *minifúndio*). Family properties and rural land units (MR) are synonymous. Thus, MR takes into account the minimum conditions for profitable resource use and extraction and social benefits of the property (Art. 4 of Law 4504/64 – Land Act).

the federal government has limited land tenure legalization to small and communal properties with the creation of Agroextractive Settlement Projects—PAE.

PAEs are areas designated for the extraction of natural resources, through viable, economically and ecologically sustainable practices executed by local occupants (Administrative Rule/INCRA 627, of July 30th, 1987). INCRA is responsible for the creation and administration of these settlements and the area continues to pertain to the public; however occupation is private (individual or collective).

Medium and large rural properties in the *várzea* prioritize the use of forest and soil resources.

Occupants of small and communal rural properties must take into consideration the use of forest, soil, and water resources, as these environmental resources guarantee the social, economic, and environmental sustainability of the *várzea*. Moreover, the grantee must take into account the community's common areas and those dedicated to individual family use once the limits for use are defined in accordance with local customs, as well as agricultural and environmental legislation.

## 5 Premises for Sustainable Management of Natural Resources in the *Várzea*

Today, when we think about management, we presume it is sustainable; in other words, when we use natural resources, we should do so in a sustainable fashion, without inflicting permanent environmental deterioration, and within the technical and scientific limits to minimize the loss of native biodiversity.

The challenge of resource management lies in the fact that it involves ecosystem manipulation to promote the growth of desirable species for their economic exploitation, or to facilitate other human activities, all of which can have negative effects on less desirable species. From this perspective, management planning seeks to diminish potential adverse impacts to promote sustainable land use.

The multiple use management plan is a planning instrument used in both private and public areas and consists of a series of practices to guarantee the use and protection of natural resources. The main objective is to establish management guidelines to assure the protection of the natural resources within specific areas.

To this end, the objective of conserving native vegetation on rural properties is to maintain ecological services intact. These areas are not simply timber reserves or more generally reserves for biodiversity. Natural resources provide basic environmental services important to sustainable agriculture and extractive activities important to local communities and their economies. Among these services, we emphasize: biological diversity, maintenance of microclimate, soil fertility and humidity, maintaining underground water supplies and water springs, recycling of nutrients, erosion control, supply of raw materials, etc. All of these services are important because, in addition to their role in ecosystem functioning, they make farming activities more profitable in the medium and long term.

Therefore, the benefits of maintaining ecological services can be viewed as belonging to two categories: resources for current and future agricultural activities, and those specifically related to the environment. While the former is of direct interest to rural workers and communities, as it guarantees the sustainability of agriculture, the raising of livestock, and natural resource extraction, the latter is linked to the health of the environment, and thereby of interest to society.

The search for systems that integrate agricultural activities with management of natural resources is essential to the protection of the environment, as these systems offer as an immediate benefit the maintenance of ecological services provided by renewable natural resources.

The process of sustainable management must consider these basic premises:

(a) There is great environmental diversity in the *várzea* and the *terra firme* (soil, forest, and water resources).
(b) Land use strategies and natural resource use is very diverse on the levels of both household and community economies; these commonly involve agriculture, fishing, extraction of forest products, small animal husbandry, cattle raising, and subsistence hunting.
(c) Internal rules to guide natural resource use should not contradict environmental legislation already in place. However, current environmental legislation that regulates forestry management needs to be reviewed to account for communal land use and organization, and local resource management.
(d) Management plan rules must be flexible and periodically reviewed and adjusted to shifting socioenvironmental realities.
(e) The complexity of the land use activities must be compatible with the organizational capacity of the community group responsible for the project, and the development of activities must follow the development of the group's capacity.
(f) Administrative rules of management must to be reviewed to foster integrated management, and not merely regulation of single activities; in other words, laws that regulate forest management and deforestation in and of rural areas in the Brazilian Amazon must be unified.
(g) The main objective of environmental protection, as well as of community management, must be the maintenance of ecological services offered by natural resources.

## *5.1 Management of Rural Properties*

Regulation of renewable natural resource use and exploitation of rural properties in Amazonia should take a holistic approach; in other words, we must analyze the regulation of agricultural activities, and forest and water resources, considering the social function of the land, the rational and appropriate use of available resources, as well as the preservation of the environment (Article 186 of the Federal Constitution).

However, a fragmented approach is the current reality of public administration. To regulate the use of forest resources on private and public properties, the government issued two administrative regulations (Administrative Regulation/MMA 3, from April 3, 2002, regulating procedures for the use of soils and conservation through permission to clear forest in Brazilian Amazonia; and Administrative Regulation/MMA 4, from April 3, 2002, regulating the exploitation of old-growth forests in the Amazon basin through sustainable multiple use forest management), each of which regulates a specific activity. This clearly demonstrates the methodology of regulation of natural resource management; the approach does not consider the possible interrelations between timber extraction, forest management, and other forms of land use.

In our opinion, the division created by these policies demonstrates the fragile nature of government environmental policy, which does not take into account the basic nature of smallholder production and livelihood processes that depend on interrelationships between agriculture, extraction of forest products, and fishing, and a system of economic and social organization that revolves around the household for the exploitation of natural resources.

Therefore, rather than requiring specific, separate permits to manage and to cut forests on individual and community properties, it is more important to develop integrated management systems that allow for both agricultural activities and forest use; or rather, to promote integrated management of multiple natural resources (soil, flora, and water). For this reason, in Amazonia, household and community properties would be better classified as zones of agroextractive production, each with its own social, cultural, and economic attributes.

## *5.2 Water as a New Element for Structuring Environmental Management*

To implement participatory multiple-use resource management plans for areas granted under concession contracts, it is necessary to integrate existing social entities, including social organizations and unions. Management plans are structured around watershed basins, and consist of three institutional groups: the community (residents), watershed basin committees, and the management committee for each concession area. The management committee is composed of representatives of watershed basin committees, social representatives active in the area, and representatives of the agency regulating the area, if they find it necessary to participate.

Watersheds or basins are the principal units for water resource management, and for this reason provide an appropriate basis for the management of natural resources. Once the geographic extent of each watershed basin has been defined, a management committee is created for each basin. Management committees are composed of representatives from communities located within the watershed basin, and are responsible for the design and implementation of management plans in the basin. Management plans for each concession area must be based on the

management plans of each individual watershed area, in cases where there is more than one watershed basin within the area. Consequently, management plans help to regulate access to and use of the natural resources, and serve as guides for the development of multiple-use management plans for concession areas.

In the context of regional environmental management, which is conducted through management of concession areas for integrated community use of natural resources, the creation of regional watershed basin committees is fundamental, as foreseen in Article 38 of Law 9433/97. It is these committees that promote debate on issues related to water resources and coordinate the activities of social entities in the region. In case of conflicts over use between residents of concession areas and third parties or within areas, the regional watershed basin committee is the administrative party that steps forward to mediate these conflicts. Likewise, one of the objectives of the committee is to guide the rational and integrated use of the water resources, including transportation, to promote sustainable development.

## 6 Conclusion

Economic use of periodically flooded areas is, from a legal standpoint, a complex problem. The questions of use and management of natural resources in these areas are not treated in a unified manner in Brazilian legislation. Here we identify three overlapping issues of concern: public or private ownership of *várzea* lands; conflicting interests between particular parties concerning ownership or occupation rights in relation to the use of soils, as well as aquatic water resources, mainly for fishing; and diverse aspects of the regulation of economic activities by the State, which focuses public policies on the preservation and sustainable management of natural resources. The lack of a legislative approach that recognizes the specificities of the problems related to *várzea* land use, and the great variation in legal references that address economic use of these resources, makes it impossible to come up with generalized solutions to conflicts that arise.

Issues of land ownership, exploitation of fisheries, and extraction of forest products are linked to the use of marginal lands, of river waters, lakes, islands, and aquatic fauna. These subjects are related not only to the laws in place, but to political decisions made at various levels, and need to be adequately evaluated to implement public policies for the *várzea*.

In this context, this study is presented as an analysis of the socioenvironmental reality of the *várzea.* It is part of a search for solutions to overcome the current impasses regarding control and use of the natural resources, with the goal of achieving sustainable management and legal security in the use of lands, waters, and vegetation in the *várzea*.

With the definition of *várzea* areas as public property, and the presentation of a proposal to legalize land tenure, the state can speed up the process of legitimizing historical rights to the access to, and the use of, natural resources throughout

the Amazon River Valley. It is essential to advance public policies that will prioritize legal, secure rights to *várzea* lands that *ribeirinhos* have long been demanding.

In conclusion, however, the economic, social, and environmental sustainability of *várzea* areas depends on how they are managed on the levels of the household, community, and landscape. To achieve the goal of sustainability, of using the land with minimal impact, we need to move beyond land tenure legalization and the recognition of land rights. It will be necessary to implement policies that promote integrated management of *várzea* landscapes. In other words, we need policies that integrate individual, collective, and environmental interests.

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# Cities Along the Floodplain of the Brazilian Amazon: Characteristics and Trends

**Sandra M. Costa and Eduardo S. Brondízio**

**Abstract** The Amazon region has been categorized as an urban forest since 1980, when the number of urban inhabitants exceeded rural ones. The floodplains of the Solimões-Amazon Rivers and the estuary within and around Marajó Island, where the region's oldest cities are located, have experienced similar trends but significantly different rates of urbanization when compared to cities of the Brazilian Amazon region as a whole. During the last decade, for instance, while other Amazonian municipalities continued to see a decline in rural population, some floodplain areas, such as those within the estuary, continued to maintain and even experience growth in their rural populations. In this chapter, we characterize cities and municipalities located along the floodplains of the Brazilian Amazon in terms of historical formation, demographic trends and dynamics, and their infrastructure. We define municipalities and respective cities along the floodplains using the classification proposed by the federal ProVárzea Program. We use a combination of demographic census data (urban, rural, and total population), and archival and historical sources (IBGE 1970–2000; CNM, 2007). Using household-level data from the 2000 demographic census, we present information on access to infrastructure and public services (electricity, public lighting, paved roads, water systems, sewage systems, and waste collection), migration (1990–1995), and other demographic changes (including data on movements for educational and employment purposes from 1995–2000). Using data from the RAIS program of the Brazilian Ministry of Labor (RAIS: Annual Report of Social Information), we examine trends in the employment and economic sectors of these cities between 1985 and 2005.

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Our discussion focuses on two main issues. First, we examine historical differences in formation, distribution, and rates of urbanization. Created along rivers, floodplain cities formed an important urban network during the formative period of Brazil, playing strategic demographic, economic, and geopolitical roles which guaranteed the effective occupation of the country's northern region. Second, we call attention to similarities between floodplain and other Amazonian cities. As in the other cities, urban conditions and infrastructure along the floodplains are poor. Limited access to infrastructure and low quality of services are widespread. Growing demands on urban services and the limited economic possibilities of the municipal governments result in a generally pessimistic trend of continuing urban problems and lack of prospects for short-term improvements in the quality of life.

**Keywords** Floodplain cities • Urbanization • Urban services • Migration • Rural-urban linkages

## 1 Introduction

The Amazon region has been categorized as an urban forest since 1980, when the number of urban inhabitants exceeded rural ones (Becker 1985). Even though it continues to be considered an "agricultural frontier," its urban population has increased at a faster rate than its rural counterparts (Becker 2005; Correa 1987; Sawyer 1987, 1997; Browder and Godfrey 1990, 1997; Browder 2002; Machado 1988). The intensity of the urbanization process in the Amazon region, however, has not been followed by proportional investments in urban infrastructure (Roberts 1992 and Perz 2000). As a result, Amazonian cities are deficient in terms of infrastructure and services, as well as employment. They are, however, still considered an "El Dorado" by many people; a safeguard against landlessness and a base for rural families to access urban services and employment opportunities that are absent or even more precarious in rural areas (Padoch et al. 2008; Costa and Brondízio 2009). While they do share some characteristics, the rhythm of regional urbanization is not a homogeneous one, as Amazonian cities vary in history, age. and location within the region.

The floodplains of the Solimões-Amazon Rivers and the estuary within and around Marajó Island, where the region's oldest cities are located, have experienced similar trends but significantly different rates of urbanization when compared to cities of the Brazilian Amazon region as a whole (Fig. 1).

By 1970, municipalities[1] along the floodplains were already predominantly urban, when compared to those in other parts of the region, and they continued to experience increasing rates of urbanization through the 1980s, 1990s, and 2000s.

[1]The Brazilian Institute of Geography and Statistics (IBGE) defines as "city" all administrative seats of a municipality.

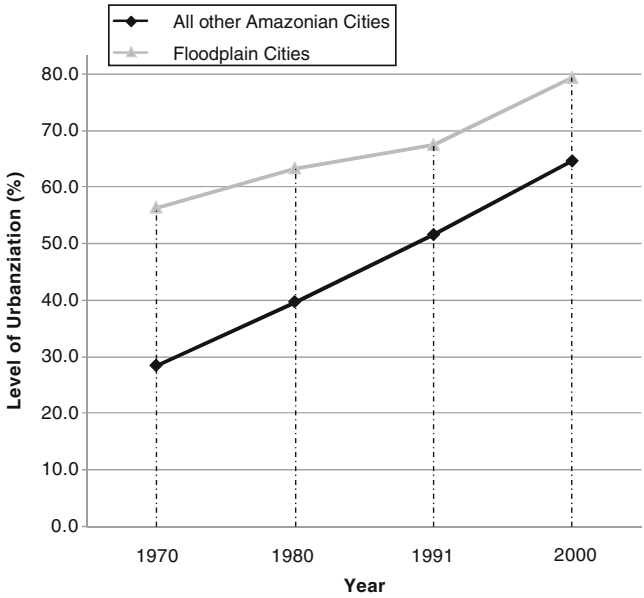


**Fig. 1** Comparing levels of urbanization between cities of the Brazilian Amazon region as a whole and the region's floodplain area

Strongly influenced by Belém, Manaus, Santarém, and Macapá, these heavily populated floodplain municipalities had reached close to 80% in level of urbanization by 2000, compared to 64% for the region as a whole. During the past decade, these trends have been changing in interesting ways. There is significant variability in population dynamics among cities along the floodplains as a result of the type of their economies, geographic location, transportation, and proximity to large urban centers. During the last decade, for instance, while other Amazonian municipalities continued to see a decline in rural population, many floodplain areas, such as those within the estuary, continued to maintain and even experience growth in their rural populations. Increasing market value for valuable floodplain resources, such as fish, timber, fruits, and cattle, together with policies supporting legalization of land tenure and the creation of mixed-use conservation areas has helped rural areas to remain viable, while becoming increasingly connected to urban economies and demographic trends.

In this chapter, we characterize cities and municipalities located along the floodplains of the Brazilian Amazon in terms of historical formation, demographic trends and dynamics, and infrastructure. We define municipalities and respective cities along the floodplains using the classification proposed by the federal ProVárzea Program. We use a combination of demographic census data (urban, rural, and total population), and archival and historical sources (IBGE 1970–2000; CNM 2007). Using household-level data from the 2000 demographic census, we present information on access to infrastructure and public services (electricity,

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Our discussion focuses on two main issues. First, we examine historical differences in formation, distribution, and rates of urbanization. Created along rivers, floodplain cities created an important urban network during the formative period of Brazil, playing strategic demographic, economic, and geopolitical roles which guaranteed the effective occupation of the country's northern region. Second, we call attention to similarities between floodplain and other Amazonian cities. As in the other cities, urban conditions and infrastructure along the floodplains are poor. Limited access to infrastructure and low quality of services[3] are widespread. Growing demands on urban services and the limited economic possibilities of the municipal governments result in a generally pessimistic trend of continuing urban problems and lack of prospects for short-term improvements in the quality of life.

## 2 Floodplain Cities of the Solimões and Amazon Rivers and the Estuary

The Amazonian floodplains include the richest ecosystems of the region with unparalleled biological productivity, aquatic and terrestrial biodiversity, and natural resources that have sustained large-scale populations since pre-Columbian times, as well as the region's most significant economic booms. Today, more than 1.5 million rural riverine inhabitants (*ribeirinhos*), manage, produce, and extract resources for consumption and markets of local, regional, national, and global import. The floodplains occupy more than 300,000 km$^2$, throughout the Amazon-Solimões river channel and its main tributaries, equivalent to around 6% of the surface of the Brazilian Legal Amazon (ProVárzea 2008) and an estimated 75,000 km$^2$ in the estuary (Saatchi et al. n.d.).

According to the Brazilian Ministry of the Environment (IBAMA 2008), despite the region's high productivity and natural resilience, current development trends and rates of resource use are leading parts of the region toward gradual degradation: deforestation, erosion and siltation, agricultural and urban pollution, cattle ranching, destruction of lakes, and extensive squatter settlements in growing cities (Lima 2005).

[2]RAIS reports annually on employment rates in the formal sector, i.e., registered workers with benefits as defined by government regulations.

[3]Services include access to water, sewage, electricity, street pavement, and waste collection.

A study supported by ProVárzea[4] of 18 *municipios* of the Amazonian floodplains (Lima 2005) showed important differences and similarities between municipalities located along the floodplains of the Solimões and Amazon rivers, associated with their location and environmental characteristics. While the whole region is known for its strong fisheries economy, cattle ranching has grown in importance on the Amazon floodplains and the estuarine grasslands. Similarly, social life and organization are strongly influenced by the risks associated with variations in river levels (e.g., flooding of gardens and homesteads, and erosion), the seasonal availability of resources, and the impact of this variability on commercial activities and consumption. The region is equally challenged by a scant presence of state services, and, in certain regions, a sociopolitical and economic structure reminiscent of colonial times (Lima 2005; Brondízio 2008; this volume). Land tenure has increasingly been legalized, particularly in areas close to large urban centers and within multiple-use protected areas, but tenure remains one of the region's most challenging problems (see Benatti; McGrath et al., this volume).

Based on criteria defined by IBGE, our analysis includes the six macro-regions of the Brazilian Amazon floodplain: Alto Solimões (9 municipalities), Médio Solimões (9 municipalities), Médio Amazonas (12 municipalities), Baixo Amazonas (16 municipalities), and the estuarine region (29 municipalities) (Fig. 2). Together, and considering their extension to the uplands, these 75 municipalities occupy an area equivalent to almost 912,000 km$^2$; these municipalities vary significantly in size. Some are relatively small, with their political

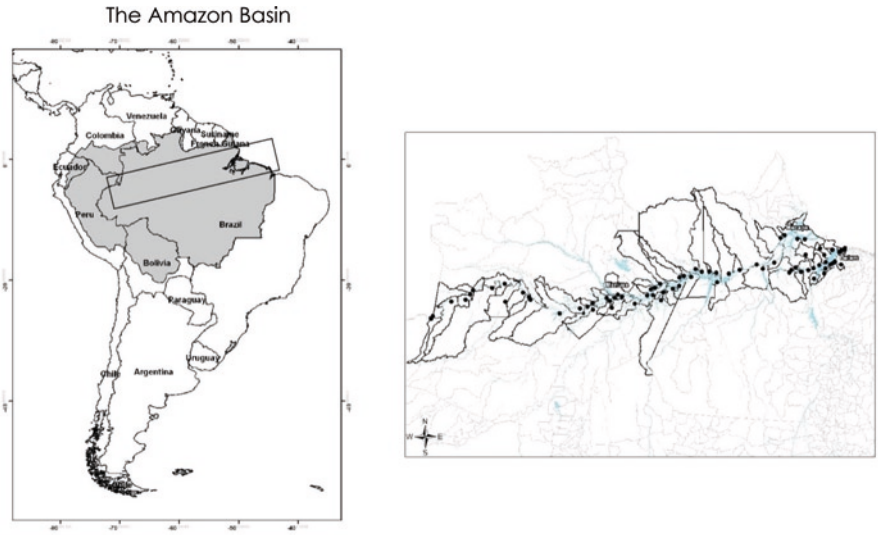


**Fig. 2** *Municípios* and cities located in the floodplains of the Brazilian Amazon

[4]ProVárzea—Projeto Manejo dos Recursos Naturais da Várzea (Project of Natural Resources of Lowland Management)—is supported by IBAMA (Brazilian Ministry of Environment).

boundaries contained within the floodplains (e.g., Carreiro da Várzea and Bujaru). Others, such as Almeirim, Oriximiná, Coari, Tefé, and Jutaí, have immense territories and dispersed rural populations. In all these municipalities, urban life is restricted to the political seat of the municipalities, which is always located along the river. The floodplain zone also includes the Amazon's largest cities, such as Manaus and Belém with their respective urban population exceeding two million inhabitants, as well as Macapá and Santarém, that are also of major economic and political importance.

In aggregate, with only 0.25% of their area classified as urban, floodplain *municipios* are rural territories. Seven *municipios* account for 71% of the total urban area of the floodplains and 80% of the urban population: Manaus, Belém, Macapá, Tefé, Ananindeua, Santarém, and Parintins. Yet, small and large, floodplain urban areas are crucial to rural populations as they provide basic infrastructure, services, and, for many, hope to improve their lives.

## 3 An Historical Overview of Floodplain Cities

The first city founded in the Brazilian Amazon was Belém, created in 1616 as a fortification for Portuguese territorial possession and to protect the entrance to the Amazon River from foreign incursions (Penteado 1968). Many other cities along the main channel were created to protect Portuguese possessions, as missionary outposts, and as hubs for resource extraction and export, forming the region's proto-urban framework. These included, for instance, cities such as Santarém, created in 1661, Manaus in 1669, Tabatinga in 1730, and Macapá in 1738 (CNM 2007). Of the Amazon's five oldest cities, four are situated in the floodplains.

As illustrated by Fig. 3 most floodplain cities were created before 1910 (42.5%), and about 66% were created before 1950. The relative historical depth of floodplain cities can be seen through their peculiar and important architectural heritage, best illustrated by the monumental buildings constructed during the golden years of the rubber boom, such as the "Teatro da Paz" and "Teatro Amazonas," in Belém and Manaus, respectively.

Although the floodplain's largest cities are also its oldest (Belém, Manaus, Macapá, Santarém), in general the region presents a nonlinear correlation between age and population size, at least when compared to the Brazilian Amazon as a whole (Costa and Brondízio 2009). While 16 of the 20 largest cities were created before 1990, the remaining 59 cities vary significantly in population regardless of their age. Among the five largest cities (urban populations larger than 100,000 inhabitants), only Ananindeua was founded in the twentieth century (1943), as part of the Belém Metropolitan Region.

Small floodplain cities[5] have been created over three centuries of regional occupation: 31.5% before 1900; 23.5% between 1930 and 1950; 21.5% between 1950 and 1961; 19.5% between 1981 and 1990; and 4% after 1993. Earlier cities

[5]The number of small cities includes 51 cities with urban populations ≤ 20,000 inhabitants.

emerged predominantly around trading posts and missionary outposts close to Indian villages but were definitively shaped by the Directorate policies of 1750 and the period of expansion of the rubber economy between 1850 and 1910 (Fig. 3). As Machado states, "throughout the centuries, even during pre-Columbian times, the geographic organization of the population in the Amazon region followed the region's fluvial network. At the beginning of the seventeenth century, when the Iberians occupied the valley with the objective of controlling the territory of the basin, they chose sites with high densities of indigenous peoples, located near extensive floodplains, which characterize most of the valley of the river Amazon and its main tributaries" (Machado 1999, authors' translation).

An Amazonian urban network began to show signs of organization in the eighteenth century, with economic, social, and administrative policies defined by Marques of Pombal, favoring in particular cities such as Belém and Manaus. In 1800, these cities had, respectively, 24,500 and 1,872 inhabitants, a difference which decreased significantly early in the twentieth century when Belém reached a population of over 236,400 inhabitants, and Manaus, 169,263. Belém also was the most important city during the rubber boom period as most export enterprises were located there. The social inequalities within urban agglomerations observed today were already evident at that time. Following the crash of the rubber economy, floodplain cities lost, at least in part, their economic strength and influence.

In 1966, the Brazilian government created the so-called Operation Amazon (Operação Amazônica), followed by the National Integration Plan (PIN), which was implemented beginning in 1970. As a series of public policies aimed at occupying

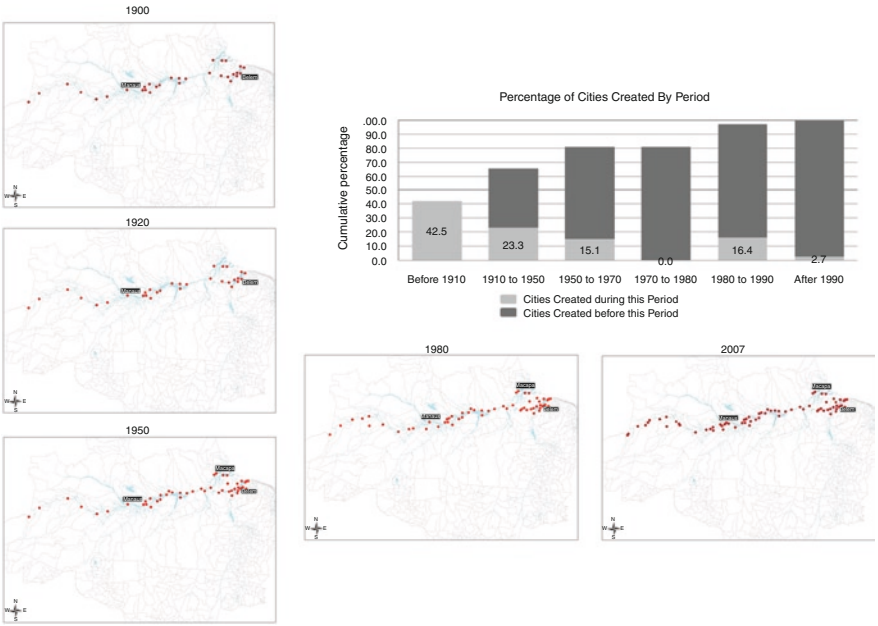


**Fig. 3** Cities along the floodplains by time period: (**a**) by 1900; (**b**) by 1920; (**c**) by 1950; (**d**) by 1980; (**e**) by 2007

and incorporating the region into the national political-economic system and demographic framework (Browder and Godfrey 1997; Corrêa 1987; Becker 1985; Machado 1999), the plan initially affected floodplain cities only indirectly, except for the largest cities, including Santarém, Belém, Macapá, and Manaus, which received state investments. The Manaus Free Trade Zone was created in 1967 and over the years transformed the city into the region's largest urban area, surpassing even Belem by 2007. Between 1970 and 1980 the population of Manaus increased from 311,622 to 633,392 inhabitants, and kept growing. Such exponential increases in population led to a process of subdivision in Manaus, which after 1980 had its original municipal territory broken up into Carreiro da Várzea, Anamã, Beruri, Manaquiri, and Iranduba.

Since the 1970s, the process of urbanization of the floodplains has heralded trends which have progressively shaped the region as a whole. Conversely, in spite of a growing road transportation network in the region, a large number of small floodplain towns continued to be accessible only by rivers (Vicentine 2004). Faster modes of transportation and communication have greatly increased these interconnections, not only between rural and urban areas, but also between urban areas along the floodplains. While the strong rural resource economy of the region supports a wide range of markets, industries, and employment (particularly informal employment), cities offer more opportunities for education, health, and employment. Again, cities along the floodplains are heralding a new concept of the urban in the Amazon region: cities with ever stronger links to the surrounding rural environment and to each other (Padoch et al. 2008). As in other parts of the Amazon, floodplain cities are increasingly embedded within a growing network of people and resources, marked by increasing interdependency between rural and urban, and urban and urban.

## 4 Cities in the Amazonian Floodplains: Characteristics and Trends

### *4.1 Population, Urbanization and Infrastructure*

When we look at the entire Brazilian Amazon, including the floodplain, urban populations have typically been concentrated in large cities (e.g., the capitals of Brazilian Amazonian states alone concentrate about 37% of the urban population). However, a growing percentage of the population lives in small urban centers: in 2000, 64.1% of the Amazonian urban population lived in cities smaller than 20,000 inhabitants (Guedes et al. 2009). When we consider only the Amazonian floodplain, the picture differs significantly (Fig. 4).

Small cities, while predominant, represent only 8.2% of the urban population of floodplain cities. The two largest cities, Manaus and Belém, concentrate almost 60% of the urban population. As mentioned above, if we add the urban population

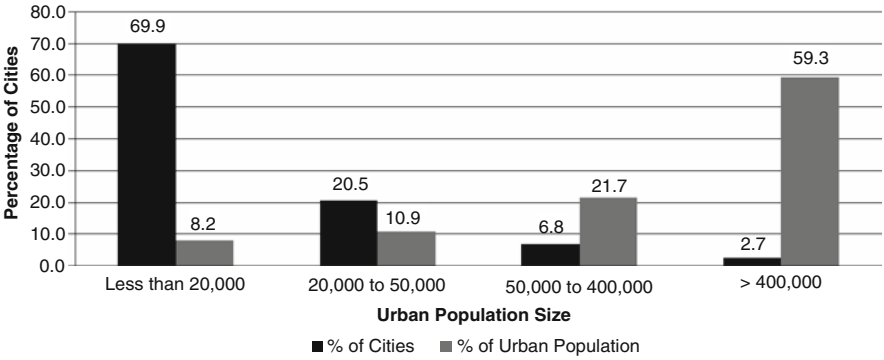


**Fig. 4** Percentage of cities according to urban population size and percentage of urban population for municipalities located along the floodplains of the Brazilian Amazon in 2000 (IBGE 2000)

of Ananindeua, Macapá, Santarém, Abaetetuba, and Parintins,[6] the proportion of urban residents living in medium and large floodplain cities corresponds to about 80% of the total. These cities not only continue to dominate the region in terms of population, but also in economic, political, cultural, and educational[7] importance.

According to the Brazilian Census of 2000, the most populated municipalities of the floodplains (Manaus, Belém, Ananindeua, and Macapá) are also the most urbanized. Twenty-seven of these municipalities have more than 50% of their population living in the urban area. Forty-six municipalities have less than 50% of their population living in urban areas. In this sense, population size and level of urbanization are not directly correlated for most floodplain cities, which indicates the importance of rural economies and activities to these districts.

The different levels of urbanization found among floodplain cities tend to reflect the importance a city may have within a subregional urban network, such as its ability to attract surrounding rural and migrant populations.[8] This aspect can be noted by looking at the data on the circulation of people[9] (Brazilian Census 2000). The city of Belém attracts 28.4% of the population involved in this sort of movement within the Brazilian Amazon (Table 1). Other floodplain cities, such as Ananindeua, Manaus, Macapá, and Santarém account for another 4.5% of this movement in the Amazon region as a whole. Considering only the states where these cities are located, we can see some interesting patterns: In the state of Amazonas, Manaus (today the largest city of the Amazon), Coari, Parintins, and Itacoatiara, which are considered medium-size cities, account for 54% of this movement. In the state of

[6]Medium-size cities with urban population bigger than 20,000 and smaller than 400,000.

[7]All these cities have at least one campus of a federal or state university.

[8]We are not discussing here the causes of migration, only how it is related to a typology of cities defined in terms of number of migrants and number of inhabitants.

[9]Circulation or circular migration (*movimento pendular*) is defined by IBGE as the movement of people between *municipios* (or states) for the purpose of work and/or study.

**Table 1** Circular migration in the Amazon floodplain

| City | Frequency | % of total for Brazilian Amazon |
|---|---|---|
| Belém | 91,382 | 28.4 |
| Ananindeua – PA | 5,312 | 1.7 |
| Manaus | 4,235 | 1.3 |
| Macapá | 3,431 | 1.1 |
| Santarém – PA | 1,307 | 0.4 |
| Total Várzea | 105,667 | 32.9 |
| Total Brazilian Amazon | 321,418 | 100 |

Pará, Belém, Ananindeua, and Santarém (the last two, important medium-size cities), account for 67% of the state's circular movement. The city of Macapá attracts 60% of Amapá's movement. These data reinforce the role of city size in defining their importance within an interurban network, and the rise of medium-size cities as significant nodes within subregional and regional socioeconomic and demographic networks.

Migration is another aspect that permits us to measure the importance of a city within a region, as it indicates pull and push factors such as the availability of services, job opportunities, and quality of life. Ten cities located along the floodplains received 15.3% of the total immigrants of the whole Brazilian Amazon. The region's largest cities, including Manaus, Belém, Ananindeua, and Macapá, all located in the floodplain, received 13.5% of the total immigrants to the region between 1991 and 1995. Some medium-size cities, such as Santarém, Barcarena (an important industrial center), and Abaetetuba, located in the State of Pará, and Itacoatiara, Tefé, and Parintins, in the State of Amazonas, received 1.8% of the immigrants moving to the Amazon region.

Manaus and Belém (and in part Ananindeua) have above average urban infrastructure relative to the region (Table 2). Although these cities have serious infrastructural constraints, they still fare better than does the region as a whole, where access to services is at best limited to a fraction of the population, according to the 2000 census (IBGE 2000). Yet, as paradoxical as it may seem, a significant portion of the urban residents of Manaus and Belém have no, or only minimum, access to clean water.

Only 5% of cities had 70–90% of their households connected to a water system (all of these had been founded before 1900). In terms of sewage systems, these cities are generally in similar precarious conditions, as is the case for the Amazon region as whole. Only one city, Fonte Boa, located in the state of Amazonas and founded in 1891, had, in 2000, around 50–% of its households connected to a sewage system. Large cities such as Belém, Manaus, and Macapá fall into the 20–50% category of households served. As a whole, no matter their age, 78% of floodplain cities have less than 20% of their houses connected to a public sewage system, and thus deliver to surrounding streams and rivers significant amounts of residential pollution.

Paved roads and streets are also limited: most cities (63%) have less than 30% of their households located on paved streets. Trash collection is most often provided

**Table 2** Distribution of urban infrastructure among households (%) in municípios (%) of the Amazon floodplain

| Percentage of households (%) | Electric energy | Public electric light | Pavement | Water system | Piped water in at least one room | Sewage system | Waste collection |
|---|---|---|---|---|---|---|---|
| 0–10 | 0.0 | 0.0 | 21.9 | 4.1 | 9.6 | 47.9 | 46.6 |
| 10–20 | 0.0 | 2.7 | 19.2 | 5.5 | 20.5 | 30.1 | 21.9 |
| 20–30 | 2.7 | 6.8 | 21.9 | 17.8 | 23.3 | 11.0 | 11.0 |
| 30–40 | 4.1 | 13.7 | 17.8 | 27.4 | 21.9 | 5.5 | 4.1 |
| 40–50 | 17.8 | 17.8 | 15.1 | 15.1 | 15.1 | 1.4 | 5.5 |
| 50–60 | 17.8 | 12.3 | 2.7 | 13.7 | 4.1 | 2.7 | 5.5 |
| 60–70 | 19.2 | 16.4 | 0.0 | 12.3 | 0.0 | 1.4 | 0.0 |
| 70–80 | 19.2 | 20.5 | 0.0 | 4.1 | 4.1 | 0.0 | 2.7 |
| 80–90 | 13.7 | 6.8 | 1.4 | 0.0 | 1.4 | 0.0 | 1.4 |
| 90–100 | 5.5 | 2.7 | 0.0 | 0.0 | 0.0 | 0.0 | 1.4 |
| Total | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |

*Source*: Brazilian Demographic Census - microdata (IBGE 2000)

in large cities such as Belém, Manaus, Macapá, Ananindeua, and Santarém (more than 70% of households served), but limited or absent among the vast majority of floodplain cities. This creates another significant source of water pollution, as rivers are used for organic and nonorganic trash disposal. Access to electricity has improved during the past decade, and continues to improve with programs such as *Luz para Todos* (Light for All), but varies significantly across states. As a whole, however, 75% of floodplain municipalities offer electricity to more than half of their urban households. Rural households, however, rarely have electricity, with the exception of those in the state of Amapá. Thus, although large cities have better services, when taken as a whole, cities along the floodplains, large and small, old and new, offer only limited public infrastructure such as sewage, garbage collection, paved streets, and to a lesser extent, water and electricity (Costa and Brondízio 2009).

Guedes and Colleagues (2009) pointed out that the lack of infrastructure and employment for a growing population is leading to the growth of subregional inter-urban networks. In other words, cities that offer job opportunities, even in the informal sector, and more access to basic health and education services, attract populations from rural areas and the surrounding cities.

In assessing the distribution of employment among the three Brazilian states located along the floodplains, we found that 31% (1,155,360) of the active economic population was employed in the formal sector (Table 3). However, most formal employment in urban areas is offered by state and municipal public administrations. Even in the state of Amazonas, with the highest level of industrial employment (25.6%) because of the Free Trade Zone of Manaus, 30% of those formally employed are in the public sector. The situation is particularly telling for state capitals: in Belém, 47% of those formally employed are in the public sector in Pará; in Macapá, 92% are in this sector; and in Manaus, 77% of the total are. This level of dependency on public employment mirrors the reality of cities throughout the Amazon.

The informal sector in these same floodplain states employs 68% of all workers.[10] This is a reality already pointed out by Becker (1985), Godfrey (1990), Browder

**Table 3** Employment by sector as a percentage in Pará, Amazonas, and Amapá in 2005

| IBGE economic sectors | Amazonas | Para | Amapá |
|---|---|---|---|
| Mineral extractive | 0.2 | 0.6 | 0.9 |
| Industrial sector | 25.6 | 10.9 | 3.4 |
| Public services | 0.9 | 0.7 | 1.3 |
| Construction | 3.2 | 4.4 | 3.7 |
| Commerce | 12.9 | 17.7 | 19.2 |
| Services | 25.9 | 24.9 | 24.9 |
| Public administration | 30.9 | 37.7 | 46.1 |
| Agropastoral, extractivist, hunting, and fishing | 0.5 | 3.2 | 0.5 |
| Total | 100.0 | 100.0 | 100.0 |

*Source*: RAIS/MTE, Brasil

[10]According to IBGE, this category includes people with or without wage, who on 12/31/2000 were executing any sort of service considering the economic sectors.

and Godfrey (1997), and Perz (2000). One can understand the scale of informal employment in the region by looking at the lack of representation of sectors such as mineral extraction, agropastoral activity, and extractivism in employment statistics, which, paradoxically, are the main bases of employment for the regional population. The açaí fruit economy is a good example. The top municipalities producing açaí fruit, Limoeiro do Ajurú, Ponta de Pedras, Igarapé-Miri, Oeiras do Pará, Muaná, São Sebastião da Boa Vista, Mocajuba, Barcarena, Cachoeira do Arari, and Inhagapi, are located in the estuarine floodplain and are responsible for 53% of Brazilian production of açaí fruit and 61% for the state of Pará. At the same time, while açaí fruit production is the most important source of employment and income for rural and many urban residents, it is still considered an informal economy activity (Brondízio 2008).

## *4.2 Trends*

Cities play an important role offering employment, infrastructure, access to information, educational services, and other essential goods and services (Amorim Filho and Serra 2001). In the Amazon region, the centrality of a town is related to its level of relative importance within a network, particularly the scope and type of functions provided to its residents, its area of influence, and its population size. The Amazonian urban network is considered atypical, if we assume the traditional model of an urban network (large cities, medium-size cities, small cities). The polarized floodplain urban network, which aggregates the oldest and largest Amazonian cities, as well as many small towns, follows the regional pattern of overall lack of infrastructure but growing interdependence for services and resources. The large number of small towns and cities with fragile economies reinforces this apparent urban network "anarchy," labeled by Browder and Godfrey (1996) a "disarticulated urbanization." In this part of the Amazon (as in the region as a whole), cities represent a place where people can access services and new economic opportunities, and try a different perspective on life. The opportunities created by cities seem to exceed the difficulties posed by an often chaotic and violent environment.

Historical cities (such as Belém, Manaus, Macapá, and Santarém) are important trade centers, and their economic importance is expanding with the development of communication networks, faster transportation, and an ever more global demand for natural resources and agricultural commodities. These cities are central places of economy, culture, and social organization. However, investments in infrastructure are not following population growth, thus hampering the ability of cities to offer basic services to a large contingent of urbanites. This situation defines and emphasizes the disarticulated urbanization mentioned above, building a particular type of urban network in which the smallest cities have simple but crucial functions, making them as important as the medium and large cities, a pattern more complex than what traditional urban geographical models have been able to explain.

The number of migrants flowing to cities along the floodplains is significant in terms of the Amazon region as a whole. Not considering the two largest cities (Belém and Manaus), medium cities such as Santarém, Parintins, and Barcarena are emerging as attractive urban centers for migrants, as a result of services and employment. In terms of circular movements, the same medium-size cities account for almost 4.5% of this movement in the whole Amazonian region.

Municipalities along the floodplains, in spite of their large resource economies and contributions to export, are highly dependent on federal subsidies, as are their counterparts throughout the Amazon. Even though these municipalities produce a great quantity of forest, agropastoral, and aquatic resources, they lack a fiscal framework and the administrative capacity to collect taxes for investment in urban and rural infrastructure. In turn, lack of infrastructure undermines the development of a transformative economy that could aggregate value locally and offer employment to the young population of the region (Brondízio, this volume). Furthermore, there is a lack of public policy committed to social change and to providing necessary educational and health services. Increasing rates of urbanization are pushing even more deficient and poor infrastructure and services in the long run.

Yet, in spite of poor infrastructure and services, people move back and forth between small, medium, and large cities, rural and urban areas (Padoch et al. 2008). In a regional context of restricted opportunities, cities do appear to be an "El Dorado" to people used to the lack of services in rural areas. Small cities located along rivers and far from large centers, even when critically deficient in infrastructure and other public services, are seen as important resources for rural populations. Many small cities, such as Soure, located on Marajó Island, or Tabatinga in Amazonas have regional campuses of state universities and airports, and thus are considered important nodes in the regional urban network. In addition, they offer services such as different levels of education, healthcare, a variety of markets, and, last but not least, a "safeguard against landlessness" to many sharecroppers living in the region for generations but without land title. Medium cities, such as Santarém, located in the state of Pará, also perform important functions, with campuses of federal, state, and private universities, the second most important port in the state, seven hospitals, and other services.

These examples contradict the traditional model of urban hierarchy and give a new sense of purpose to medium and small cities along the floodplains. In small cities, people can find at least a small possibility of changing their lives and accessing new economic opportunities. Medium-size cities are consolidating their position and functioning as important nodes within the Amazonian urban network. From one point of view, these trends could be seen as relieving large cities but, at the same time, they increase pressure on smaller cities that are not prepared to assist even their existing populations. Quality of life in floodplain cities during the next decade will depend on whether public policies are able to address the mismatch between the growing demand for urban services and the declining economic ability of Amazonian municipalities to provide them.

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# Part II

# Introduction: Amazon Fisheries

**Fabio de Castro**

**Abstract** Twelve years ago, a session on aquatic resources was organized during the first várzea conference. The articles presented in this session focused exclusively on fish resources, and analyses were based on only two study areas. The potential of community-based management for sustainable use of aquatic resources dominated the discussions. Twelve years later, the second várzea conference organized a similar session on aquatic resources. Some resemblances between the sessions could be noted, including familiar authors, research areas, and topics. The differences, however, are worth noting, among them the inclusion of floodplain resources other than fish. Community-based management again dominated the discussion but the second conference featured more critical analysis of its potential and limitations since after years of practical experience, several initiatives are evaluated. In general the chapters in this section show that significant progress in theory, methods, and practice was achieved in the last decade. Several issues remain to be better explored, including monitoring problems, and the availability of very limited data on co-management processes for making policy decisions. Scale also remains an issue, as do a series of land tenure issues.

**Keywords** Floodplain • Comanagement • Fishing • Amazon • Land tenure

Ten years ago, a session on aquatic resources was organized during the first *várzea* conference. The articles presented in this session focused exclusively on fish resources, and the analyses were based on two study areas (the Mamirauá Sustainable Development Reserve and the Lower Amazon). The potential of community-based management for sustainable use of aquatic resources dominated the discussions. However for Goulding, the discussant of the session, the emphasis on community-based management represented a concern. The shift of focus from the resource to

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the users, he argued, was misleading. According to him, fish depletion stemmed mainly from habitat destruction. Therefore, local rules would not halt the fish depletion process unless the rules addressed habitat protection. Both Goulding and the community-based management advocates had a point. The former wanted to call attention to the danger of a new "fad" that could be misused by policy makers as a new blueprint strategy. The latter, on the other hand, attempted to make visible a local institution which was already in place for several years and deserved proper attention and support from policy makers.

The disagreement described above illustrates the process of paradigm shift in floodplain research and policy at that time, led by the establishment of three major projects in the Amazonian floodplain—Mamirauá, Iara, and Várzea. The articles presented in that session were based on these projects. Due to their being in initial stages, both data and discussion were preliminary, and policy proposals were rather rudimentary. Nevertheless, the authors succeeded in setting the research agenda for the next decade by conveying the following messages: (1) fishing is a human activity, so the fishers' behavior should be included in the equation; (2) the floodplain is a heterogeneous system, so integrated management should be emphasized; (3) land occupation in the floodplain is complex and depends on historical, ecological, and social factors; (4) legislation on the resource use and land occupation were inadequate; and (5) community-based management systems represented a good starting point to build up a comanagement system in the floodplain.

Ten years later, the second edition of the *várzea* conference organized a similar session on aquatic resources. Some resemblances between both sessions were expected, such as familiar authors, research areas, and topics. The differences, however, are worth noting.

The first remarkable difference was the inclusion of other floodplain resources in the discussion, in addition to fish. Silveira discusses the state of floodplain wildlife and shows how the lack of attention by both researchers and policy makers leads to a devastating illegal hunting practice. McGrath et al. emphasize the importance of a systemic approach to the floodplain, as local social and biological processes are strongly connected to both water- and land-based resources.

Community-based management systems dominated the discussion again in this session. The novelty this time was a more critical analysis of the potential and limitations of these local institutions for the management of the floodplain. After a few years of practical experiences, the evaluation of some initiatives can now be carried out. For example, Almeida et al. compare the CPUE and income of fishing in managed and unmanaged lakes, and conclude that local management had a positive effect on lake productivity. The authors also briefly discuss the possible effects of a proliferation of the fishing accords in other fishing systems (e.g., rivers). Silveira presents a less optimistic analysis. His findings reveal a lack of regulation of the exploitation of turtle, caiman, and dolphin in areas managed by local residents. Adams argues that the challenges for a sustainable management in the floodplain go beyond a few best practices initiatives targeting a handful of species. According to the author, infrastructure; state-based services such as health care, education, sanitation,

and clean water; and extension of local management to buffer zones, connected ecosystems, and nearby urban centers are some of the crucial aspects to tackle the related socioenvironmental processes such as population mobility, transboundary effects, and "leakages." For McGrath et al., the current land tenure system represents the main bottleneck for the success of co-management systems. The authors contend that the formalization of semiformal local agreements, such as the fishing accords and the Terms of Adjustment of Conduct to regulate fishing and cattle ranching activities, respectively, represent two important pillars of the co-management process. However, only with the recent initiative of INCRA to implement agroextractive settlements in the floodplain has the third long-needed pillar been available to ensure a successful co-management system. The land demarcation, claim the authors, will provide floodplain residents with status similar to that of their upland counterparts. As a result, local residents will enjoy access to funding, technical assistance, and better control of their managed lands. Ruffino's experience as the coordinator of the most extensive research program on participatory management in the Amazonian floodplain gives him a special position from which to present an evaluation of a co-management system from a policy maker perspective. In spite of its pitfalls, his analysis of the institutional evolution of the comanagement approach in the Amazon in the last decade helps remind us that this process is a "work in progress" based on collective learning and continuous negotiation among the stakeholders, and as such, compromises must be made by all groups involved.

In general, the articles in this session illustrate significant progress in theory, methods, and practice achieved in the last decade. Flood pulse, multiple resource use, and comanagement are a few examples of important concepts that have been developed further and applied to address management issues in the last decade. Moreover, the articles show an advance in combining concepts from different disciplines such as economics, social sciences, ecology, and legal studies. In regard to methodologies, models to evaluate comanagement systems (Almeida et al.), or participatory research strategies (Ruffino), are some examples developed in the last decade. The explicit concern with scale and management unit raised by Ruffino, Silveira, and Adams is another important methodological development in this field. One aspect implicitly mentioned in the session is the importance of the household as unit of analysis. The focus on community-based management in the last decade has led to an emphasis on the community structure and organization, with little attention to the private-based activities held by households. The land regulation processes described by McGrath et al. touches this issue by combining collective- and private-based use and management of the floodplain resources. Perhaps another unit of analysis missing which deserves special attention is the role of individuals in facilitating social mobilization and social cooperation. Likewise, new emergent actors such as NGOs and committees have played major roles in the development of more robust social networks in the region. The analysis of leadership as social capital in the region could help to bring new insights to the development of comanagement systems.

Perhaps the major advance we saw in the last decade has been the move from theory to practice. The formalization of local agreements regarding fishing and cattle ranching, and the establishment of community monitoring systems, are well

described by McGrath et al. and Ruffino. These achievements are the outcome of collaborative research and policy making including the government, NGOs, and the local stakeholders. The development of an institutional arrangement upon which policy measures can be designed and monitored represents a milestone in the management of the floodplain. As pointed out by Ruffino and by Adams, from the policy viewpoint, the goal of management goes beyond resource and habitat conservation, and includes social goals such as local conflicts reduction, food security, improved life quality, and increased participation of users in policy decisions. As Adams reminds us, more than just the establishment of comanagement systems, the way those initiatives are designed, implemented, and monitored are crucial for their successful outcome.

The progress presented in those studies, however, is only the beginning of a long and bumpy process. Some issues raised in the discussions deserve close attention. Monitoring problems, for example, remain unsolved. Silveira is skeptical about the role of community-based management to control the exploitation of reptiles and dolphins, and calls for more stringent actions from the government to regulate these activities in the floodplain. McGrath et al. argue that the effectiveness of local monitoring systems of Volunteer Environmental Agents trained by IBAMA is rather limited. Ruffino mentions the challenge of monitoring large areas. The success of any management system depends on an efficient monitoring system in order to ensure rule compliance across stakeholders.

A second concern is the limited data available on which to base policy decisions and assess the comanagement process. In some cases, scientific information is available but ignored by policy makers. In other cases, data are available to evaluate specific management initiatives (Almeida et al.). In general, however, one would agree that data collection at larger spatial and time scales is necessary to assess the effectiveness of different management initiatives in the Amazon. Information from different regions will help to generate comparative analysis through time and across regions. An efficient adaptive management process relies on data upon which periodical assessments can be undertaken. Such assessments will help eventually to tackle new problems, and guide the changes necessary to adapt to new realities. A few projects in the region have been building up valuable databases in the last decade, an effort which will hopefully continue in the future.

In some cases, lack of information is due to resistance from the research projects to disclose unsuccessful cases. As a learning process, mistakes are expected to happen during different stages of the participatory management experience. Unfortunately, successful experiences are usually emphasized, whereas unsuccessful cases are limited to anecdotes cited in informal discussions. A systematic analysis of such cases could reveal important lessons. Silveira's example on wildlife illustrates the importance of discussing the process leading to mismanagement which can be applied to different cases. Perhaps researchers refrain from sharing their unpleasant experiences for fear of harsh criticisms from their peers. If researchers actively involved in those projects understood the importance of making this information available, and their critics understood the difficult tasks of those researchers, everyone would benefit from this constructive approach.

Scale is another important issue in floodplain management revealed in this session. There is a consensus among the authors that efficacy of community-based management is limited to small geographic areas, and that a multi-scale approach to floodplain management is needed. Although the scale issue has been raised in the past (e.g., sedentary and migratory species), Ruffino brings concrete suggestions for transboundary resources based on international agreements. Despite the limited achievements from those agreements, they may represent a good starting point from which to develop more effective arrangements. Considering different management units according to the target resource/system, heterogeneous floodplain landscape, and close interconnectivity between ecosystems, the challenge of building up a multi-scale management system that is compatible with the ecological and institutional scales should be better developed in the future. If monitoring is a problem for small-scale management systems, a larger-scale monitoring system may represent a major bottleneck in this endeavor. In any case, community-based management and international agreements represent two opposing levels where appropriate intermediate levels can be identified according to the management units.

One last concern raised in the discussion is land tenure. As one of the key problems limiting the success of community-based management systems, McGrath et al. bring us the news about the long-awaited demarcation of the floodplain properties. As one reads the description of this process, the good news quickly turns into major concern. Despite the claimed advantages of land regulation for floodplain residents, including land rights and access to loans, the fast pace of this process is rather disturbing. As recognized by McGrath et al. in this volume themselves, the traditional land tenure system in the floodplain is complex and varies across regions, and access and use may oscillate between collective and private according to ecological, economic, and social conditions. The demarcation of floodplain properties will turn the changeable traditional system into a rigid property rights system. Land-related conflicts are not rare and, due to the regulation process, they are likely to grow. In fact, the negative effect on floodplain ranchers has already triggered some political actions from this elite group. Moreover, access to cash for the households involved in this project (e.g., loans and cash payment for infrastructure) may lead to local investment in unsustainable production systems, such as cattle ranching and intensified fishing. This is not to say that land tenure regulation is inappropriate in the floodplain. However, the actors involved in this process need time to gather information, to assess the implications, to identify potential problems, and to carry out negotiations. Considering the history of INCRA in other land demarcation projects, it is difficult to believe that important support such as monitoring, legal and technical assistance, and institutional organization will be provided by government agencies. Rather, dozens of PAEs and thousands of settled families on paper will suffice for them to consider their mission accomplished, and leave behind massive social conflicts for local NGOs and grassroots organizations to address. One hopes that this unique opportunity to strengthen the floodplain management system and achieve ecological and social goals will not turn into a source of additional social costs and resource degradation resulting from increased conflicts between floodplain actors.

# Impacts of the Comanagement of Subsistence and Commercial Fishing on Amazon Fisheries[1]

**Oriana Almeida, Kai Lorenzen, David G. McGrath, and Sergio Rivero**

**Abstract** This paper characterizes two types of fisheries in the Lower Amazon and their interactions: small-scale (subsistence-oriented) and commercial fisheries. Small-scale fishing is carried out by floodplain residents who practice fishing as part of a diversified, subsistence-oriented, livelihood strategy that also includes activities such as farming and cattle raising. Small-scale fishers operate locally, with small boats. Commercial fishers, on the other hand, practice fishing as a primary occupation and are highly mobile, operating with motorized boats of up to 70 t storage capacity. Smaller commercial boats (with storage capacity less than 4 t) focus on the capture of scale fish that are sold at the local fish market. Larger boats specialize in catching migratory catfish that are sold mostly to fish processing plants. Small-scale fishers account for about 75% of the total catch in the Lower Amazon, while commercial fishers account for 25%. The average annual catch per area in the region is 34 kg/ha/year. This is approximately 37% of the maximum production potential estimated from an empirical catch-effort model for Amazon floodplain lakes. At present

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therefore, the fishery is only moderately exploited overall, but some species of great commercial interest are overexploited. There have been no appreciable trends in fishing effort or catches in the Lower Amazon over the past decade. Bioeconomic models suggest that the commercial fleet operates at the open access equilibrium (where profit is equal to costs), so that expansion can occur only should there be an increase in demand. Many floodplain lakes are now subject to fishing regulations set by local communities under legally supported comanagement schemes known as 'fishing agreements.' The agreements primarily restrict fishing methods favored by commercial fishers, and have been associated with moderate average increases in catch rates in the lakes (mostly for the benefit of subsistence-oriented fishers). At the regional level, the conservation benefits of effort reductions in comanaged lakes may have been approximately offset by effort increases in other lakes and the main river. Greater attention to regional-level management may be required in the future, particularly if demand for fisheries products should increase.

**Keywords** Small-scale fishers • Commercial fleet • Amazon • Management • Floodplain

## 1 Introduction

Amazonian fisheries sustain more than 100,000 small-scale fishers and almost 40,000 commercial fishers, providing each group with a viable livelihood. The fisheries sector generates roughly R$400 million annually (Almeida et al. 2004). Commercial and small-scale fishers employ distinct practices and often have conflicting interests (McGrath et al. 1993; Queiroz 1999). One conflict is access to fishing resources. With the intensification of commercial fishing, fishers in *várzea* communities initiated a process of closing off lakes and defining fishing laws that aim to reduce the impacts of commercial fishing on fisheries.

We studied fishing activity in the Lower Amazon to understand the dynamics of small-scale and commercial fishing and the impact of management rules on their fishing practices. Lorenzen et al. (forthcoming) demonstrated the importance of small-scale fishers, who, despite their small capacity, are responsible for up to 70% of the regional catch. Thus, while great effort had been made to manage commercial fisheries, larger-scale fishers have had a smaller impact on the state of the fisheries, as their catch represents a much smaller portion of the total fish catch in the Lower Amazon.

In this chapter, we characterize small-scale fisheries of smallholder *várzea* communities, as well as commercial fishing in the Santarém region (State of Pará, Brazil). We also evaluate the interaction between these two fishing groups and the impact of community management regimes on these actors.

## 2 The Impact of Comanagement on the Extractive Use and Productivity of Lakes in the *Várzea* of the Lower Amazon

For commercial fishers, fishing is considered a primary activity, because these fishers dedicate their time solely to this activity. This is not the case for small-scale fishers, who generally engage in other rural activities, such as farming and large- and small-scale animal husbandry. These residents diversify their livelihood activities to reduce risks and to adapt to the availability of resources and the flood cycles of the *várzea* (Allison and Ellis 2001). *Várzea* smallholders cultivate crops on the levees and graze livestock on floodplain grasslands during the low-water season. The dry season is also the most productive fishing season, making it possible to fish while tending crops and animals.

The principal sources of income for families in this region can be placed into six categories: fishing, farming, cattle raising, small animal husbandry, government jobs (salaries), and government benefits (Almeida et al. 2009). Of these, the most widespread is fishing, followed by farming, salaries and government benefits, raising livestock, and government employment. Raising small animals is a widespread activity and is usually subsistence oriented. The two most important activities in terms of income are fishing and farming (excluding government benefits) (Table 1).

### *2.1 Fishing*

Fishing is the main economic activity and is practiced by 84% percent of households in the study area. For the most part, fishing families use canoes, fish alone or in pairs, and use various types of fishing gear, of which gill nets, cast nets, and fishing poles are the most important. On average, families fish three times a week. Fishing effort varies depending on the season: dry or rainy. Fishing trips last an average of 4 to 5 h. The average catch per trip is approximately 6–7 kg of fish, which translates to an average CPUE (catch per unit effort) of 2.4 kg/h of fish in the dry period and 2.3 kg/h in the rainy/flood season (Almeida et al. 2009). Thus, over the course of a year a family catches approximately 1.178 kg of fish, of which roughly 600 kg is consumed by the family and the remainder, approximately 578 kg, is sold to local fish buyers or taken to market (McGrath et al. 1993).

**Table 1** Frequency of the activities practiced by sample families, Lower Amazonas

| Source of income | Frequency (%) |
|---|---|
| Fishing | 84 |
| Agriculture | 81 |
| Raising small animals | 88 |
| Public employment | 60 |

## 2.2 Agriculture

Farming is the second most cited economic activity. The main crops cultivated on the *várzea* include beans, corn, watermelon, and manioc. Beans are cultivated by 56% of the families, corn by 40%, watermelon by 39%, and manioc by 29%. Other products include: squash, tomato, cabbage, and green peppers—all of which, with the exception of squash, have only recently been adopted by local farmers. Only 7% of the families cultivate these products (Table 2).

We observed that the total area under agricultural production was much greater in communities located entirely on the *várzea* than among those who live in *terra firme* areas adjacent to the *várzea*. In general, smallholder farmers located in the *várzea* cultivate about 0.75 ha, while those living on *terra firme* sites farmed only 0.38 ha. The area in cultivation also varies with the crop. For example, watermelon patches average 0.43 ha and squash 0.11 ha.

The area in cultivation is small, and there is also little crop diversity. The majority of families (73%) specialize in one or two crops, and 22% cultivate just three crops. Only 4% of families cultivate more than three. Smallholders market a large percentage of what they grow. 93% of the bean and 63% of the manioc and corn crops are marketed.

## 2.3 Household Income

Although we did not find significant correlations among economic activities, there is a tendency for families with more diversified economic strategies to have higher incomes. The majority of families engage in a variety of activities, with only a small number of families specializing in just one activity. These specialist families represent 25% of the total sample and earn a much lower income than the others, varying between R$63–1,888. For these families, agriculture and retirement pensions account for R$750–900, while fishing and government salaries contribute between R$1,200 and $1,888, respectively (Table 3).

**Table 2** Area designated for the cultivation of each product, Lower Amazonas, 2001

| Product | % Cultivated area (Sample) | Average area (Ha) |
|---|---|---|
| Beans | 33 | 0.30 |
| Corn | 23 | 0.20 |
| Watermelon | 23 | 0.42 |
| Manioc | 17 | 0.22 |
| Zucchini | 1 | 0.11 |
| Others | 3 | – |
| Total | 443 Areas | |

**Table 3** Number of families practicing one or more activities and annual income of the family

| Activity | Quantity | % | % (of 259) | Income | SD |
|---|---|---|---|---|---|
| Only fishing | 21 | 32 | 8 | 1,201.57 | 1,458.82 |
| Only agriculture | 13 | 20 | 5 | 767.71 | 835.53 |
| Only retirement pension | 7 | 11 | 3 | 884.17 | |
| Only salary | 5 | 8 | 2 | 1,888.15 | |
| Only livestock | 3 | 5 | 1 | 63.35 | 109.73 |
| Total | 66 | 100 | 25 | | |
| Fishing and agriculture, no livestock | 70 | | 27 | 2,361.33 | 3,785.21 |
| Agriculture and livestock, no fishing | 12 | | 5 | 2,853.69 | 4,005.95 |
| Fishing and livestock, no agriculture | 18 | | 7 | 3,172.03 | 5,403.18 |
| Fishing, agriculture, and livestock | 78 | | 30 | 3,796.70 | 6,874.93 |
| Fishing, agriculture, livestock, and retirement | 3 | | 1 | 5,782.73 | 1,574.85 |

Families that engage in more than one economic activity report higher incomes. Groups that engage in two activities have somewhat higher incomes. For example, 27% of families engage in fishing and farming and have an average income of R$2,361. A smaller group, comprising 12% of families, combine cattle raising and farming or fishing and earn roughly the same level of income, ranging from R$2,900 to $3,200. Around 30% of the families engage in three activities, farming, cattle raising, and fishing, and have an average income of R$3,797. A final group engages in three rural activities and also earns government salaries and retirement pensions. This group has the highest total income, approximately R$5,783 (Table 3).

## *2.4 Community Management*

Fishing is essential to every family, both for consumption and income. Community management of fisheries developed recently to reduce pressure on local fish stocks, primarily by controlling the fishing activities of commercial fishers (who generally are not members of smallholder *várzea* communities), and secondarily that of local fishers (McGrath et al. 1993; De Castro 1999; Oliveira and Cunha 2000; Pereira 2000; Smith 2000). Various measures have been introduced by communities to reduce pressure on local lake fisheries, including bans on the use of certain types of fishing gear, limits on total catch, and restrictions on the size of boats used for fishing in lakes. Almeida et al. (2009) evaluated the impact of comanagement regimes on the productivity of fishing, comparing total catch, fishing effort (time), and productivity (CPUE) in nine pairs of communities—half with a system of comanagement in place and half without—to investigate differences in income that could be attributed to fishing effort, total catch, and catch per unit effort.

Research results indicate that while there is a difference in fishing effort between managed and unmanaged lake fisheries, it is not statistically significant. However, the study did show that productivity (CPUE) is greater in managed than in unmanaged

lakes. The difference in productivity between the managed and unmanaged lakes was determined by comparing catch per unit effort (CPUE) in two situations. This difference was attributed to the reduction of commercial fishing in the lakes as a result of the fishing agreements. On average, CPUE was 60% higher in the managed lakes and 40% higher if the outlier case is removed from the analysis.

One of the issues that is often raised regarding community management is the extent to which regulations are actually followed. According to the majority of fishers, the key regulation with an impact on fish catch is prohibition of the use of gillnets during the low-water season. In the Lower Amazon, the use of gillnets is significantly lower in communities with fishing agreements (on average 38%) compared to unregulated communities (76%). These data indicate that regulations regarding the restriction of gillnets are largely observed. However, fishers compensate by using alternative methods to catch fish. Consequently, despite the limitations placed on the use of gillnets, no differences in total fishing effort (in hours) are observed (Almeida et al. 2009).

Comparing the total volume of fish caught by households in communities with and without regulations, we also see no differences. This is particularly evident when the volume of fish caught on fishing trips in managed and unmanaged lakes is compared; there is practically no difference in these values. The regulations do not alter fish catch, in part because 99% of families catch small volumes of fish; only 1% of fishing families exceed the volume limits of the fishing agreements (15, 30, and 50 kg per fishing trip) in either managed or unmanaged lakes.

## 3 The Commercial Fishing Fleet in Amazonia and the Comanagement in the Lower Amazon

The commercial fleet has a large impact on a small scale. Based on the registries of fishing boats maintained by the *Capitania dos Portos* in the major fishing ports, it was possible to estimate a total 7,531 commercial fishing boats in the Solimões-Amazon River (Almeida et al. 2004). In reality, this number is greater because the estimates do not take into consideration the boats that operate in the other ~40% of the Amazon basin, although the majority of boats do operate in the Amazonas Solimões channel (Almeida et al. 2004). This fleet operates in *várzea* areas that make up 2.6% of the Amazon basin (Bayley and Petrere 1989).

In the Santarém region, large and small boats use essentially the same fishing gear. However, there are significant differences in fishing strategies. In general, small boats fish mostly in floodplain lakes, catch a large variety of fish species and supply local urban markets. Larger boats tend to specialize in a few species of migratory catfish, fish more in the river channels, and generally supply fish processing plants (locally termed *frigorífico*). There are also distinct differences in the efficiency between large and small boats. Small boats are less efficient in terms of CPUE (kg/fisher/day) but are more efficient earning greater economic returns. The majority of the boats that operate in Santarém have an ice capacity of less than 4 tons.

Boats of this size make up 87% of the total fleet and 73% of the total income generated (Almeida et al. 2004; see also Isaac et al. 1996).

Rivero and Almeida (2008) modeled the behavior of commercial fishing on the Lower Amazon, starting with a general characterization of fishing using a multi-agent simulation (Rivero et al. 2009, and Rivero and Almeida 2008). The model considers two markets, the urban market of the city of Santarém, and the fish processing plants (*frigoríficos*) (Almeida et al. 2004), and differences in demand between these markets. The model takes into account the seasonality of fish supply in the urban market and the more constant and large-scale demand of the *frigoríficos.* In addition, the model also considers *frigorífico* demand for migratory catfish species, which have a lower price per kg, but are more abundant. Finally, the model also takes into account the fact that urban consumers principally demand fish with scales, which have a greater average price per kg but are less abundant. Fisheries data indicate that the urban consumer market is more sensitive to the total supply and that fish prices vary inversely to supply (Almeida et al. 2004), while the *frigorífico* market offers slightly higher prices to boats with larger catches.

Multiple simulations have been conducted with various scenarios, assuming that boat owners will seek a strategy that maximizes their short-term sales. These simulations demonstrate that boat size is the principal factor in determining fishing strategies. Smaller boats maximize the catch of fish with scales, large boats fish for migratory catfish to sell to *frigoriíficos*, and medium-size boats exploit both types (Rivero and Almeida 2008).

In considering fishing environments or locations, those who fish species with scales primarily operate in lakes, while migratory catfish species are caught in rivers. Given this pattern, fishing accords will particularly affect fishers with small boats who fish in lakes, rather than the larger boats operating in rivers.

The continued dissemination of the comanagement agreements will result in significant changes in the commercial fishing sector. Based on simulations like those of Rivero and Almeida (2008), we can infer these impacts; however, a more exact approximation of the effects of the fishing accords must be obtained through a thorough study of seasonal fishing patterns. Regardless of the outcome, the ways in which commercial fishers respond to changes presented by the comanagement of lakes is fundamental to the sustainability of their activities and to the future of the sector.

## 4 Interactions Between Commercial and Subsistence Fishing in the Lower Amazon: Using a Bioeconomic Model

Based on field data on subsistence and commercial fishing in the Lower Amazon and the data on fish landings from the IARA Project, Lorenzen et al. (forthcoming) constructed a model to quantify the impact of the comanagement system on both commercial and subsistence fishing. This model was used to identify fishing localities

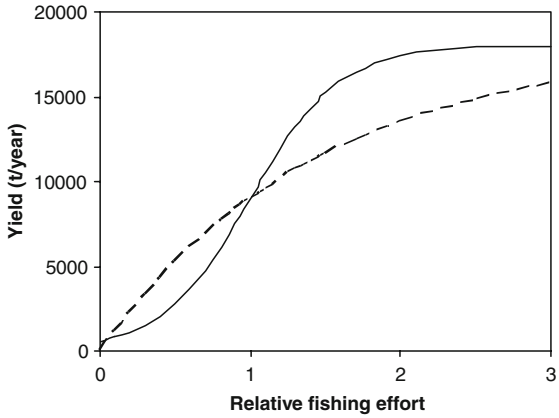


**Fig. 1** Examples of sigmoid and asymptotic models of production (continuous line and disconnected line, respectively) for fishing in the Lower Amazon

and analyze interactions between commercial and small-scale rural fishers. In building this model, fishers were classified as commercial or small-scale, and identified on the basis of their fishing locations (lake or river). Two alternative functions in relation to the aggregated catch of species and fishing effort were used: a sigmoid-shaped model and an asymptotic model (Fig. 1).

Estimates of fish catch and fishing effort—based on data from the IARA/IBAMA project and from interviews with the residents in Santarém—were compiled to provide a basis for simulations. To understand long-term commercial fishing trends in Santarém, fish catch and fishing effort data from commercial landings were used. These data indicate that during the last ten years, fish landings and fishing effort in the Santarém region have remained stable. Even when separate analyses for the ten principal species were conducted, disaggregating the data, no distinct trends in catch or CPUE were found. When catch, fishing effort, and CPUE were analyzed in relation to locality data (rivers or lakes) for the same 10-year period, trends were again absent, as they were when data were analyzed year by year. In summary, the analyses presented in Lorenzen et al. (forthcoming) showed that, in general, commercial fishing in the Santarém region appears to have remained static.

While data on fish catch and fishing effort in Santarém do not provide us with the ability to evaluate the status of fishing or overfishing, aggregated data from total catch provide insight into this question. Total landings by commercial fishers in this region added to the totals estimated for small-scale fishers in the Lower Amazon, give a figure of approximately 9,015 t/year obtained from a total area of 268,300 ha. This corresponds to approximately 34 kg/ha/year. This is approximately 37% of the maximum production estimated for a lake designated for the fishing of multiple species in Amazonas (91 kg/ha/year) by researchers conducting an empirical comparative study in a *várzea* community (Almeida et al. 2009; Lorenzen et al. 2006). Based on these values, at present it seems that most fish species are moderately exploited (Welcomme 1999), while major commercial species are overexploited.

**Table 4** Base scenario for the bioeconomic model, Lower Amazon

| | | Fishing effort (Days per year) | % | Capture (tonnes per year) | % |
|---|---|---|---|---|---|
| Commercial | Rivers | 63.000 | 12 | 1.165 | 13 |
| | Lakes | 98.000 | 19 | 1.610 | 18 |
| Subsistence | Rivers | 115.000 | 22 | 2.130 | 24 |
| | Lakes | 250.000 | 48 | 4.110 | 46 |
| | | 526.000 | 100 | 9.015 | 100 |

The level of exploitation indicates that large or slow-growing species are overexploited, while the majority of smaller, faster growing species are not yet exploited to their maximum capacity.

Estimates of fishing effort and catch from commercial boats and for all families in the Santarém region have been summarized to provide a base scenario for the model; these are displayed in Table 4. Here we observe that small-scale fishing is responsible for two-thirds of the region's fish catch.

Based on these data, a simulation was done that varied fishing effort of commercial fishers but kept subsistence fishing effort fixed, as in the base scenario. A simulation was also undertaken in which fishing effort of subsistence fishers varies, while that of commercial fishing is fixed. The sigmoid model that most closely fits the data (see Lorenzen et al. forthcoming) showed that the impact on catch and income is small. For example, with the growth of commercial fishing pressure, there is only a small decline in the catch of the small-scale fishery.

Using the asymptotic model, however, the impact is different. When there is an increase in fishing effort of the commercial fishers, a decrease in the total catch of small-scale fishers is observed. When the fishing effort of commercial fishers varies, in the sigmoid model there is a small impact on total catch by subsistence fishers; with the asymptotic model, however, there is a greater impact. In either case, the models demonstrate that by using a sigmoid function and considering various levels of possible exploitation (30%, 50%, and 70% of the maximum sustainable), commercial fishing will be operating at the point of equilibrium (where profit is equal to costs) with no room for expansion (Lorenzen et al. forthcoming). Growth would only be possible if there were an increase in fish prices or a reduction in expenses. A price increase of 30%, for example, would lead to the doubling of commercial fishing effort until a new equilibrium is reached.

## 5 Possible Impacts of Further Proliferation of Comanagement Agreements

If fishing agreements are expanded to regulate all lakes of the Lower Amazon, the impact on catch and income might depend on the decisions made by the commercial fisheries sector. If commercial fishing were eliminated, there would be a positive impact on the productivity of subsistence fishing. But if commercial fishers

merely concentrate all their fishing effort in the river, this positive outcome would be eliminated and final productivity would remain the same.

While communities that adopt the comanagement model will benefit from a reduction in commercial fishing pressure in their lakes if commercial fishing efforts are redirected to unregulated areas (such as rivers and unmanaged lakes), the costs eventually will be shared by all because of the maintenance of the total fishing effort. In this case, it is possible that the benefits gained by each community decrease as more lakes are managed throughout the region and fishing effort is redistributed from lakes to rivers. It is important to emphasize, however, that while the sigmoid model better fit the data (Lorenzen et al. forthcoming; Lorenzen et al. 2006), the asymptotic model would indicate a much greater impact on fishing effort. For this reason, careful attention should be given to the differences between the models.

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# Integrating Comanagement and Land Tenure Policies for the Sustainable Management of the Lower Amazon Floodplain

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**Abstract** The ten years between the first and second conferences have been a time of considerable importance for the conservation of the Amazon *várzea* based on the comanagement of floodplain resources. This paper describes the development of a regional comanagement system in the Lower Amazon *várzea*. The comanagement system has grown out of the grassroots movement, known as the "acordos de pesca," in which floodplain communities asserted control over their traditional lake fisheries. In the 1990s these agreements provided the basis for IBAMA's development of a community-based comanagement policy for floodplain fisheries. The evolving *várzea* comanagement system has developed in three phases: (1) IBAMA developed and implemented a fisheries comanagement pollcy in the Santarém region; (2) individual *várzea* communities and the Public Ministry negotiated agreements, Termos de Ajuste de Conduta (TACS), with local cattle owners to regulate cattle grazing on community grasslands;, and (3) these comanagement agreements were integrated into a more comprehensive land tenure and settlement policy based on the Projeto de Assentamento Agroextractivista (PAEs). Thus far 41 *várzea* PAEs have been created, including some 13,000 families and covering a total area of 740,000 ha in eight Lower Amazonian municipalities. These PAEs

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are now in the process of preparing the Utilization and Settlement Development Plans needed to obtain environmental licences. A major long-term investment is needed to take advantage of this process and integrate these PAEs into municipal and regional comanagement institutions.

**Keywords** Amazon • Floodplain • Comanagement • Fisheries • Land tenure

## 1 Introduction

The first meeting of this conference occurred at an important moment in the development of participatory management systems for the *várzea*. Since the beginning of the 1990s a number of conservation and participatory management[1] initiatives had developed that built on local and regional grassroots movements for the conservation of floodplain fisheries, habitats, and biodiversity. The potential of these participatory approaches to managing floodplain fisheries was the subject of some debate, as skeptics questioned optimistic assertions regarding the potential of community management as a strategy for conserving floodplain biodiversity (Goulding et al. 2003, 1996; Smith 1999). The last decade has been one of intense activity in the development of policies, institutions, and management systems for the participatory management of floodplain resources (McGrath et al. 2004). While this experience has proven the validity of many of the concerns raised by skeptics, few if any have proved insurmountable, and much has been learned and achieved towards construction of a *várzea*-wide framework for the participatory management and conservation of the floodplain ecosystem (McGrath et al. 2006).

While much has been accomplished, much remains to be done before a region-wide policy and institutional framework is consolidated and local populations throughout the *várzea* network are sustainably managing their resources. The process of constructing this regional comanagement system is at a particularly critical moment. INCRA (Instituto Nacional de Colonização e Reforma Agrária), the federal colonization and land reform institute, has begun implementation of a new land tenure policy for the *várzea* that will have far-reaching consequences for floodplain settlement, resource management and conservation. This paper describes the development of the new land tenure policy and evaluates its impact on the comanagement system that has been constructed over the last decade.[2] The paper is organized in four parts. In the first we describe briefly the relevant aspects of Lower Amazon ecology

[1]We use the term participatory management to cover situations in which resource users have a significant role in management of the resource, including community management and comanagement.

[2]In many ways this paper is a sequel to McGrath et al. (2004), which examines the development of the comanagement system and evaluates its performance.

and settlement. The second focuses on the development of comanagement systems for floodplain fisheries and grazing lands in the Santarém area. The third describes the development of land tenure policy for floodplain settlement and resource use; and in the final section we evaluate the potential impact of this policy for the sustainable management and conservation of the *várzea*.

## 2 Lower Amazon *Várzea* Ecology and Settlement

The Lower Amazon is a cultural term for one of the four major ecological regions of the Brazilian portion of the Amazon River, stretching roughly from the mouth of the Madeira River downstream to the mouth of the Xingu (O'Dwyer 2005). The landscape of this region of the *várzea* is dominated by wide, shallow lakes interconnected by a network of channels. Grasslands are the predominant vegetation of the floodplain interior, and forest vegetation is largely restricted to the levees bordering the river channels. Settlement consists of two main types, larger properties and smallholder communities that are strung out along the levee. Larger properties specialize in cattle and water buffalo ranching, while smallholders usually employ more diversified strategies involving some combination of fishing, farming, and small and large animal husbandry.

From a management perspective it is useful to distinguish four main environmental zones: river channels, forested levees, permanent lakes, and the grasslands that cover much of the transition area between permanent lakes and levee forests. Settlement and economic activity are closely tied to the main habitats and resources, so there is a clear horizontal zonation of the floodplain, with each zone characterized by a distinct habitat, key resources, economic activities, and property rights (Denevan 1984). Houses, gardens, and fields are usually located on the higher levees where the frequency and duration of flooding are lowest. Cattle are grazed on grasslands inland from levees during the low-water season, and families fish in lakes all year round. There is also an important seasonal fishery in the river as water levels fall. Forests were largely cleared to plant jute from the 1950s through the 1980s, and today forest-oriented activities are limited to collection of firewood and some minor forest products for local consumption.

There is also a zonation of property rights that corresponds to these four major habitats (McGrath and Gama 2005). *Várzea* properties are usually aligned perpendicular to the river. Properties are measured in terms of meters of frontage rather than area, and extend inland from the river's edge to the margins of a central canal or lake. Levees are considered to be private property. Lateral boundaries are fenced, and most farm investments are concentrated in this zone. Grasslands inland from the levee are also nominally private property, but in most communities are unfenced and comprise a common grassland where residents graze their cattle. Lakes behind the community are considered the common property of all those living around them, and individual rights are not recognized. For the purposes of this discussion, then, there are two main common pool resources, lake fisheries and floodplain grasslands.

The central dynamic of the *várzea* ecosystem is the flood pulse, the seasonal alternation between high- and low-water phases (Junk et al. 1989). Rising floodwaters spark a period of intense ecological activity in the aquatic system, as aquatic macrophyte communities expand and fish and other aquatic organisms move into the flooded vegetation. These expanding mats of aquatic vegetation provide an important habitat for microorganisms and juvenile stages of fish and other vertebrates. Many trees and shrubs fruit at this time of year, providing an important food source for fish, turtles, and other aquatic species (Goulding 1980). Sediment-rich waters are decanted, and accumulating sediments fuel terrestrial plant growth as water levels recede. Fish and other aquatic vertebrates move out of the flooded forests and into deeper lakes and river channels, some migrate upstream, reentering the *várzea* as waters begin to rise again. Birds, river turtles, and other aquatic vertebrates nest at this time, their offspring dispersing as floodwaters begin to rise. This seasonal movement of river waters and organisms, and the resulting interaction between terrestrial and aquatic communities, are responsible for the great ecological productivity and rich biodiversity of the *várzea* (Bayley 1991). Consequently, maintenance of this seasonal pulse is the key to the sustainable management of the *várzea*.

## 3 Development of a Fisheries Comanagement System in the Santarém Region

Grassroots movements for the conservation of floodplain lakes are quite widespread in the Amazon, and while each region has its own history, all share a common origin in the broad movement of traditional peoples to protect their resources and way of life (Pinedo-Vasquez et al. 1992; Lima 1999; McGrath et al. 2004). As rubber tappers organized to protect their forests from commercial loggers and ranchers, so floodplain communities organized to protect local fisheries from outside commercial fishermen. In so doing, these groups set in motion fundamental changes in management philosophy that led to the development of participatory management regimes that build on their collective management initiatives and which are still in the process of construction.

The development of participatory management regimes is taking place at two different but overlapping levels: formal comanagement structures at the regional level, which provide a basic regulatory framework for floodplain fisheries, and community-level initiatives involving the management and marketing of pirarucu and other aquatic species.[3] These two levels of management initiatives are evolving more or less simultaneously and are, in general, mutually reinforcing processes.

[3]For now the only species being managed for commercial objectives is the pirarucu. Management of caiman has been tested at Mamirauá. Work with turtles is conservation-oriented, as commercial management is not yet permitted.

In this paper, the emphasis is on development of the formal comanagement system, keeping in mind that the parallel development of local management systems for important commercial species is a key element of the overall process (Castello 2004; McGrath et al. 2005).

Construction of the Santarém comanagement system has addressed three overlapping dimensions of *várzea* settlement and resource use, each of which involves different resources, habitats, institutions, and policies: fisheries comanagement agreements provide the basis for management of aquatic systems; cattle grazing agreements for managing terrestrial habitats; and floodplain land tenure regularization defines individual and collective property rights to floodplain lands and resources.

During the first phase, extending from the mid 1990s to 2001, the basic institutional and policy framework for comanagement of floodplain fisheries was worked out and implemented in the municipality of Santarém. The potential legality of fishing agreements was recognized by IBAMA, and administrative decrees defining the criteria and procedures for legalization were published (IBAMA 2003). At the same time, the institutional structure for comanagement was developed. Regional Fisheries Councils, intercommunity councils representing all communities of a given lake system, were created to develop and implement collective fishing agreements. Once approved by IBAMA, they are made into administrative decrees (originally a *portaria* and later an *Instrução Normativa*). By 2001, Regional Fisheries Councils had been created for the seven major lake systems of the municipality, involving some 170 communities and roughly 40,000 people. By this time, all but one of these Regional Fisheries Councils had fishing agreements that had been legally recognized.

IBAMA also created the category of Volunteer Environmental Agents (VEA), a member of the community who has been trained and accredited by IBAMA to educate the local population on fisheries management, and to organize local monitoring and enforcement activities, including regular lake patrols in collaboration with IBAMA field agents (IBAMA 2001a, b). VEAs can issue citations and confiscate illegal gear, but cannot make arrests. IBAMA agents are responsible for periodic visits and patrols with VEAs and community groups and for bringing charges against those who are cited by the VEAs. While promising in theory, in practice this comanagement system has been something of a disappointment.

The second element in the construction of a regional comanagement system was the development of collective agreements, Terms of Adjustment of Conduct (TAC), to regulate cattle ranching on the floodplain. Cattle ranching, on scales ranging from a few to many thousands of head, is the predominant land use activity of the Lower Amazon *várzea*, and overall some 45% of smallholder families raise cattle (Sheikh et al. 2006). Cattle have generally been allowed to roam freely, and even where grasslands are fenced, these often are so flimsy that cattle are constantly escaping and damaging neighbors' crops. In addition, cattle grazing in lake shallows occasionally damages fishing nets, angering fishermen. As a result, cattle ranching is second only to fishing as a source of conflicts on the floodplain. Communities sought out the Fishers' Union and the Public Ministry for help in

resolving conflicts between cattle owners and other community members. A working group was formed to develop criteria for evaluating complaints, especially cattle-related environmental impacts. The TAC was chosen as the best available legal mechanism for cattle agreements, as it is a contract enforceable by law that legally binds all those who sign it to comply with its provisions. It also commits the Public Ministry or federal government to enforce it. Thus far, 51 TACs in three municipalities are operational, and most of the Santarém floodplain is covered by TACs.

At this point the fisheries comanagement system and the TACs are legally and institutionally distinct spheres of local governance. IBAMA is the federal agency responsible for fisheries comanagement policy and Regional Fisheries Councils are the primary user group institutions. The Public Ministry is responsible for TACs, and these typically involve local cattle owners and one or two neighboring communities. While the two systems are largely independent, they are united by the facts that they involve the same communities and governmental organizations, and are working towards the larger common objective of a comprehensive comanagement framework for managing floodplain land and resource use.

The two comanagement systems have now been operational for several years, so sufficient time has elapsed to permit evaluations of their performance. For both structural and operational reasons, the medium-term sustainability of these systems is questionable; and if problems are not resolved, this approach is unlikely to achieve its basic objectives and may eventually collapse.

Structural problems are derived from IBAMA's interpretation of constitutional constraints on access rights and the right to levy fees or taxes (McGrath et al. 2004). Free access by water to all continental water bodies is guaranteed by the constitution, so one criterion for legal recognition of fishing agreements is that they do not restrict who has access to the lake fishery (Brasil 1934; IBAMA 2003). More specifically, agreements cannot define who has access to the fishery, nor condition access to the fishery on participation in management activities. Thus while one group is responsible for managing the fishery and enforcing the rules, anyone has the right to the benefits of management activities in the form of a more productive fishery. Furthermore, Regional Fisheries Councils cannot charge fees for access to the fishery, so there is no endogenous mechanism through which those who benefit from the fishery are required to contribute towards maintenance of the management system. The result is a system that violates basic principles of collective action (Ostrum 1990). Access cannot be restricted to a well-defined group, access to the fishery does not depend on contributions to the management system, and managers are not allowed to charge users for the costs of maintaining the system (Ostrum 1990; McGrath et al. 2004).

Structural problems exacerbate the operational problems that VEAs have encountered in seeking to perform their duties. Communities often consider VEAs to be responsible for enforcement activities, rather than helping to organize community participation. IBAMA agents have also proven unresponsive to VEAs. Part of this is due to budget and manpower constraints, but part is also due to agent resistance to sharing power with VEAs. VEAs are increasingly frustrated as they

find themselves losing credibility and support from their communities and from IBAMA and many have simply stopped performing their duties.

While TACs operate on a somewhat different logic, the result has been similar to that of fishing agreements. Unlike comanagement agreements, TACs do involve a distinct group of people – those who signed the contract, who are legally bound by its provisions. However, the Public Ministry is simply not equipped to enforce all the agreements that have been implemented, with the result that compliance is highly variable. While agreements do seem to have reduced cattle conflicts and provided mechanisms for compensating damages and resolving disputes, overall performance has been disappointing. Aware that it does not have the capacity to enforce agreements, the Public Ministry has pushed for a definitive solution within the context of a policy for regularizing floodplain property rights.

In summary, the overall problem with the comanagement system is the combination of legal constraints on local capacity to exclude outsiders, charge user fees, and enforce agreements. A related problem is the distribution of the costs generated by the comanagement system. Two studies (Almeida et al. 2006; Inhetvin 2004) find that the costs of the comanagement system are high and disproportionately borne by communities. While the logic is impeccable as a strategy for minimizing government expenses in managing fisheries, the lack of mechanisms for compensating VEAs and Regional Fisheries Councils for the costs incurred is a serious threat to the long-term sustainability of the system. But while the unequal distribution of costs is an important issue, it was not the main problem for the VEAs. In a survey of environmental agents, 95% of respondents considered lack of support from IBAMA as the main problem for the comanagement system (Almeida et al. 2006). Only a few respondents were concerned with financial compensation.

In entering comanagement agreements with the state, communities sought to both legitimize fisheries agreements and to obtain state support in enforcing them. What they have found is that only the first half of their concerns have been met. At the same time, constraints on access restrictions and charging of fees limit community capacity to solve enforcement problems. For many floodplain residents, things were better before the comanagement system was implemented, when they enforced agreements unilaterally without worrying about what was or was not permitted by IBAMA.

IBAMA's legal department continues to be stuck on a concept of continental fisheries that seems to confuse water bodies with the fish that swim in them. One thing is the right to navigate across a body of water; another is to take fish from it. The former is a public good where use does not affect future availability, while the latter is a common pool resource where use by one does affect use by others. Given the principle of equal access, the only way to define a distinct user group is to implement a licensing system with a fixed number of licenses. Even here, though, there must be equal access to the licenses; so in theory there is no legal mechanism to ensure that licenses go to community members. IBAMA's principle of equal access is in conflict with the idea of territorial rights to a fishery, the central premise of the community lake reserve movement.

## 4 Land Tenure Regularization

The third component of the evolving comanagement system is land tenure policy. This is the major unresolved issue. Land tenure policy for the floodplain has long been a source of confusion. Technically, the floodplain is the property of the federal government and legal titles cannot be issued for floodplain lands (Benatti et al. 2005). In practice, most of the floodplain is divided into individual properties, which are bought and sold in local land markets, though without involving legal titles. Because of the insecurity of this informal arrangement and the inability to use *várzea* property as collateral for loans, legal recognition of their claims has long been a concern of *várzea* landowners.

The critical question is how to do this. First, local land tenure systems have developed in response to local political ecology, the ecological characteristics of the floodplain, and the political economy of settlement and resource use (Benatti et al. 2005). Secondly, as noted earlier, traditional property rights, as in the case of the Lower Amazon, vary depending on habitat and resources, and these vary regionally along the Amazon floodplain. For example, in the Tefé region some communities claim collective territorial rights and recognize individual use rights to agricultural fields and whatever investments have been made (fences, buildings, etc). Low population density and the more ephemeral nature of floodplain communities in this region may make explicit recognition of property rights unnecessary in some areas (Lima and Alencar 2000). There is also evidence that the alignment of properties does not always follow the perpendicular orientation described earlier. Maps of the island of Careiro from the early twentieth century, for example, show some properties that occupy just the levee and are oriented parallel to the river (Sternberg 1998). Population density is also modifying land tenure patterns. In some Lower Amazonian communities smaller properties are now being subdivided parallel to the river, with children constructing their houses behind those of their parents. The tidal landscape of the Amazon estuary has still other patterns of land use and settlement (Treccani 2005).

State and federal government roles with regard to floodplain lands have also varied. The agency responsible for the floodplain is the SPU (Serviço de Patromônio da União) and its regional office in Belém the GRPU (Gerência Regional do Patrimônio da União). However, only a tiny handful of properties have been registered with the GRPU and there is no documentation at all for the thousands of properties of the Lower Amazon. Iterpa, the state agency responsible for registering properties on state lands, has never assumed responsibility for *várzea* lands. The state of Amazonas, in contrast, used a dubious legal argument to claim responsibility for administration of *várzea* lands, and maintained separate registers for *terra firme* and *várzea* properties (McGrath and Gama 2005). This system was discontinued when the state land agency was shut down.

The process of regularizing floodplain land tenure has followed two converging paths. In the early 1990s the SPU-GRPU and the municipal governments of Santarém and Gurupá signed agreements to regularize floodplain properties by

granting renewable use concessions that formally recognize the conditional property rights of owners and that can be used as collateral for obtaining bank loans. Because most smallholder properties are smaller than the minimum legal size for a rural property, it was decided to regularize floodplain communities collectively via community associations. Large properties outside communities were to be regularized individually at a later date. Four communities were selected for the pilot project and surveys were conducted in each to map individual properties and document household economic activities. The process of regularization then stalled for several years in the Santarém area, but was concluded in Gurupá with several communities receiving concessions (Treccani 2005).

During the period in which the process of regularization initiated by the SPU was stalled in Santarém, Provárzea initiated a strategic study of floodplain land tenure and experiences regularizing floodplain land tenure (Benatti et al. 2005; IBAMA 2001c). This study initiated a new, more systematic investigation of the legal status of the *várzea*, existing land tenure patterns along the Amazon floodplain, regularization experiences in Amazonas, Santarém, and Gurupá, and policy and institutional alternatives for legal recognition of floodplain land tenure. The results of this study were discussed in a series of workshops bringing together representatives of state, federal, and municipal government institutions and other organizations concerned with the issue.

Out of this process emerged a critique of the original regularization plan implemented by the GRPU and proposals for an alternative approach. One concern is the differential treatment given to small and large properties, with large landholders receiving individual concessions, while smallholders receive collective concessions. A second is the fact that the separate regularization of individual communities and large properties would dismember lake systems into separate blocks. In many cases, this would mean that important lake fisheries located within large properties might no longer be available to neighboring communities. Also, there would be no legal mechanism to insure that landowners do not engage in activities, such as large-scale irrigated farming, that could disrupt lake system fisheries. Finally, the SPU, and more specifically the GRPU, do not have the capacity to issue and monitor such a large number of concessions spread out over such a large area.

One outcome of the strategic study was the definition of four design principles to help orient development of an appropriate land tenure policy (McGrath and Gama 2005). (1) Based on the Pulse Concept, management should seek to maintain interactions between aquatic and terrestrial components of the floodplain ecosystem, conserving floodplain vegetation (grasslands and forests), and also avoiding physical modifications to the floodplain that affect flows of water between the river and the floodplain, such as dikes and canals. (2) Integrated management of floodplain resources would be instituted, combining fishing, farming, and small and large animal husbandry in order to optimize global production, rather than intensifying individual activities such as cattle ranching or agriculture. (3) Lake systems should be the basic settlement and management unit. This can ensure that the functional integrity of the lake system is maintained.

(4) Zoning of use rights would follow existing patterns of individual and collective use of different ecological zones of the floodplain. These four principles could provide the basis for the design of a policy for land tenure regularization that is consistent with the existing patterns of *várzea* settlement, resource use, and ecological processes.

In late 2005 the GRPU[4] (Gerência Regional do Patrimônio da União) transferred responsibility for regularization of Amazon floodplain land claims to INCRA, the National Institute for Colonization and Agrarian Reform. This transfer was motivated by the fact that the GRPU/SPU does not have the capacity to regularize lands at the necessary scale. Initially, rather than recognizing their preexisting claims, INCRA proposed converting floodplain settlements into Projetos de Desenvolvimento Sustentável (PDS), a colonization model designed primarily for new colonists (Benatti 2004). While the PDS does incorporate collective use, in order to qualify, residents would have to meet the conditions of prospective colonists.[5] Finally, in July 2006, INCRA proposed using a different model, the Projeto de Assentamento Agro-Extrativista (PAE), one that had been created by INCRA in 1988 for use with traditional populations, and which is comparable to the Extractive Reserve created by IBAMA shortly thereafter (Benatti 2004). As with the Extractive Reserve, the land is owned by the federal government, and residents are granted concessions to live in the reserve. Both individual and collective property rights are recognized.

Several aspects of the new proposal are consistent with the design principles described earlier. The PAEs cover entire lake systems and not just individual communities. In the case of Santarém, the Regional Fisheries Council territories have been transformed into PAEs. Also, both large and small properties will be included in the PAE, though only smallholders will be recognized as clients of agrarian reform and qualify for government benefits. Smallholder communities will be regularized collectively, with community associations then granting concessions for individual properties. Formal concession of the PAE will depend on approval of a Utilization Plan for the PAE. Utilization Plans are also required to integrate existing collective agreements for lake fisheries and cattle grazing. Thus, in the Santarém region at least, PAEs should reinforce the institutional and policy framework for comanagement of floodplain resources.

In September of 2006, INCRA began field surveys to register all floodplain land claims and collect basic information on the number of people and the main economic activities of each household/property. By October 2006, all properties in the municipality of Santarém had been surveyed and GPS points for their boundaries recorded. INCRA then created five PAEs, four of which were the *várzea* portions

[4]The GRPU is the regional office of the SPU, Serviço de Patrimônio da União, responsible for all federal properties, including the floodplain.

[5]For example, people with more than one property would have to give up one of their properties. Since a significant number of smallholders have more than one property, this alternative would not be accepted by floodplain land owners.

**Table 1** PAEs created in the municipality of Santarém

| PAE | Area | Communities | Families | Population |
|---|---|---|---|---|
| Aritapera | 25,000 | 12 | 750 | 3,750 |
| Urucurituba | 19,500 | 10 | 500 | 2,500 |
| Tapara | 11,700 | 14 | 850 | 4,250 |
| Ituqui | 21,920 | 8 | 420 | 2,100 |
| Ponta Negro | 5,048 | 1 | 400 | 2,000 |
| Total | 83,168 | 45 | 2,920 | 14,600 |

of five Regional Fisheries Councils (Table 1).[6] INCRA went on to survey and register floodplain land claims for the other seven *várzea* municipalities of the Lower Amazon. As will be discussed below, PAEs in these other municipalities where there is no preexisting comanagement structure, may be based on individual communities, rather than multicommunity networks associated with entire lake systems. To oversee the creation of PAEs and decide policy issues, a Governing Committee (Comitê Gestor) was created, composed of voting and nonvoting members.[7] This committee is responsible for defining PAE policy issues within the context provided by INCRA's interpretation of existing legislation.

Beginning in January 2007, a series of regional meetings were held in each PAE, with the objective of educating community leaders on the nature of the PAE settlement model, the steps involved in establishing a PAE, and to discuss rules for the main resource use activities to be included in the Utilization Plan that must be approved before a PAE can be formally established. Regional meetings to discuss fishing agreements were held in March. In addition to general fishing agreements covering the entire PAE, individual communities or groups of communities can also define more stringent agreements for lakes in their immediate area, provided that other PAE communities are in agreement. This will allow communities managing local pirarucu populations, or which prohibit use of gill nets in their lakes, to continue doing so. These meetings were followed by a series of four meetings addressing management of game species such as turtles, caiman, and capybara.[8] Workshops to discuss rules for agriculture and ranching were to be held in May, but because of growing confusion regarding collective or individual concessions, it was decided to

[6]The Maicá Regional Fisheries Council district adjacent to Ituqui will be divided into two parts. The *várzea* portion will be annexed to the Ituqui PAE, while the *terra firme* portion is in the process of being transformed into a Quilombo. The other two Regional Fisheries Councils, Arapixuna and Lago Grande de Ciuruai, will be dealt with differently because virtually all settlement in these districts is located on the uplands and is therefore part of existing upland INCRA settlements.

[7]Members include: INCRA; IBAMA; SPU/GRPU (voting); EMATER; EMBRAPA; STR (Rural Workers' Union); Z-20 (Fishers' Union); SIRSAN (Union representing large rural landowners); IPAM (NGO); SEMAB (Municipal Secretary of Agriculture) (nonvoting).

[8]Managing wild populations of these species is not yet legal; however, a number of communities have begun monitoring local caiman populations, and/or protecting turtle nesting beaches and/or managing capybara populations, and would like to include rules for these activities in the Utilization Plans. IBAMA is currently evaluating the development of criteria and procedures for permitting the management of wild populations of some species of commercial value.

hold a series of meetings to clarify options, and to explain that INCRA had opted for collective rather than individual concessions because the land claims of the vast majority of smallholders were below the minimum of 3 hectares required by law to title rural properties. Workshops to discuss rules for agriculture and ranching were held later in the year, when river levels were lower and cattle owners had returned from the uplands.

The major issue is the future of large ranchers whose land claims are within the boundaries of the four PAEs. By opting for the PAE as the model for regularization of floodplain properties, the fate of ranchers with large land claims was sealed. Because of their wealth they do not qualify as clients of agrarian reform and so cannot remain within the PAE. Even if they are allowed to remain, they will lose substantial portions of their present land claims. Part of their lands will be used to settle current landless residents or those whose lots are too small to be economically viable. Another portion of their lands will be used for the expansion area required for all PAEs. A final factor is that new stocking rates of six hectares per head for cattle on the *várzea*, recommended by a recent study by Embrapa, combined with rules that give everyone equal access to PAE grasslands rather than allocating access by the size of the land claim, will effectively eliminate commercial cattle ranching as an economic option.

It took ranchers a while to realize that INCRA's strategy was not just intended to regularize floodplain land claims but to remove them from areas of smallholder settlement on the *várzea*. As the consequences of the implantation of the PAEs have sunk in, ranchers, through their union SIRSAN, have begun to mobilize political support to protect their land claims. Because *várzea* ranchers are the core of the traditional Santarém elite, they have considerable political clout. They requested a public hearing (*audiência públic*) that was held in late April in the Municipal Town Council, with the participation of several state and federal deputies. Here they questioned the legality of the process now underway on several grounds, but were unable to open any legal avenues for halting the process. While thus far the Governing Committee, with the exception of the representative of SIRSAN, has been united behind the PAE initiative, there are clearly misgivings on the part of some representatives about the direction the process has taken.

As the process of creating PAEs in Santarém advances, INCRA has completed surveys of smallholder settlement in the other seven *várzea* municipalities of the Lower Amazon and created some 36 PAEs covering 657,000 hectares and including 10,489 families, approximately 52,490 people (Table 2). In contrast to Santarém, many PAEs in other municipalities have been created for individual communities, rather than all the communities associated with a specific lake system, as there are no preexisting intercommunity comanagement systems. The process of developing Utilization and Sustainable Development Plans in these municipalities will begin once the process has been concluded in Santarém. Where the areas allocated to each PAE may or may not be coterminous with the local lake system, it may be possible to insure the integrity of the local lake management system through the Utilization Plan, which apparently may cover an area larger than the boundaries of

**Table 2** Várzea PAEs created in lower Amazonian Municipalities

| Mun | PAEs | Area | Families | Population |
|---|---|---|---|---|
| Alenquer | 2 | 354,000 | 630 | 3,150 |
| Curuá | 1 | 15,850 | 500 | 2,500 |
| Juruti | 5 | 106,900 | 1,240 | 6,200 |
| Mte Alegre | 12 | 18,436 | 1,862 | 9,310 |
| Óbidos | 7 | 88,960 | 1,942 | 9,710 |
| Oriximiná | 2 | 40,449 | 2,082 | 10,410 |
| Prainha | 7 | 32,249 | 2,242 | 11,210 |
| Santarem | 5 | 83,168 | 2,222 | 11,110 |
| Total | 41 | 740,011 | 12,720 | 63,600 |

the PAE. These issues will be resolved as INCRA begins developing Utilization Plans for PAEs in other municipalities.

## 5 Discussion

The PAE model for regularization of floodplain land tenure would seem to resolve many, if not all, of the issues raised earlier with regard to development of an effective policy and institutional framework for the participatory management of the *várzea*. By taking floodplain lake systems as the basis for defining the territorial jurisdiction of PAEs, this approach insures that the physical integrity of the lake system is maintained. By including both large and small properties, the model insures that all resident stakeholders are included. By recognizing Regional Fisheries Councils as the governing body of the PAEs, and by requiring that existing comanagement agreements be incorporated into Use Plans, this model builds on the foundations provided by the comanagement system and should reinforce comanagement agreements and institutions.

The PAEs have other features that could significantly improve the efficacy of participatory management systems. First, as members of formal settlements, PAE residents have the right to the exclusive use of habitats and resources within their boundaries, thereby cutting the Gordian knot of equal access.[9] Second, all residents must be members of the PAE association, so the PAE association can charge fees for the use of local resources, and this income could help to maintain the PAE management system. Associations could also organize the marketing of fish products, providing another source of control over local fisheries, as well as a mechanism for generating funds for association activities. Third, by linking concessions to compliance with Use Plans, PAEs introduce a potentially effective mechanism for enforcing management plans and maintaining the ecological integrity of the

[9]It is not clear how these contradictory institutional positions will be resolved. A document has been signed that includes IBAMA in the review process for Use Plans, and IBAMA could reject Use Plans that exclude outsiders.

floodplain lake system. Finally, the transformation of Regional Fisheries Councils into PAEs transfers primary responsibility for floodplain settlements and resource use from IBAMA to INCRA, although IBAMA will continue to play a secondary role in the administration of the system.

While PAEs address a number of important concerns, they are not without potential problems. First, while the initial reaction of large landowners on the *várzea* has been muted, it is by no means certain that they have accepted this new legal and institutional status. Depending on how they react, and how INCRA deals with their reaction, there is the potential for polarization and conflict that could disrupt the entire process and put the issue in limbo for years. INCRA's main advantage here is that there is no question of obtaining legal titles, so landowners know that their property rights are conditional and their bargaining power limited.

Second, while recognizing rights to exclusive use could solve one problem, it creates others by leaving out urban and *terra firme* fishers that have traditionally fished in lakes in the region. As currently conceived, at least in the Santarém region, there is a strict distinction between *várzea* and *terra firme*, so that the *terra firme* portions of the Regional Fisheries Councils, most of which are part of existing *terra firme* colonization projects, are not included in the PAEs. If exclusive use rights are not claimed by PAE communities, then there is no problem. However, if they do claim exclusive access, then some mechanism for integrating outside fishers into the lake management system will have to be developed.

Third, the existing institutional structure of the comanagement system provides an excellent base for the governance structure of the future PAEs, but what will happen in other Lower Amazonian municipalities that do not have a system of Regional Fisheries Councils, nor local offices of key government agencies? Apparently, INCRA is considering declaring the entire area of *várzea* in each municipality a single PAE. This would have the advantage of not creating smaller units before having an adequate knowledge of what those geographical divisions should be. It would also ensure virtually complete coverage of the Lower Amazon *várzea* by the PAE system, creating a policy and institutional basis for the sustainable management of the *várzea* that could be far more effective than the existing comanagement system implemented by IBAMA. However, capturing the potential benefits of the PAE model outside the Santarém area will require a major investment from all levels of government, as well as from the grassroots and nongovernmental organizations that have been involved in developing the regional comanagement system. This support is critical. INCRA's track record in managing the settlements it has created along the major highway corridors of the Amazon does not inspire confidence, and there is no reason to believe that the *várzea* PAEs will get special treatment once they have been created.

Finally, there is a potential time bomb at the end of the process of creating each PAE: cash payments of roughly R$7,000 for home improvements and farm investment. Since *várzea* households are already structured, it is likely that a significant proportion of this money will be invested in cattle, pasture formation, and/or commercial fishing gear, all investments that would intensify pressure on key floodplain resources just as PAEs are getting organized and before governance structures can

be consolidated. These investments could lead to the depletion of lake fisheries, discouraging fisheries management initiatives and hastening the expansion of ranching. The resulting conflicts and depletion of resources could reduce economic opportunities for smallholders who might choose to sell out and move to the city or to the upland frontier (McGrath and Gama 2005). Since *várzea* residents are already established, and have been for some time, there does not seem to be a technical justification for the payments. It would be better if they could be divided between the household and the PAE governance structure to strengthen these collective organizations so they are operational as the PAE is implemented.

## 6 Conclusions

The history of the great floodplains of the world is not in most cases one that inspires confidence when contemplating the future of the Amazon *várzea*. The productivity of floodplains has always attracted settlement, and floodplains tend to be among the most densely settled and most intensively farmed areas of the world. It was not too long ago that Sioli (1973, 1984) argued that development in the Amazon should be concentrated on the floodplain so as to spare the unproductive *terra firme* forestlands. His views echoed those of Carmargo (1958), and many others of their time who saw the *várzea* as the key to Amazon development. Despite their views, history has so far followed a different path, with settlement concentrating in the uplands and the *várzea* remaining something of a backwater in regional development. In fact, the relatively stable social and economic conditions of the *várzea*, and especially the lack of polarization among *várzea* stakeholders, have provided quite favorable external conditions for developing another model for *várzea* settlement, one in which the participatory management of natural habitats provides the basis for the sustainable development of the *várzea*. Much of the last decade has been dedicated to constructing this alternative trajectory. INCRA's new land tenure policy is a major gamble. If it works, it could consolidate this participatory management development trajectory. If it does not, much of the progress made over the last two decades could be lost.

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# Management of Wildlife in the Floodplain: A Critical Look at Threats, Bottlenecks, and the Future in Amazonia

**Ronis Da Silveira**

**Abstract** The main bottlenecks for conservation and management of fauna in the Brazilian Amazonia have been the lack of scientists and of adequate legislation. The hunting of aquatic vertebrates such as turtles, crocodilians, and more recently, the pink river dolphin in the floodplain forest represents the most important illegal wildlife trade in the world. My objective in this chapter is to present a qualitative analysis of the main trends in the use and management of wildlife in the *várzea* floodplain forests of Amazonia, and the consequent evolution of related legislation. Considering all the Brazilian ecosystems' conservation policies, wildlife was the component least discussed and for which legislation was not modified in the last 40 years. The proclamation of the National System of Conservation Units (SNUC; Law 9.985) in 2000 became the most important development for the direct use of wildlife in Amazonia, especially in the case of Extractive Reserves and Sustainable Development Reserves. Over the last decade, thousands of projects have claimed to identify themselves as examples of sustainable management in Amazonia. Until better procedures are implemented, regional authorities and environmental agencies should label as sustainable management only those planned human interventions which include some intrinsic compensatory mechanisms for the exploited animal populations, and which through these mechanisms guarantee the genetic variability of the populations. However, we cannot assume that protection efforts constitute effective sustainable management, unless the monitoring shows what the population trends are, and mechanisms exist to alert conservationists in case of unsustainable use. Over the next decades, public policies within Brazilian Amazonia related to the sustainable management of wildlife should include the following: a source-sink system, an adequate monitoring program, satisfactory community involvement, commercial trade focused initially on the Brazilian market and on the MERCOSUL region, supervision of the state government by the federal government

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and by NGOs, and all of these components monitored by the academic community. The management of crocodilians in the Brazilian *várzea* floodplain forests of Amazonia is self-defeating and a looming threat to what could have been one of the few and best empirical examples of sustainable wildlife use and management in the Amazon basin.

**Keywords** Brazilian Amazonia • Management of wildlife • Floodplain • Hunting • Crocodilian

## 1 Introduction

The title of this article expresses more my enthusiasm than any real capacity to evaluate the topics it raises regarding wildlife in the *várzea* floodplain forests of Amazonia, including their diversity, their productivity, and the hunting pressure to which their species are subject. It also concerns me that among the dozens of scientists and themes that make up this volume, I am the only author explicitly tackling the question of conservation and management of fauna in the *várzea*. Could this observation be an indication of how relatively little we have studied and learned about fauna in these habitats over the last several decades?

For species conservation, all bottlenecks, whether technological, scientific, genetic, legal, economic, or social, should be considered a threat, especially if they concern commercially exploited populations. In Brazilian Amazonia, the main bottlenecks for effective conservation and management of fauna have been the lack of scientists and of adequate legislation (Magnusson and Mariano 1986; Magnusson and Mourão 1997; Da Silveira 2006).

Throughout the *várzea* forests of Amazonia, limitations imposed by the flood pulse (Junk 1997) and the lack of electricity generally make management of wildlife nonviable if it is based on closed (farming) or semi-open (ranching) systems. Consequently, exploitation of animals in these environments largely takes the form of hunting. However, local people generally concentrate their hunting efforts in the *terra firme* forests that are adjacent to the floodplain forests where they live; and when compared to fishing or agriculture, hunting is much less important in the subsistence of these human populations.

In the last several decades in Brazil, hunting in the Amazonia floodplain has created the largest illegal trade of fresh-water turtles (Fachín-Terán et al.2000; Kemenes and Pantoja 2006), crocodilians (Da Silveira and Thorbjarnarson1999; Da Silveira 2003), and pink river dolphins (*Inia geoffrensis)* (Da Silveira and Viana 2003) in the world. During the same period, the number of scientific research projects evaluating the impact of hunting on game species in the *várzea* floodplain forests has been relatively small. The only relevant studies to be carried out include ones done with three ethnic groups in the Uaçá Indigenous Territory in the state of Amapá (Mühlen 2005), and in the Sustainable Development Reserves of Mamirauá,

Amanã, and Piagaçu-Purus (Da Silveira and Thorbjarnarson 1999; Da Silveira 2003; Amaral 2005) in Amazonas state.

The objectives of this chapter are to describe the main trends of use and management of wildlife in the *várzea* floodplain forests of Amazonia and the evolution of relevant legislation on wildlife use in Brazil. Most of what is expressed in this chapter I learned from a new generation of researchers who are very active in the *várzea*, among them Adriana Terra, Augusto Kluczkovski Jr., Boris Marioni, Eduardo von Mühlen, Emiliano Esterci Ramalho, Francivane Fernandez, João Valsecchi do Amaral, Guto Ruffeil, Robinson Botero-Arias, and Márcio Sztutman. However, the ideas presented here were based primarily on my own perceptions of the past, present, and near future of subsistence and commercial use of fauna in the Brazilian floodplain of Amazonia. The concepts explained here do not necessarily apply to invertebrates, fish, or amphibians.

## 2 The Legal Bottleneck

Brazilian legislation on the use of wildlife is the same for the two major ecosystems of Amazonia, the *terra firme* and the *várzea* floodplain forests. Ecologically this can be justified, because of the complementarity of these two environments for the conservation of biological diversity (Haugaasen and Peres 2005). Wildlife has been the component of the ecosystems and biomes of Brazil least discussed and legislated in the last four decades. Full protection of species and an "elitization" of management became the national strategy for wildlife management.

After transiting through the National Congress for 12 years, the publication of the National System of Conservation Units (SNUC; Law 9,985) in 2000 was the most important advance in legislation regarding the use of wildlife in Amazonia during recent decades. In this law a ban on amateur and professional hunting in Extractive Reserves (RESEX) was clearly set up. At the same time, the lack of an explicit prohibition on wildlife use in Sustainable Development Reserves (SDR) gave margin for debate and interpretation. Even today, more than 10 years after the publication of the law, legal interpretations of the SNUC are tenuous, questionable, and require further discussion. It is important to highlight that even before the final publication of the SNUC, the noninclusion of the expression "amateur and professional hunting … is prohibited" in the article of SNUC regarding SDR was proposed by the great zoologist José Márcio Ayres.

## 3 The Risks of Rupturing the Bottlenecks That Protect the Fauna

If we were able to observe wildlife issues in a temporal perspective that is longer than our careers or life plans normally permit, maybe it would be possible for us to find some positive aspects of the bottlenecks to the conservation of wildlife that are

imposed by the system. One extreme case can be observed in Colombia, where many local colleagues suggest, although reluctantly, that the difficulty of access to natural resources in the portion of Amazonia under control by armed groups represents one of the most effective mechanisms to reduce human pressure on wildlife.

In Brazil, the ban on hunting imposed by the military dictatorship in 1967 was crucial for the conservation of Amazonia's biodiversity, allowing many species to recover to reasonable numbers. This included some populations of aquatic mammals, terrestrial carnivores, and reptiles that were considerably overexploited in the past.

Since then, a new "philosophy" of sustainable management has been constructed, based on a successful example carried out in the *várzea* floodplain forests of Mamirauá SDR. This has stimulated state governments to create innumerable protected areas permitting "sustainable" use of wildlife, but with the main hidden purpose of allowing extensive and uncontrolled exploitation of wildlife.

In this situation, pressure on wildlife will increase and new legal barriers will need to be implemented to protect species populations. In the meantime, the number of exploitation proposals for Amazonian wildlife is growing every year, and control mechanisms for the harvest of wildlife have not been properly discussed.

## 4 Economic Exploitation Disguised as Management

In the past 20 years, thousands of projects have emerged, been developed, and proposed by governmental agencies, NGOs, local businessmen, and landowners. They all try to involve traditional or indigenous populations so that they can call themselves "sustainable management."

Until better regulatory procedures are available and applied, environmental authorities and local stakeholders should allow the label of sustainable management to be used only with projects that include intrinsic compensatory mechanisms for the harvested populations, guaranteeing population numbers and genetic variability. All other projects should be considered supplemental ways of using wildlife that add pressure to the species populations. Without the implementation of efficient monitoring programs, capable of effectively evaluating sustainability of harvest and real population trends over time, we will not be able to distinguish between sustainable management and mismanagement.

## 5 One Terrible Example of Mismanagement

Around 1997, Mamirauá SDR ceased to be the area of greatest illegal harvest of caiman meat in the world. This was in part due to the law enforcement activities of the Brazilian Institute of Environment and Renewable Natural Resources (IBAMA).

However, it is likely that the main factor was economic, as Colombian traders lost interest in caiman dry-salted meat. At the same time, illegal hunting was intensified along the lower Purus River, in the area of the Piagaçu-Purus Sustainable Development Reserve, from where caiman meat is mainly exported to markets in the State of Pará (Da Silveira 2003).

A few years later a massive trade of the pirate catfish (*Calophysus macropterus,* Pimelodidae) was established in Central Amazonia, supplying markets in Colombia. The pirate catfish is a scavenger species and until that time had basically no commercial value. The particularly damaging circumstances of this commercial trade was that fishermen use the meat of the black caiman (*Melanosuchus niger*), spectacled caiman (*Caiman crocodilus*), and pink river dolphin (*Inia geoffrensis*) as bait (Da Silveira and Viana 2003).

The poaching and trade of pink river dolphin and caiman carcasses to use as bait for the pirate catfish fishery is today common practice between Tefé and Tabatinga, and along the lower Purus River in the state of Amazonas, although pirate catfish fisheries in this region only started in 2004. In these areas, one adult pink river dolphin is worth up to R$100 (~$50 USD), and it is increasingly common to encounter live dolphins tied along the riverbanks awaiting the pirate catfish fishermen to collect them. In the Mamirauá SDR, a decrease in numbers of pink river dolphins since 2000 is likely to have been caused by this uncontrolled harvest (Da Silva, personal communication).

Despite denunciations sent to the IUCN/SSC (Da Silveira and Viana 2003), and to the Brazilian and global environmental communities, nothing has been done by the government to stop or control this activity, and the practice continues to expand in the *várzea* floodplain forests of Central Amazonia. In the mid-Solimões River region the number of caiman killed to be used as bait is at least as large as the number slaughtered for the illegal caiman meat trade of past decades (Da Silveira and Thorbjarnarson 1999).

## 6 Good Management for the Next Decade

For some time now I have been convinced that decentralizing the mission of protecting wildlife that was not in danger of extinction from the federal to the state governments would be the best solution for conservation and management in Amazonia (Magnusson 1993). However, the recent experience of caiman "management" clearly indicates that this may not be the case. The demands of the political agendas of the Brazilian state governments can be even more harmful to wildlife than the inertia of the federal government.

Over the next decade, sustainable wildlife management projects in Brazilian Amazonia need to include at least the following characteristics: (a) a source-sink system (Novaro et al. 2000), (b) an adequate monitoring program, (c) satisfactory community involvement, (d) commercial trade initially focused on local and regional Brazilian markets and on MERCOSUL, (e) supervision of the state governments by

the federal government and by NGOs, and (f) all of these components monitored by the academic community, NGOs, and the stakeholders involved in the Management Unit.

## 7 The Management Unit

Since 1967, one of the few effective contributions of the federal government to the discussion on wildlife in Amazonia occurred in May 2006 during the First Workshop on Policy for Amazon Wildlife, organized by IBAMA and the Ministry of the Environment (IBAMA 2006). One of the major advances discussed during the event was the definition of the concept of the Management Unit.

In general terms, a Management Unit should be as large as the area required by the target species or group of species for its survival and subsistence. Species with a habitat that falls within a single land or land-holding unit can be managed by those legally responsible for that land unit. If the habitat necessary for a species or group of species is found in more than one land unit, then representatives of each unit will participate in any decisions made.

## 8 The Amazonian Caimans, a Case Study

To my dismay, I have become one of the biggest critics of the harvesting of caimans, the so-called sustainable management that has been practiced in Amazonia since 2002. The reasons for my criticisms are many, and I will list here the ones I consider the most important:

1. The activities that are planned and implemented strictly follow a governmental agenda rather than the opinion or scientific results of the most experienced and competent specialists on the target species, or the demands of organized civil society
2. The great majority of technicians involved have neither the necessary knowledge nor experience in wildlife management, and lack familiarity with the local way of life, local perceptions, and of the Amazonian universe in general
3. The government agencies and the civil institutions responsible for caiman management have philosophical and practical divergences, or are in plain disagreement, about almost everything
4. Excessive lobbying and marketing have become common in official campaigns. This scenario has created an incorrect popular belief among local communities and other Amazonian countries that the harvesting and commercialization of caiman is, or will become, legal and unrestrained in the Brazilian Amazonia
5. The elimination of any decision-making authority of the regional Superintendency of IBAMA/AM in the state of Amazonas, with the concentration of power in IBAMA/Brasília and the National Center for Conservation and Management of

Amphibians and Reptiles (RAN) in Goiânia/GO—both outside Amazonia—has caused a pronounced deterioration of conservation and management of Amazonian crocodilian species

6. The extrapolation of various conclusions about population parameters and ecology of the targeted species from studies in the focal area of Mamirauá SDR is unadvisable and risky, even for neighboring areas
7. The not explicitly declared intention to export skins of the black caiman (*M. niger*), rather than to prioritize meat production, could unleash in the next few decades an illegal traffic in skins (and meat) as has never been seen before (Da Silveira and Thorbjarnarson 1999)
8. The commendable, but extreme, caution of the Ministry of Agriculture, Livestock, and Food Supply (MAPA) in certifying the quality of caiman meat using rigorous sanitary standards never seen before in Amazonian context makes harvest nonviable. Regulation regarding certification of caiman meat has to be more flexible if it is to be realistic
9. The political pressure of local governments on their own technicians and state institutions to certify "officially produced" caiman meat is a bottleneck for the effective conservation of Amazonian caiman populations
10. The bogus monitoring of some populations of caiman carried out by the government agencies is frightful and violates the basic principles and good practices of efficient wildlife management

For these and many others reasons, the management of crocodilians in the Brazilian *várzea* floodplain forests of Amazonia can be labeled "shooting oneself in the foot;" that is, it is self-defeating and a looming threat to what could have been one of the few and best empirical examples of sustainable wildlife use and management in the Amazon basin.

Finally, the future of wildlife conservation in the *várzea* is unpredictable, and will depend on the social and biological strides that will be made in the coming decades. The most critical aspect is how the inhabitants of Amazonia will react to new technologies. The key to achieving a balance in Amazonia is "to manage with care."

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# Comanagement of the Application of Fisheries Resources in the Amazon: Present Status and Challenges for Management and Conservation

**Mauro Luis Ruffino**

**Abstract** The present article documents the progress of the comanagement strategies for the application of fisheries resources in the Amazon over the last 10 years, as has been observed through localized, diffuse, and demonstrative experiments. The article also shows that some of these experiments have played a key role in the modification and establishment of new relations, through the projection of these findings onto regions, both in the short and long terms. The background and reported experiments exemplify how diversified groups, such as communities, fishing colonies, local NGOs, governmental agencies, and international donors and organizations related to international conservation, can work together in order to develop a new comanagement system of fisheries resources that supports and legitimates the efforts of base organizations so as to defend the resources and livelihoods. The process of fisheries intensification and local organizational development has led to the emergence of new models of joint management. However, the establishment of these models not only has represented a response to an ecological change (effort restriction and an increase in the lakes' productivity), but also has raised the question of the right to common resources as a matter of concern. Despite the considerable progress made up to the present moment, it is necessary to carry out an analysis on the shared river basins, to perform a critical evaluation of the diverse fisheries activities, aimed at assessing their strengths and weaknesses, and ultimately to evaluate the institutional mechanisms (rules, procedures, monitoring) which may be necessary to determine management and comanagement strategies with the adjoining Amazon countries.

**Keywords** Amazon • Comanagement • Empowerment • Fisheries • Fishery • Participation

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## 1 Introduction

The present document presents an analysis and synthesis of the status of continental fishing in the Brazilian Amazon, taking into account the available information, and makes some recommendations regarding the sustainable management of the region. It is paramount to emphasize the social importance of this activity, in addition to its role in human development, particularly with regard to diminishing malnutrition and the fight against poverty, not to mention the need to conduct this activity through sustainable ecosystem management on a regional level.

Considering the existing documentation and the previous analyses on this theme, it is necessary to acknowledge that despite having the general data concerning the situation of the Amazon fishery and its populational and biological aspects, there is limited knowledge and analysis of the social and economic impact these fisheries might reflect. However, it is essential to place emphasis on the analysis of the shared river basins, to carry out a critical evaluation among the diverse fisheries activities focusing on the assessment of their strengths and weaknesses, and finally to estimate the possible institutional mechanisms (rules, procedures, monitoring) necessary for the countries regarding management decisions.

The development of comanagement of fisheries resources in the Amazon should be regarded as an important experimental means of reversing the dynamics that had generated social exclusion in Brazil in the 1980s and 1990s. Only recently have the most successful experiments concerning this been conducted, and it is possible to say that in Brazil this is an early process. Nevertheless, we face alternatives in which the integration of public participation and policies has a new reference basis, linking active and productive involvement in the workforce with exercising citizenship and increasing participation in democracy.

According to Goulding and Ferreira (1996), the meadows, the river canals, and the estuary are considered to be the three main components of the ecosystem that maintain the Amazon fisheries. Each of them sustains hundreds of fish species, providing several habitats for energy, seasonal reproduction, and protection against predators. And considering the fact that the flooded forests, the floating vegetation, phytoplankton, and periphyton are all responsible for maintaining the trophic chain of the Amazonic fisheries, the conservation of these habitats will significantly contribute to their sustainability.

The present article documents the progress of the comanagement strategies for the application of the fisheries resources in the Amazon since the conference "*Várzea: Diversity, Development, and Conservation of Amazonia´s Whitewater Floodplains*" took place in the city of Macapá in December 1994 (Padoch et al. 1999). Findings are based on localized, diffused, and potentially demonstrative comanagement experiments of the application of fisheries resources; they show that some of these experiments may result in the modification and establishment of new relations, when amplified onto a regional scale in the short and long terms.

Finally, it must be emphasized that the experiment described in this report is the result of the following: a serious effort to mobilize and raise social consciousness,

prediagnosis and participatory referential plans, organizational training, and subsidies for public policies aimed at the improvement of local people's living standards, greater participation in power structures, gender equality, autonomous and independent political action, the understanding of the environment as an agent of development, and the elaboration of new paradigms prompted by more sustainable development models.

The present article starts with a brief summary about the types of fisheries found in the Amazon and their economic, ecological, and social importance. Also, it describes some aspects of the management of large-scale projects already carried out in the past years which contributed to the institutionalization of comanagement, and documents the impacts and the sustainable aspects of that management, concluding with suggestions regarding the terms, opportunities, and recommendations for the management of fisheries resources in transborder waters.

## 2 The Structure or Classification of Fisheries in the Amazon

There have been several attempts to classify fishing efforts according to a set of criteria, such as people involved and the geographic areas where their operations and eventual markets are focused. When observing the connection between the riverbank population and the fish, Furtado (1990, 1993) classified the fishermen as resident fishermen, farmer fishermen, and professional fishermen. The first two categories include people who live in rural areas. Resident fishermen exploit the flooded forest and sell their catch to the fishery fleet (professional fishers) or to cargo boats during the freshet season; whereas the farmer fishermen fish mainly for their families' consumption, selling their excess catch occasionally, and managing their time between the fisheries and their agricultural activities. Both categories are extreme when it comes to the continuous division between fishing and agricultural activities. Professional fishermen live in cities and fish full time, commercializing their production in the cities in which they live or in their own harbors.

Bayley and Petrere (1989) identified two main types of fisheries: diffuse and commercial, both large-scale. Diffuse fishing is carried out by inhabitants of rural areas, villages, and small cities, along riverbanks and in lakes, whilst commercial fishing occurs near big cities.

Isaac and Barthem (1995) classified the fisheries into these categories: subsistence fishing, artisanal fishing, and industrial fishing. Subsistence fishing is a traditional activity of the rural population in the Amazon and is complementary to other activities. Artisanal fishing has commercial ends; the fishermen are professionals and work almost exclusively in fisheries activities. The artisanal fishermen, however, can hire fishermen from the rural areas temporarily, providing them with ice and equipment. Industrial fishing uses large-capacity boats, operating in the estuary to capture piramutaba (*B. vailantii*), shrimp, and some other species.

Barthem et al. (1997) classified the fisheries according to their level of investment, and also classified the working hours of the fishermen as industrial and artisanal, including several subdivisions in the latter category.

Araújo-Lima and Ruffino (2001) analyzed the activity based on their markets, which integrates the other classifying systems and recognizes fisheries for export markets and fisheries for regional and local markets.

In order to aid in the understanding of the Amazon fisheries and to facilitate the establishment of adequate normative markers, the types of fisheries were classified based on their objectives. By doing so, it was necessary to know the magnitude and dimensions of each type, as well as the social and economical relevance in relation to the sustainability of each of them.

(a) *Subsistence Fishing*: its main objective is to feed the fishermen, their families, and their communities. The catch originating from this fishery usually provides the main source of protein to the rural populations in an elevated consumption of approximately more than 360gr/person/day (Batista et al. 1998; Cerdeira et al. 1997), thus highlighting its social importance, since it represents up to 60% of all the catch in the region (Bayley and Petrere 1989). It is a common practice among the riverbank population, and it explores a great diversity of species—preferred, however, are those that live in the meadow lakes

(b) *Commercial Fishing*: full- or part-time activity, although the fishermen earn the majority of their annual income from it. Commercial fishing supports partly or fully the local and regional economies. Based on the average price of approximately US$0.50/kg during the first year of commercialization, at a production rate of around 200,000 tons per year, this type of fishing generates about US$100 million/year and creates more than 200,000 direct jobs (Ruffino 2001). This type of fishing aims at human consumption and can be divided into:

i. *Monospecific fishing,* whose target species are mainly the Siruliforms such as dourada (*Brachyplatystoma rouseauxii*), piramutaba (*B. vailantii*), piraíba (*B. filamentosum*), the surubins and caparari (*Pseudoplatystoma tigrinum* and *P. fasciatum*), pirarara (*Phractocephalus hemiliopterus*), and the mapará (*Hypophythalmus marginatus*). The fishing of these species has industrial characteristics in the mouth of the Amazon River and artisanal ones in the interior along the Amazon and Solimões Rivers. Dourada (*Brachyplatystoma rouseauxii*) and piramutaba *B. vailantii*) carry out great reproductive migrations from the estuary to the headwaters of the Amazon-Solimões affluent rivers. Batista et al. (2005) shows that the genetic-populational analysis regarding dourada and piramutaba suggests that there is only one population with large-scale reproductive migrations along all the channels, tributaries of the Amazon River, and argues that the affluents must be seen as the authentic birthplaces of these species. This is not only because they are places of spawning but also because the affluents provide a source of great genetic diversity for the whole group, as the species is formed in the channel and migrates towards the Amazon estuary. The catch of bagres along the channel of the Solimões-Amazon Rivers is an activity connected mainly to the fishing industry, represented by cold-storage containers. Parente et al. (2005) registered that between the harvest periods of 2002–2003, the gross profit from fishing bagres in the Amazon was approximately R$121.9 million. This activity generates employment opportunities for about 16,000 fishermen in this region. Two places in the Amazon have

highlighted concerns about fishing bagres: (a) the State of Pará, with eight fishing companies associated with the labor union, and 20 federally inspected cold-storage units, with storage capacity reaching 7.852 t of fish and 6.832 t of ice; and (b) Leticia, in Colombia, which has generated about 10,000 t of catch per year, with its production destined, in its greatest part, for Bogotá, Cali, and Medellín. The great majority of the catch commercialized by the cold-storage units in Leticia comes from the State of Amazon, an area that stretches from Tefé to Tabatinga

ii. *Multispecific fishing* exploits mainly the migrating species such as jaraquis (*Semaprochilodus insignis* and *S. taenirus*), pacus (*Myleus* sp., *Methynis* sp., and *Milossoma* sp.), tambaqui (*Colossoma macropomum*), matrinxã (*Brycon amazonicus*), and curimatã (*Prochilodus nigricans*). The majority of these species is greatly influenced by the hydrologic cycle, which is the main regulating source in the whole ecosystem, directly affecting the species' reproductive and migratory cycles, and therefore the fishery. Some of these species have already presented a level of overexploitation, as can be observed with the tambaqui. However, the continuous monitoring of the storage of curimatã and jaraqui is recommended because of the intense level of exploitation of these species (Freitas et al. 2007).

(c) *Sport Fishing*, which is usually practiced by tourists coming from other urban centers and other countries, and which does not necessarily involve consumption. Sport fishing is currently one of the greatest touristic industries in the State of Amazonas. It is estimated that approximately 10,000 tourists practice it and the industry directly employs about 1,000 people per season. The beginning of the fishing season coincides with the ebb season of our rivers, and it continues until the end of the drought season, representing a total of 6 months per year. Despite the number of tourists, jobs, and the foreign exchange this industry brings, the section still lacks an arrangement that could enable the sustainable development of this activity. The main target of sport fishing in the State of Amazonas is the tucunaré (*Cichla* spp.) and the main fishing region is the Middle Negro River basin. According to the FAO (1998), the figures related to sport fishing in the Brazilian Amazon would amount to more than US$400 million (including direct and indirect costs). The progress made in recent years occurred as a result of a national development policy on sport fishing (IBAMA 2006), aimed at the promotion of this kind of fishing so as to transform it into a means for social and economic sustainable development

(d) *Ornamental Fishing*: which is characterized by the catch of small fish used in aquariophilia. According to Chao (2001), there are 800 species of registered fishes in the Negro River, and only about 60 of the fishes in the basin have been explored for ornamental purposes. The target species, the cardinal tetra (*Paracheirodon axelrodi*), represents 76–89% of all exported fishes per year (Chao 2001). Other species that are highly exported include the neon verde (*Paracheirodon simulans*), Rodóstomos (*Hemigrammus bleheri*), rosaceu (*Hyphessobrycon* spp.), borboletas (*Carnegiella* spp.), and the apistogramas (*Apistogramma* spp.). Arraias (*Potamotrygon* spp.) represent a potential ornamental resource, briefly explored, which were exported under the regulation of a Normative Instruction until December 2005, but it is suspended at present.

The Middle Negro River—more specifically, the municipalities of Barcelos and Santa Isabel do Rio Negro—can be considered the main productive region of ornamental fishes in Brazil. The fishery is mostly artisanal, based on the fishermen's empirical knowledge of the use of the rapiché,[1] cacurí,[2] and traps (Leite and Zuanon 1991). The export of ornamental fishes is an important source of income in the region, generating more than US$2 million and employing more than 10,000 (Chao 1993). The main exports are from Amazon State, representing about 90% of the total production; the remaining 10% comes from the State of Pará. Exportation reached its apex in 1979, when 20 million fishes were exported, diminishing to between 13 and 17 million in the 1980s. However, in the Xingu River, next to Altamira (Pará), there is a great variety of bodós.[3] In the Purus River, Amazon, many species of acarásdisco[4] and coridoras[5] can be found. Amazonian countries such as Peru, Colômbia, Venezuela, the Guianas, and Suriname are also great producers of ornamental fishes, and because of the lack of structure and control of their borders, they have become a biopirate's natural resource. In Brazil, despite all the efforts of IBAMA (Brazilian Institute for Environmental and Natural Resources), smuggling is still frequently present (Ferreira 2002).

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[1]Rapiché is an artisanal indigenous trap (puçá), made of a wooden frame measuring a meter in length by 0.5 m in width, on which a one-millimeter nylon grid is sewn in opposing knots around it.

[2]Cacurí consists of a cylindrical trap with a very small sideways longitudinal opening, which allows the entrance of small fishes. This device is made of a one-millimeter nylon canvas woven in opposing knots. The top is made of iron and the base is made of wood. In order to maximize its effectiveness, fishing baits are used inside the device as a way of attracting the fishes, similar to the first-mentioned device.

[3]*Bodós* belong to the Loricariidae family, which has around 670 spp., and are distributed in all neotropical fresh water environments. The characteristics of the group include a cupping glass shape of the lower jaw, which suggests the origin as coming from fast waters, from which it spread to other types of environments. Another characteristic is the bone armor-plated body, composed of several longitudinal plates. They are commonly known in Brazil as acaris, bodós, or cascudos.

[4]*Acarásdisco* belong to the Cichlidae family, which represents the largest family of fishes in terms of numbers. The cichlideos can be found from the southern United States to the Argentine Patagonia. In the Old World they can be found throughout a vast area of the African continent, with a few present in Israel, Syria, and Iran, and in the Indian subcontinent. However, the discuses are included in the Symphisodon species, and are restricted to the Amazon basin. There are four species: *S. discus* with a dark brown body, dark vertical stripes, bluish lines, and blue-bordered fins; *S. aequifasciata aequifasciata* with a reddish coloring, and strong bluish stretching marks on the body; *S. aequifasciata haraldi* with a blue-greenish body and strong blue stretching marks on the head, back, and fins; and *S. aequifasciata axelrodi* with a brown-yellowish body and blue stretching marks on the head.

[5]*Coridoras* belong to the Callichthyidae family; they have approximately 180 spp. distributed from Panama to the Argentine Patagonia. Their characteristics consist of a bone armor-plated body formed by two series of longitudinal dermic plates and they are small-to-moderate in size, reaching 16 cm maximum. They are popularly known as corridoras, and they live in the margins of rivers and igarapés. They are considered one of the most exploited fish in the aquarium industry nowadays.

## 3 The Management of Fisheries Resources in the Amazon and the Progress Made in the Comanagement of the Application of these Resources

Brazilian laws that endorse all fishery activities are the legal structure from which measures for the protection of migratory species are formulated. The fishery activities must obey Decree Law 221/67 and Law 7679/88, nationally recognized. The first law upholds the fisheries definition and rights concerning aquatic biota property. It relates to three fishery categories only: commercial, sport, and scientific; and it claims that all aquatic organisms living in Brazilian waters, including lakes, reservoirs, basins, rivers, gulfs, etc., are part of the public domain and may be used by all people in these categories. This law also forbids fishing with the use of explosives and poisons. Law 7679/88 restricts fishing during the spawning season in fresh and salt waters.

Besides the difficulties in the application of sanctions, the laws described above are intrinsically flawed (Isaac et al. 1993; Ruffino 1999). For instance, they ignore the subsistence fishermen, who represent a great part of the fishing effort, and the stipulation as to the minimum size of the grid at 7 cm brings an unfortunate effect. This size is effective in reducing the catch of curimatã (*Prochilodus nigricans*) and immature jaraquis (*Semaprochilodus insignis* and *S. taenirus*), but not the catch of tambaqui (*Colossoma macropomum*), whose storage is under great pressure.

The conventional strategies of fishery management focus on the storage of fishes and the recovery capacity after the withdrawal of the captured ones. However, the preservation of the meadow habitats represents an important agent in the maintenance of the fishes' profusion. The extreme sensitivity of the fresh water fishes to the habitat modification (Welcomme 1985) is especially marked in the Amazonian meadow fisheries, in which the slowly descending and rising level of the water has enabled several species to take advantage of the environmental conditions during each phase of the cycle. The meadows provide food for the growth of fish as well as habitats for shelter. When it comes to the development of a new perspective on management, the environment, the fishes, and the fishermen must be considered as a unit, whose integration is vital to maintaining the resource.

Fishing reservations were considered during a period of time for the Amazon. Bayley and Petrere (1989) suggested that the control of the fisheries in distant areas of the Amazon could be an option in terms of feasible management of the region and that it would protect overexploited species. Ribeiro and Petrere (1990) suggested that the establishment of controlled areas, periodically closed for two consecutive years, then reopened for a year, could relieve the pressure on the fishing of the jaraqui, whereas Petrere (1990) suggested that the creation of controlled reservations could be an effective manner to manage the migrating species.

Rural communities have also supported the creation of fishing reservations. Due to the limited presence of the state, communities living around the meadow lakes started organizing themselves and imposing their own fishing regulations. In the

1970s, these rules aimed to reduce the activity of fishing boats in Manaus and other cities (Petrere 1990).

Conflicts also developed among the communities, and between members of the community and farmers. In the communities, some resident fishermen became totally dependent on fishing because of the loss of profit from other agricultural products they grew; since then fish stocks in the community lakes have declined (Câmara and McGrath 1995; Furtado 1998). The impact generated by the presence of cattle in the meadow is seen as harmful to fishery production, according to the riverbank communities (Furtado 1998).

Community management has evolved into "fishing agreements" resulting from the communities' interests. Such agreements are evidently established in order to protect the exploitation rights of the members of the community and are apparently not connected to environmental purposes (Ruffino et al. 1999). The agreements are made in community meetings and are based on the communities' needs. The fishermen's associations are occasionally present. Nowadays, these fishing agreements are common along the meadows in the Amazon.

During the conference in Macapá in December 1994, some experiments concerning the sustainable management of fishery resources at the community level were presented, which was the objective in the Middle Amazon and Solimões Rivers. Despite the institutional and methodological differences, these projects evaluated how the riverbank populations exploited their fisheries resources, as well as how they organized themselves and associated with their neighbors.

At that time, the decisions made by the federal government, as well as the means of organization of fishing in the Amazon, were still centralized and hardly participatory, with a few local experiments in participatory management, though not institutionalized. The states did not have their state fishing laws, and the communities' existing management measures were strongly based on their traditional knowledge.

Among the experiments presented at that time, three large-scale projects stood out:

1. The Iara Project, the administration of fisheries resources in the Middle Amazon carried out by IBAMA and GTZ (German Technical Cooperation Agency), developed some managing mechanisms (discussion forums, participation stimuli, intra-institutional integration, fishing in an intersectoral context, acknowledgment of the fishing agreements[6] as potential instruments for fishery organization in the region, etc.), which subsidized the organizational actions and the application of the fisheries resources in the Middle Amazon. These mechanisms aimed

[6]Fishing Agreements – a set of established rules by the riverbank community members which define the access and the application of the fishery resource in a determined geographic area. The rules are strongly based on the local ecological knowledge, and monitoring is carried out based on local social ethics. For IBAMA, the fishing agreements represent a set of specific norms resulting from consensual treaties among several users of the fisheries resources, defined within a determined geographic area.

at the sustainable optimization of the resources, in accordance with the interests/needs of the local population and society and with respect to the regional and national economy (IBAMA 1995; Ruffino and Mitlewski 2003). Such a strategy was reinforced from 1995 onwards through the government's establishment of clear policies on integrated co-management and by the institutional reorganization (deconcentration, decentralization, etc.) that IBAMA developed

2. The Mamirauá project, carried out by the nongovernmental organization the Mamirauá Civil Society (SCM), is responsible for the comanagement of the Mamirauá Sustainable Development Reserve (RDS Mamirauá), which the Amazon State government created through the Amazon Environmental Protection Institute (IPAAM). The experiment that was developed in the Reserve stood out as innovative in that period because it incorporated the local populations in the decision-making process and sought compatibility between the conservation of biodiversity and the continued permanence of traditional populations residing in the area. This culminated in the elaboration of a Management Plan for the Reserve (SCM 1996). In the fishing sector, the Reserve launched a program for the commercialization of fishing that involved four communities and 200 people in 1998. The program anticipated that the fishermen would avoid fishing the forbidden species. By doing so, the pressure on fishing would be diverted to species whose stocks were in good standing and presented no restrictions on fishing. However, the major difficulty that arose was that these species were the fishermen's main source of income, especially the pirarucu and the tambaqui. Thus the program developed a system of fishing management for the pirarucu, including the rotation of lakes—a strategy based on a traditional technique the fishermen used, involving counting the number of individual fish as they come up to the surface to breathe, once the breathing area of the species is determined (Castello 2004). Such a system, as was developed in Mamirauá, showed quite satisfactory results, including an increase in the number of pirarucus in the lakes, and therefore a rise in the fishermen's income (Viana et al. 2004, forthcoming), and the extension of the species to other regions.
3. The *Várzea* Project, carried out by the Research Institute of the Amazon (IPAM), aims at contributing to the construction of a participatory comanagement system of the natural resources in the Lower Amazon meadow. The project has been carried out along three strategic lines: (1) development of management systems integrated in the meadow that involve the principal activities of the family: economy, fishing, agriculture, small-scale cattle raising, and wild beekeeping; starting with the pirarucu, the project focuses on integrating other groups of species of high commercial value, such as the chelonians and alligators, into the management system; (2) development of policies addressing participatory management of the meadow, including fishing agreements, Terms for Conduct Adjustment for cattle raising, and the strengthening of institutions which are responsible for the comanagement system on various regional levels, including the fishermen colonies, the Regional Fishing Advisory Board, and community associations and (3) involvement and training of human resources for a participatory comanagement; this project develops an environmental education program

for the meadow school through a partnership with the Secretary of Education in Santarém and a nonformal educational program, so as to form leaders of the participatory co-management, which gathers together the Colonies of Fishermen, the Regional Fishing Advisory Board, and community associations.

Thus, based on these local comanagement experiments and in an attempt to implement new comanagement mechanisms, in 1997 IBAMA published a document establishing norms, policies, and criteria for the regulation of fishing agreements. During the same year, in the region of Tefé, the first regional regulations, supported in the legal and judicial systems and aimed at supporting the communities' initiatives, were established by IBAMA (Pereira 2004).

In 2000, another alternative strategy to the management of natural resources emerged in Brazil as a result of the federal government's approval of the National System of Conservation Units (SNUC). This document sought to review all of the acts concerning environmental protection rights, assembling the different categories of the country's conservation units in a single document. The inclusion of sustainable use conservation units in legislative policies allowed for the interpretation of traditional populations' permanent residence in protected areas as an important and active element in the process of the conservation of natural resources, rather than as mere agents of consumption and devastation, as a number of neoclassical economists have claimed (Fearnside 2003).

In that same year, IBAMA introduced a new initiative aimed at the consolidation and expansion of the successful experiments carried out under the comanagement of existing fisheries resources, although an integrated complementary focus was placed on other productive activities. It refers to the Meadow Natural Resources Management Project (ProVárzea), inserted into the Pilot Program for the Tropical Rainforests in Brazil (PPG-7). This project had conducted a series of strategic studies during the previous six years, during which it provided technical and financial support to various promising initiatives, developed and tested controlled monitoring, and promoted comanagement systems with a focus on fisheries resources for the meadow natural resources (IBAMA 2001). The ProVárzea project adopted a strategy that focused on the strengthening of base organizations, not only through the promotion and support of projects which work as catalysts for change in the areas in which they are being carried out, but also by highlighting their methodologies and lessons learned that can be replicated in other areas and regions. The ProVárzea project supported 25 subprojects in 32 municipalities in the states of Pará and Amazon, comprising a wide variety of thematics, which are all directly connected to the overall aim of reducing pressure on fish stocks, such as: ecotourism; management of fisheries resources in lakes; the strengthening of base organizations; environmental education for indigenous populations; community forest management, whether aimed at lumber production or not; agriculture and cattle raising; management of Chelona; stingless beekeeping; and reforestation.

Concerning the communities' capacity to enforce the management rules, obedience to the laws is facilitated when infractions involve fishermen "outside" of the community, whereas complications arise when it comes to controlling members

inside the community. Hence, the implementation of the Voluntary Environmental Agent program (AVV), with training and accreditation by IBAMA, has yielded very positive results. In 2001, ProVárzea/IBAMA helped to the establish a Work Group composed of representatives from IBAMA and NGOs, and held a technical meeting that resulted in drafting of the Normative Instruction, thereafter published by IBAMA, thus institutionalizing the mission of the AAV (IN nº 19, de 05/11/2001).

In 2002 and 2003, ProVárzea/IBAMA and WWF Brazil organized the First and Second Community Management Meetings for Fishing in Amazonia to promote an exchange of experience between fishermen, local communities, technicians, and researchers—representing the main governmental organizations and civil society involved with fisheries—in order to evaluate the present situation (main problems, lessons learned, and needs), and to determine proposals for actions aimed at strengthening and consolidating this management practice that was developed by traditional peoples. As a result of the first meeting, IBAMA published Normative Instruction n° 29 on January 1, 2003, which establishes the criteria for the regulation of fisheries agreements, defined within a particular fishing community. The outcome of the Second Community Management Meeting for Fishing, was the publication of the guidelines "Fishing Agreements: The Community in Charge" (Oviedo et al. 2003), the objective of which was to distribute the rules and procedures as outlined in the fishing agreement in plain language that would be more accessible to the riverbank population.

Concurrently, by tracking progress towards the improvement of the comanagement experiments based on lessons taken from ProVárzea, IBAMA initiated studies and evaluations in order to structure the AAVs' actions, establishing guidelines, criteria, and capacity for the AAVs as well as internal procedures for IBAMA in order to sustain the program. Following several internal and public debates, IBAMA published IN nº 66 on December 5, 2005, which replaced IN nº 19, and established AAV as a national program. The program seeks to promote the coparticipation of organized civil society in the management of natural resources. By carrying out activities in line with the terms for Local Sustainable Development (Aquino et al., mimeo), civil society will play a proactive role in the protection of biodiversity.

In 2004 and 2006, the ProVárzea/IBAMA project trained more than 250 technicians, state environmental organizations, and NGOs from the states of Acre, Amazonas, Amapá, Pará, Rondônia, and Tocantins in community management and comanagement of fisheries resources, with the intent to build up the institutions' technical capacity and to facilitate the comanagement of the fisheries resources.

## 4 The Sustainability of Community Management in the Amazon

Community management is inserted into the comanagement system, which is understood as a continuum between two extremes: governmental management and community management, each having different administrative levels. The

state is comprised of federal and state levels. In civil society, actions are developed by nongovernmental organizations, with professional fishermen colonies, associations, cooperatives, and others. The comanagement mechanism links the state to the organized civil society. Society exerts its role on a local level, through particular mechanisms of shared decision making, characteristic of community management.

According to Castro and McGrath (2001), natural resources management is a human activity, and therefore its evaluation must be carried out through decision making processes. The same authors state that in order to evaluate the community management from a social-environmental perspective, the characteristics of the ecosystem, of the group of users, and of the set of rules defining the terms of use of the resource must be analyzed in relation to the different dimensions of sustainability.

Almeida et al. (2003), analyzing the fish landing data over the last ten years in Santarém, verified that there was no trend in terms of capture and total commercial fishing in the Lower Amazon throughout these years. While there is some evidence of seasonal variations and some other fluctuations, no significant trends can be observed. Further analyses had been carried out for each of the most important species, but they had also shown no trends in catch or CPUE (calculation of productivity per unit of effort). Thus, in general, commercial fishing in Santarém's region is balanced. According to the same authors, interviews with community leaders in the localities that have fishing agreements indicate that most of the agreements have been established to guarantee enough fish for the community's subsistence through their prohibition of the use of gill nets during the drought season and restrictions on commercial fishing. All fishing agreements banish the use of gill nets during the drought season, and many agreements also establish daily limits for catching or restrict boat sizes on lakes. Some agreements explicitly forbid the commercial capture of fish.

Analyzing the data on fishing effort, Almeida et al. (2002) did not observe significant differences in standardized fishing effort between communities with management and without management. But, when analyzing comparatively the fishing productivity measured by the calculation per unit of effort (CPUE) in managed and unmanaged lakes, it was verified that the productivity was significantly and consistently higher in the communities that have agreements than in those that do not.

Raseira et al. (2006), analyzing the ProVárzea supported experiments, have observed that local projects have directly mobilized the communities and generated concrete results related to the recovery of fisheries' supplies and the improvement of the quality of life of the respective populations. As examples, the authors mention that in Fonte Boa (AM), the population of pirarucu (*Arapaima gigas*) increased 360% in 3 years. As for Gurupá (Pará), with the dissemination of innovative methods of shrimp fishery management (*Macrobrachium amazonicum*), the income of the fishing families grew 55%, and simultaneously, the reduction of fisheries pressure over this species was verified, with the rate of reduction in the number of catches with traps at 41%.

In addition to the conservation of supplies and social mobilization, these projects have facilitated the dissemination of technologies developed through interchanges among the fishermen of different areas and counties. On the other hand, the projects present limitations in terms of influence. The effects are multiplied in a community, a lake, or a region of a county; however, when they reach the county and regional level, the projects have greater difficulties maintaining active involvement of base organizations. On the county level, they operate through representatives of communities or groups. On the other hand, they are in a better position to influence public policies that regulate the fisheries sector in the Amazon on a broader scale, since they stimulate leadership that is capable of acting competently on countywide and regional projects. At the same time, these same leaders can favor local actions. Moreover, the most far-reaching experiments have propitiated the establishment of partnerships between base institutions and public agencies, facilitating the communication of the riverbank communities' social, economic, and environmental demands.

Increase in family income, strengthening of the colonies' organizations, and greater participation of the users in the decision making processes are some of the positive impacts of the community management actions on fisheries resources regulated by the fishing agreements. However, if we consider the fishery supply of the Amazon basin as a whole, the reach of these actions is still limited. As observed by Isaac and Cerdeira (2004), the main effects of the fishing agreements up to now have been the reduction of conflicts among fishermen, once they participate directly in the formulation of management proposals that attend to their own interests. The agreements also have played an important role in the development of the fishing communities, and contributed to the decentralization of the procedures for natural resources management.

In short, the process of fishing intensification and of local organizational development has led to a new comanagement model. However, the establishment of the fishing agreement did not only represent a response to the ecological change (a restriction on effort and an increase in the productivity of the lakes), but also laid a claim for the right to access common resources. Therefore, the performance of such models depends on conformity between the local laws and the social and environmental systems, and also on the organization's ability to indicate the continuous environmental changes (Ostrom 1999).

Because of the differences of perception and interests among the parties involved, the result of the implementation of a comanagement system naturally has conflicts. For that reason, it is important to keep in mind that comanagement is a negotiation arena, where participation and conflict resolution are exercised. This political process is slow and has many obstacles, and the comanagement strategy is delicate—each participant must be willing to compromise a little on his/her interests in order to participate more effectively in the negotiation. The learning is, therefore, the most important process. It is where information is gathered, possibilities are tested, and alternatives are chosen according to the results obtained.

# 5 Conditions and Opportunities for Fisheries Resources Management in Transboundary Basins

## *5.1 The Role of International Agreements and Conventions on Fisheries Management*

The use of international agreements and treaties can be a robust strategy to strengthen the experiments developed throughout these last years in the Brazilian Amazon, and to contribute to the amelioration of the benefits and social impact of fisheries in continental waters which are in partnership with neighboring countries.

## *5.2 Convention on the Conservation of Migratory Species*

Some mechanisms that help to focus the attention of the decision makers and policy formulators on transboundary supplies are in the Convention on the Conservation of Migratory Species. The main focus of this treaty is mammals and birds. No fish species is currently mentioned in the appendices. However, the Convention applies to all the migratory species, and the fact that several countries of the Amazon basin are signatories makes it an important instrument for transboundary supplies management (www.cms.int).

The first step would be to establish which species and supplies are shared between which regions/countries, to verify if they are vulnerable and to define what to do. When relevant supplies are declared shared resources, the countries must identify the necessary management measures in a cooperative and complementary way.

## *5.3 The Application of the Convention on Biological Diversity (CBD) in Transborder Basins*

The CBD is by far the most advanced and detailed agreement and the most comprehensive instrument currently in use for fish supplies management. The CBD was signed by and is legally binding in all the member countries of the Commission for Inland Fisheries of Latin America (COPESCAL).

The Convention distinguishes the jurisdiction of the countries in terms of their resources, and recognizes that the eradication of poverty is a current priority for the developing countries; but it holds the parties (that is, the countries) responsible for carrying out the following objectives: "... biodiversity conservation, the sustainable use of its components, and the fair and equal sharing of benefits derived from the use of the genetic resources....." The implication of this for fisheries is not widely recognized. However, the important links between biodiversity and sustainable use of the aquatic resources in inland fisheries mean that the Convention could be used as a powerful instrument to protect important but vulnerable fishing.

According to Coates (2001), the diversity of effort in riverbank fishing results in a high level of participation, and the alteration of the ecosystem or the reduction of the species diversity can reduce the number of job opportunities in the sector, especially in small-scale fisheries, and can turn into financial loss for the subsistence fishermen, independently of the effects on total fishing production. Moreover, it is probable that the existence of less-diverse fisheries can lead to an intensification of fishing effort and negatively affect the sustainability of the resource. Thus, maintenance of the diversity of a fishery must be a management objective.

The CBD also makes specific reference to the need for states to manage transborder resources. Article 3 specifies that the parties must: "... assure that the activities inside their jurisdiction or control should not cause damage to the environment of other countries, or areas beyond the limits of the national jurisdiction...."

Inland Waters was adopted as a thematic area of the CBD in the Fourth Conference of the Parties, in Bratislava. The Inland Waters program in the Convention promotes the ecosystemic approach, including the comanagement of basins as a better way to harmonize competing demands that reduce the inland waters' production.

Critical to maintaining biodiversity, the demand for fresh water and its management must be considered in conjunction with other demands. The program identifies the activities that the parties must carry out in order to put a stop to biodiversity depletion, including monitoring and evaluating the biological diversity of the inland waters ecosystems, directing the Evaluation of Environmental Impact on water development projects, developing strategies to prevent pollution, choosing and using appropriate technologies, and promoting transborder cooperation—management based on the ecosystem and the involvement of the local and indigenous communities on all levels. The program on the biological diversity of inland water ecosystems also promotes the integration of other conventions and cooperation with other organizations through Joint Work Plans—in particular, the Ramsar Convention and the Convention on the Conservation of Migratory Species (www.biodiv.org).

## *5.4 The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)*

CITES (www.cites.org) is an international agreement between governments. Its aim is to ensure that international trade in specimens of wild animals and plants does not threaten their survival. This Convention was signed by 169 countries and is legally binding in all the COPESCAL member countries.

Multiple aquatic resources that are hunted or caught for consumption or commercialization, such as manatees and a variety of reptiles and amphibians, are already listed in one of the three appendices of the treaty. However, only one species of fish from Latin America, the pirarucu (*Arapaima gigas*), is currently covered by the Convention, in Appendix II. This means that the species may

become threatened with extinction unless commerce is tightly controlled. The pirarucu is a very important commercial species in the Amazon, and its international trade is regulated by the Convention. The fishing pressure on this species is high in the region. In some areas, the numbers of the species are diminishing and some countries have regulated its catch by establishing minimum size limits and fenced season periods. Other species that can benefit from the CITES are those exported as ornamental fish, such as river stingrays (Potamotrygonidae). Stingrays are exploited by subsistence and ornamental fishing, and are also used in traditional medicine (Araújo et al. 2004a, 2004b). Some populations are under pressure, and IBAMA prohibited the exportation of 13 species and placed quotas on six others. However, because most fishing occurs in border areas, exportation is difficult to control. This is because the neighboring countries do not have similar legislation. The inclusion of river stingrays in Appendix III of the Convention could compel other countries to verify the legality of their imports from Brazil.

## *5.5 The Ramsar Convention on Wetlands*

The Ramsar Convention provides the framework for national actions and international cooperation for the conservation and use of wetlands and their resources. Its mission is "the conservation and wise use of all wetlands through local, regional, and national actions and international cooperation, as a contribution towards achieving sustainable development throughout the world" (www.ramsar.org).

All the COPESCAL members are already signatories of the Ramsar Convention, and even though the resolutions are not legally binding, the governments have a moral obligation when they sign the agreement, and there is a strong expectation that their provisions will be respected and followed automatically, with a certain pressure to comply.

One of the obligations of the Ramsar Convention signatories is to assign at least one wetland to be included as a Ramsar Site, and "... to promote its conservation and wise use...." The selection of wetlands as Ramsar Sites must be based on their significance in terms of ecology, botany, zoology, limnology, or hydrology. In July 2005, 126 Ramsar Sites were selected in the Neotropical Region, covering a total area of 28,600,000 ha. This represents 22.8% of the world's wetlands of international importance (http://ramsar.org/cop9_doc12_e.htm).

Brazil is a good example of how much the Ramsar Convention can stimulate development, because since 1993 it has engaged in updating its environmental laws and institutions as a direct response to the Ramsar Convention meeting, and it currently has an environmental policy that is focused on the sustainable use of natural resources. Still, two Amazon countries (Brazil and Colombia) have the legal responsibility to carry out an Environmental Impact Assessment (EIA) in all cases where there is a potential threat that could alter the ecological character of a wetland; in other Amazon countries, such as Peru, Bolivia, Ecuador, and Suriname, the EIA is required in certain circumstances (http://ramsar.org/cop9_doc12_e.htm).

## 5.6 Commission for Inland Fisheries of Latin America (COPESCAL)

COPESCAL (Commision for Inland Fisheries of Latin America) is a regional fishery body of the FAO, open to all the member countries and serviced by the regional office for Latin America and the Caribbean. The transformation of international plans of action into national strategies requires, in many cases, assistance and support. COPESCAL can contribute greatly as an impartial forum to the design of regional strategies and management plans. With the FAO supplying technical orientation and recommendations on how to develop an institutional and legal agreement, the necessary technical research can be carried out. A recent example of this approach is the Binational Technical Cooperation Project between Peru and Colombia on Putumayo River management, which was completed in 2005.

Depending on the availability of the countries' supporting funds, this assistance can take on a variety of forms, from technical support for the establishment of consultations, to training at the national and subregional levels on international resources management, as well as negotiation and conflict resolution. This assistance could include the establishment of binational or subregional appropriate structures through a treaty or an international agreement, where such instruments still do not exist.

## 5.7 Amazon Cooperation Treaty (TCA)

The TCA is an agreement between Bolivia, Brazil, Colombia, Ecuador, Guyana, Peru, Suriname, and Venezuela that together commit themselves "... to improve the standards of living of the Amazon region inhabitants, under the unquestionable responsibility of each Nation to use their natural resources in a sustainable basis, and also to fairly and equitably distribute the benefits derived from their use...." (OTCA 2004).

When they signed the TCA, the eight member countries committed themselves to "carry out efforts and joint actions to promote the harmonious development of their Amazon territories, by means of the conservation and the rational use of the natural resources with equitable and mutually beneficial results" (www.otca.info).

Taking into account the imperative that the exploitation of the flora and fauna of the Amazon region be rationally planned so as to maintain an ecological balance in the region to preserve the species, the contracting parties decided:

(a) to promote scientific research and the interchange of information and technical staff among the responsible agencies in their respective countries, in order to increase their knowledge of the flora and fauna of their Amazon territories, and to prevent and control disease in those territories; and
(b) to establish a standardized system for an adequate exchange of information on conservationist measures adopted or to be adopted by each country in their Amazon territories; this will be the subject of annual reports to be presented by each country.

## 6 Conclusion

We can affirm that, in the last 12 years, considerable progress has been made in the development of management mechanisms for the use of fisheries resources in the Amazon, built upon the knowledge and handling of resources by the Amazon floodplain's base organizations. The history and the experiments described here exemplify how diverse groups—communities, local fishermen colonies, local NGOs, governmental agencies, and organizations with interests in international conservation—can work together to develop a new comanagement system for fisheries resources that supports and legitimizes the base organizations' efforts to defend these resources and their way of life.

Despite all the treaties and conventions, the worst enemy of sustainable management of transborder fisheries in the Amazon is the fact that the real social and economic relevance of these fisheries is still not yet recognized by the governments. Unfortunately, this is the case with the large migratory catfishes in the Solimões-Amazon Rivers channel, and great efforts must be made to monitor these resources and, mainly, to implement comanagement measures among the countries for their sustainable use.

The examples of comanagement through fisheries agreements mentioned above are of small capacity and small scale, since the geographic areas are small.

## 7 Recommendations

- Many developing countries have fishing communities that informally regulate their fisheries efforts based on their observations of large amounts of fish and other indicators throughout time. These cases have been documented, summarized, and synthesized, and suggest that an important challenge for developing countries might be to identify such domestic systems, and to support and integrate them into the regional and national management by means of comanagement agreements.
- It is necessary to strengthen the local (community) and institutional capacities for the fisheries ecosystem management (including the equitable distribution of resources and social improvement). With this objective, and through the appropriate institutions, including the OTCA, countries would benefit from sharing their experiments on both national and subregional levels.
- It is of vital importance that cooperation among the countries for the management and sustainable use of their common hydrographic basins be strengthened, mainly taking into account the principles and pertinent rules of the Code of Conduct for Responsible Fisheries.
- The countries' governments must fully recognize the social, economic, and environmental value of the continental fisheries, and, as part of this recognition,

must assure the implementation and continuity of fisheries statistics, so as to provide the quantitative information needed to evaluate the role of these fisheries in social development and the fight against poverty, in addition to evaluating the important role that they play in the conservation of the ecosystems.

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# Part III

# Introduction: Management and Conservation of Terrestrial Resources

**Nigel Smith**

**Abstract** There is a vast amount of land on the Amazon floodplain that requires different strategies for conservation and management than do upland environments. Because of their relative fertility and position close to fluvial avenues of trade, many higher parts of the várzea have been farmed and much of the original vegetation disturbed. The chapters in this section explore the histories of deforestation and use in several várzea sites, as well as the ecological complexity and resilience of várzea mosaics, and the flexibility and adaptability of patterns of use. They also discuss instances where expansion of markets for local products have enhanced efforts to conserve forests and manage resources in a sustainable manner, with varying consequences for local livelihoods. All three chapters provide new primary data as well as a thorough analysis of the existing literature and constitute a contribution to the understanding of human impacts on the floodplain and the value of local knowledge and tradition in helping to conserve várzea resources.

**Keywords** Cultural forests • Forest management • Agroforestry • Secondary forests • Agricultural intensification • Nontimber forest products

The Amazon floodplain embraces broad swaths of land that are seasonally dry, essentially mimicking terrestrial ecosystems on nearby uplands or *terra firme*, albeit with different flora and fauna. Indeed, even at the height of "normal" floods, some banks of the Amazon are not breached by the annual rise of the waters, and some parts of the floodplain may be under water only every 10 or even 20 years. So there is a vast amount of "land" on the Amazon floodplain, which requires different strategies for conservation and management than upland environments.

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Because the Amazon floodplain is relatively fertile, especially when compared to most soils on uplands in Amazonia, many higher parts of the *várzea* have been farmed, so much of the original vegetation has been disturbed. Furthermore, rivers in Amazonia were historically the main avenues for travel and trade, and that is where settlement was concentrated. The *várzea*, then, has a long and extensive history of human intervention, including the clearing of vegetation and reassembling of the "biological furniture" with economic plants. The Amazon floodplain thus is a mosaic of fields, second growth in various stages of succession, cultural forests, and mature forest.

In "River and Human Legacies in Amazonian Floodplain Postagricultural Forests," Javier Arce-Nazario compares the changes resulting from natural and anthropogenic disturbance of vegetation on the Amazon floodplain near Iquitos, Peru. He finds that topography is the main determining influence on floristic composition, and that the legacy of human disturbance has not overridden the differences in microrelief. While all open habitats are colonized by the same pioneer species, their replacements depend to a large extent on topographic conditions. In the region of Iquitos, Arce-Nazario suggests that the deforestation pattern has been sporadic and small, at least in relatively recent times, and farmed plants are interspersed with various types of forests, including swamp forests. Importantly for conservation, this widely scattered pattern of disturbance allows for pockets of forest that serve as "seed banks" for reestablishing forest. Also, floodplain farmers typically spare certain forest trees that provide useful products in and around their fields, thus facilitating the reemergence of forest after the plots are abandoned. The author cautions, however, that efforts to intensify agriculture, such as through mechanization and controlling of the annual floods, could compromise the resiliency of the landscape.

Ecological complexity and resilience are also explored in "*Várzea* Forests: Multifunctionality as a Resource for Conservation and Sustainable Use of Biodiversity." In this chapter, Miguel Pinedo-Vasquez and Robin Sears explore land use practices that enhance the environmental services of floodplain forests and their biodiversity rather than degrade them. Their analysis is based on empirical studies in three locations: the Amazon estuary, Mamirauá in the central Amazon, and Contamana and Pucallpa along the Upper Amazon (technically the Ucayali River). An important point raised by the authors is that smallholders, often vilified in the Amazon as agents of deforestation, are also driving reforestation and forest protection in some areas of the Amazon floodplain. Farming on the Amazon floodplain has resulted in a mosaic of vegetation that provides a wide array of cultural and environmental services, from edible wild fruits to food and habitat for fish and other wildlife. River dwellers typically "bend" with nature, that is, incorporate natural processes such as the annual pulse of the floodwaters into their farming and gathering strategies, rather than try to dominate or destroy the environment. Specifically, the authors examine the expansion of managed forests, the replanting of valuable timber that had been depleted, community-based conservation of fisheries through the planting and protection of trees and shrubs that provide shelter and

food to fish important for subsistence and commerce, in addition to regulation of catches and the restoration of degraded pasture.

In the third chapter of this section, "Forest Resource Markets and Recurrent Underdevelopment in the Amazon Estuary," Eduardo Brondízio acknowledges that extraction of forest products and agroforestry in the Amazon estuary have enhanced efforts to conserve forests and manage natural resources in a sustainable manner, but he decries the overall lack of economic development. Although strong markets for the fruit and heart-of-palm of açaí, for example, have led to widespread management of natural stands as well as planting of the palm, educational and job opportunities are still limited and health services are still inadequate. Furthermore, export markets for açaí have driven up the price of açaí pulp and juice for local markets, and in some cases have led to the lowering of quality of açaí juice, which is essentially a basic staple for both urban and rural poor at the mouth of the Amazon. Brondízio's analysis is based on over two decades of field work based at Ponta de Pedras on Marajó Island, and is thus rich in data and insight. He explores the many actors involved in the açaí boom, and pinpoints some of the failures, ranging from "sustainable" factories going bankrupt to political turmoil and corruption at many levels. On the other hand, many rural families have benefited from the açaí boom, enjoy much higher incomes than their parents, and have been able to secure a better education for their children by placing them with relatives in towns and cities. Brondízio thus provides a balanced perspective on the outcome of a "forest friendly" economic activity.

All three chapters provide new, primary data as well as a thorough synthesis of the existing literature. A major strength of all the studies is that they are based on extensive and in two cases prolonged field work, extending over many years at some sites. Also the studies integrate socioeconomic, cultural, and ecological perspectives. These authoritative essays are thus a major contribution to a better understanding of the impacts of humans on the Amazon floodplain and the value of local knowledge and tradition in helping to conserve the natural resources.

# River and Human Legacies in Amazonian Floodplain Postagricultural Forests

**Javier A. Arce-Nazario**

**Abstract** Studies in postagricultural forests have suggested that the effect of land use overrides that of environmental factors in defining the present forest composition. This study demonstrates that the effect of land use history in the composition of postagricultural forests can be reduced by exposure to frequent disturbance. The study was undertaken in a rural landscape of the Peruvian Amazon floodplain with a history of land use and periodic river disturbance. The history of land use for the region was reconstructed using a set of remote sensing images dating from 1948. Trees above 2.5 cm DBH were identified and measured in 46 plots of 600 $m^2$ in postagricultural forests older than 10 years. For each plot, I measured its distance to other landscape features (river, swamps, lowland forest, upland forests) and its elevation above sea level. In this region, elevation correlates to the probability of a site being exposed to flooding. Correlations of the explanatory variables to a nonmetric multidimensional scaling (NMDS) ordination were used to evaluate the relative effect of elevation, distance to landscape features, and time since abandonment in the canopy and understory composition of the plots. Correlations to the NMDS ordination show that both canopy and understory species compositions are better explained by flood exposure for older plots. It also indicates that the distance to forest patches affects the composition of postagricultural forests. In general, the results show that land use in the Amazonian floodplain has not erased the natural environmental gradients of the landscape.

**Keywords** Disturbance • Historical ecology • Peru • Resilience • Tropical secondary forests

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## 1 Introduction

The notion that the vegetation composition of an area is mostly determined by its history of human exposure has become a paradigm in historical ecology (de Blois et al. 2001; Dupouey et al. 2002). This conclusion mainly derives from postagricultural studies in temperate and tropical regions that have observed that modern forest composition is primarily a reflection of its land use history, rather than other environmental factors, such as soil or topography (Foster 1992; de Blois et al. 2001; Dupouey et al. 2002; Thompson et al. 2002). However, other studies suggest that, especially in regions exposed to cyclical fire or hurricane disturbance, environmental constraints are eventually reestablished as the main drivers of vegetation organization (Boose et al. 2004; Uriarte et al. 2004). For other kinds of periodic disturbance in landscapes with a history of human use, more research is needed to understand if and when the paradigm of land use legacies applies. Here I analyze Amazonian postagricultural forests exposed to periodic flooding of a whitewater river.

The Amazon floodplain natural landscape is shaped by seasonal floods and the river channel migrations. The seasonal floods in the Iquitos region in Peru vary up to 10 meters between the low-water season and the high-water season. This cyclic change in the river level which shapes the floodplain ecosystem is known in the scientific literature as the flood pulse (Junk et al. 1989). The effects of the flood pulse on vegetation are observed in the distribution of species with different flood tolerances at different elevations (Worbes et al. 1992). Furthermore, the flowering and fruiting of many floodplain species is synchronized with the water elevation, so that the river and fish can serve as seed dispersers (Goulding 1980). The river channel migration is also an important process affecting the natural vegetation patterning of the floodplain: river meanders usually erode forested land in the convex section and deposit the soil in the concave section, where the newly created unvegetated spaces are then colonized by pioneer species (Kalliola et al. 1991). In this study I focus only on the effects of flood disturbance.

Flood pulses and river channel migration are relatively unpredictable events. While the extreme water levels typically occur during certain months, every year the river level varies. For example, 2005 had a record low water level season, and during the 1970s extreme floods were observed (Arce-Nazario 2006). Particularly in anastomosing river regions, the channel migration is also very unpredictable (Puhakka et al. 1992). The unpredictability of floods and channel migration affects the human use of the landscape (Arce-Nazario 2007).

The Amazonian floodplain is mainly inhabited by *ribereños*, who are the nonindigenous peasants of the Amazon. The *ribereños* have traditionally practiced a variety of agricultural and extractive activities, throughout different elevations and habitats in the floodplain landscape (Hiraoka 1985). Although the elevation and distance from the river partially determine the risk of a farmer losing produce, farmers tend to use land at all elevations and practice relatively similar agriculture across the elevation gradient. An exception is the planting of fruit trees, which is

typically limited to higher elevations, since many fruit tree species are not resistant to floods. For example, a taperiba (*Spondias dulcis*) dies when exposed to flood, so it is not planted at elevations that are likely to be flooded before one can harvest its fruit. A cacao tree (*Theobroma cacao*) can be planted in lower elevations, as it can withstand some flooding. For other produce such as manioc, rice, corn, jute, and some plantain varieties, the planting occurs at elevations that on average are flooded for less than 6 months during the flood cycle.

Because the Amazon floodplain has been exposed to both anthropogenic and natural river disturbance, it presents an opportunity to evaluate the persistence of land use legacies in a dynamic environment. Furthermore, the fact that there have been similar agricultural activities across the different elevations of the floodplain makes the region a particularly useful case. The following questions framed my analysis:

- Does human history override the effect of natural disturbances?
- Do understory vegetation and canopy trees respond differently to disturbance events?
- How do the results of this study compare to the results observed in other tropical and temperate regions?

## 2 Methods

### *2.1 Study Area*

The study was undertaken in the floodplain forests of four rural communities 30 km upriver from the city of Iquitos, Peru. The study region is a white water floodplain, or *várzea*, since the main river is rich in sediments that come from the Andes. Every flood season the river deposits soil at different rates over the floodplain landscape. As a result, the levees are composed of recent alluvial soil and have different elevations above the river level.

The human communities surrounding the study site have a total population of 1,500 (INEI 1994). The population is mainly dedicated to agriculture and other extractive activities such as fishing, hunting, and charcoal production. In the past, the government had an extensive program for agricultural loans, which promoted the creation of agricultural fields throughout the floodplain (Chibnik 1994). With the end of economic incentives and the increase in migration to cities, many agricultural plots were abandoned in this region. Fallows are also created and managed through the common practice of local farmers: they clear a forest, farm it several years for annual crops, then for perennial herbaceous crops, and finally for fruit trees and timber (Padoch and de Jong 1991). The land is subsequently abandoned before being cleared again after a certain number of years.

## 2.2 Sampling Procedures

The sampling consisted of 46 (10×60 m) plots. The 10×60 m plot size was chosen to reduce edge effects and elevation variability. The initial point of the plot was randomly selected, while the direction of the plot was determined in such a way that it would vary in elevation by less than 25 cm, and would not include the edge of the levee. Diameter and height were recorded for all woody plants above 2.5 cm DBH (diameter at breast height). Palms and lianas were not included in the study. The diameter of trees with buttresses was measured 40 cm above the buttresses. For trees shorter than 7.5 m, a telescopic ruler was used to measure height, and for trees taller than 7.5 m a laser hypsometer (Optilogic Model 100LH) was used. Individuals that could not be identified in the field were tagged and sampled for future identification. Elevation above sea level was measured to 1 decimeter precision using an engineering level and the water marks on the trees. Levee elevation above sea level directly correlates to the probability that a region is exposed to flood disturbance in a given year. Forests in lower regions are more often exposed to flood disturbances and longer periods of flood (Fig. 1).

## 2.3 Data Analysis

Based on previous forest inventories of the study region (Arce-Nazario 2006), studies in Jenaro Herrera (Nebel et al. 2001a, b), and other studies in the Iquitos region (Vásquez-Martínez 1997), I classified species into those that could reach the canopy (tree species that can reach at least 15 m in height and are canopy species at a certain stage of forest succession) and understory tree species (tree species that do not reach higher than 15 m and are not part of the highest canopy at any stage of forest succession). Based on photo interpretation and field interviews, plots were classified into three age categories (*young:* 10–20 years since abandonment, *medium:* 25–35 years since abandonment, and *old:* 40–60 years since abandonment). Based on the topographic survey, each plot was also classified into three elevation categories (*low:* 115.1–115.7 m, *intermediate:* 115.9–116.6 m, and *high:* 116.8–117.6 m above sea level).

For each plot, I determined the distance to various land cover features of the landscape. The distance was measured using simple raster proximity analysis. Distance was measured from pixels that represented features that had not changed since 1940, based on the sequence of land cover maps from 1948 to 1987 (Arce-Nazario 2007). The land cover features selected were river, upland forest, lowland forest, and swamps (Fig. 1). These specific features were selected since they represent land cover features that affect the distribution of both natural and human elements of the landscape. Forest features represent seed sources (Uhl and Clark 1983), and distance from the river is related to a gradient of soil deposition during flood time (Kalliola et al. 1991). From the human perspective, rivers and streams are transportation routes which allow better mobility of farm and forest products.

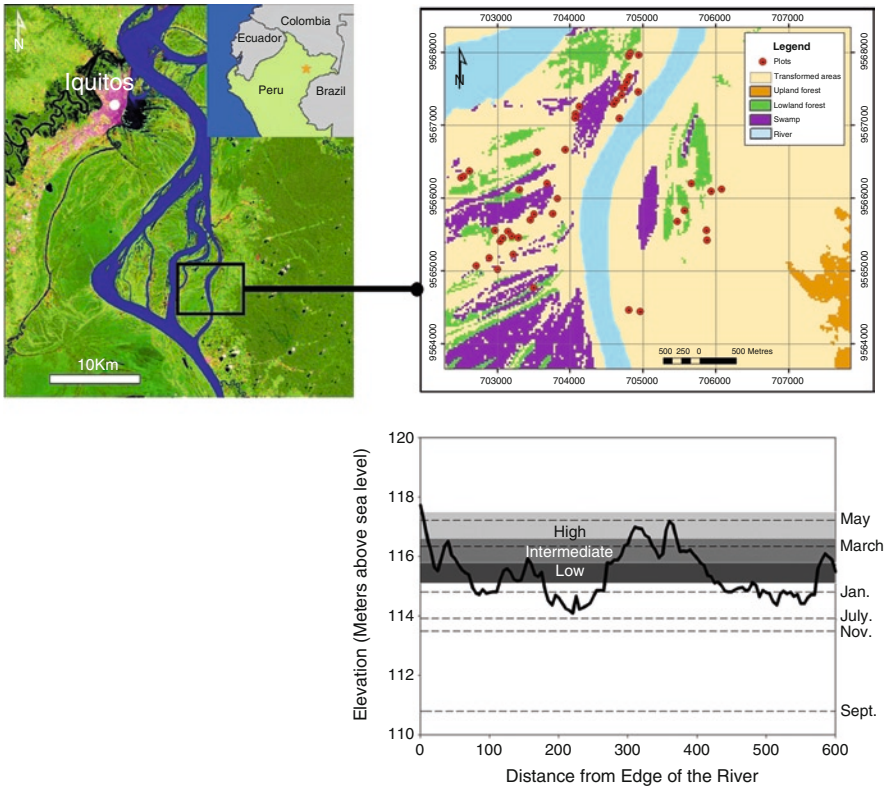


**Fig. 1** Map depicting the study area, the geographic position of the sample plots, and the principal landscape features. Sand-colored areas represent regions of the floodplain or upland forest that have been farmed, deforested, or heavily altered by humans since 1940. Currently, this transformed region is a complex mosaic of land cover types. The figure in the lower right is an example of the floodplain topography along a 600-m transect from the river edge inland, measured using an engineering level. Measurements with a vertical error of ±5 cm were taken every 5 m. The dashed lines represent the average river height for that month. The different shades represent the elevation categories used in this study (*low*: 115.1–115.7 m, *intermediate:* 115.9–116.6 m, and *high:* 116.8–117.6 m above sea level)

Most communities and farms are arranged close to the river; hence the distance to the river also encodes the probability of human disturbance (Arce-Nazario 2007). On the other hand, features such as swamps can be considered geographical barriers to human displacement. Bivariate correlations were computed using Kendall's t nonparametric significance levels for each of the geographic distance measures, age, elevation, and northing and easting, to test how direction was correlated to the explanatory variables.

The data for each inventoried sample consists of six explanatory variables (age, elevation, and distance to upland forest, lowland forest, swamp, and river) and two dependent variables (canopy and understory forest composition). To measure the

relationship of the environmental, historical, and geographical variables to the species composition, I used nonmetric dimensional scaling (NMDS) of sites and species. Species composition was measured by calculating the log transformed total basal area of each tree species in the plot. A Euclidean distance measure was used to calculate (dis)similarity between each pair of plots. NMDS was selected as a preferred ordination procedure, since it does not make any assumptions about the distribution of the species. Furthermore, this method was chosen because it is the ordination method used by other ecological studies analyzing the effects of land use in postagricultural forest composition (Fuller et al. 1998; Pascarella et al. 2000; Thompson et al. 2002). I ran the data on PC-Ord 4.34, using 40 runs with real data and 50 randomized runs to find the configuration of the ordination. The number of dimensions was determined by examining the scree plot and the results of the Monte Carlo test. The resulting ordination was correlated to the eight explanatory variables and their concordance measured using Kendall's t nonparametric coefficient.

## 3 Results

I sampled a total of 202 species, of which 125 (61.9%) were canopy species and 77 (38.1%) were understory species. The canopy species were represented by 88 genera in 29 families, while understory species were represented by 50 genera in 31 families. The most dominant canopy species was *Cecropia membranaceae*, followed by *Ficus insipida* and *Maquira coriacea.* The most dominant understory species were *Neea divaricata, Zygia juruana*, and *Xylosma benthamii.* The most frequent families for canopy species were Moraceae (including Cecropiaceae), Euphorbiaceae, and Leguminosae (including Mimosaceae, Faboideae, and Caesalpinaceae). For the understory trees, Melastomataceae, Rubiaceae, and Leguminosae were the most dominant families.

Several features of the landscape are correlated with one another (Table 1), but age is not correlated with any other explanatory variable. Elevation is negatively

**Table 1** Correlation between explanatory variables and geographic position for each plot; numbers shown are Kendall τ correlation values with $p<0.05$

| | Elevation | Lowland forest | River | Swamp | Upland forest | Easting | Northing |
|---|---|---|---|---|---|---|---|
| Age | – | – | – | – | – | – | – |
| Elevation | | – | – | 0.252[c] | –0.228[c] | 0.262[c] | – |
| Lowland forest | | | –0.281[b] | – | –0.330[b] | – | – |
| River | | | | 0.235[c] | 0.381[b] | –0.294[b] | –0.404[a] |
| Swamp | | | | | –0.250[c] | –0.290[b] | –0.209[c] |
| Upland forest | | | | | | 0.786[a] | – |
| Easting | | | | | | | 0.318[a] |

n = 46
[a]P < 0.001 [b]P < 0.01 [c]P < 0.05

correlated to distance from upland forest ($\tau = 0.228$ $p < 0.05$) and positively correlated to distance from swamps ($\tau = 0.252$ $p < 0.05$) and easting ($\tau = 0.262$ $p < 0.05$). These correlations respond to the usually higher levee elevation in the mainland and lower levees on the island. Since the upland forests are only found on the mainland, a strong correlation exists between the UTM easting of a plot and the distance to the upland ($\tau = 0.786$ $p < 0.001$). The negative correlation between river distance and lowland forest distance ($\tau = -0.281$ $p < 0.01$) demonstrates the local land use patterns of the region: farmers prefer regions close to the river for farming.

The resulting NMDS ordination of canopy species resulted in 3 axes which explained 76.8% of the variation in the original data, at a 16.8 stress level ($p < .02$). Elevation had the most significant correlation with the third axis ($\tau = -0.444$ $p < 0.001$), while history had less significant correlation with the first axis ($\tau = 0.269$ $p < 0.05$). Distance from lowland forests had a significant correlation to the second axis ($\tau = 0.329$ $p < 0.01$), while distance from swamps had a significant positive correlation with the third axis ($\tau = 0.346$ $p < 0.01$). The other distances were also significantly correlated with one of the three ordination axes, with the exception of river distance, which was not significantly correlated with any of the axes (Table 2). A visual assessment of the ordination shows that plots tend to be more similar at early stages of succession, while later they are more dissimilar and grouped by elevation (Fig. 2).

The NMDS ordination of understory species also resulted in 3 axes. The three axes explained 83.7% of the variance at a 13.2 stress level ($p < 0.02$). Both elevation and history had strong correlations (Table 3). Elevation was significantly correlated with the third axis ($\tau = 0.524$ $p < 0.001$), while age was significantly correlated with the first axis ($\tau = 0.579$ $p < 0.001$). Distances from landscape features, except swamps, were significantly correlated to the second or third axis. Unlike canopy species, understory species showed a significant correlation to distance from river with the second axis ($\tau = 0.263$ $p < 0.05$). The three dimensional ordination graph of understory species shows a different pattern than that observed for the canopy species (Fig. 3). The understory ordination shows a clear separation in elevation groups, even at early stages.

**Table 2** Correlation of explanatory variables with NMDS ordination axes 1–3 for canopy species

| Explanatory variables | Axis1 | Axis2 | Axis3 |
|---|---|---|---|
| Age | 0.269[c] | – | – |
| Elevation | – | 0.271[b] | 0.444[a] |
| Lowland forest | – | –0.329[b] | – |
| River | – | – | – |
| Swamp | – | – | 0.346[b] |
| Upland forest | – | – | –0.274[b] |

n = 46

[a]P < 0.001 [b]P < 0.01 [c]P < 0.05

**Table 3** Correlation of explanatory variables with NMDS ordination axes 1–3 for understory species

| Explanatory variables | Axis1 | Axis2 | Axis3 |
|---|---|---|---|
| Age | 0.579[a] | – | – |
| Elevation | – | – | 0.524[a] |
| Lowland forest | – | – | – |
| River | – | 0.263[c] | – |
| Swamp | – | – | – |
| Upland forest | – | 0.219[c] | 0.277[b] |

n = 46
[a]P < 0.001 [b]P < 0.01 [c]P < 0.05

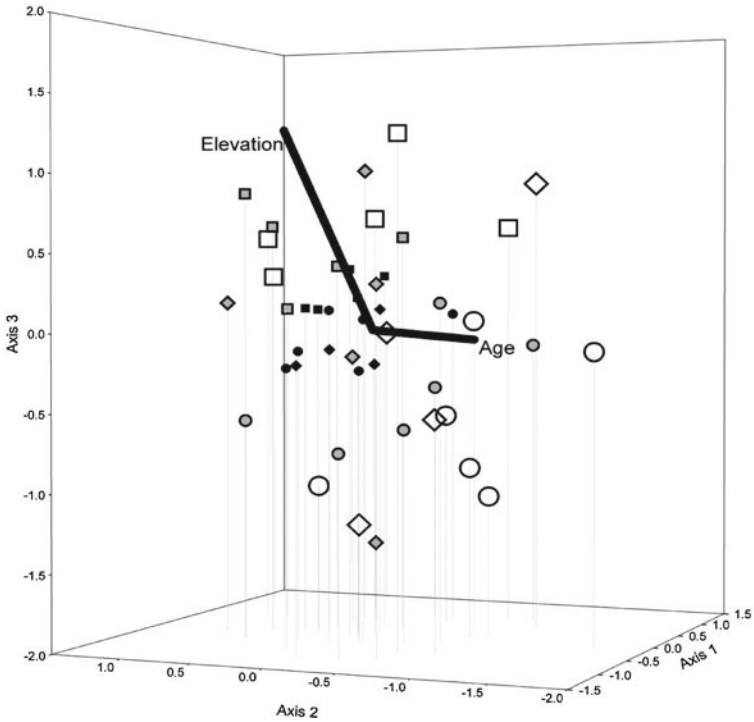


**Fig. 2** NMDS of plots in canopy species space. Squares represent plots in *high* levees (116.8–117.6 m above sea level); diamonds, plots in *intermediate* levees (115.9–116.6 m above sea level); and circles, plots in *low* levees (115.1–115.7 m above sea level). The size of the symbol represents the age since abandonment: Large and open symbols represent *old* plots (40–60 years since abandonment), medium-sized shaded symbols represent *medium* plots (25–35 years since abandonment), and small black symbols represent *young* plots (10–20 years since abandonment). The vectors represent the correlation between the ordination axes and two of the explanatory variables. Only age and elevation are presented for clarity. The correlations for the other explanatory variables are presented in Table 2

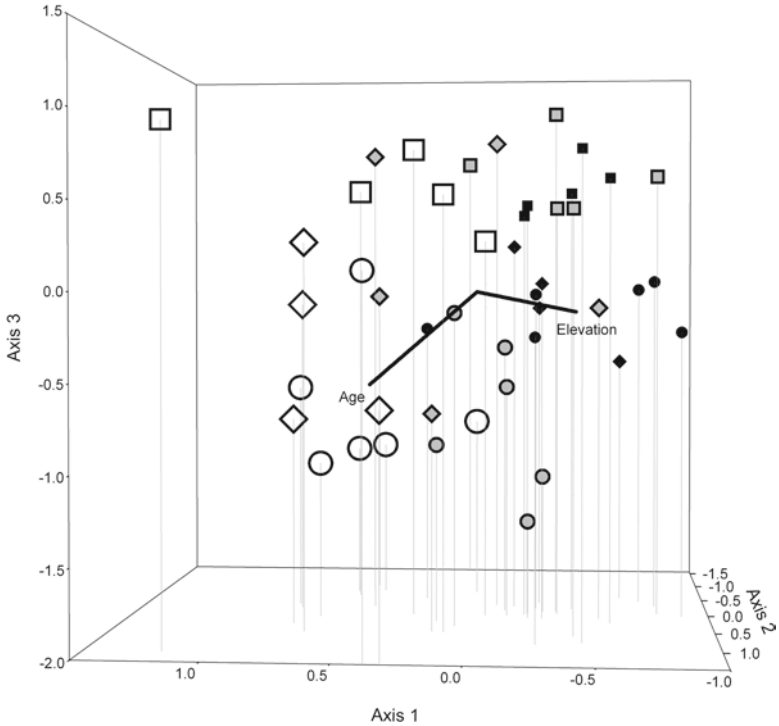


**Fig. 3** NMDS of plots in understory species space. Squares represent plots in *high* levees (116.8–117.6 m above sea level); diamonds, plots in *intermediate* levees (115.9–116.6 m above sea level); and circles, plots in *low* levees (115.1–115.7 m above sea level). The size of the symbol represents the age since abandonment: Large and open symbols represent *old* plots (40–60 years since abandonment), medium-sized shaded symbols represent *medium* plots (25–35 years since abandonment), and small black symbols represent *young* plots (10–20 years since abandonment). The vectors represent the correlation between the ordination and two of the explanatory variables. Only age and elevation are presented for clarity. The correlations for the other explanatory variables are presented in Table 3

## 4 Discussion

The ordination analysis shows that modern forest species composition in this region is significantly correlated to elevation for both the canopy and understory layers. However, at younger stages, the postagricultural plots show a relatively homogeneous canopy species composition. At older stages, this homogeneity becomes less evident, and different forest types separated by elevation can be distinguished. Therefore, unlike other temperate and tropical regions, legacies of agriculture in the Peruvian floodplain have not overridden the environmental gradients. Several reasons might explain this: the river dynamics, the floodplain landscape configuration, and the landscape's history of land use.

The constant exposure to river dynamics probably enables the persistence of a heterogeneous species composition correlated to elevation through flood disturbances, soil deposition, and the river's role in seed dispersal. While all young forest sites are colonized by the same few pioneer species, the species composition that replaces this pioneer group reflects topographic characteristics. As plot age increases, there are higher accumulated probabilities of dramatic floods, which would kill species lacking the capacity to withstand long periods of flood in the lower levees. Also, many of the floodplain seed dispersers are present, such as the river flow and fish, which carry the seeds throughout different regions of the landscape. This dispersal is not randomly distributed over the floodplain and can promote the differentiation between lower and higher levees (Kubitzki and Ziburski 1994).

The landscape configuration of the Amazon floodplain is much more complex than the landscapes used in previous postagricultural studies. The floodplain landscape has landscape features such as muddy swamps populated by spiny palms and trees with stinging ants, which serve as natural barriers. These barriers have controlled deforestation patterns, allowing a heterogeneous landscape composed of many interconnected forest types. In other landscapes, obstacles to agriculture were more easily overcome. For example, in Massachusetts, United States, the few geographical barriers which existed were relatively modest, and only areas low in soil nutrients or with poor water drainage were not deforested for agriculture (Foster 1992). In Puerto Rico, the main obstacles to agricultural development were slope and elevation (Pascarella et al. 2000). These two factors resulted in a generally homogeneous, farmed landscape, with less-disturbed forests relegated to patches on tops of hills or in hedgerows. This probably resulted in a long-term homogenization of species distribution in the landscape, and allowed a persistent human legacy in the landscape.

The rich species diversity of the Peruvian floodplain might also contribute to the strength of the environmental gradient. If one species is eliminated or reduced through human disturbance, many others would still exist, increasing the likelihood that a general analysis could detect an environmental gradient in forest types.

Finally, human land use history in the Peruvian floodplain region is different from the histories for most study regions where an erasing of the environmental gradients has been observed. The deforestation patterns in the floodplain are sporadic and small. Agriculture is nonmechanized and is interspersed with patches of different forest types. This pattern of low intensity agriculture permits the existence of seed sources and seed banks necessary for a rapid species diversity rebound (Uhl 1982). Furthermore, *ribereño* forest use continues after agricultural activities cease, so drivers of floodplain vegetation patterns may differ from previously studied tropical regions.

The local human population has played a role in protecting this environmental pattern. It is a common modern and past management practice (as observed in aerial photographs) to conserve certain tree species in or adjacent to agricultural plots. After farming stops, a set of trees that represent the environmental gradient before agriculture are already present in the young forest. Moreover, modern farmers conserve certain species that are otherwise almost locally extinct. For example, by the

1970s *Cedrela odorata* was almost entirely depleted for timber wood, and *Ficus insipida* for the extraction of its antihelminthic resins. However, locals kept (and planted, in the case of *Cedrela odorata*) a few individuals on their farms or at the farm edges. As shown in Nebel et al. (2001b), *Cedrela odorata* is more common on the higher levees. This trend was also observed in the plots inventoried here; however, the correlation is the result of planned management rather than a "natural" event. In this instance, human management conserved the landscape heterogeneity and created an environmental gradient (Arce-Nazario, forthcoming).

Other local management strategies might temporarily increase the importance of elevation as a descriptor of the vegetation's arrangement in space. Farmers usually make orchards and plant their fruit trees in higher levees. Dramatic floods are especially important agents in erasing the legacy of these orchards. Trees such as avocado (*Persea americana*) and taperiba (*Spondias dulcis*) are trees that can survive for several decades in a secondary forest, until a high flood occurs. None of these trees were encountered in the sites, since a dramatic flood covering all the plots occurred in 1999. Other trees such as breadfruit (*Artocarpus altilis*), cacao (*Theobroma cacao*), ubus (*Spondias mombin*), and several *Inga* species survive longer periods of flood, and so persist for decades in the forest. In other regions, the persistence of fruit trees in postagricultural forests are major elements affecting the future establishment of species and the modern vegetation composition (Marcano-Vega et al. 2002; Uriarte et al. 2004). In Puerto Rico, the transition of coffee plantations has differed greatly from the transition of pastures, because of the use of fruit trees and shade trees in the coffee plantations (Pascarella et al. 2000). Furthermore, studies in northern Argentina demonstrate how the presence of exotic species that dominate postagricultural landscapes limits the recruitment of native species (Lichstein et al. 2004). In the Amazon floodplain, extreme flooding erases this type of human legacy in the landscape. Furthermore, the Amazon River's unpredictable channel migration can erode entire farms and villages. Disturbances in other regions, such as hurricanes in the Caribbean, cannot so completely erase human legacies and regenerate the heterogeneity of the landscape.

This study demonstrates that the land use history of the Peruvian Amazon has not erased the natural environmental gradient of the floodplain. However, this state of resilience can probably be disrupted if the land use systems and management of the rivers are intensified. Control of the river flow, mechanization, overfishing, and greater deforestation of the floodplain landscape could result in the homogenization of the Amazonian floodplain. It is therefore necessary to identify the strategies that will conserve the heterogeneity of the floodplain landscape without compromising the social and economic productivity of those who reside on it.

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# *Várzea* Forests: Multifunctionality as a Resource for Conservation and Sustainable Use of Biodiversity

**Miguel A. Pinedo-Vasquez and Robin R. Sears**

**Abstract** In this paper we analyze and discuss the multifunctionality of *várzea* forests and their role in the conservation and sustainable use of *várzea* biodiversity. Based on data collected over the last 10 years in three *várzea* regions, we argue that the dynamic function of the *várzea* forest facilitates the application of spatially and temporally heterogeneous management systems, and the resulting use regime enhances rather than undermines ecosystems services and goods. Among a complex array of outcomes from managing *várzea* forests include a number of ecosystem services (i.e., seed dispersion as well as nesting grounds for fish, birds, and other *várzea* inhabitants) as well as products (i.e., timber, fruits, fish). Herein we present data on four major land use systems practiced by *várzea* residents that enhance the multifunctionality of forests for the production of ecosystems goods and services. These emerging forests are the result of four main transitional land use changes produced by the increase in the demand for forest fruit and fast-growing timber species in the local, regional, and international markets. These emerging smallholder-managed forests are diverse; they include everything from single species plantations to natural forests. Management regimes to restore vegetation in degraded pastures in the estuarine *várzea* have increased the population and diversity of fish species, particularly of the species classified by local people as *peixes do mato* (forest fish). Similarly, the conservation of riparian vegetation around oxbow lakes in Mamirauá is greatly increasing the nesting and resting grounds of caimans and turtles, as well as resident and migratory birds. A growing local and regional market for fast-growing timber species is increasing the commercial volume as well as facilitating the restoration of overexploited hardwood species in fallows and

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surrounding levee forests in the three *várzea* sites. Management practices that aim to maintain the multifunctionality of *várzea* forests are leading to variation in land cover and varying levels, types, and structures of *várzea* biodiversity. Our data on multifunctionality of *várzea* forests presents a considerable conceptual and practical alternative to conservation and sustainable use of *várzea* resources.

**Keywords** Ecosystem function • Resource management • Multifunctionality • *várzea* • Smallholders

## 1 Introduction

Emerging concerns about environmental problems are leading to the application of ecological concepts such as multifunctionality to legal frameworks to guide domestic and global agriculture, forestry, and other land use practices (ITTO 2006). This concept is applied by international entities such as the World Trade Organization to emphasize the viability of combining forestry, agriculture, and other land use systems to achieve both food security and biodiversity conservation (Putzel et al. 2008, ITTO 2006).

Heterogeneous landscapes are naturally suited for multiple land use functions. The floodplain environment is one such area where hydrological, geomorphologic, and biological complexity provide multiple functions and ecological services (Amoros and Bornette 2002). As evidence of its productivity, the Amazon floodplain, the *várzea*, is an environment characterized by complex hydrological processes and a long and ongoing history of human occupation, resulting in a highly dynamic socioenvironmental landscape (Sioli 1984). Researchers agree that *várzea* forests are important to the livelihood of residents as well as to the biological, ecological, and hydrological processes of the watershed (Junk 1984; Sioli 1984; Pinedo-Vasquez 1995). The majority of *várzea* forest area, up to 65% in some areas, is the product of socioenvironmental processes, under different regimes and scales of management or protection by smallholders, such as shifting cultivation, fallow management, and collective action to manage fisheries (Cunningham et al. 2002; Arce-Nazario 2007; Brondízio 2008). While smallholder farmers are often vilified in studies on deforestation in Amazonia (Oliveira et al. 2007), studies on forest management by smallholder farmers show that forest cover has been increasing in some parts of the Amazon *várzea* during the past decade (Zarin et al. 2001; Arce-Nazario 2007; Brondízio 2008).

As a highly dynamic and biologically productive landscape (Junk 1997), the *várzea* lends itself to illustrate the relevance of multifunctionality for conservation and livelihoods in rural Amazonia. Hydromorphological processes drive the natural vegetation succession, resulting in a banded pattern of vegetation types from the river's edge inland. These stands, including a diversity of meadows, shrublands,

and forest types, change rapidly on the dynamic and productive floodplains of the Amazon River. Humans also shape the *várzea* landscape and vegetation by employing a diversity of management and conservation strategies. The predominant shifting cultivation practices of *várzea* residents result in mosaics of small, interconnected, and highly diverse vegetation patches that dominate the *várzea* landscapes. In these productive landscapes, farmers maintain a gradient of forest types horizontally arranged from riparian to levee environments. These forests provide multiple functions, from producing goods such as fruits, fish, and timber (Pinedo-Vasquez et al. 1990), to reducing risks of pests or disease outbreak (Wilby and Thomas 2007), and regulating hydrologic flow and the process of sedimentation (Pinedo-Vasquez et al. 2002). Therefore, an assessment of the multiple functions and products from *várzea* forests provides an opportunity to test the concept of multifunctionality as a result of both social and environmental dynamics.

Although the multifunctionality concept is being discussed in the ecological, economic, and policy literature, there is still little empirical data that demonstrates multifunctionality of *várzea* land use systems. The few studies on multifunctionality of *várzea* forests suggest that most managed forests in the estuary and western Amazonia *várzea* are working forests, managed for both enhancing and diversifying ecosystem goods and environmental services (Sears and Pinedo-Vasquez 2004).

In this paper we review some of the relevant literature on multifunctionality, and present empirical data to demonstrate how the local residents of *várzea* ecosystems have developed ecosystem-based land use strategies to enhance the functionality of the landscape to obtain a suite of ecological goods as well as environmental services. We demonstrate how *várzea* residents incorporate natural hydrologic and ecological processes into their management systems to optimize the production and function of their forests. We present four cases where smallholder residents are driving emerging transitional processes that effectively restore or enhance the multifunctionality of forests on the *várzea* landscape. By examining their management systems through the conceptual lens of multifunctionality, we can begin to understand the complexity of interdependencies among the social and natural systems that are shaping *várzea* forests.

The cases are drawn from long-term research at three *várzea* sites: the settlements of Ipixuna and Foz de Mazagao, located in the estuarine *várzea* region of the state of Amapá; the Mamirauá Sustainable Development Reserve in central Amazonia; and communities near the Amazon towns of Contamana and Pucallpa in the Peruvian Amazon (Fig. 1). Smallholders (*cabolos* or *ribeirinhos* in Brazil, *ribereños* in Peru) comprise the great majority of *várzea* residents.

By highlighting the complexity of smallholder land use and resource management systems, we demonstrate that local ecological knowledge gained through experience helps them to constantly adapt to changing biophysical conditions and sociopolitical and economic constraints and opportunities without eliminating the multifunctionality of forests (Sears et al. 2007). The resultant adaptive management approach helps farmers to maintain functional and productive forests in a highly dynamic *várzea* landscape. We show such adaptive capacity by describing four forest management systems that are driving emerging transitional processes on the

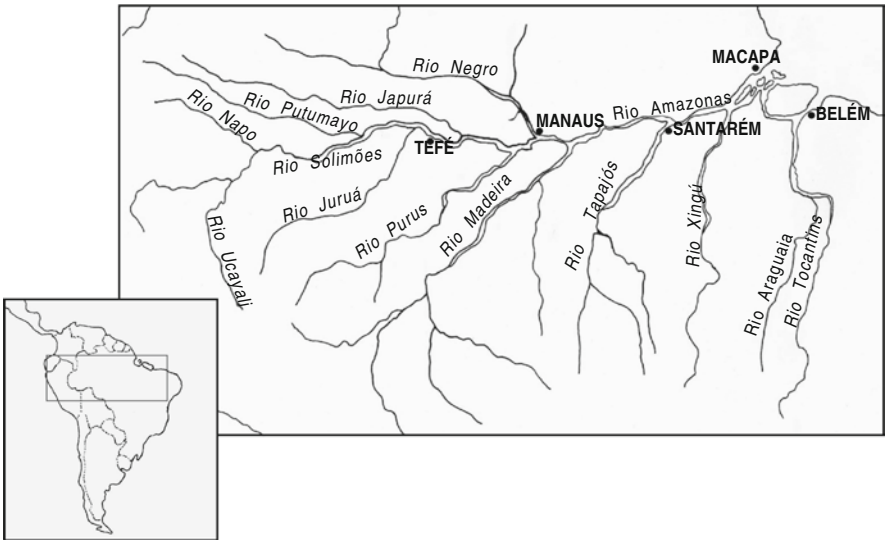


**Fig. 1** Map of study sites

*várzea*. These four cases are (1) the expansion of managed forests, (2) the repopulation of scarce high-value timber, (3) collective action for productive conservation in fisheries, and (4) the restoration of riparian vegetation and pastureland.

We analyze these four types of emerging forests that are transforming the *várzea* forests, driven by smallholder residents, through the establishment and expansion of productive forest in *várzea* regions. The underlying question for these cases is to what extent *várzea* residents are enhancing, regulating, and restoring multifunctionality. To answer this question, we first describe the natural and human systems that influence the *várzea* landscape. We introduce the concepts of working forest and multifunctionality, and through these lenses examine the socioenvironmental dynamics of the four transitional processes on the *várzea* landscape driven by *várzea* residents.

## 2 The *Várzea* Environment, *Várzea* Residents

### *2.1 Várzea as Dynamic Environment*

The v*árzea* includes some of the most biologically productive ecosystems in Amazonia (Junk 1997). Sediment-laden and nutrient-rich flood waters feed the environment seasonally, and daily in the case of the estuarine *várzea* near and at the

mouth of the Amazon (Zarin et al. 2001). The pulse dynamic of seasonal and tidal floods creates and maintains a constantly changing array of ecotones across the landscape where a diversity of ecological communities are established according to specific environmental conditions (James et al. 2006). This hydrogeomorphic heterogeneity results in a highly productive mosaic landscape of diverse and interconnected patches of forests, meadows, and water bodies that provide habitat for diverse terrestrial and aquatic biota.

In this way, the riverine vegetation mosaic is an integrated ecological system (Ward et al. 2002) in which the connectivity of habitats on the riparian landscape allows for the mobility of resources, organisms, and propagules. Water, both moving and still, provides the first element of connectivity, transporting propagules, individuals, and nutrients. The riparian vegetation as the second element presents an important conduit of animals, especially birds and insects (Amoros and Bornette 2002).

The dynamic nature and heterogeneous structure of the *várzea* ecosystem provides a multiplicity of ecological services and tangible goods. These include fertile soils for agriculture, with annual or seasonal renewal; flood mitigation and water cleaning; and abundant natural resources such as fisheries, timber, fruits, medicines, and wildlife. Forests play an important role in maintaining both the ecological function (services) and the production function (goods), and *várzea* residents have developed land use systems where forest patches are a key element in these productive landscapes in which the landscape configuration is highly interconnected.

Disturbances to those "connective tissues" of the *várzea* landscape, forests and riverine vegetation, can create obstacles to mobility. As such, simplified resource use or land use systems with much reduced functionality can also pose as obstacles. The structural complexity of the *várzea* landscape has been reduced in several regions with the promotion of cattle ranching and large-scale industrial production of soybeans and other cash crops. These intensive single-product land use systems fragment the landscape and disrupt the flow of materials and energy across the *várzea* environment. For example, pastures for water buffalo, which are often established in riparian areas, create a spatial obstacle to many terrestrial wildlife and aquatic species between the river's edge and inland water bodies and land features.

## *2.2 Várzea as Residence*

Natural hydrological and successional processes are not the only factors that influence the biological communities, geomorphology, and productivity of *várzea* environments. Anthropogenic factors have a major role to play in the structural composition of the *várzea* landscape, particularly in defining the number, size, location, structure, and composition of forest patches. Historically, the floodplain forests and meadows were the most heavily populated regions of the Amazon basin (Denevan 1992; Roosevelt 1999; Arce-Nazario 2007). At that productive

interface of terrestrial and aquatic systems, people have been taking advantage of the diversity and abundance of natural resources provided by the constantly changing environments.

*Várzea* residents have always made their living by engaging in multiple management and extractive activities, focusing on timber, fisheries, shifting agriculture, and nontimber forest products such as natural rubber, seeds, and medicinal plants. *Várzea* residents have developed complex and diverse resource management systems that successfully utilize the ecological complexity and hydrological dynamics of the natural environment to enhance production of forest, fishery, and agricultural resources. The result of these adaptive and integrative natural resource management and production activities is a multifunctional landscape that has a long history of use and change, some of which is apparent in the landscape elements today (Arce, forthcoming).

*Várzea* residents long ago discovered that the main threat to the productivity of the landscape and to their livelihood and well-being is the promotion of single-crop or single-product land use systems as a model of development. From experience they discovered that the segregation of different economic activities, such as fisheries, agriculture, and forestry in both time and space results in a destructive decline in both the production function and the ecological function of the *várzea* landscape. *Várzea* residents have discovered that survival in this dynamic environment requires a combination of agriculture, forestry, and fisheries, and depends on natural landscape functions.

*Várzea* residents have a great deal of knowledge about the ecological and hydrological processes that shape and reshape the land configuration of the *várzea*. Most *várzea* farmers have the capacity to identify key ecological functions of the *várzea* landscape that are critical for sustainable livelihood and for maintaining ecosystem function. Their ecological knowledge helps them to maintain forests in the highly productive conditions for which *várzea* ecosystems are known. Their resource management systems are based on ecological principles that recognize the productivity and ways the systems respond to change. They understand how a single species, a stand, or an ecosystem should respond to a change in management or to a given kind of disturbance. Many of the techniques used by smallholders in the management of forests for multiple products and multiple functions were developed over years and even generations of trial and error and of taking calculated risks. Over lifetimes and generations, such practices of forest management by smallholders have helped them to build a multifunctional, productive landscape and "working forests" that provide food security and environmental protection.

## 3 Interdependencies of Natural and Human Systems

### *3.1 The "Working Forests" on the Várzea*

We conceptualize *várzea* forests as "working forests," based on their degree of management and the multiple functions that they play in providing goods and

ecological services (Cunningham et al. 2002). In such a productive bioregion where people have always been and intend to stay, we have little use for strictly ecological concepts and measures of ecosystem dynamics if they are not related to the productive function of working forests. A survey of a working forest stand may not reveal the reverse-J tree size distribution indicating a "healthy forest," but it likely will yield information about the history of use of the forest and current management objectives. Likewise, a forest may have no value for forestry operations, but it may be immensely valuable for managing fish and game by creating spaces for habitat diversification and protection. For instance, in the estuarine *várzea* region, natural forests that managed to optimize both açaí production and biodiversity conservation contain a high density of *açaí* palms, but they also host many additional species that serve other functions, such as attracting seed dispersers and pollinators, and they provide timber (Pinedo-Vasquez and Padoch 2002).

The management systems of *várzea* farmers are multifunctional, in which a farmer may combine timber management with fruit production, and in the same space promote fish nesting or feeding grounds during the flood periods. Hunting and collection of plant material, such as seeds or cuttings, are also important economic and subsistence activities. Working forests thus play an important role in providing multiple productive and ecological functions.

It was reported by several researchers that the increased expansion of working forest in the estuarine *várzea* regions is greatly increasing forest areas—that is, reversing the land cover change from a process of deforestation to a process of afforestation, resulting in an enormous advantage in the preservation of biodiversity (Brondízio 2008).

## *3.2 The Lens of Multifunctionality*

Landscape ecologists have demonstrated how the concept of multifunctionality can be applied to diverse ecological and socioenvironmental systems (Lankowski 2000; Naveh 2001; Heilig 2002; Brandt and Vejre 2004). There are different approaches to using the concept of multifunctionality, each deriving from different disciplinary lenses (Brandt and Vejre 2004). First, on a purely ecological basis, multifunctionality is an expression of the many different functions of the natural landscape. It can, for example, describe the ecological complexity and heterogeneity of the *várzea* landscape, and the associated multitude of ecosystem goods and environmental services this landscape provides over space and time. The concept can help elucidate the multiple roles the *várzea* forests play in regulating floods, erosion, and sedimentation, as well as many other environmental processes. From the standpoint of human interests, multifunctionality may refer to the links between different land use types, reflecting human values; or the related land cover types, reflecting the management objectives bounded by the ecological limits of the landscape. These links may be mutually beneficial, as in the multiple benefits provided by an agroforestry system; or conflicting, as in the exclusion of biodiversity conservation functions from monoculture plantations.

To encapsulate the economic, political, and ecological dimensions of multifunctionality, we combine two main conceptual approaches to examine landscapes: ecological functionality and production functionality. In the case of the *várzea* forests, multifunctionality describes how farmers approach the integration of ecological functions and production functions in their managed forests, where the goals and actions of farmers enhance rather than undermine the overall functionality of the *várzea* ecosystem. In our analysis of the multifunctionality of *caboclo* management systems on the *várzea* landscape, we are interested in the relationship between the ecosystem and the human value systems, not merely their coexistence and potential conflict.

The multifunctionality of *várzea* forests managed by smallholders also helps to sustain the rural social and economic systems otherwise threatened by conventional forest management and agricultural systems that tend toward segregation of production from function. *Várzea* residents have a long tradition of combining ecological, social, economic, and political systems in their land use decisions, particularly in managing forests (Pinedo-Vasquez et al. 2002). This tradition recognizes that human value systems that directly affect the landscape, i.e., forest management objectives and practices, are influenced by multiple signals, including market opportunities, environmental policy, human and social welfare programs, such as government pensions and credit programs, and the empirical knowledge of residents. Multifunctional land use systems, if appreciated and valued as such, can bridge the demands of multiple stakeholders (Brandt and Vejre 2004).

The multifunctionality approach to managing *várzea* forests helps to move from the dominant view of forests as providers of products to providers of multiple ecological, environmental, and productive functions. For most *várzea* residents the value of the forest comes not only from its capacity to yield products or control sedimentation, but also its function in providing habitat for fish and game and other types of biodiversity, such as insects and algae, that are recognized by residents as critical elements to the productivity and functionality of the *várzea* ecosystems (Pinedo-Vasquez and Padoch 2002). *Várzea* residents incorporate multifunctionality in their land use decisions, and the location, size, and composition of their forests are defined by the multiple functions they can and need to provide to maintain ecosystem productivity and secure the household economy. Farmers think not of single-crop yields, but of the diversity and seasonality of products yielded from the landscape. They create ecological conditions for attracting fish, game, or pollinators, while protecting habitat and crops alike from strong river currents during floods.

In our analysis of the multifunctionality of the *várzea* landscape and management strategies of *várzea* farmers, we examine a set of empirical indicators for the ecological and production functions of different forest types. In the next section we describe four transitional processes that are occurring on the *várzea* landscape that reflect an awareness and dependence on multifunctionality in the working landscape. These four forests are emerging as a result of residents responding to signals from the market sector, environmental policy, and government programs. The strongest signal comes from increasing local, regional, and international demand for forest products, including fruits and fast-growing timber.

# 4 *Várzea* Forest Transitional Processes

## *4.1 Conversion of Agricultural Field to Working Forest*

The first transitional process on the *várzea* is driven by an increasing demand for forest fruits and fast-growing timber. The increased demand in regional, national, and international markets for these products has provided an economic incentive for smallholders to engage in forest management activities that boost production; while declining prices for conventional agricultural crops over the past decade have resulted in smallholder farmers reducing their dependency on agriculture as the main source of their household income (Pinedo-Vasquez and Rabelo 2002; Brondízio 2008). We provide data that show the diversity of the emerging forests that are managed for the production of forest fruits and fast-growing timber species while preserving ecological function.

In the last two decades, most farmers in the estuarine *várzea* region have been engaged in forest management for the commercial production of forest fruits, including the açaí palm fruit. Similarly, an increase in demand for inexpensive lumber in periurban areas has become a major incentive for Brazilian and Peruvian farmers to manage fast-growing timber on their landholdings. Species such as *Guazuma crinita* and *Calycophyllum spruceanum* can attain commercial size (25 cm dbh, for the purposes of house construction lumber) in 5–10 years. In both cases, the emphasis on forest management for the production of forest fruits and fast-growing timber is transforming the *várzea* into a forest-dominated landscape in several areas of the estuarine *várzea* and the western *várzea* located in the Peruvian Amazon.

There are several types of *várzea* forests that are managed by smallholders for the production of forest fruits and fast-growing timber in Brazil and Peru. In a study of 12 households located in the estuarine *várzea*, we found that all managed three distinctive forests types for the production of açaí and other fruits (Table 1). Similarly, households in the Peruvian sites managed three forest types for the production of fast-growing timber species (Table 1). In both cases, while farmers have increased the production volume and sale of products with high demand in the market (açaí fruit in Brazil and fast-growing timber in Peru), all of the 24 sample households are also producing a diversity of other goods for household consumption and commercial sale, including game, fish, shrimp, medicines, and a number of other household resources. In the estuarine sites, sample households are producing an average of 34 products in their house gardens, fallows, and mature forests. Similarly, households at the Peruvian sites were producing from six to 32 products in pastures and mature forests.

The diversity and number of products managed by the 24 sample households changes according to the season and the intensity and duration of floods. In the estuarine region, fish resources are more abundant during high tidal flood season in the months of March, April, and May, while game is more abundant during the dry season in the months of July, August, and September. Farmers in the estuarine

**Table 1** Types of forests managed by 24 sample households on their *várzea* landholdings (average 28 ha in the estuarine *várzea*, 17 ha at the Peruvian sites) and number of species used

| | Average number of species used per family | | | | |
|---|---|---|---|---|---|
| Forest types | Fruit | Timber | Aquatic* | Game | Total |
| a. Estuarine *várzea* | | | | | |
| 1. *Quintal* (house garden) | 13 | 9 | 2 | 6 | 30 |
| 2. *Capoeira* (fallow) | 8 | 7 | 2 | 15 | 32 |
| 3. *Mata* (mature forests) | 11 | 14 | 3 | 12 | 40 |
| b. Peruvian *várzea* | | | | | |
| 1. *Vuelito* (forest patches in pasture) | 2 | 2 | 0 | 2 | 6 |
| 2. *Purma* (fallow) | 17 | 6 | 1 | 0 | 24 |
| 3. *Monte* (mature forest) | 11 | 5 | 3 | 13 | 32 |

*Aquatic resources include numerous specie species of fish, five turtle species, and two shrimp species

region classify the fish that are caught during the flood season as fish of forests (*peixe do mato*) and game that is hunted during the dry season as summer game (*caza do verão*). On the other hand, in the Peruvian *várzea*, fish are more abundant during the dry season and game is more abundant during the flood season. During the dry season, which is in June and July, farmers fish in small pools (*pozas*) that are managed in their forests to trap fish when floods recede. Fish caught in small pools are known as pool fish (*pescado de pozas*). Peruvian farmers also manage the highest landscape elements (levees) as refuge areas for game during the flood season by preserving or planting the animals' favorite food. Hunting in these areas tends to be controlled by families. Game that is hunted in these areas during the flood season is known as levee game (*caza de restinga*).

In both the estuarine *várzea* and the western *várzea*, smallholders are producing the products with high demand in the market by diversifying their production, thereby increasing rather than reducing the production function of their managed forests. Smallholders are increasing the production function of their managed forests by incorporating rather than replacing the ecological functional attributes of the *várzea* environments. In the long term, the multifunctionality of smallholder managed forests offers greater economic and environmental benefits, and economic security, than the single-species forest plantations that are promoted by extension agencies for the production of timber in Peru and açaí fruits in Brazil (Table 2).

Smallholder forest management systems provide mutual benefits for the environment and the livelihood of people, while the plantation system provides some economic benefits but creates conflicts with the ecological function of the *várzea* environment. Plantation systems provide only two of the eight ecosystem services that are provided by the three forest management systems, pollination and carbon storage. In both *várzea* sites farmers enhance the production of açaí fruit and timber by facilitating the provision of three main ecosystem services: humidity control, seed dispersal, and pollination. Based on our observations, smallholders believe that although it is important to have pollinators, the most critical ecosystem service for producing açaí fruits is to regulate humidity and temperature by managing large canopy trees. Farmers found that the removal of canopy trees reduces the

**Table 2** Categories and types of managed fallows and forests and the ecological services and goods that farmers identified in the sample sites of Amapa, Brazil (n = 70) and Muyuy, Peru (n = 50)

| Categories | Types | Soil fert | Biomass | Habitat | Flood reg | Nat regen | Game | Ag | FW | Timb | Fish | Other |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Fallow from agricultural fields | 1. Imbaubal (cetical), dominated by pioneer species, such as *Cecropia* spp. and *Pouteria* spp. | | | | | | | | | | | |
| | | x | x | x | | | x | x | x | | | Rain control |
| | 2. Ingaubal (shimbillal) dominated by leguminous trees and shrubs, esp. of species in the genus *Inga* | | | | | | | | | | | |
| | | x | | x | x | | x | x | x | x | x | |
| | 3. Ciposal (sogal), dominated by vines and shrub vegetation | | | | | | | | | | | |
| | | x | x | x | | | x | x | | | x | |
| Fallow to produce fast growing timber | 1. Pau mulatal (capironal), dominated by juveniles of *Calycophyllum spruceanum* | | | | | | | | | | | |
| | | | | x | x | x | x | | x | x | x | Pest and disease control |
| | 2. Mutambal (bolainal), dominated by juveniles of *Guazuma* spp. | | | | | | | | | | | |
| | | | | x | x | x | x | | | x | x | |
| Fallow to produce fruits | 1. Frutas do mato (Brazil) and frutas del monte (Peru): Fallows managed to produce wild fruits of vine (e.g., *Passiflora*), shrubs (e.g., *Inga*) and trees (e.g., S*pondias*) | | | | | | | | | | | |
| | | | | x | x | x | x | | x | x | | Pest control NTFPs |
| Açaí production | 1. Açaí do mato. Mixed stand dominated by açaí palm with other native forest species; structurally complex | | | | | | | | | | | |
| | | | x | x | x | x | x | | | x | x | Pollination |
| | 2. Açaí de capoeira. Mixed stand dominated by açaí palm with fast growing timber and native fruit species; structurally complex | | | | | | | | | | | |
| | | | x | x | x | x | x | | | x | | Pollination |

quality and volume of açaí fruits because exposure to full sunlight increases the temperature and reduces the humidity in the stand, which results in less pulpy fruits.

Other fruit trees mixed in the açaí stands (*Carapa guianensis, Spondias mombin, Astrocaryum murumuru*) provide habitat for wildlife, in particular rodents and birds that disperse the seeds of açaí and other valuable species. In all landholdings we found high populations of agoutis, allowing farmers to hunt an average of eight adult individuals per month. Similarly, in Peru, fallows managed for the production of fast-growing timber species are known to maintain healthy populations of agoutis, panguanas, and other land-dwelling birds.

Extension agencies in both countries are conducting trials of production of açaí and *Guazuma crinita* and *Calycophyllum spruceanum* in plantation systems. Our concern is that while the monoculture system may result in higher product yield, the multiple goods and services provided by heterogeneous managed stands in house gardens, fallows, and forests will be lost.

## *4.2 Fallow Forestry and Enrichment*

Parallel to the expansion of açaí forests, smallholder farmers on the *várzea* are increasingly engaging in the management of fallows and other second-growth forests for the production of fast-growing timber. The stimuli for this trend include an increasing scarcity of traditional timber species and the continuing expansion of periurban settlements, which spurs demand for low-cost construction lumber (Brondízio 2008). *Várzea* residents are supplying the local and national urban markets in both Brazil and Peru with fast-growing timber for construction infrastructure (scaffolding) and building lumber. The management of fast-growing timber species in fallows is primarily through natural regeneration, since two commercial species occur in high densities in agricultural fields, *Calycophyllum spruceanum* and *Guazuma crinita.* At the same time, farmers often enrich their fallows with slow-growing, high-value timber (Table 3) and fruit trees.

The highest-value timber species, including among others mahogany and tropical cedar, have been depleted from these forests by selective logging from the 1960s through the 1990s (Barros and Uhl 1995; Zarin et al. 2001). Plantation forestry has been attempted in the Amazon estuary, but with little success for these high-value timber species. As a result, loggers have moved on to other regions in search of those highest-value species, or they are exploiting other species, as interest in their timber is promoted in markets. We have found that smallholder farmers have been successful at reestablishing populations of these most valuable species in their landholdings through enrichment planting.

The enrichment of fallows, housegardens, and forests with valuable, overexploited timber species is a decision farmers make based on a set of factors, not least among them the expectation that the value of these species will still be high 20–50 years down the road. They strongly consider the value these trees will add to the

**Table 3** Average number of trees of high-value, overexploited timber species in landholdings of 70 families in Brazil (average size 12 ha) and 50 in Peru (average size 9 ha)

| Scientific name (Common name in Brazil, Peru) | Number of trees | |
|---|---|---|
| | Brazil | Peru |
| *Cedrela odorata* (cedro) | 11 | 6 |
| *Calophyllum brasilense* (jacareúba, lagarto caspi) | 4 | 8 |
| *Swietenia macrophylla* (mogono, águano) | 3 | 2 |
| *Maquira coreacea* (muiratinga, capinuri) | 9 | 14 |
| *Aniba* spp. (louro, moena) | 5 | 17 |
| *Ceiba pentandra* (samauma, lupuna) | 2 | 5 |
| *Virola surinamensis* (virola, cumala) | 4 | 22 |
| *Copaifera officinalis* (copaiba) | 3 | 7 |
| *Minquartia guianensis* (acapú, huacapú) | 2 | 5 |
| *Hura crepitans* (assacu, catahua) | 12 | 4 |

landholding, but also the ecological value they add to the ecosystem. As with any productive land use activity, especially timber, the decision to maintain slow-growing valuable timber is based on the availability of land that can be dedicated to long-term production. In these enriched stands, high-value tree species are managed as a family savings account; in case of a financial emergency they can harvest and sell the timber. In this way residents are restoring the economic and ecological multifunctionality of forests.

A second critical function of forest and fallows enrichment activities is to reestablish the seed sources for restoring the populations of valuable, overexploited species both within the landholdings and in the surrounding forests. The propagule dispersal of mahogany and tropical cedar occurs by movement of wind and water, and the establishment of timber species with fleshy fruits attracts game animals and birds.

The diversification of these restored habitats provides the ecological conditions that favor the dynamic function of these forests, providing important ecosystem services such as habitat and food for game and fish, as well as ecosystem goods such as timber. Availability of seed dispersers facilitates the ecological capacity of degraded forests for the establishment and growth of an array of tree species with different niche requirements. More seedlings and juveniles of the most valuable

tree and palm species are growing in the forests and fallows of households in Foz de Mazagão and Ipixuna in Brazil (Fig. 2).

Smallholder enrichment systems start in house gardens from where seeds and vegetative propagation materials are dispersed to forests and fallows. Most farmers in the communities of Foz de Mazagão and Ipixuna have planted or protected a few individuals of high-value timber or fruit species in their house gardens. The adult trees have become seed producer trees. This process of enrichment is a viable alternative to the state-sponsored reforestation programs, particularly for restoring the populations of overexploited *várzea* timber species. Smallholder forest enrichment systems combine both economic gains (production of fast-growing timber and fruits) and ecological benefits (restoration of the regenerative capacity of populations of depleted valuable timber species).

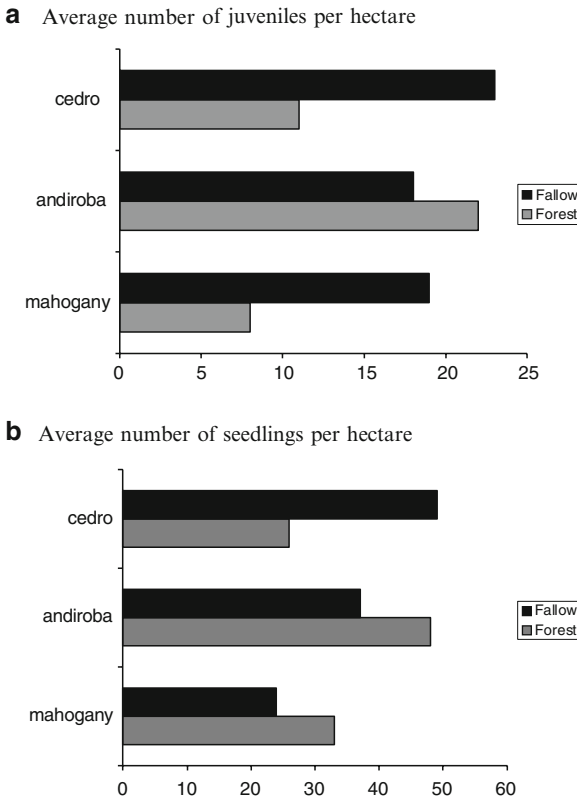


**Fig. 2** Average number of (**a**) juveniles and (**b**) seedlings per hectare in landholdings in Foz de Mazagão and Ipixuna as a result of the enrichment system

## *4.3 Collective Action for Productive Conservation*

A third process that is transforming the productive and ecological function of managed *várzea* forests is the practice of productive conservation. The multiple functions of riparian and levee forests are managed or conserved as part of lake or forest village or intervillage reserves. By engaging in collective action, *várzea* residents self-regulate access and use of aquatic and forest resources at the community and regional levels. An end result of conserving and managing *várzea* forests is an increase in fish and wildlife populations, including the giant pirarucu (*Araipa gigas*), rodents, and other game animals. Data collected during the last 10 years from the Mamiraua Sustainable Development Reserve show an increase in the commercial stocks of fish and game as well as an enrichment of the forests with mainly slow-growing tree and shrub species.

In the Mamiraua Sustainable Development Reserve, in central Amazonia, Brazil, community participation in decision making is an important element in the management strategy of the reserve. Most collective management decisions are based on the ecological knowledge of residents, and the implementation of the particular management operation is conducted as part of a collective agreement. In Mamiraua, communities regulate activities through collective actions, including fishing technologies and practices, farming practices, and protection of forest stands, especially those containing tree species important to fisheries (especially in the Lauraceae and Moraceae families). Residents identify areas where fish tend to feed, rest, and nest, noting the tree species that provide services such as food or shade. These areas and stands, locally referred to as *moradia de peixe,* are carefully managed by the collective as fully protected areas for fish.

In a survey conducted around the six lakes serving as important fishing areas for one community, 174 fruit trees and 28 stands of palms were found. Those areas were fully protected by the community as *moradia de peixes*. Farmers reported an increase in their catch of tambaqui (*Colossoma macropomum*) from an average of three fish per day per lake to 17 during the months of May and June, the fruiting season on the *várzea* in this region. Farmers have observed an increase in the natural regeneration and growth of certain tree species, especially palms and fruiting trees, likely a result of seed dispersal by fish.

The establishment of these feeding grounds as fully protected areas by collective action helps the residents of the community to secure both the production function—increase in fish stocks—of the lakes, and the ecological function of the system—the dispersion of seeds and maintenance of riparian species and habitat. The application of ecological knowledge and collective action that results in an increase in fish stocks and the enrichment of the forests with valuable tree species are the two main components of what we define as productive conservation (Fig. 3).

Based on the case of Mamiraua, productive conservation is not just the protection or increase of biodiversity, but rather an increase in both the productive and ecological functions of the ecosystem. Productive conservation is in many ways the result of both the application of local ecological knowledge and the capacity for

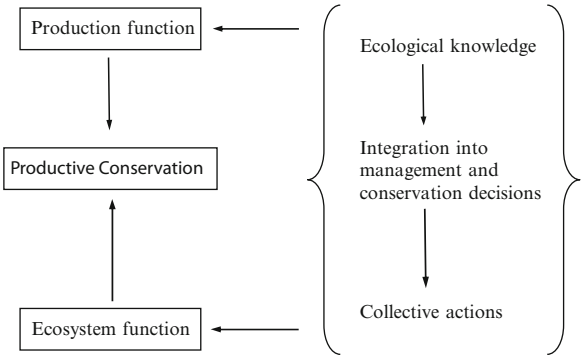


**Fig. 3** A schematic illustration of productive conservation based on the *moradia de peixe* conservation initiative and the collective action implementation

implementing collective actions. With their vast empirical knowledge, smallholders are competent at the restoration of both the productive and ecological functions of lakes. Our data from Mamiraua suggest the equal importance of securing the fish stocks and creating and protecting the feeding, nesting, and resting grounds of fish provided by the riparian vegetation, which also hosts populations of birds, turtles, and fish. The main result is the capacity for local people to engage in conservation actions that result in an increase of the populations of different fisheries, and the sustainable management of those resources.

## *4.4 Pasture Restoration*

The increase in the area of managed forests for production of açaí, timber, and other products is changing the vegetation cover of landholdings and landscapes that have been dominated by agricultural fields and pastures for generations (Brondízio 2008). The pastures and fields have been sources of erosion sediment and nutrient pollution. Such emerging forests are also redefining the function of land use systems in maintaining important ecological services. For instance, along the *várzea* there are large areas of riparian vegetation protected or conserved as habitat for fish, turtles, birds, caimans, and other wildlife species. These are critical areas for nesting, and serve as nurseries for fish and shrimp. Although there are still large parts of the estuarine *várzea* riparian areas that are affected by animal husbandry, especially buffalo, the successful restoration of riparian areas for fish and shrimp habitat is influencing ranchers to employ management practices that enhance the multifunctionality of their landholdings. We have identified the participation of smallholders in the restoration of degraded landscapes, particularly of degraded and abandoned buffalo pastures on the estuary.

Smallholder restoration systems start with the reestablishment of riparian vegetation, in particular the large herbaceous aquatic plant aninga (*Montrochiardia*

*arborescens*), that provides habitat for aquatic wildlife such as shrimp and fish. Through planting, the fast-growing aninga establishes and rapidly spreads along the tidal riverbank. In a matter of two years the shrimp population returns and people may begin to harvest them. The dense aninga stands also capture the propagules of palms and tree species, along with mineral-rich sediment, as the tide ebbs and flows across the landscape, allowing for a diversification of the riparian vegetation. In this way, the restoration of the riparian vegetation starts at the water's edge, rather than on the land, where land managers take advantage of the movement of materials and nutrients during the diurnal and seasonal flood pulse dynamic. The reestablishment of the riparian belt yields important ecosystem services, such as filtering the sediments and nutrients that run off degraded pasture. This water "cleaning" process is critical for the establishment of a healthy habitat suitable for the provision of valuable ecosystem goods, the fish and shrimp populations.

The value of the restored pasture is further improved by the broadcast of seeds (*semeamento*) further from the river's edge for the establishment of diverse forests that provide habitat for wildlife as well as other ecosystem products and services. In the beginning, residents focus on establishing palm species such as açaí, murumuru (*Astrocaryum murumuru*), and others. As the stand grows, the palms create suitable conditions for the establishment of woody species, and the system begins to function once again as an ecologically and economically productive area.

The restoration of these degraded pastures results in the conversion of a single-product system, cattle or buffalo, from one that tends to be ecologically poor and damaging to adjacent ecosystems, into multifunctional landscapes in which not only is vegetation restored with valuable products, but also in which ecological services return, such as water filtering and wildlife habitat.

Table 4 provides a summary of the functions and risks of the four transition types. Ecosystem and production functions were identified in samples of 75 farmers with açaí forests (all in Amapa), 100 farmers with managed fallows (50 in Muyuy and 50 in Amapá), 80 farmers with enriched forests (40 in Muyuy and 40 in Amapá), and 50 farmers with restored forests (all in Amapa). These sampled farmers also identified the main risks for losing ecosystem and production functions.

## 5 Conclusions

Recognizing the diversity and multifunctionality of forests that are emerging from the four main management systems, we can identify their multiple economic and ecological functions and the *interdependencies* among various functions of the forests. It is particularly critical for our understanding that *várzea* residents, by employing multipurpose management schemes, are not only diversifying products but also providing multiple functions. Accordingly, the driving forces of these multiple products and multifunctional forests are linked to an array of household income opportunities as well as the provision of ecological services.

**Table 4** (**a**) Functions and (**b**) risks of açaí forests, managed fallows, enriched and restored forests in Peru and Brazil

| Functions | Açaí | Fallow | Enriched | Restored |
|---|---|---|---|---|
| **(a) Functions of featured transitional stands** | | | | |
| Regulation of light, humidity, and temperature | x | | x | |
| Regulation of pests and disease | x | | | |
| Diversification of habitats | x | x | x | x |
| Nursery grounds and habitat for aquatic wildlife | x | | | x |
| Maintain soil fertility | x | x | | x |
| Flood mitigation | x | x | x | x |
| Fruit | x | x | x | x |
| Fish | x | | x | x |
| Shrimp | | | | x |
| Game | x | x | x | x |
| Commercial timber | | x | x | |
| Construction timber | x | x | x | x |
| Medicinal plants | x | x | x | x |
| Seed source | | x | x | x |
| Natural regeneration | | x | | x |
| Regulation of forager populations | | x | x | |
| **(b) Risks of habitat degradation with improper management** | | | | |
| Conversion to monoculture | x | | x | |
| Conversion to pasture | | | x | x |
| Use of agrichemicals | x | | | x |
| Increase of pests and disease | x | | | |
| Loss of fish and game | x | | | x |
| Overharvest or early harvest | | | x | x |

Others have recognized the importance of a diversity of forest products to tropical livelihood systems and the enhancement of the ecological function of forests (Perz and Skole 2003). They have also recognized the importance of the "hybrid behavior" of farmers who maintain multifunctional landscapes, allowing them to respond to opportunities as they arise (Walker 2003). The role of management in enhancing the multifunctionality of the landscape, and, indeed, in creating a diversity of functional patches, cannot be underestimated. The management objectives of *várzea* residents reflect economic opportunities, the empirical knowledge of long-time residents, and ecological opportunities.

In a region where agriculture is declining, where government and international programs offer benefits for conservation, and where residents are actively combining their ecological knowledge with access to those conservation benefits and markets alike, a calculation of the value of the landscape is necessarily multifaceted. Conventionally, the market value of the landscape is considered in land use decisions (Heilig 2002). In this region of transition, the Amazon floodplain, where the extractive and agriculture-based economy is being supplanted by an economy

based on ecosystem productivity and conservation, land values are determined based on the interaction of a combination of bio-physical factors and the economic (market), social (demand, access) and political (conservation, pension programs) factors. *Várzea* residents from Peru to Brazil have transformed a landscape where historically large-scale production has resulted in ecological decline and conflict. They utilize the natural heterogeneity of the riverine landscape to diversify production objectives and to combine conservation with production by enhancing the ecological function and services of the *várzea*.

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# Forest Resources, Family Networks and the Municipal Disconnect: Examining Recurrent Underdevelopment in the Amazon Estuary

**Eduardo S. Brondízio**

**Abstract** There has been a widespread assumption that a strong market for locally managed, sustainable production systems provides the key for regional development and conservation in the Amazon. During the past decades, a variety of factors has allowed for the first part of this equation to happen throughout the Amazon estuary. The region has experienced significant growth, intensification of production, and wide participation in the market economy of forest fruits and products. The expected outcome, however, has yet to be realized and seems far from certain.

Throughout history, the Amazonian estuarine floodplains have experienced some of the most dramatic demands for forest and agricultural products: cacao, rubber, sugarcane, rice, logging, fisheries, heart of palm, and açaí fruit are some examples. The productivity of regional forests, accessibility, proximity to state capitals, and the agroforestry knowledge of local populations are some of the factors facilitating these processes. However, despite stronger market connections, incentives for sustainable development, and valuing of regional products and cultural identities, old problems persistently exist in ever more puzzling forms. Why do we see a recurrent pattern of underdevelopment, as measured by education, health, job opportunities, income distribution, and public services, even under good market and production conditions?

This chapter combines long-term longitudinal ethnographic research and regional census data (economic, social, human development) to analyze the intensification of production and commercialization of forest and agricultural resources in the Amazon estuary.

Different factors mediate the interaction between producers, municipalities, and regional markets. In spite of a growing market for forest products have had limited impact in aggregating economic value at the municipal level, thus limiting local investments in social services and infrastructure, and creating employment

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opportunities. As in many parts of the Amazon, estuarine municipalities suffer from the lack of basic services and political conditions that enable economic development, while depending on federal assistance funds. This chapter discusses the need for initiatives focusing on the creation of transformative industries and producer-based cooperative systems connected to rural areas and small towns.

**Keywords** Forest resources • Family networks • Development • Longitudinal research • Amazon estuary

## 1 Introduction

There is a widespread assumption that strong markets for locally-managed, sustainable production systems provide the key to regional development and conservation in the Amazon. During the past several decades, a variety of factors have allowed the first part of this equation to appear throughout the Amazon estuary. The region has experienced significant growth, intensification of production without deforestation, and broad participation in markets for forest fruits and products. The expected development outcome, however, has yet to be realized and seems far out of reach.

Throughout history, the Amazonian estuarine floodplains have experienced dramatic demands for forest and agricultural products: cacao, rubber, sugarcane, rice, timber, fish, heart of palm, cattle, and açaí fruit are some examples. The productivity of regional forests, their accessibility, their proximity to state capitals and export routes, and the agroforestry practices and ethnoecological knowledge of local populations have facilitated these processes. However, despite strong market connections, political incentives for sustainable development, and valorization of local cultural identities during the past decade, old problems persist, and in ever more puzzling forms. Why do we see a recurrent pattern of underdevelopment, as measured by education, health, job opportunities, income distribution, and public services, even under strong and sustained market demand and production conditions?

In the spirit of the volume's title, this article explores the ups and downs of social, environmental, and economic changes in this part of the Amazon during recent decades, and discusses conditions that are shaping the region's near future. My arguments are based upon a range of published works reflecting 20 years of longitudinal research on rural, and more recently, urban households and communities in the context of their sociodemography, land use, and economy, and on ongoing observations of change. In particular, I use evidence from the booming açaí fruit

economy during this period to discuss the economic impact as well as the limitations and potentials of a forest-based economy in addressing current development problems of the region.

In spite of ideal conditions for production and commercialization, the regional forest-based economy has had limited success in generating economic development at the level of the municipality, including support for investment in social services and infrastructure for growing urban and rural populations. As in many parts of the Amazon, estuarine municipalities have neither the basic services nor the political conditions that might enable economic and social improvements. Paradoxically, along with increasing economic activity during the last two decades, both families and municipalities have significantly increased their dependency on federal assistance funds and aid. Following this introduction, I comment briefly on various aspects of longitudinal research and the challenges of discussing poverty and well-being among historically rural populations such as those who reside along the floodplains of the Amazon estuary.

My discussion concentrates on two main points. First, while individual households and families are benefiting from a growing agroforestry-based economy, municipalities have seen limited improvements in economic conditions and declining abilities to provide for growing populations and the large number of services decentralized from state and federal governments. Individuals, rich and poor, depend and invest in social and economic networks centered on family relations to secure that revenues are captured, maintained, and redistributed within families. The lack of a fiscal framework that would help add value to resources locally leads municipalities to experience an active and large local economy without seeing revenues reinvested locally. The lack of transformative industries close to production areas limits the potential of adding locally to the value of açaí fruit, to generate tax returns for municipalities from their industrial transformation, and to create jobs for local youth.

Second, the commodification of forest resources under global market demand has had differing impacts on rural and urban populations. Rural producers are seeing growing competition (thus lower prices during peak season) from other areas of Amazônia that are now producing açaí fruit, as well as from other parts of the country. Lacking support and organization, the economic returns producers receive depend increasingly not only on seasonality, but also on transportation costs and contractual agreements with large buyers. At the same time, the commodification of forest resources (açaí palm and several other species) is leading to tighter and more formal private control of access to forest resources and land. This change affects primarily, but not exclusively, sharecropper families, which are many. Urban residents, on the other hand, have seen rampant price increases and/or decreasing quality of açaí juice as external demand competes with local supply of açaí as a staple food, particularly for low-income populations. I conclude the article with a discussion of the underlying causes and implications of these changes and argue for the need to move from a resource management-focused to a transformative economy in the region.

# 2 Beyond Culture Shock? Longitudinal Research and Development Déjà Vu

## *2.1 Reflections on Longitudinal Research*

Following the Amazon estuary, and in particular the town of Ponta de Pedras, during the past 20 years has given us the opportunity to observe economic and social change as we could never imagine. From the booming days of liberation theology projects that created and transformed numerous communities' social organization, land tenure, and production technology, to the high hopes of university- and corporation-based "high-profile" development projects such as POEMA, and to the international boom in açaí fruit, people and institutions have experienced successive waves of optimism and shattered hopes. Each of these projects and their multiple political dimensions left scars and contributions. On the one hand, there is more political organization and secure land tenure for some communities; on the other hand, deforestation, food insecurity, debt, and perhaps most significantly, mistrust and skepticism of programs and institutions have increased among community members. From an ethnographer's perspective it has been daunting to follow these processes and understand their outcomes. The dialectical nature of persisting structural problems, creative cultural practices, and perverse social structure has rendered any attempt at simplification or linear explanation useless. During this time, it is fair to say that, apart from a significant influx of aid funds for development projects and more recently of government family aid, the rise of the açaí fruit economy has created a level of economic activity not seen for almost a century. How then does one make sense of a critical deterioration of physical and social capital amid apparent prosperity? Apart from an endless list of failed projects, over the last 10 years the town has lost its bank and gas station (despite a growing pool of cars, boats, and buses); the historic city hall building was burned down due to political unrest; one mayor was impeached and one "expelled;" a large agricultural cooperative failed; a promising and internationally-promoted local "sustainable" factory went bankrupt, bringing down one community with it; and numerous cases of corruption plagued associations, unions, and individuals of all walks of life.

During the same period we also observed the life cycle of many families who succeeded in educating their children, improving their houses and transportation, and escaping their condition as sharecroppers by acquiring a lot in the city. Improvement in access to education has allowed many children, rural and urban, to graduate from secondary school. Ironically, however, one of the top complaints of rural families today is the lack of employment and opportunities beyond the informal, highly gendered, economy of seasonal urban labor and/or açaí production and commercialization. While the estuarine economy depends on açaí fruit, forest and river products, and cattle, these sectors make almost no fiscal contribution to the economic structures of the municipality, functioning largely as informal.

Municipalities depend increasingly on federal and state subsidies and aid; in Ponta de Pedras for instance, government employment accounts for over 90% of so-called formal employment (RAIS 2005).

Families have shifted their strategies to take advantage of a changing reality. Work opportunities in the trade of açaí fruit, faster transportation to Belém and other cities, and better communications have increased the level of circulation and economic networks in significant ways. For most families dependency on açaí fruit production has increased. Participation in the commerce of açaí fruit has arguably attracted adult males from virtually every family. Migration, permanent or seasonal, to local towns and the state capital has affected most rural families and significantly changed the urban scene in towns like Ponta de Pedras. Families have strengthened their economic networks and strategies by expanding households between rural and urban, towns and capital (Padoch et al. 2008). The lack of health and educational services are compensated by the spread of supporting family networks assisting families when they visit urban centers, or move to study or seek medical care. Expanding opportunities in the açaí fruit economy have increased the number of families that have members working as middlemen and/or brokers. Likewise, family members living in urban areas benefit from resources coming from their rural counterparts, and participate in production and commercialization during parts of the year. Estuarine households have become multisited, mimicking within the Amazon estuary the mobility of agricultural labor in many parts of the world.

Improved transportation and communication have not only facilitated a high rate of movement and seasonal migration and the "multisitedness" of households, but also changed standards and expectations, particularly as more educated and media-exposed children and adults are attracted to urban areas and express consumer behavior different from the patterns of the past. In the absence of employment opportunities other than work in agroforestry and subsistence activities, we see the rural–urban boundary progressively more blurred, as urbanites are workers and producers in a rural economy, and vice versa. For an increasing number of people, particularly women, direct sales of beauty products, clothing, household utensils, and decorations have provided the best economic opportunities. Few sectors have expanded so much in the region and other parts of Latin America as such direct sales networks (Chelekis and Mudambi 2010).

These two decades of research in the estuary have contributed and benefited from comparative work in different parts of the Amazon. It is interesting to view the estuary in the context of colonization areas throughout the region, both old and new. The estuarine region faces persistent historical problems. In the estuary, we have seen countless sharecropping families of multiple generations expelled, as absentee owners renewed their land claims during the boom of the açaí fruit economy. Elsewhere, we have observed many colonization areas designated for agrarian reform experience high rates of family turnover and quickly return to large estates. Despite differences, these problems are common throughout the region.

The estuary also has strong intraregional differences, particularly when comparing areas shaped by different economic histories and environments (e.g., grasslands vs. forested parts of the estuary), located at various distances from state capitals, and affected differently by government policies. The latter is particularly striking. The State of Amapá, for instance, has been able to resolve most land tenure problems in the floodplains and has extended electricity to virtually all riverine houses, offering a striking contrast to the state of Pará. The different conditions that these two factors create for riverine families are striking.

Perhaps the most difficult aspect to come to terms with during the past few years has been the implication of the so-called *Bolsa Familia* program (roughly translated as Family Aid).[1] Established in its present form in 2003 by the Lula government, it is a modification or hybrid of its predecessor, *Bolsa Escola* (roughly translated as School Aid) and the emergency aid *Fome Zero* (Zero Hunger) programs. The level of dependence on the *Bolsa Familia* in Ponta de Pedras is astonishing during a time of market activity as strong as the past decade. A recent survey conducted by members of our research team indicated that the majority of açaí producer families depend on the *Bolsa Familia* as their first or second source of income. This alone underscores my point on the limitations of a forest economy, even at its best, to address regional structural problems. Without question, *Bolsa Familia* has provided fundamental and much-needed support to local families. Even R$2 a day has made a significant difference to low-income families. However, it is having a limited long-term impact in helping these same families transition to a stronger economic foundation and improve local institutions. Families basically have no obligations or commitments to fulfill, such as increased involvement with schools or local institutions. Accusations of political manipulation and favoritism are commonplace. Although in place for many years, the *Bolsa Familia* continues to be fundamentally an emergency program. The end of *Bolsa Familia,* if politically feasible, would show once more the fragility of aid-based policies and economies based on resource export occuring in a vacuum of value-added transformation industries export resource economies.

## 2.2 Walking a Fine Line: Discussing Poverty and Development in the Amazon Estuary

Poverty in the Amazon in general, and the estuary in particular, is not an "obvious" subject of discussion or research. The rise of the açaí economy, for instance, has furthered the idealization of local producers as indigenous, traditional, and idyllic forest people whose culture and material conditions are essentialized as representing

[1] *Bolsa Familia* provides a monthly stipend to families below the poverty line having children younger than 17 years of age. The maximum monthly stipend per family is R$95.

material simplicity, sustainability, and native beauty. It has also reinforced perceptions of their condition as nonentrepreneurial extractivists whose inability to "produce rationally" requires the help and aid of others, i.e., the new entrepreneurs of the booming açaí fruit economy (Brondizio 2008). In short, it has reinforced a vision of their economic and social conditions as explained by culture, not structural problems. On the other hand, most indicators of well-being easily demonstrate that poverty and inequality characterizes the region. Even in Amazônia, which lags behind Brazil as a whole, the Amazon estuary falls behind in most indicators of well-being (PNUD-IDH 1970, 2000). Inequality, measured as a component of the human development index, has increased between 1991 and 2000 in estuarine municipalities producing açaí fruit. A recent survey indicates that electricity reaches less than 10% of estuarine rural populations, while over 90% have no access to sanitation systems. The level of truancy is no less appalling. While access to education has improved, in quality and continuity the estuary ranks low even by Amazonian standards. Similarly, land tenure problems in the estuary have deep historical roots. Across estuarine municipalities and rural communities, sharecropping affects from 10% to 90% of riverine families. Land titling and security also vary significantly. More than 50% of households lack title to their land; in some areas the percentages are far higher (Benatti et al. 2005).

Navigating the fine line between indicators and perceptions of poverty is not a challenge unique to the region, but an issue in the global poverty debate (Duraiappah et al. 2005, MEA). At its heart, this is a debate on cultural relativism and social reality, one that requires accounting for both socioeconomic indicators and an understanding of social relations. Few would disagree with Chambers (1992) that poverty needs to be approached in a multidimensional way as a condition resulting from an imbalance between survival, security, and self-respect. Yet there are no clear-cut approaches to these dilemmas. Indicators are notoriously poor in capturing economic and social conditions of populations whose forms of exchange and economic relations are complex. These often combine market, subsistence, reciprocity, and social relations, which are valued as highly as material exchange. On the other hand, an overly cultural interpretation of well-being falls into the trap of naturalizing poverty by only paying attention to desirable cultural markers (e.g., an idyllic palm-thatched house) without a critical inquiry into the ability to choose (e.g., a preference for a brick and tin-roofed house).

The informality of resource economies in the Amazon and the hierarchical nature of social relations render both etic and emic perspectives problematic. Measures of income are inaccurate as representations of access to resources, while perceptions are shaded by explanations which naturalize the "condition of the *caboclo*" as being content with limited goods, while blessed by nature's resources and the "good will" of his landlords, both notions that have little grounding in reality. Low income or lack of access to income opportunities subject families to food and land insecurity, and abuse by landlords, middlemen, and merchants. The bounty of nature, while generous, betrays the hopeful at the turn of each season when resources can be plentiful or scarce (or during the peak production season when açaí prices may crash).

The growing urban reality of estuarine populations further complicates these discussions. On the one hand, urbanward migration exposes families to new opportunities, social relations, and access to work and services; and on the other hand, to economic insecurity, questionable living conditions, and the violence common to urban slum areas. Nonetheless, it is not easy for the outsider to evaluate the meaning of these individual choices (particularly if we consider that individual freedom represents a reaction to poverty) without holding them up against an idyllic image of rural life or a cynical image of urban life.

On the fine line we walk as ethnographers, the question then becomes whose interpretation is important. Is it the view of professionals and academics, or the perception of "the poor?" To paraphrase Kluckhohn's (1949:11) maxim, "Can the fish see the water?" when both perspectives can be argued as ethnocentric and constructed through power relations, subordination, and hegemony of one kind or another. Furthermore, I would argue that while there may be differences in the ways "each" perspective categorizes material conditions and social relations, what varies most significantly is not the assessment of current conditions per se, but how one sees the future. What ideas of maintaining cultural identity and reaching a good life are important? And, at the very core of this discussion, who wants to transform whom in what direction?

The rise of neoliberal multicultural policies in Latin America, to use C. Hale's (2002) argument, has further polarized this discussion by "essentializing" rural material conditions and production technology as cultural markers defining traditionality and rights to land. In Brazil, for instance, the legalization of the concept of "traditional populations" has created conditions for many communities to guarantee land rights, while at the same time creating expectations of cultural continuity that perpetuate the use of simple technologies, extensive and environmentally friendly production systems, and low levels of consumption (De Castro et al. 2006).

On the other hand, poverty is a strong word, and, as an ethnic identity, used more often as a situational reference than a self-imposed category. More commonly than not, as is argued by Lima and her colleagues' work on the *Sociodiversity of the Várzea* (Lima 2005), riverine Amazonians will prefer to frame their condition in terms of neglect, political disregard, and isolation, rather than poverty itself. The term "poor," then, is dislocated from one's own reality to become a political statement. And thus talking about neglect gives one a chance to point to unsolvable problems and one's desires to overcome—a tool of hope and self-dignity. It is in presenting these conditions as relative, where there is always a worse case or other victims, that one's poverty is renegotiated. In such terms the table is turned; the lack of opportunities and material conditions are contrasted with the richness of resources offered by nature. Social oppression, prejudice, and perverse political relations are contrasted with celebrations and festivities and the enjoyment of the moment. Paradoxically, if we consider that we are talking about "the poor," one is confronted with a hedonistic explanation of the good life. We have faced this situation many times when discussing the disproportional investments by the city in shows, events, and parties. On the one hand, it epitomizes the value put on social relations and enjoyment. On the other hand, it represents a form of political

exploitation aimed at compensating the failure of political institutions to provide services and even pay for salaries, but caring enough to invest in activities of "popular demand" attending "needs of local culture:" "*Isto é da cultura caboclo, é isto que o povo gosta*" ("This is part of *caboclo* culture, it is what people like"). The ethnographer, then, is at a crossroads: to contest the political manipulation of hedonism is to contest local culture, but accepting it as culture is accepting a perverse social reality.

These dilemmas play a large role when discussing policy and development programs for the region, and help explain why so many attempts to improve local conditions have failed but continue to be used as models for development policies. The Amazon is emblematic of the global poverty debate, as the region has been a laboratory for development experiences based on a combination of trickle-down, aid, and trade models. I am arguing in this paper that both aid and trade offer limited solutions to development and poverty problems in the region, and that trickle-down policies (e.g., credit subsidies to large farmers) have further promoted concentration of wealth and land. While both aid and trade are at their apogees in the region, advances in social conditions and opportunities and their sustainability are questionable at best.

This realization takes us back to the question above: who formulates desirable futures for the region? In other words, in what terms are development goals framed? To side with the current political populism of aid or the solution of trade is to uphold a vision of path dependency that essentializes poverty and social conditions as cultural. By not recognizing structural problems, it is assumed that people adapt "well" to conditions of deprivation, conditions that become romanticized as culture. In other words, this is a view based on cultural parochialisms, which epitomizes the contentedness and "sustainable" condition of the *caboclo* without a critical assessment of social inequality. Development policies and projects in the region, to use Sen's theory of justice (2006), reproduce a transcendental view of justice and development which romanticizes current conditions and idealizes a utopian end point framed by the vision of outsiders. The concept of sustainable development has further popularized the idea of development as an end point represented by steady state human-environment interaction. In practice, as the end goal of projects and policies becomes unachievable (or not shared), the very process of constructing change is disregarded and undermined, and thus blamed on persistent local cultural practices. Thus, with due cynicism, locals refer to their region as the land of the "*já teve*" ("once we had it") pointing to the endless list of projects which once presented a "magic bullet" solution, without considering local needs and the very process of change through which improvement takes place. This is not very different from the way the current açaí fruit boom is presented by government and corporations, as well as locally: as the magic solution for sustainable development in the Amazon. As a growing market alone is unable to create cumulative and transformative change, the idealized promise of a sustainable economy becomes an end in itself and a convenient market tool for certain players, and not a tool for incremental change.

Sen's alternative to this scenario, a comparative or relational framework of justice, may offer a better starting point by focusing on ways to advance justice or reduce

manifest injustice as part of the process. In other words, the focus changes from disputing an idealized view of a just future to finding a moral compromise which respects the current dynamics of culture and social relations, while articulating alternative social arrangements which identify and set incremental goals to improve basic conditions of well-being. Setting indicators and valuing the process of incremental change shifts the goal of an idealized sustainable future to a process of sustainable changes.

## 3 A Short Overview of the Emergence of the Açaí Palm Economy

Açaí fruit is the most salient case of economic expansion in the region during the past century. The fruits of açaí (*Euterpe oleracea*), a palm native to the Amazon estuary and extensively managed in mixed forestry and intensive agroforestry systems by farmers, have been an important human food since pre-Columbian times. The exponential expansion of the açaí fruit economy since the 1970s (and particularly during the 1980s and 1990s) was largely based on management and intensification of production (Brondízio and Siqueira 1997) to supply a growing regional urban population demanding culturally preferred and low-cost caloric staple food. Reports indicate that consumption of açaí juice in Belém rose from 90,000 L/day in the late 1980s to an estimated 400,000 L/day in the late 1990s (Mourão 1999; Rogez 2000; IBGE 1974–2003), an increase largely mirroring urbanization rates. This figure implies an estimated consumption of more than 60 L/person/year, or as noted by Rogez, twice the volume of milk consumed in Belém. Families with the lowest level of income consume the largest amount of this food, buying and eating it fresh twice daily as a staple. Poullet (1998) estimates that daily consumption in another smaller estuarine city, Macapá, ranges from 27,000 to 34,000 L. Since the mid-1990s, following a phase of expansion as a regional urban staple food, açaí fruit has reached national and international markets and developed into multiple forms of industrialization, which continues to drive an increasing demand for the fruit. Elsewhere, I defined this latest phase as related to its rise as an urban fashion food (Brondízio 2004b, 2008).

The rise of the açaí fruit economy has positively affected the livelihood and economy of a great part of the riverine populations and small towns throughout the estuary. During this period, açaí fruit has also increased its role in the diet of low-income urban families and has spurred a processing economy involving tens of thousands of individuals across urban areas in the Amazon. Estimates of the current economic impact of the açaí fruit market in the region range from R$100 to 500 million/year depending on how, what, where, and how far along the commodity chain one counts. (IBGE 1974–2006; Rogez 2000; Brondizio 2008). By now, its overall industrial economy has surpassed several billions. Its contribution to rural household income has been reported to range from 40% to 90% across the estuary (Brondízio et al. 2002), but a recent survey in Ponta de Pedras indicates that only 20% of the families have it as their first source of income year-round.

The so-called "açaízation" (Hiraoka 1994) of the estuary is an effect of the importance that açaí as a food has gained during the last 30 years. Over the past two decades, farming in the region has shifted from predominantly annual crop agriculture to forest-based production systems centered on açaí fruit, heart of palm, and managed and unmanaged forestry (Pinedo-Vasquez and Padoch, forthcoming). This region has, contrary to the rest of the Amazon, experienced net afforestation and decreasing rates of forest clearing over the past several decades (Brondízio 2006a). For instance, in a 10 km radius around Ponta de Pedras, a town on Marajó Island, the area of intensive açaí agroforestry increased from around 1,100 ha in 1985 to around 2,150 ha in 2000, and we estimate it now occupies more than 4,000 ha. This last estimate represents more than 75% of the total area of floodplain forest in the area analyzed. At the community level, we observe that riverine communities have 75% or more of their territories under forest cover managed mostly for açaí production, while upland communities with a history of pasture and mechanized agriculture have experienced a doubling of area in secondary tree vegetation over the past decade, when these activities were abandoned in favor again of agroforestry. Similar rates of regrowth characterize communities previously dedicated to small-scale manioc cultivation.

I believe the history of açaí fruit serves as a window to discuss the interactions between Amazonian rural communities, urban consumers, and large-scale markets. Elsewhere (Brondízio 2004), I have argued that producers have been benefiting from the expansion of this market, but have been unable to participate on new sectors of the economy associated with the commercialization and control of fruit stock, its transformation, and its market. Producers suffer from the stigma of extractivism and the invisibility of their intensified management and production to address market demand since the mid-1970s (Brondízio and Siqueira 1997). New entrepreneurs and large regional producers have come to occupy the most profitable niches of the market and assume greater control over production, commercialization, processing, and marketing (Brondízio 2004). Furthermore, açaí fruit production has expanded throughout Amazônia and elsewhere in Brazil, which is leading to tighter competition for estuarine producers who see price crashes during parts of the year.

## *3.1 The Emergence of a Forest Transition in the Estuary*

The economic importance of forest products, aligned with increased competition from agricultural products from southern Brazil and a shifting household economic portfolio, has led the region to a forest-based economy. As a result of these changes during the past two decades, we see signs of a "forest transition" in place. During this period, while the rest of the Amazon has experienced an exponential increase in deforestation, the opposite has taken place in the estuary. The above discussion, however, raises questions about the long-term sustainability of a forest-based economy, when the return to producers may fall with growing competition from other parts of the Amazon and Brazil.

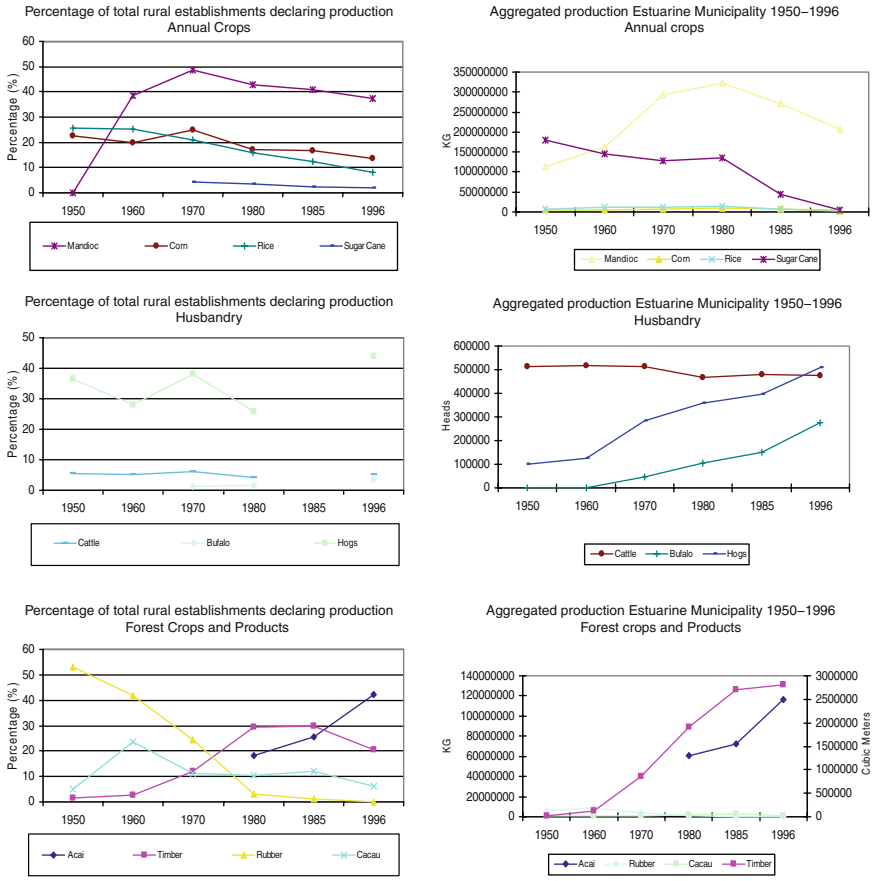


**Fig. 1** Transition in annual crops, forest products and husbandry production, 1950–1996

Regionally, estuarine municipalities have experienced overall decline in annual crop production and a progressive increase in agroforestry systems based on the açaí palm (Fig. 1). The number of establishments producing açaí fruit shows a steady increase, inversely to annual crops. While the number of establishments that report extracting timber has declined, total production has increased. Most notable is the decline in manioc production, which has been compensated by increasing imports from other parts of Pará and Maranhão. It is interesting to note the rise of hog production and its correlation with açaí fruit production. Combining hog and açaí production has been a preferred strategy among large and small owners. For large owners, hogs have been an investment with low economic risk and with utility to offer proof against land claims. By allowing sharecroppers to raise hogs (mostly open forest foraging, but in same cases semiconfined), they undermine the management of agricultural gardens that are easily raided by hogs. Buffalos have also increased, but largely in parts of the estuary dominated by grasslands.

In Ponta de Pedras similar trends have been observed. Few households continue to practice swidden cultivation of manioc. Other agricultural systems, such as floodplain gardens, continue to be used to plant and establish intensively managed açaí agroforestry groves. Ponta de Pedras now depends almost completely on manioc meal imported from other regions. The municipality continues to feature cattle production in areas of grasslands, but little or no deforestation has been observed in the municipality since the early 1990s, when most farmers turned their full attention to açaí fruit production. As reported elsewhere, Brondízio (2006a, 2008), following a period of increasing upland forest clearing associated with phases of cooperative formation and the implementation of mechanized agriculture and cattle ranching, many of these areas have been abandoned to secondary succession.

The rise of a forest economy, however, has other implications for rural producers and urban consumers. As discussed below, the increased value of açaí fruit and other forest products has driven a process of growing privatization of resources. This in turn has led to controlled access to and commodification of different species, and to the formalization of sharecropping contracts related to the use of floodplain areas and the management of açaí agroforestry areas. For urban consumers, export demand for açaí fruit now competes with local demand as an urban staple food.

## 4 Discussion

### *4.1 Family Networks and the Municipality Disconnection*

Municipal district governments have been largely disconnected from the rise of forest resource economies in the Amazon estuary. In spite of increasing inequality in the region (discussed below), it is clear that individual households have benefited from the expansion of the açaí fruit economy. State and federal governments have also benefited from growing national and international exports and from the processing industries in Belém and surrounding areas. The açaí fruit economy during the mid-2000s is estimated to generate between 100 and 500 million dollars across sectors in the region, most of it fueled by riverine producers in estuarine municipalities. It has spurred an economy many times that amount nationally and internationally. In terms of production, estuarine municipalities represent over 70% of national açaí fruit and heart of palm production.

Parallel to the expansion of the açaí economy, municipalities have also seen a growing urban population and demand for infrastructure, as well as more responsibility for education and health programs decentralized from state and federal governments. Their ability to generate capital, however, has dwindled, in spite of an active and growing economy. This presents a paradox central to understanding regional development. While at the center of a booming economy, the financial capacity of municipalities has decreased. Municipalities are essentially bypassed in the process of economic expansion, and thus unable to generate revenue from

resources produced and exported from their territories. The economic and fiscal structure of resource extraction, production, and export is one of the most significant problems affecting municipalities in the Amazon as a whole, and in the estuary in particular, where there is such an active agroforestry/animal husbandry/water resource economy. Municipalities such as Ponta de Pedras, always among the top three national açaí producers, see virtually no returns from production and export, or commercialization and industrialization. In other words, the boom in economic activities has no direct relevance to municipalities; conversely, they have experienced increased demand for services and investments to support growing urban and rural populations.[2]

Although one would expect that an active and growing resource economy could help fuel an active commercial sector and thus harness benefits in municipal sales taxes, the lack of regulation and fiscal accountability indicates otherwise. The vast majority of commercial transactions in municipalities such as Ponta de Pedras are done informally, with no receipt or tax, such as the ICMS,[3] assessed. Even large stores and supermarkets carry out transactions informally. While Ponta de Pedras has very active commerce with hundreds of operations ranging in size, recent data[4] on formal employment for the municipality indicate that this sector contributes only 0.8% to formal employment in the municipality (up from 0.6% in 1985). Not surprisingly, transformation industries corresponded to 0% of formal employment, while resource activities (forest, fishing, agropastoral sectors) corresponded to 2.2% in 2005. One can argue whether these classifications of sectors and formality are meaningful in the local context, but the numbers do show the outlines of the economic structures that underlie resource production and markets in the region. On the other hand, municipal employment puts this scenario in perspective, as it represents 95.5% (2005) of formal employment. In the absence of opportunities supporting value aggregation and employment at the local level, it is no surprise that, in spite of a strong and growing açaí economy, most families producing açaí depend on the *Bolsa Familia* as their primary or secondary source of income next to retirement benefits.[5]

The municipal budgetary deficit for Ponta de Pedras[6] in 2006 was over R$1.3 million, a situation apparently getting worse during the last 5 years. Of the total proceeds received by Ponta de Pedras, less than 3% result from taxation for services, resources, and industries, with the last two sources virtually nonexistent. As in many other municipalities in the region, Ponta de Pedras is facing a changing demographic situation. Both rural and urban populations are increasing and require more investments in education, health, and general infrastructure. Without an employment basis, opportunities are restricted to the informality of the forest and

[2] See: http://www.tesouro.fazenda.gov.br/estados_municipios/situacao_fiscal_municipio.asp

[3] Imposto sobre Circulação de Mercadorias e Prestação de Serviços (tax on the circulation of goods and services)

[4] Source: RAIS (2005)///MTE, Brazil.

[5] Unpublished household survey 2007/2008, 8 communities, 264 households.

[6] See: http://www.amam.cnm.org.br/amam/financa/mu_financa.asp?iIdMun=100115095

fishing economy, commerce, and the growing direct sales networks mentioned above. And, as indicated above, public employment at the locally referred "*mãe prefeitura*" ("Mother City Hall") is one of the most desirable jobs for urban and rural individuals alike. Aside from commerce and public employment, the employment basis associated with açaí and other resources is highly gendered (Siqueira 2006). IPEA[7] data indicates that in 2000, 66% of working-age men were economically active, compared to 30% of women. Resource-based economies, including agriculture, forestry, fishing, and husbandry, are predominantly controlled by men, both in terms of production and of commercialization and trade. Most rural families have at least one male member working in the commerce and transportation of açaí fruit. On the other hand, direct sales networks have opened opportunities for rural and urban women to seek both a professional identity and more independent income, despite incurring some level of economic risk.

It is important to note that there has been some recent improvement in graduation rates from middle and high school, and in school attendance among rural populations, but little change in terms of quality and truancy among particular age groups. The overall percentage of students attending middle and high school went from about 10% in 1991 to about 30% in 2000, according to IPEA (IPEA 1991–2000).[8] However, the lack of opportunities for those with better education and the rise of economic opportunities associated with açaí fruit also help to explain an actual increase in truancy from 1991 to 2000. In Ponta de Pedras, for instance, work-related truancy among students 10–14 years of age, who are highly desirable as açaí harvesters, increased from about 9% to over 20%, according to IPEA data (apud IPEA 1991–2000).

The disconnectedness of estuarine municipalities from their own resource economy speaks to a widespread problem in the Amazon and perhaps one of the most important development dilemmas of the region: how to capture and locally invest revenues from valuable resources. The lack of a tax framework to capture value before resources leave the region results from several historical problems, but fundamentally it reflects an extractive colonial economy. In other words, wealth and rent value generated by resources are captured by family groups, small and large, and negotiated directly in the open market, but based on a system of social and power relations. There is a growing system of contracts between producers and large firms, which has helped producers to buffer themselves against lower prices during seasonal peak harvests. Few of these contracts are negotiated collectively. Organization of producer groups aimed at controlling stocks and processing the fruit for pulp and commercialization is incipient. The organization of producers to commercialize and add value through processing is hampered by numerous factors, including lack of support for cooperative formation and development, lack of training and preparation of producers for administrative management, absent extension

[7] Instituto de Pesquisa Econômicas Aplicada (Institute for Applied Economic Research)

[8] http://www.ipea.gov.br/001/00101001.jsp?ttCD_CHAVE=2&btOPERACAO= (accessed May 20, 2008)

services for production and commercialization, and mistrust in institutions, public and private. In a vicious cycle, families are discouraged from investing in collective action and institutions, which in turn limits their ability to have a better position to negotiate with external markets.

The inability of the state to provide services and social support systems fuels investment in family networks. The development of social networks centered on individual relations becomes the main form of access to services and economic opportunities, and to secure that access, revenues are captured, maintained, and redistributed within family networks. Families, rich and poor, invest in the control of resources within their networks, including relationship-based or nepotistic, which essentially aims at transferring resources from public to private hands. Interfamily relationships are also strong and based on reciprocity of labor exchange, and most importantly, food redistribution. At different levels, families may invest in community cooperation and joint arrangements, but long-term observation has shown that such investments tend to be short-term. Investment in community organization is proportional to the level of return expected by families, and tends to focus on short-term opportunistic prospects for accessing external funds or harness improvement in local conditions. We have observed, for instance, that many projects that started at the community level ended up controlled by different family groups with significantly unequal distribution of benefits. Similarly, cooperatives created (by outsiders) to involve a large coalition of communities are often usurped by individuals and families. This situation creates an intrinsic social capital dilemma, represented by the mismatch between long-term investment in family social networks, short-term and opportunistic investment in communities, and virtually minimum investment in public spheres, such as the municipality.

An extractivist's mentality is extended to public goods; in this case, the municipality (or agencies bringing funds to the region) is seen as a source of resources, which because of its corruption and lack of competence to manage and provide services can be "expected" to be expropriated while resources last; a form of tragedy of the commons played out with public resources. However, at the same time that public institutions are seen as independent of society, families expect their assistance through formal and informal types of benefits. Thus, concomitantly, individuals disregard public institutions as a public good while expecting a high degree of paternalism, both of which are reinforced through political alliances of privilege. Political candidates and/or the administration provide jobs and goods to favored families and/or facilitate access to federal and state aid programs. The current situation of the region could not be more telling of this reality. About 40% of families in Ponta de Pedras depend on the federal aid program *Bolsa Familia,* which is controlled and distributed by the city. The figure is higher for several other estuarine municipalities and, as discussed below, indicates the growing concentration of wealth in the region during the past decades.

The paternalistic relation between families and the municipality is reproduced between the municipality and the state and federal governments. The municipality itself, lacking even a minimum economic basis to support its functions, depends on assistance funds (through political and formal channels) from state and federal governments, which provide most of the income, not only for Ponta de Pedras, but also for most municipalities in the Amazon.

Ironically, in the midst of a strong export economy, never before have families depended so much on local and federal government subsidies, while municipalities have depended on federal assistance. This creates a vicious cycle, which not only drives political populism from local to federal levels, but also undermines the economic sustainability of one of the most successful economic systems in regional history.

## *4.2 Global Market Pressures and Local Commodification of Resources*

While global market demands bring new economic opportunities, they put in motion new forms of resource competition and control, with diverse implications for the livelihoods of rural and urban populations. This is especially the case with culturally and economically important resources such as açaí fruit. Different from other commodities such as soybeans, competition for açaí fruit touches on the supply of staple food for low-income populations and the control and rights of use of a range of forest resources in rural areas. Elsewhere, I discussed extensively the implications of growing competition for the economic return of producers based on their land tenure regimes, their ability to decide on harvest, and their costs of transportation (Brondízio et al. 2002, Brondízio 2004, 2008). Here I concentrate on different dimensions of this process: control of land and resources, inflation of staple food provisioning, and concentration of wealth during the açaí economic boom.

During the last few years we have observed significant institutional changes in the control and use rights of a range of forest resources essential to local material culture and livelihood. Since the 1980s, the increased value of açaí fruit and floodplain forest land has brought many absentee owners back to manage and monitor their inherited lands and forests. In many cases, wholesale evictions of sharecropper families have taken place. Large owners and corporate groups have also acquired larger tracts of floodplain land to develop açaí plantations. The valorization of açaí fruit has led not only to tighter control of land, but also to the formalization of rules of management, harvesting calendars, and transportation and commercialization contracts, in many cases legally sanctioned in local courts with advantages and disadvantages to producers. Producers who lease floodplain land find security in such contracts because they clearly define rights and timeframes of use, while landowners feel protected from squatting claims. Sharecroppers, on the other hand, are affected differentially depending on their previous history with the land. Sharecropping families who have already farmed an area for a longer time may find themselves signing a contract that disregards previous activities and eliminates their ability to claim rights to land which some have occupied over generations. In general, however, the region has seen a high rate of family turnover as owners substitute sharecropping families to avoid the risk of land claims. As such, the region has seen a transformation from the historical social category of "*morador*" (resident sharecropper of a given landlord) to that of hired farm workers, although still defined by sharecropping arrangements.

Besides greater control of land and floodplain forest areas, increasing market demand for raw materials important to local use and to the açaí economy is leading to more control of the ownership of particular species, particularly palm species. Examples include jacitara (*Desmoncus macrocanthus*) and jupati (*Raphia taedigera*) palms, which are widely used to prepare açaí baskets as well as fishing traps (e.g., *matapis*). Some vines have also increased in price, and access to them has become more restricted. As a reaction to these processes there has been a significant change in the use of raw materials. Plastics, recycled or purchased, are substituting for palm products in the construction of baskets and fishing traps. Although costly at first, they may offer more durability; and in a region used to recycling, they are slowly gaining ground among local users. Other species subjected to more control include palm species such as ubucu (*Manikara saccifera*), preferred for roof thatching, but today marketed at a high price. While many rural residents are moving to roof tiles, those who cannot afford either ubucu or tile substitute less durable and efficient palm leaves.

Urban residents are perhaps feeling the most significant impact of competition for açaí fruit. By mid-2006 Belém experienced an annual inflation of açaí costs close to 30% (for instance, see *Diario do Pará* July 4, 2006). Discussions of a "threatened tradition," and "global market loser" started to appear in local newspapers and popular conversations about the scarcity of açaí fruit. While inflation has affected low-income açaí consumers, product quality has actually been more affected by this process. Because of the inability of consumers to pay higher prices, processors have developed ways of increasing production of açaí pulp by manipulating content. This includes adding several additives, such as ice cream thickeners, corn or manioc starch, artificial coloring, or beet water, as an alternative to keep prices low but increase return per basket. The result is a tainted, low-quality, watery açaí which many say "cannot even be called açaí." While good quality açaí can be found, few can pay the high prices. Proportionally, while supply has been mostly maintained, the quality and nutritional value of açaí has declined substantially for low-income consumers. Although most visible for açaí, given its role as a regional staple food (Siqueira 1997), this process is not unique to açaí, but can be seen in other regional staples, such as fish and shrimp.

Notwithstanding the gains and benefits of a large and active economy from which low-income families have benefited, the economic expansion of açaí fruit has not only led to tighter control of resource ownership, but concentration of wealth. Available data on per capita income (IPEA 1991–2000) indicate small improvements for Ponta de Pedras, from R$73.20 in 1991 to R$83.04 in 2000. This average change, however, is compromised by the increasing concentration of resources and income. Figures 2a and 2b indicate across the board concentration for the same period, not only in Ponta de Pedras but throughout the estuarine municipalities. In Ponta de Pedras the wealth controlled by the poorest 80% has decreased from 48.4% to 38.2%. Perhaps more telling, the ratio of income[9] between the richest 10% and the poorest 40% has increased significantly during this period, from

[9] IPEA: This ratio measures the degree of inequality existing in the distribution of per capita income. It compares the average income of individuals belonging to the top 10% with the income of individuals belonging to the lowest 40%.

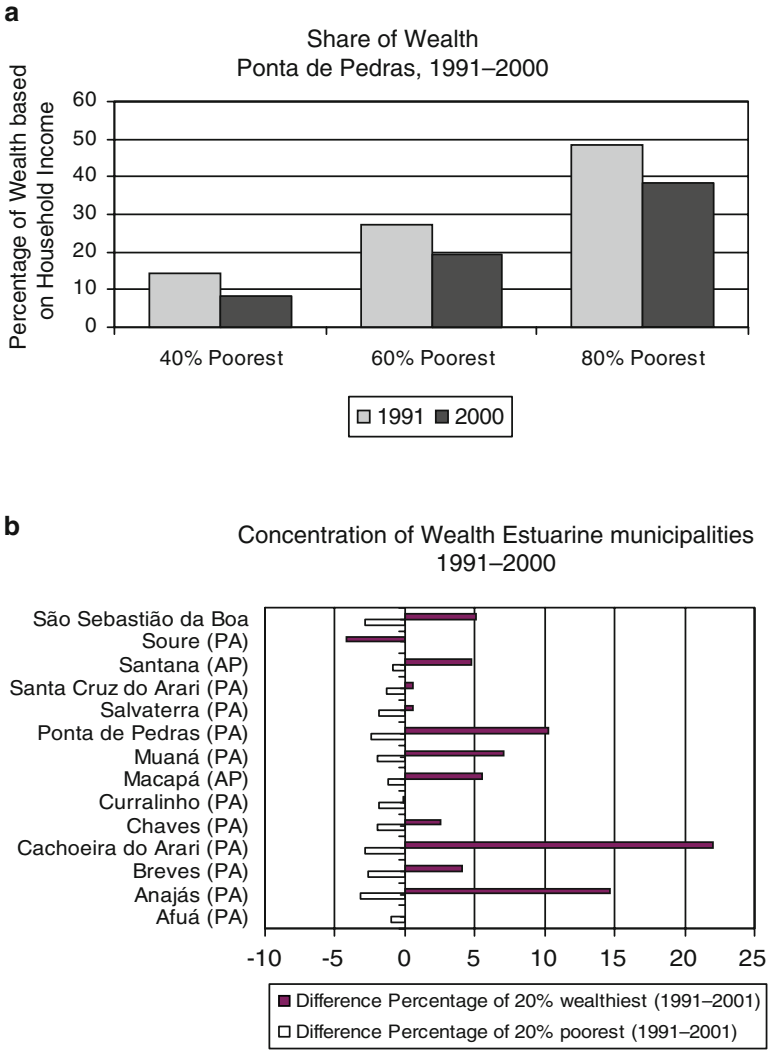


**Fig. 2** (**a**, **b**) Concentration of Wealth in Ponta de Pedras and Estuarine Municipalities (Source: IPEA 2008)

9.9% to 21.8%. Aggregate indicators of inequality, such as the L de Theil index,[10] show significant increase since 1970 (Fig. 3), not only for Ponta de Pedras, but also across the estuarine municipalities. For Ponta de Pedras, it has increased particularly since the latest boom of the açaí economy in the early 1990s: 0.32 (1970), 0.30

[10] L de Theil index: This measures the inequality distribution according to per capita income, not including individuals who are not economically active. It is the logarithm of the ratio between the arithmetic and the geometric average of income; the lower the value, the lower the inequality; a higher value indicates increasing inequality.

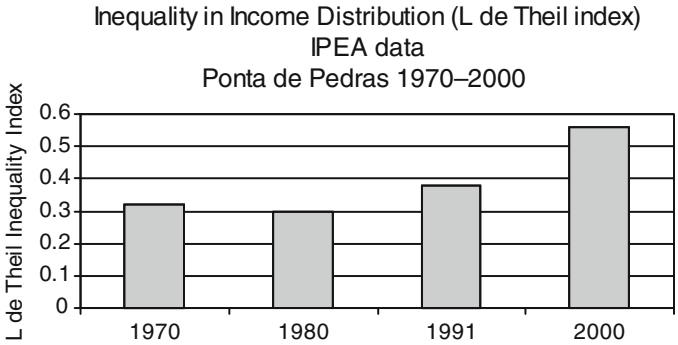


**Fig. 3** Inequality in income distribution in Ponta de Pedras, 1970–2000 (Source: IPEA 2008)

(1980), 0.38 (1991), 0.56 (2000). Thus, it is no surprise that *Bolsa Familia* and retirement benefits together today represent the primary source of income for most açaí fruit–producing families surveyed in Ponta de Pedras in 2007 and 2008.

## 5 Concluding Remarks and Policy Reflections

As in other parts of Latin America, the Amazon has been a laboratory for dominant ideologies of development. "Trickle-down" and "aid-trade" approaches have abounded in the region during the past four decades. The idea that promoting and creating incentives favoring strong economic groups and stimulating large-scale activities has, albeit diversely across the region, reproduced or increased concentration of resources and the appropriation of public incentives with diverse social, environmental, and demographic consequences: rural conflicts, explosion of urban squatter settlements and slums, and continuous record levels of deforestation. Development becomes an end in itself measured through indicators of aggregated production and gross product, and not a process of cumulative change.

On the other hand, the idea that opening markets for forest products offers opportunities for wider economic participation requires careful examination. Products such as the açaí fruit, engrained culturally within the estuarine society, have the potential to involve a wide range of families and social groups. The familiarity of local producers with açaí palm ecology and management, and their technological knowledge of how to develop an intensive food production system without incurring deforestation provides an example of great value to the Amazon. However, as a production system evolves and expands, revenues move from the production side of the chain to sectors controlling the commercialization, processing, and marketing of the fruit. Farming families have limited ability to participate and benefit from these developments and have been reinforced in their condition of small-scale producers subjugated to other sectors of the economy. Furthermore, growing competition from other producing regions and the growing number of

corporations and large farmers, with exceptions, in the estuary put small farmers and sharecroppers at an increasing disadvantage in negotiating prices. Elsewhere, I called this process "shifting cycles, shifting opportunities" to illustrate the unfavorable shift in the position of producers along the evolution of an economic system. On a higher level, these processes illustrate how the region continues to be pressed to provide an increased supply of resources to meet national trade surplus and global commodity needs, instead of being the focus of cumulative economic and social growth.

The government emphasis on aid programs to deal with regional inequality and poverty is questionable at best. It has provided emergency support to needy families, but without providing opportunities for lasting economic improvement. As conceived in the region, the *Bolsa Familia* program represents a missed opportunity. It does not involve families with the improvement of schools and/or community services, and it does not set goals advancing their conditions. As an emergency program, it has contributed to important immediate needs, but will leave little trace, besides political discontent, when and if terminated. The interdependence of açaí fruit production and government aid (*Bolsa Familia*) and welfare (retirement) in providing economic support to the majority of rural families illustrates the limitations of these approaches to ameliorate economic and social conditions of the region and move them toward more equitable and long-lasting forms of development.

In reflecting on the longitudinal research and my own difficulties in understanding the intersection of culture, poverty, and development in the region, I have argued for a need to reframe development and the poverty debate in the estuary along the lines of A. Sen's (2006) framework for a comparative perspective aiming at reducing manifest injustice while setting incremental goals for sustainable change. This requires moving beyond the parochialism of essentializing poverty as culture or idealizing development scenarios without setting incremental goals for improving local conditions. It also requires recognizing structural changes, their political dimensions, and conditions undermining local forms of collective action. Before any incremental development model can be implemented, the region needs attention to and real investment in land tenure legalization, rural electrification, a complete rebuilding (e.g., Emater) and expansion (e.g., Sebrae) of extension services and credit programs, support for cooperative organization, and foremost, actual investment in education and health. Correcting the structural imbalance between municipality administrations and resource-based economies, as illustrated by the açaí fruit economy, will require new models of taxation and incentives aimed at decentralizing the commodity chain of resource exports and developing transformative industries throughout municipalities in the region. Favoring aid subsidies and trade models based on the export of commodities has undermined the emergence of a transformative economy for the region.

Yet, this regional scenario will not change without recognition that the region is plagued with nepotism and political distrust, conditions which are reinforced by the paternalistic policies of local, state, and federal governments. The region has achieved an impressive forest-based economy through the cumulative investment of farmers and their ability to use local technology and knowledge systems to manage

forests and intensify food production to attend market demands. The scale and positive impacts of these transformations illustrate the potential of regional production systems to respond to local and external forces and conditions. They also call attention to the limits of resource management and resource export economies to engender structural changes and create conditions for local improvement. There are no magical solutions, and açaí is no magical fruit, but it can serve as a window through which we can see the nature of persistent development problems and the possible tools to overcome them.

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# Part IV

# Introduction: Strategies for Social and Environmental Conservation in Conservation Units

**Philip M. Fearnside**

**Abstract** Two groups of considerations are essential for choosing strategies for conservation: linking conservation to the interests of local peoples, and linking conservation to core national and global interests. This section addresses the question of conservation strategies in conservation units by presenting several examples in specific areas that are also parts of a wider effort towards formulation of strategies for social and environmental conservation in Brazilian Amazonia. Brazil's conservation units are grouped into two categories: "sustainable use" and "integral protection". At present, opportunities are more evident for the former rather than the latter. However, one must be constantly aware that supposedly "sustainable" activities are not always sustainable nor are they invariably environmentally benign. There must be constant reinforcement of awareness among local people who receive payments for environmental services that it is their role as environmental guardians that is the reason for the support they receive. There has been notable progress over the last few years in rating conservation units and in organizing civil society so that they act as a force for conservation. However, these rest on a shaky foundation since political considerations may reverse this progress. Several recent instances illustrate the fragile nature of environmental advances and indicate the need for a concerted effort to elevate the environment in decision-making in Brazil.

**Keywords** Amazonia • Brazil • Parks • Protected areas • Reserves

## 1 Introduction

Conservation units in the Amazon region can conserve both social and environmental values, but achieving this requires a strategy. A "strategy" is a broad approach, or general direction, for making progress towards a goal, not the details of how

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individual situations are handled from day to day. Here the goal is social and environmental conservation, meaning assuring the long-term maintenance of both the human and nonhuman portions of ecosystems.

The chapters in this section address the question of conservation strategies in conservation units by presenting examples in specific areas. Leandro Castello and coworkers examine the pirarucu fishery in the Mamirauá Sustainable Development Reserve. They show that participatory efforts must put priority on identifying key individuals who are especially knowledgeable about the resource in question, and on developing an effective monitoring program. The pirarucu fishery at Mamirauá is widely recognized as a success, especially by the participating communities. The principles upon which it is founded could be extended to other resources and locations in the *várzea.*

Helder Queiroz reviews the history and environmental resources of the Mamirauá reserve, emphasizing that the successes achieved there have depended on promoting best practices of sustainable use in pilot management systems. He draws on the examples of the pirarucu fishery and timber management program to show that pilot projects within the reserve were important in spreading the management technologies throughout Mamirauá, and in some cases beyond. Some of the groups that have adopted the techniques outside of the reserve, without the full suite of social and scientific controls, have suffered the consequences of omitting components of the management packages. Future challenges include obtaining better clarity in regulations and coming to terms with the rapid growth of the human population in the Mamirauá reserve, in part as a consequence of the reserve's economic success.

Finally, Ronaldo Lobão recounts the rise of extractive reserves and the relationship of the people and the ecosystems they inhabit to various social theories and stereotypes. He concludes that a new economic policy of resettlement is needed and that this should be based on respecting differences.

The examples given in these chapters are part of a wider effort towards formulation of strategies for social and environmental conservation in conservation units throughout Brazilian Amazonia. Two groups of considerations are essential for choosing strategies for conservation: linking conservation to the interests of local peoples, and linking conservation to core national and global interests.

## 2 Linking Conservation to the Interests of Local Peoples

Since the launch of the National System of Conservation Units (SNUC) in 2002, Brazil's conservation units such as parks and reserves are grouped into two categories: "sustainable use" and "integral protection." The first category includes federal units such as extractive reserves, national forests, and state-level conservation units such as sustainable development reserves and state forests. Sustainable development units are intended to maintain traditional populations such as rubber tappers and Brazil nut gatherers, and, in the case of the *várzea,* communities supported by fishing and by small-scale logging in flooded forests. Integral protection units such as national parks, biological reserves, and ecological stations do not have resident populations within

them; but the involvement of populations in the surrounding buffer zones is essential both to the effectiveness of the reserves and to the welfare of the people. Indigenous areas, although not considered to be conservation units, protect much larger areas of natural habitat than do units under the SNUC, and the role and interests of their indigenous inhabitants are subject to the same considerations (Fearnside 2003).

The political attractiveness of "sustainable use" conservation units is much greater than that of units for "integral protection." This is evident from the proposals made by the Amazonas state government's Secretariat of Sustainable Development (SDS) for conservation units to be created in the Area of Provisional Administrative Limitation (ALAP) along the Manaus-Porto Velho (BR-319) Highway. While completely protected areas also have their place, the rationale for allocating a substantial part of the conservation effort to the "sustainable use" category is strong, especially for the *várzea* (Amazonian floodplain), where virtually the entire area is occupied by local residents.

A strategy for investment in conservation must face the tradeoff between options that take on long, expensive struggles for creation of a few highly protected areas versus a strategy of seizing opportunities to quickly create large reserves, even if relatively weakly protected. For this opportunistic strategy one must be able to pick up the ball and run with it when the opportunity arises. Ecologists will recognize the parallel with "r-" and "K-selected" life-history strategies (MacArthur and Wilson 1967). This refers to how plants and animals allocate their efforts in growth, defense, and reproduction. For example, a Brazil nut tree (*Bertholetia exelsa*) is slow-growing, has hard wood and produces a relatively small number of large seeds with thick shells; whereas a *Cecropia* grows quickly, has soft wood, and produces many tiny seeds without defensive shells. The r-selected *Cecropia* is adapted to quickly spreading to occupy openings that appear in the forest, either caused by trees falling, as when toppled by storms, or by agricultural clearings made by humans; whereas the K-selected Brazil nut is adapted to outcompeting its neighbors as it slowly grows in the shade of the forest. These strategies are appropriate for different periods in the process of ecological succession. The same is true of strategies for conservation units. In Amazonia, we are still very much in the "r-selected" phase, where rapid expansion of conservation units, even if they are incompletely protected and/or weakly defended, has the greatest payoff for conservation, both social and environmental.

At present, opportunities are much more evident for sustainable use units than for integral protection. In particular, the receptiveness of the current government in the state of Amazonas to creating substantial areas of reserves represents an opportunity that should be matched with the support and investment of entities interested in conservation, both social and environmental. Opportunities such as these are temporary, as they tend to become unavailable due to political changes or to the continued advance of destructive occupation of the habitats that might be conserved.

The sustainable use category includes the presence of local peoples, which is seen by some as an impediment to conservation. The fact that local people can damage natural ecosystems is undeniable. Nevertheless, these people also represent an opportunity. Inclusion of the people, as opposed to relocating them, gains support

at all levels, from political support in the upper echelons of government, to an on-the-ground presence in guarding the environmental resource.

The most immediate results from the creation of sustainable use areas are seen in the case of those based on fishery resources. Exclusion of outside fishing boats creates local support for proposed conservation units such as sustainable development reserves (RDS) and extractive reserves (RESEX). Simply closing off the access of commercial fishing boats from distant centers, such as Manaus, increases the amount of fish that can be harvested by the local population and removes the open-access situation that makes unsustainable exploitation the logical choice for all involved (McGrath 2000).

One source of income in conservation areas that include human populations is from the sale of sustainable products that are certified for environmental niche markets. These can include fish, açaí, wood, and handicrafts. Often the local people who sell these products are not fully aware that the principal product they are offering to the market is social and environmental correctness, and that they must be very careful to be correct or risk losing this market from one day to the next.

In discussing the creation of sustainable use units, one must be constantly aware of the multiple pitfalls presented by "politically correct" discourse on this subject. The supposedly "sustainable" activities are not always sustainable, nor are they always environmentally benign. Logging can easily pass these limits. Problems can be caused by the very success of projects that prove to be highly productive, attracting immigration. Immigration may mean simply moving from one side of the river to the other, but when this increases the population of a conservation unit, it has impacts. Local people are not necessarily environmentally conscious. The alligator extermination effort in an environmental protection area (APA) near Itacoatiara described by Ronis Silveira provides an apt example.

Political support of the local people was generated by former Amazonas state governor Gilberto Mestrinho's calls for elimination of the alligator population in the *várzea* near Nhamundã, and by his sending his wife to distribute artificial limbs to *várzea* residents who had been attacked. In other words, antienvironmental positions can bring support.

## 3 Linking Conservation to Core National and Global Interests

This author has proposed environmental services as a means for making conservation into a basis for supporting the human population in the Amazonian interior (Fearnside 1997). The proposal had originally been made as a more modest complement to plans for forest management for timber (Fearnside 1989a) and for extraction of nontimber forest products (NTFPs) (Fearnside 1989b).

The basic rationale for this applies to ongoing government programs to create reserves and to support local residents, such as those in the *várzea.* One must ask, "Why do the Pilot Program to Conserve the Brazilian Rainforest (PPG-7) and its

PróVárzea project, the Brazilian government in general, and environmental NGOs care about people in the *várzea*?" The answer is not human rights, correction of historical injustices, or poverty alleviation. For example, building schools and health centers in urban shantytowns (*favelas*) is much cheaper per capita than is providing these services to an equivalent number of poor people in far-flung reserves.

The population is accustomed to receiving government support as a political favor, essentially in exchange for votes. This includes benefits to which the population theoretically has rights as citizens, such as retirement benefits, as well as new programs like the "family scholarship" (*bolsa família*). It will be important to assure that this pattern does not accompany payments for environmental services, such as the "forest scholarship" (*bolsa floresta*) program that was created by the government of the state of Amazonas on 26 April 2007.

There must be constant reinforcement of awareness among the local people that it is their role as guardians that is the reason for the support they receive, and that they must perform this environmental role. The reasons for supporting the programs must be disentangled both for the supporters and the supported. For example, support for PróVárzea was withdrawn by the British government because a policy on poverty reduction was issued for all British aid expenditures as a national decree. The support that had been flowing to projects such as Mamirauá was summarily transferred to Africa. This is not an indication that the environment is not of interest. The same relationship applies to strategies on the international level to get financing for conservation units (PPG-7, etc.). This author served on the International Advisory Group (IAG) of the PPG-7 for 9 years (1992–2001), during which time this was repeatedly evident.

There has been notable progress over the past few years in creating conservation units and in organizing civil society in the Amazonian interior so that these units act as a force for conservation. This can lead to a tendency to become complacent and self-congratulatory. However, important as the many advances may be, they rest on a shaky foundation. This was dramatically apparent at the time of the PróVárzea conference in December 2006, shortly after a confrontation had occurred between Environment Minister Marina Silva and Dilma Rouseff, the head of the "Civil House" (*Casa Civil*)—the second most powerful person in the Brazilian government. A situation such as this, which can recur at any time, showed that Brazil's notable progress on environmental matters could be reversed virtually overnight. Appointment of a new minister of the environment could easily be caused by such political figures as Blairo Maggi or Jader Barbalho. Due to political favors that the current administration has received from these notoriously antienvironmental politicians, these are not entirely hypothetical possibilities (e.g., Leal 2007).

The subordinate nature of environmental concerns was made publicly clear on 21 November 2006, when President Lula da Silva declared that the environment "*entrave*" (an impediment, or "monkey wrench") for development (e.g., Paraguassú and Nossa 2006). The statement was made while speaking at a political rally on the same stage as Blairo Maggi, Brazil's largest soybean entrepreneur. Lula listed "*entraves*" as including indigenous peoples, *Quilombos* (descendents of escaped African slaves), and environmentalists. *Riberinhos* (riverside residents) were left

off the list, perhaps out of forgetfulness. The statement served to remove the illusions of many as to the distinction between rhetoric on environmental and social issues and the core priorities of the government. Another reminder came when, just prior to the PróVárzea meeting, Brazil abstained on a critical vote in the UN Council on Human Rights, with the practical effect that the UN continued to do nothing to stop genocide in Darfur. Brazil's foreign ministry was putting the oil purchases of its trading partner China ahead of any considerations based on human rights (Folha de São Paulo 2006; Gallas 2006; O Globo 2006). These illustrations illustrate the unreliability of expecting concern for others, such as poverty alleviation, to override selfish financial interests.

The federal government's launching of the Program for Acceleration of Growth (PAC) in January 2007 indicates the fragile nature of environmental advances. The Amazonian portion of the program is a package of highway and other development projects, with no environmental initiatives included. One of the most destructive projects, the BR-319 Highway linking Manaus to the arc of deforestation in Rondônia, is going forward without an environmental impact study (EIA/RIMA) (Fearnside and Graça 2006).

These events indicate the need for a concerted effort to elevate the position of the environment in decision making. The environment must pass from being a matter of public relations to becoming a core interest of decision makers. Because environmental services involve both national and global core interests, this represents the firmest foundation for social and environmental conservation, both inside and outside of conservation units.

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# Protected Areas of Sustainable Use, Involvement of Social Actors, and Biodiversity Conservation in the *Várzea*: The Case of the Mamirauá Reserve—Sharing Conservation Benefits in Central Amazonia, Brazil

**Helder L. Queiroz**

**Abstract** Biodiversity conservation in the Amazonian *várzea* depends heavily on the protection of large portions of this threatened environment. In the Brazilian Amazon there is a handful of protected areas with significant portions of *várzea,* but only one large protected area entirely formed by this particular ecosystem, the Mamirauá Sustainable Development Reserve (MSDR), created by the Amazonas State government in the early 1990's. This reserve has been comanaged by a Brazilian NGO since its creation, in continuing cooperation between public and private efforts for the conservation of the *várzea* and its biodiversity. Here, we present the trajectory of this protected area, and a special emphasis is given for one of the most relevant elements of Mamirauá, the involvement of different social actors interested and concerned with local protection and conservation. In the case of the Mamirauá Reserve, this involvement was crucial to deal with the many challenges related to the protection of such a large portion of the territory. The combined efforts of government, NGOs, and the local population, among other actors, also made possible a strong positive impact on the maintenance of local livelihoods and the improvement of the quality of life for the local inhabitants. Possibly as a consequence of that improvement, increasing population growth rates may now pose a threat for the near future of the reserve, and require new, enhanced forms of sustainable use for local biodiversity. Besides that, it is important to maintain the widespread distribution of benefits from these conservation practices for all social actors involved.

**Keywords** Amazonian *várzea* • Protected areas • Mamirauá Reserve • Sustainable use of natural resources • Local community participation and involvement

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# 1 Introduction

Mamirauá is a Sustainable Development Reserve (SDR) in the Brazilian Amazon where biodiversity conservation has been carried out, in agreement with the Amazonas State government, by a local environmentalist nongovernmental organization with the support of the WCS for the last 17 years (Ayres et al. 1996). An SDR is a new Brazilian category of protected area, corresponding to IUCN Category VI. It is located in the floodplains of the Central Amazon, alongside the Solimões (Amazon) River (Fig. 1).

Mamirauá Sustainable Development Reserve (MSDR) is located at the confluence of the Solimões and Japurá Rivers and the Auatí-Paranã, a branch of the Solimões draining into the middle course of the Japurá. The seasonal flooding of the Solimões River raises the water level from 10 to 12 m above the levels recorded during the low-water season. When floodwaters are at their highest point, virtually all the land at the Mamirauá Reserve, or 1,124,000 ha, is completely submerged, and only the highest parts of the forest canopy can be seen above the water line.

This flooding pulse, typical of the Central Amazon, defines large portions of seasonally flooded terrestrial habitats, locally called *várzea.* MSDR is the largest Brazilian protected area devoted to the conservation of the biodiversity of flooded forests of any kind, and the only functional area conserving the *várzea* flooded forests, which are present along many Amazon white water rivers.

The geomorphology of the Mamirauá Reserve has provided a large number of aquatic habitats inside this protected area. They vary from open water habitats such as rivers, and river branches, or *paranãs,* streams (or channels), and lakes, to other perennial habitats such as backwater areas, or temporary ones such as water holes, pools of water in the forest floor, or in the sands or mud of the beaches.

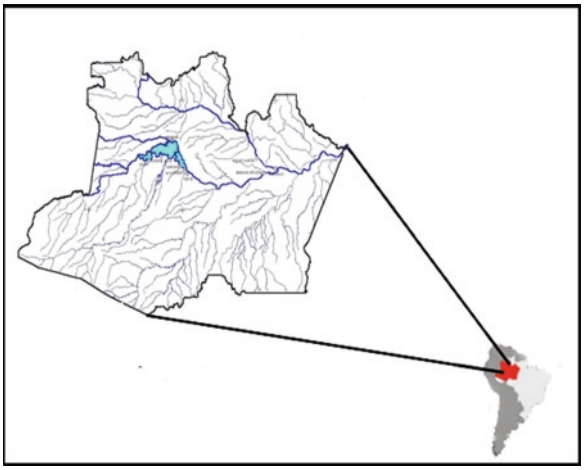

**Fig. 1** Mamirauá Sustainable Development Reserve (in *blue*), Amazonas state, northwestern Brazil, in the floodplains of the Central Amazon

The differences in the height and the duration of the flooding, due to the variations in the relief of the *várzea,* lead to the development of distinct terrestrial habitats, with different vegetation structures and compositions in the *várzea* ecosystem (Ayres 1994). Approximately 10.2% of the area of the Mamirauá Reserve is covered by permanent water bodies, and out of the remaining 89.8%, 44.3% comprises *restingas* (flooded forests located in the higher levees), 31.3% is made of *chavascal* (flooded shrubby vegetation located in the lower areas), and 14.2% is formed by other plant communities (palm groves, grasslands, beaches, and cleared lands and gardens) (SCM 1996).

The fauna found in Mamirauá shows a higher degree of endemism. There are also some high biodiversity figures in some specific taxonomic groups of the Reserve, such as in the fish fauna, which are more diverse than the adjacent black water or whitewater river sections. The Mamirauá Reserve was created specifically to protect the famous white uakari, *Cacajao calvus calvus,* the only neotropical primate with a very short tail, covered in whitish fur, and with a bald red face. Almost the entire range of distribution of this primate is located inside the Mamirauá Reserve. Another endemic and very important primate species from Mamirauá is *Saimiri vanzolinii*, the black-headed squirrel monkey. Other threatened species are also present, like the giant black caiman, *Melanosuchus niger,* the Amazon manatee, *Trichechus inunguis*, the jaguar, *Panthera onca*, and the giant bony tongue fish, *Arapaima gigas*. They are all very abundant in Mamirauá, although rare in many other parts of the Amazon (Queiroz and Fernandes 2001).

The mid- to large-size vertebrate fauna of Mamirauá are basically identical to those found in the surrounding *terra firme* forests, although less diverse, since only tree-dwelling animals, or those that swim with some degree of expertise, are able to survive in the *várzea* during the long periods of floods (this can be as long as 5–6 months in some years). Mammals such as the tapir (*Tapirus terrestris*), the white-collared peccary (*Tayassu tajacu*), the *paca* (*Agouti paca*), the *cotias* (*Dasyprocta* spp.), and the armadillos (*tatus*) (*Dasypus* spp. and other genera) do not occur in Mamirauá (or are very rare) because they have their horizontal displacement limited by the seasonal floods. This is true for almost the entire terrestrial component of the vertebrate fauna. However, animals that are markedly terrestrial in other localities, such as the tortoise (*Geochelone denticulata*), apparently find a favorable habitat in the *várzea,* and can be found in Mamirauá throughout the year. Depending on the characteristics of the annual flooding, large-size animals can enter the area to take advantage of its food resources, as occurs in other *várzea* areas. Among this group we find the white-lipped peccaries (*Tayassu pecari*) and, probably, the brocket deer (*Mazama* sp.). However, all these species can be and are actually found in the dry tall forests (*terra firme* forests) located at the Amanã Reserve, on the opposite bank of the Japurá River, and in other areas in the vicinity of Mamirauá (Amaral 2005).

In total, about 340 species of birds are found in Mamirauá (Brangham 2000). The avian fauna of Mamirauá is placed within that of the High Amazon Province, in the domain of forests in environments with an aquatic influence. It can be said that this fauna represents the whole of the avian fauna of the *várzea* of the Solimões Sector.

To date, about 340 species of fish have been recorded in the Reserve and in the immediately adjacent bodies of water. There is little doubt that Mamirauá has an exceptionally diverse fish fauna. This is the greatest number of species ever registered for a *várzea* environment. The reason for this diversity is probably the range of aquatic habitats available and the wide environmental fluctuations that characterize the hydrologic regime (Queiroz and Crampton 1999).

So far, almost 300 species of trees and lianas have been identified in Mamirauá, mainly inventoried in five independent studies, which covered a total of 20 ha. Nearly 60 species of submerged or true floating aquatic macrophytes have been recorded. The most significant macrophytes in Mamirauá are *Paspalum* sp., *Eichnochola* sp., *Salvinia* sp., *Pistia* sp., *Azola* sp., *Eichornia* sp., and *Utricularia* sp.

The Amanã Sustainable Development Reserve (ASDR) is adjacent to the Mamirauá Reserve, and also protects large extensions of flooded environments, just like its neighbor on the opposite bank of the Japurá River.

Located in the middle of two enormously important river basins, the Japurá and the Negro Rivers, the Amanã Reserve comprises 2,350,000 ha, and holds many of the aquatic and terrestrial habitats present in the most significant Amazonian ecosystems, such as the *várzea* and the *igapó* flooded forests (forests flooded by backwaters), with 16% and 9% of the total protected area, respectively, and the *terra firme* forests (nonflooded forests), with 69% of the surface. Other environments, like *campinas* (shrub woodlands and grasslands) or *cocais* (palm tree groves), may represent around 5% of the area. Anthropogenic environments, like villages, gardens, and others, are smaller than 1% of the total area of the Amanã Reserve. The single most relevant morphological trait of the Amanã Reserve is the Amanã Lake, the fourth largest ria lake of the Amazon, 42 km long and 3 km wide. Amanã Lake, together with Urini Lake, another ria lake, form a characteristic watershed, receiving small tributaries (*igarapés*) from the Japurá River basin and the Negro River basin, and making a very large and complex set of aquatic habitats in the Amanã Reserve (Queiroz and Fernandes 2001).

Amanã links together two other extremely important protected areas: the Mamirauá Reserve westwards, and the Jau Park eastwards. In doing so, the Amanã Reserve enables the gene flow through large extents of the Central Brazilian Amazon. These three protected areas together make one of the largest blocks of contiguous protected tropical rain forests on the planet today, with about six million ha. Because of that, they are the core of the Brazilian Central Amazon Ecological Corridor, made of protected areas, Indian territories, and other territories, forming a total of almost 24,000,000 ha (Ayres et al. 2005).

The contemporary human settlements at the Mamirauá Reserve date from the first half of the twentieth century. Prior to this occupation, the entire region was inhabited by various Amerindian groups, among which the Omágua supergroup predominated. The Amerindian population was largely decimated by the wars and diseases introduced by Europeans in the colonization process, and the remaining indigenous peoples were incorporated into the colonial society by

means of miscegenation, instigated by the Portuguese crown at the time. At present, even the few remaining indigenous communities living in the region (two of which are located inside the Mamirauá Reserve and three others in the surroundings of the Mamirauá and Amanã Reserves) have a high degree of miscegenation, both cultural as well as biological (Queiroz 2005a). The dominant ethnic group in the area, however, is the *Caboclo,* resulting from the miscegenation that took place from the sixteenth century on, but mainly in the seventeenth and eighteenth centuries. The American Indian ethnic groups present in the reserve today represent less than 10% of the population (Queiroz 2005a).

The current human population at the Mamirauá Reserve is comprised of about 26,500 people living inside the area or immediately outside the borders. These people are grouped in approximately 125 small villages, ranging from 35 to almost 600 inhabitants each.

Only a small part of the population of the Mamirauá and Amanã Reserves is located in or associated with the *terra firme* forest. In this type of environment a specific set of subsistence activities are performed, usually linked with agriculture and exploitation of non-timber forest products (NTFPs). However, most of the populations of the Mamirauá and Amana Reserves are linked with the flooded environments (mainly the *várzea* environment). Consequently, subsistence is contrastingly different from that in the nonflooded areas, and is based on a multitask seasonal calendar, where activities linked with fisheries, hunting and gathering of aquatic game species, timber extraction, and agriculture are mixed in accordance with the seasonal hydrologic pulse of inundation. As a matter of fact, people living in the flooded forests are involved in a large number of traditional management systems, and have a diverse knowledge of traditional techniques (some of them very well adapted) for the sustainable use of natural resources (Queiroz and Peralta 2006).

Despite the abundance of natural resources and the expertise in the technologies of exploitation, income is very low, on average, for the households at Mamirauá. Due to the unfair and unbalanced insertion of these populations into the regional and national markets, extractive products never contribute reasonable financial resources to the local traditional producers; but a better share of the value is retained by the economic links of the market in the local towns, and by middlemen who intermediate the trade between the chains of custody and the producer. This population is faced with difficult relationships with the formal market. They have very limited buying power and identify education and health among the most needed public services to which they have limited or no access. Invariably all villages in the area have very limited resources and personnel with which to provide education for their children and healthcare for all their members.

Based upon this background, an elevated rate of displacement of the local work force has been recorded from these small villages to regional town centers or even to large regional cities in the Brazilian Amazon. This has been very widespread throughout the Brazilian Amazon, and in this area in particular, since the Reserves were first created almost 20 years ago.

## 2 Some Historical Remarks on Mamirauá as a Protected Area

The Mamirauá Reserve was created in 1984 as an Ecological Station of the federal government, aiming for the protection of the white uakaris, one of the most threatened primate species in the Amazon. This act was the result of a proposal made by José Márcio Ayres, a WCS biologist, to the Brazilian environmental authorities of the time. However, this protected area had a very short life, and before it was lost in the middle of big administrative changes in the government at the end of the 1980s, it was turned into an Amazonas State Ecological Station in 1990 (Ayres et al. 1996). Ecological Stations are protected areas that are devoted solely to protection, environmental education, and scientific research, and this category was not in accordance with the traditional occupation of the area and the economic activities of the inhabitants (Queiroz 1994). With the intention of making the management of protected areas more realistic, it was proposed to transform this into a new category created by the Amazonas State government, the Sustainable Development Reserve. In this new category, of which the Mamirauá Reserve was the first attempt, the presence of traditional human populations is allowed in accordance with a zoning system that establishes zones of sustainable use and zones of total protection. In addition, this category allows only the sustainable removal of natural resources from the local biodiversity, and puts all human activity under the administration of a management plan, approved by locals and by the state environmental authorities (Queiroz 2005b; Queiroz and Peralta 2006).

When this category was first created in 1996, it was received as one of the new solutions to the problem of traditional human populations inside protected areas in a moment when other important solutions were being proposed in Brazil. In this new category, however, a larger emphasis was put on the scientific bases for the establishment of management plans and of plans for the sustainable use of natural resources. But the emphasis on the involvement and participation of locals in the process of conservation and protection was also very strong, even crucial to the establishment of the characteristics of the decision-making process inside the protected area. As the experiences of the Mamirauá Reserve proved to be successful, the Amanã Reserve was created as a Sustainable Development Reserve by request of the local inhabitants, and by a formal proposal to the Amazonas State government, submitted in 1997. The decree for the creation of Amanã Reserve was signed in 1998 (Queiroz 2005b; Queiroz and Peralta 2006).

The impact of this new category of protected area in Brazil was considerable, and Márcio Ayres, his group, and their proposals had a very positive impact on the National System of Protected Areas. This system, approved by the Brazilian Congress in 2000, brought to the federal level the category of Sustainable Development Reserve. Nowadays this category is well distributed in the Amazon, and also in other biomes, as in the Atlantic Forest, on the coast (Fig. 2).

The SDRs created more recently at all levels of governmental administration (federal, state, and municipal governments) suggest that this model of protected area of sustainable use is now considered a valid and effective category of

**Fig. 2** Current (December 2006) distribution of Sustainable Development Reserves (*SDR*) in Brazil. The large *grey dot* shows Mamirauá Sustainable Development Reserve and the small *black dots* show other *SDRs* in and outside Amazonia

protected area in Brazil. This is a category where the presence of human settlements and the maintenance of traditional activities under the regulation of management plans are allowed, and conservation via the sustainable use of biodiversity is promoted. Other proposals for protected areas of sustainable use, nevertheless, like the extractive reserves (RESEXs), are more widespread in the region than the SDRs. Perhaps extractive reserves and similar models proved to be more adapted to the present times in the Amazon, and/or to the purposes and current needs of the environmental authorities.

## 3 Natural Resource Use, Traditional and New Managements

The national impact of the management developed at Mamirauá was due to the fact that the reserve not only provided adequate (or improved) levels of protection to local biodiversity, but also made this happen by means of a strong alliance with the local human population, for their great benefit. This alliance was based on the empowerment of locals (by their involvement and participation in all levels of the decision-making process), and was based on the assumption that adequate management of sustainable use of biodiversity could promote a better quality of human life in natural environments (Queiroz 2005b; Queiroz and Peralta 2006).

Currently, the human settlements or villages (locally known as *comunidades*), at the Reserve are organized into political sectors of neighboring communities. This organization was strongly supported by the Catholic Church in the middle 1970s

and early 1980s in many parts of the Amazon, and provided a strong base for the current system of representation. Those villages and sectors have representatives that organize and participate in bimonthly meetings for each sector, as well as annual assemblies.

The representatives gather in sector meetings to discuss and decide about the most important management actions for that particular sector, and provide a very effective means of local community participation. The annual assemblies are organized by the leadership and representatives, and until 2005 they constituted the most comprehensive forum for discussion and decision making concerning the whole reserve. After that year, in accordance with the new Brazilian environmental legislation concerning protected areas, a management council with around 20 seats was established to make decisions regarding the Reserve. While in the previous decision making system of assemblies decisions were reached by vote of the representatives of the villages, in the current system the decisions are reached by the vote of those representatives and representatives of other social groups (such as the government, universities and research institutions, etc.). The implications of this new system of participation in the decision-making process are yet to be determined.

Regardless of the system, decisions are always made on many different aspects. The definition and regulation of the zoning system or of the rules for the management of a particular natural resource have to be discussed, voted on, and decided by the management council, as they were by the annual assemblies before 2005.

Involvement and participation are also important on other levels. There is always the need for accordance or approval by the local representatives for any activity carried out in the area of a particular village or group of villages. Scientific research, visitation, guarding, and management in itself have to be approved by the locals or their representatives, who also are directly involved in those activities. This system of involvement and participation, together with a continuing service of environmental education, and the circulation of relevant information, guarantees to the representatives, through time, a high quality of discussion and deliberation, and a good level of commitment of the local population to the conservation of the protected areas (Queiroz 2005b; Queiroz and Peralta 2006).

Governance of the Reserves in such a participatory system is based on an effective alliance with the locals. This alliance assumes that the involvement of local villagers in all activities can be assured if those villagers have a clear understanding of the benefits derived from the protection of the areas, the conservation of local biodiversity, and the sustainable use of local natural resources. This is probably the factor that raises the most constituencies among local villages in both Reserves, gathering local political support, and ensuring that a large part of the local population will contribute to the enforcement of the rules and regulations previously agreed.

Nowadays a large number of species are part of a portfolio of managed natural resources. Although Mamirauá is famous for the management of pirarucus, the large and famous Amazonian fish with a bony tongue and aerial respiration, more than ten species of fish are also managed in a sustainable way. All of them are fish species used as food by locals, but they also reach very high market values in the

Amazon and other parts of the country. Equally, locally-managed timber comes from more than 30 species, valued both locally and regionally.

Recently, reptiles (caimans and river turtles) are part of a pilot program for wildlife management, but other new management systems have been built. Two of them will be mentioned here, because they rely on very important natural resources. The first one is the management system for ornamental fish species. These species are highly valued internationally, but removal is not sustainable in many parts of the Amazon. It is expected that the first experimental removal will take place in the second half of 2007. The second management system under implementation is that of game species. This is something difficult to put forward, since Brazilian legislation still forbids the management of wildlife. But there is a good possibility for big changes in the legal framework, and some experiments will be put in place in the near future.

The management systems implemented so far in Mamirauá do not differ in relation to the ethnic background of the villages. *Caboclos* and Amerindians may both take part in all management systems, as long as they agree with the basic regulations proposed (Queiroz 2005a). Nevertheless, Amerindians have sought a more independent path in the last 2 or 3 years, as part of a process of empowerment of their ethnic identity. As a result of that, the involvement and participation of members of Native American villages at Mamirauá are now reduced, and it is not certain that these groups will continue to support participatory management systems. But it was the decision of those villages, and not a limitation imposed by the Reserve management regulations.

When the management programs were first planned as a conservation strategy in 1995–1996, it was believed that local production inside the reserve would be greatly reduced if the management plan were to be implemented and enforced. Local producers would have to reduce the off-take to bring it down to sustainable levels. The economic impact would be high. But if sustainable use were implemented, access to new markets and new prices would be possible, attenuating the negative impact on the bulk of natural resources removed (Queiroz 2005b, Queiroz and Peralta 2006).

As proved to be the case, the market for adequately managed natural products in protected areas is increasing fast in Brazil. It is already a large market, and a lot of evidence suggests that it will expand even more in the following years. Consequently, demand for the managed products will tend to increase soon. This can produce a negative effect on protected areas, if production is not under strict control. One of the alternatives to avoid this risk is to multiply management systems, replicating the management regulations on the same basis used originally. It does not even have to take place inside protected areas, since most of the natural resources managed can also be found outside their boundaries.

As mentioned earlier, most of the conservation targets were under intense pressure for unsustainable use at Mamirauá. For some natural resources, this threat was documented by carefully monitoring the levels and intensity of traditional use of natural resources in the Reserves. In doing so, the need for intervention and for implementing more sustainable practices was made clear to all social actors

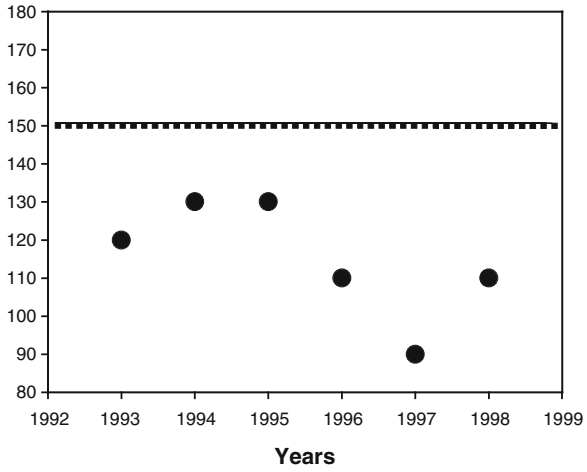


**Fig. 3** Average size (total length in cm) of pirarucus caught from 1993 to 1998 at Jarauá Sector, Mamirauá Reserve, represented by the open *circles*. The *dotted line* represents the minimum size of catch established in the current legislation

involved. The killing of game animals, the catch of the most important fish species, and all timber extraction in the area are examples of time series of data built with the participation or collaboration of local residents. Fig. 3 presents an example of the monitoring of the pirarucu fishery from 1993 to 1998, before sustainable use was established with the implementation of this particular management system.

From this time series of data it was possible to demonstrate that more than 70% of all pirarucus produced in the part of the Mamirauá Reserve under the monitoring network were below the minimum size of catch established at the time by the Brazilian Environmental Authority (IBAMA), namely, 150 cm total length. This evidence of bad traditional management was crucial to galvanize the attention of local social actors, especially the fishermen inside the Reserve, and led the way to the agreements about new regulations and modifications in the behavior of local fishermen. The need for change on a large scale was obvious, and the best way to promote this was from the inside out. Promoting best practices of sustainable use in pilot management systems was an idea that followed the publication of the Mamirauá Reserve Management Plan in 1995–1996. Consequently, in 1998, after a series of initial studies (Queiroz 1997; Queiroz and Sardinha 1999; Queiroz 2000), added to by further studies (Castello 2004; Viana et al. 2004), the most important pilots of management systems were put in place. In that year, the promotion of sustainable fisheries of pirarucus and the sustainable extraction of timber started.

It has been a success so far. The populations of managed resources have presented good demographic parameters, production has been increasing, and the producers have been able to reach better markets and get better prices for their products (Viana et al. 2007). After a few years it was clear to all local associations that those involved in management systems were better off. Something that

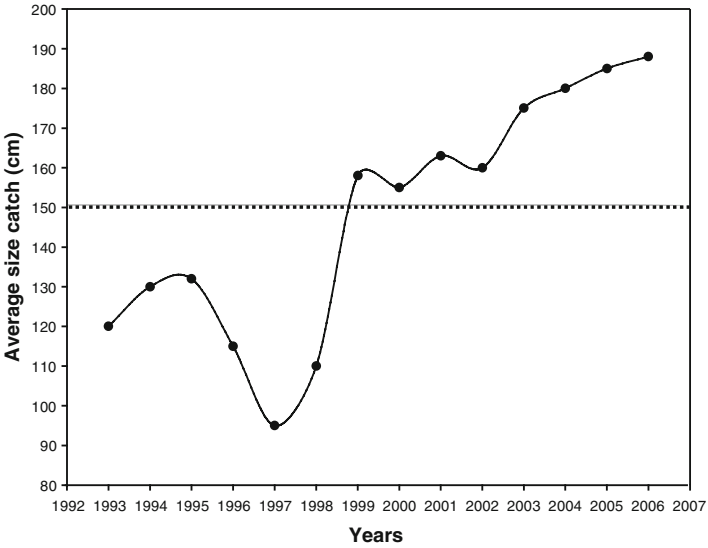


**Fig. 4** Average size (total length in cm) of pirarucus caught from 1993 to 2006 at Jarauá Sector, Mamirauá Reserve, represented by the open *circles*. The *dotted line* represents the minimum size of catch established in the current legislation. The years 1993, 1996, and 1998 represent important moments in management history. In 1993, the campaigns for public awareness and environmental education began. In 1996, the implementation of the management plan began, with which was agreed, voted, and approved a set of regulations for the sustainable use of pirarucus. In 1998, the productive management system of pirarucus fisheries at the Reserve began

deserves to be emphasized for all management systems put in place at Mamirauá-Amanã is that the pattern of natural resources use did not change immediately after the implementation of public awareness and environmental education (1992–1993), nor after discussions with local leadership on the agreement for new regulations for protected area use, and publication of the management plan. Change did occur immediately after the beginning of the productive management, when the financial results of the new trade were obtained (Fig. 4).

Something similar happened to the management system for timber extraction (Pires et al. 2001). Besides the fact that a program of awareness and environmental education, including loggers, has taken place since 1993, and that the local producers agreed upon the need to stop unsustainable off-take of trees of many species (including threatened or rare species), and voted in agreement with the new regulations of the management plan in 1996, it was only when the productive management of logging started, in 1998, that the illegal timber extraction was really reduced inside the protected area (Fig. 5).

In the case of the management of timber resources, the effectiveness of the protection was obtained after two major groups of measures. At first, awareness and education proved to be very effective, but a reasonably high number of illegal loggers were still operating inside the area. Second, when productive management was put in place, almost all the illegal logging was abolished inside the protected

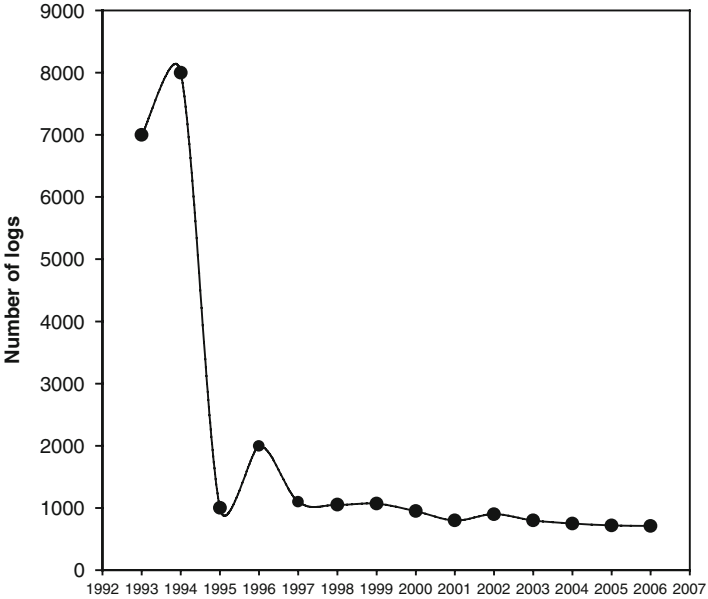


**Fig. 5** Number of logs illegally removed from Mamirauá from 1993 to 2006. In 1993, the campaigns for public awareness and environmental education with regard to illegal timber extraction began. In 1996, the implementation of the management plan began, including the agreed, voted, and approved rules to regulate logging inside the protected area. In 1998, the productive management system of timber extraction at the Reserve began (Modified from PIRES 2004)

areas. It is expected that the same effect will be accomplished in relation to NTFPs, ornamental fish, and game animals, when the respective management systems are put in place in the near future.

## 4 Local Livelihoods and Quality of Life

Access to the natural resources of Mamirauá and permission to use them have been granted only to the local associations, and a few external agents from local towns. As these management systems proved to be successful and a widespread demand to join the systems increased, this limitation creates a pressure difficult to restrain. Most locals living outside the protected area want to move inside to take part in the sustainable use of the resources. Migration pressure to the Reserves to become members of the local associations is strong.

So after less than two decades, the protected area, once seen locally as a problem and as something negative that would make livelihoods difficult for locals, has become a center of attraction and a target. No longer just a target for invasions and illegal exploitation of the local resources, it is perceived now as a place to have a better life.

There are many different ways to represent the improvements of the quality of life in these areas of natural resources management. The idea itself of "quality of life" is enormously difficult to quantify, and many indices and indicators have been created to describe it. Here we choose to represent the idea using only a few socio-economic indicators, for the purpose of explaining why Mamirauá-Amanã became a very attractive center.

Income generation has increased a lot inside the reserve. In general terms, households inside the protected area improved their income almost 110% in only a decade (1994–2004). For those households directly involved in the managed fisheries of pirarucus, the improvement reached much more than that (Fig. 6). The implications of that for the improvement of health conditions and education levels are obvious.

Pirarucus are managed in Mamirauá only for a little longer than two months every year (October–December). Today more than 400 fishermen participate, from almost the same number of households. Despite the fact that "quality of life" can be measured by many other points of view, this improvement in income has impacted other aspects of social life, like heath and education, in the villages.

Consequently, replication of these management systems is a very important demand all over the region. Nowadays, most of the local associations outside the protected areas ask for replication and expansion of the system, and most communities in the vicinity of the Reserves are also interested in implementing such systems on a similar basis.

This is a large improvement in the relationships with the people of the reserves and the people living around them. These relationships went from suspicion, in the first year after the creation, to involvement, agreement, and attraction in recent years. This improvement in public relations is something yet to be achieved in the Brazilian Amazon by the National Environmental Authority, IBAMA. Despite the fact that management of timber extraction and pirarucu fisheries is legal, most of the other uses of natural resources are not yet regulated, and sometimes ruled out by the current legislation. Wildlife management is among those. Despite that, all these uses continue to be carried out in disregard of the current regulations and the efforts of IBAMA, something that makes this difficult relationship worse.

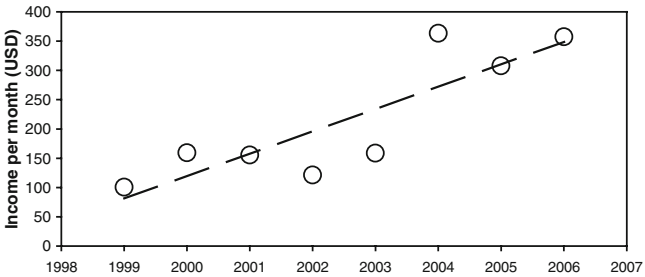


**Fig. 6** Income (in American dollars, per capita per month during the fishing season) of fishermen involved in the management systems of pirarucu fisheries at Mamirauá and Amanã, from 1999 to 2006 (Data modified from Viana et al. 2007)

For some time the replications of these management systems were carried out by the Mamirauá Institute, building capacity among the villages inside the reserves and their producers associations, investing in basic infrastructure, and promoting a link between local producers and other market components to cut better deals, aiming for a "fair trade" situation. But there are limits to the capacity of the Mamirauá Institute's ability to fund all needed replication and to provide appropriate advice to so many associations in the entire region.

The pilots tested in the Reserve that proved to be replicable were extended to a larger number of beneficiaries, but other forms of replication are now under development. Local leadership and other institutions could be involved in the efforts to bring benefits to a larger array of villages, and to promote better conservation levels of the natural resources in larger areas. Building the capacity of other institutions, and training personnel to fulfil the needed roles, are two of the new activities of the Mamirauá Institute now. This is one of the reasons why the Institute is establishing formal training courses from 2007 on, to build capacity in other Amazonian institutions (governmental and nongovernmental) for the promotion of managed fisheries of pirarucus and other species in different sites across the Amazon.

A lot of issues have to be considered in the planning for replication of management. It is vital that all the new systems implemented take into consideration the technical criteria developed so far. The clear identification of the stock to be exploited, the constant monitoring of this stock, the definition of the sustainable rate for removal, and a very effective participatory system (to ensure equal/fair distribution of benefits, and to grant means of governance for regulation enforcement and control) are crucial aspects that have to be considered if the system is to be successful. Recent experiences of replication of pirarucu management in nearby areas suggest that the risk of failure is great when stock assessment and involvement of locals are not implemented adequately.

In near parts of the floodplains of Central Amazonia, not far from the management system of pirarucus implemented by the Mamirauá Institute, the Fonte Boa Institute for Sustainable Development (FBSD) established another management system to promote pirarucu fisheries. It was supposedly a replication of the original system, based on the same principles and with the same objectives. However, the efforts directed towards stronger organization of the local associations, a careful annual survey for stock assessment, and a comprehensive monitoring system failed to be put together. Despite these weaknesses, FBSD has received permits to remove large amounts of animals for the last 3 years. As a consequence, the local organizations involved are not able to extract the allowed amount, the trade is not based on the principles of benefit sharing, and there is no guarantee that the stock managed is not under risk of collapse.

Another important aspect to be considered in regard to the replication of management systems in general is that one of the consequences can be an increase in the availability of managed products to be offered to the markets. This can have a negative effect on the values and prices paid to producers. Despite the fact that the demand is very large in the region and in other parts of the country, if the distribution or transportation of the product is in the hands of a few, they will be able to control the strategic parts of the market, and therefore control the prices of products.

Bad experiences with the marketing and regional trade of managed pirarucus in 2003–2004 (Viana et al. 2007) were important in demonstrating that market issues are very relevant to the survival of participatory management systems of natural resources. These issues have to be under the careful attention of experts. In one instance, the local associations decided to sell the whole production to one single buyer, and based their decision only on his higher offer. After many months waiting for payment, the producers received only around 65% of the value owned. Despite the losses, this episode had a positive consequence as well, since it led the associations to evolve towards a more mature attitude in their negotiations with potential buyers, and to implement more business-like tools, such as adequate contracts.

Other market problems were also identified in recent years. Potential buyers are acting together to offer prices that are lower than the prices obtained by local producers in the past. Perhaps a better solution to all these market problems is to expand participation in the management systems. Other social actors, including the government, and other links in the chain of production and trade of natural resources (from producer to consumer) have to be brought in and involved in the management systems as soon as possible. This expansion could create other opportunities for business, introduce new buyers, achieve better prices, and so on. Regardless of the possible solutions adopted, in the future these issues have to be dealt with by experts. People with experience and knowledge of the markets can offer important contributions to the conservation of these components of biodiversity.

Other experiences in different management systems also proved to be very insightful, and provided information for deep analysis of replication. The Amazonas State government is currently implementing a management system for caimans with the support of the Mamirauá Institute and other Amazonian institutions. The planning and implementation of this experimental management project is in the hands of the members of the government agencies. As a primary objective, it was proposed to use these animals in sustainable levels to provide meat to the Amazonian market, and in a second phase, also to provide skins for the national and international trade. After almost three years of joint efforts, the lack of commitment to the technical criteria for wildlife management was once again observed. There was seen to be an inadequacy of methodologies applied in the surveys of caiman stock assessment, something that was widely discussed but was never improved after more than one year of discussions. Inconsistencies in the demographics of the population, and the lack of other important biological information that had to be extracted by the staff in charge, were among the problems identified. There was no information about the organization of the illegal chain of production, and there was no evidence that additional effort to understand this trade and industry in depth were ever carried out. More recently, commercialization problems were identified, since there were difficulties with the permits to trade the meat produced, and the villages were not adequately paid for their products. This weak relationship with the local villages may make it impossible to improve the project and take it to a higher, more organized level.

In general, the lack of regulation, or the lack of commitment to the available regulation, and the absence of strong links to the local communities are the more

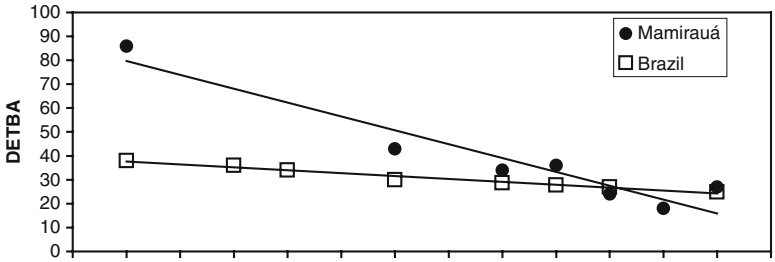


**Fig. 7** Infant mortality (measured as the number of deaths for each thousand born alive, *DETBA*) at Mamirauá and in the country

relevant sources of risk to these management systems based on the participation of locals, and sometimes bad management in particular sites may threaten whole successful management systems implemented in vast areas.

Despite these threats, management systems in Mamirauá can be considered successful for this first decade. Perhaps one of the more important impacts of improvement in the income of local producers in the Reserve, as a consequence of the productive management of natural resources, is that infant mortality was reduced by more than a factor of four during the last 15 years (Fig. 7).

However, this reduction also implies another aspect that might pose a problem. Due to this decrease in infant mortality, and also to the transformation of the protected area into an attraction center, the population growth rate recorded in the last decade is considerably higher than the rate recorded before the implementation of management systems and sustainable use of natural resources. In 1994 the Mamirauá population living in the focal area of the reserve was growing at a rate of 2% a year; but in 2005 it grew at an annual rate of 3.2% (Fig. 8). In only 11 years, the population increased by 37%.

Based on these numbers, various scenarios can be built, and they are presented in Fig. 8. If it were possible to keep the population growth rate constant from now on, and population size were to increase at an annual rate of 3.2% as it is doing currently, the population would double in 24 years (1994–2018).

If we were able to reduce growth rate to the levels observed in 1994, and after ten years population growth were back to a 2% annual rate, population size would increase less rapidly, and this size would double after 28 years (1994–2022). But if population growth continues to increase at the same rate as it has so far, it will make population size increase very fast, and it will double in only 20 years (1994–2014).

In all cases, population growth is a reality now. It means, among many other things, that shortly the number of humans using components of the local biodiversity will increase a lot. If the carrying capacity of the Reserve were increased when management systems were implemented, it is unknown if that carrying capacity would be able to sustain a doubled human population. Public services, mainly in health and education, which are not offered at adequate levels now, could represent a big challenge for this future scenario.

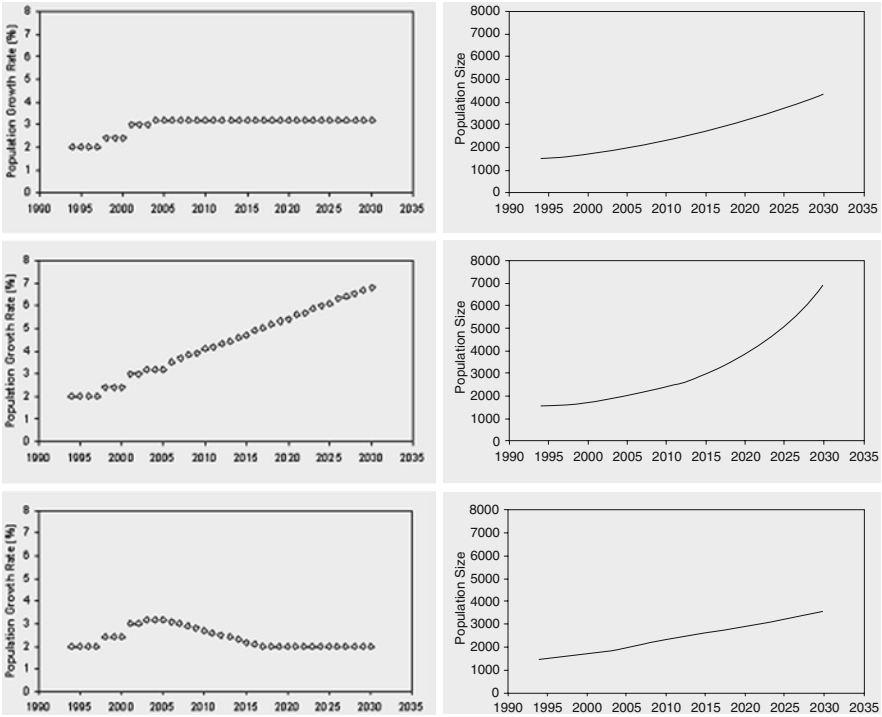


**Fig. 8** Population growth rate and population size for villages inside focal area of Mamirauá Reserve (1994–2006) and scenario simulation for different population geometric growth rates for the next 23 years (2007–2030). (**a**) Growth rate is kept stable at the present level. (**b**) Growth rate increases at the same rate as in the last 15 years. (**c**) Growth rate is reduced to the same levels as 15 years ago

This is a problem for which we are not yet able to provide potential proposals and/or solutions, but which will be one of the main issues to be discussed in Mamirauá-Amanã for the next several years.

Of course the legal framework to support sustainable use of natural resources inside protected areas, and participatory management of natural resources as a whole, needs more clarification and regulation. Perhaps most of the problems identified so far could benefit from clear regulation. This could be one of the potential solutions; but also crucial to the success of the system is the availability of strong and comprehensive data with regard to the biology of the natural resource to be exploited, as well as information on the social and economic aspects of management. Another important aspect for in-depth research is the carrying capacity of different types of natural environments (with and without deep disturbances).

But probably the most important aspect not yet investigated is the production and custodial chain of the products. This includes their availability, means of production, technology, costs, capacities, legality, and structure of demand and consumption, among other things. The lack of strong information about these

aspects will unveil many different opportunities to act on the chain, change it, improve it, and find new solutions for most of the problems described.

Perhaps one of the potential solutions would be to encourage other groups and institutions to act as promoters of management systems, also outside protected areas and in their vicinity. Conservation action directed to such areas would provide better levels of biodiversity conservation in general, and expand the benefits for a larger audience. In doing so, new areas of attraction would be available, including outside protected areas. This could also provide higher levels of governance, and government organs and agencies could share good positive support to manage larger portions of the region. Another potential solution would be to involve all links of the custodial and production chain equally under the coordination of neutral oversight, in search for better opportunities and fairness to all social actors in the industry.

Perhaps this could help to decrease these new pressures, and ensure a good perspective for the protected areas, such as Mamirauá, that now are under threat as a consequence of their success. Perhaps this is a good opportunity to remember that protected areas are only one of the strategies to provide good levels of biodiversity protection and conservation in tropical environments.

**Acknowledgements** This text is a compilation of information produced by a large number of people, members or collaborators of the Mamirauá Institute, who have been producing strong data in time series since 1994. I thank each and all of them for the very important information. Among them, I am very thankful to Míriam Marmontel, Andréa Pires, João Valsecchi do Amaral, Edila Moura, Ana Claudeíse do Nascimento, Ellen Amaral, and Ana Rita Alves. Members of the villages of the Mamirauá and Amanã Reserves are always responsible for a big part of the work, and I am also grateful to them. Most of the inspiration for the group of people working at the Mamirauá Institute, which is very briefly described in this paper, still comes from the teachings of Márcio Ayres, a true believer.

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# Participatory Conservation and Local Knowledge in the Amazon *Várzea*: The Pirarucu Management Scheme in Mamirauá

**Leandro Castello, João Paulo Viana, and Miguel Pinedo-Vasquez**

**Abstract** Participatory natural resource management has become the most used approach to the conservation of the Amazonian *várzea*. But poor understanding of the process of integration of local knowledge in such conservation schemes impedes further progress. We contribute to this subject by analyzing some of the challenges of one of the most significant schemes of participatory conservation based on local knowledge in the várzea. The scheme relies largely on the knowledge and skills of local fishers, and it has been shown to be very effective at promoting the recovery of previously overexploited populations of the fish pirarucu (*Arapaima spp*). Our analysis shows that the prevailing practice of simply including local communities in the management process is not sufficient to promote resource conservation. It also is necessary to (i) identify individuals of the communities that possess acute knowledge of natural resources, (ii) develop cost-effective approaches to assess local knowledge in a systematic fashion, and (iii) monitor the effectiveness of participatory schemes at promoting resource conservation. We suggest that conservation and development organizations need to develop further their current practices with the knowledge of local inhabitants, if that knowledge is to contribute further to the conservation of the *várzea*.

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**Keywords** Local knowledge • Participatory conservation • Resource management • Overexploitation • Sustainable development reserves • Livelihoods

## 1 Introduction

The Amazon *várzea* floodplain – like much of the tropics worldwide – has always challenged the workings of the conventional (top-down) approach to natural resource management (Castello et al. 2007; Padoch et al. 1999; Goulding et al. 1996). Its gigantic size, relative lack of scientific information, and minuscule government management structures all have contributed to the degradation of its productive and biodiverse natural resource base (Ruffino 2004; Crampton et al. 2004). The *várzea* already has been altered by overexploitation of key species such as manatee (*Trichechus inungis*) and tambaqui (*Colossoma macropomun*), and by deforestation associated with agriculture and cattle ranching (Veríssimo 1895; Goulding et al. 1996).

Natural resource management and conservation capacity in the *várzea* now is being supplemented through participatory approaches (Crampton et al. 2004). Social constructivist theories have shown that participatory conservation can be critical to enhancing and even developing environmental institutions (Ostrom 1990). Furthermore, experience has shown that through partnerships among NGOs and grassroots and government organizations these participatory approaches have created valuable opportunities in the Amazon. A famous example is the protection of rubber forests; another is the creation of new categories of conservation units such as sustainable development reserves. Successful results from participatory conservation initiatives are being adapted as local and regional conservation policies. For example, fishing agreements ("*acordos de pesca*") that previously were successfully implemented in communities now are being implemented as municipal and government policies controlling fisheries in several relatively large regions (McGrath et al. 1993; McGrath et al. 2008).

Indeed, there is no question that participation is key for environmental conservation. The shift towards increased participation of local populations in natural resource management processes is happening all over the world in a variety of systems (Berkes 2004). There are several benefits associated with it (Haggan et al. 2007; Stocking 2003; Pinkerton 1989; Costanza et al. 1998; Castello 2008c), such as:

- Improved distribution of the costs and benefits across all stakeholder groups, because local populations can develop, implement, and enforce management regulations more efficiently than centralized underdeveloped management organizations.
- Improved compliance with regulations, because the incentives of local populations to manage their own resources sustainably often are high, since they tend to have few economic alternatives.
- Improved knowledge, because local populations can provide valuable knowledge of the exploited resources.

However, participatory conservation is difficult. A growing body of knowledge indicates that "successful" participatory conservation requires (i) consideration of practices that are embedded locally, socioculturally, and historically (Aswani 2005; Baelde 2007); (ii) a focus on the resource users, not the resource (Berkes et al. 2001; Castilla and Defeo 2001; Orenzans et al. 2005); and (iii) actual empowerment of local resource users in decision-making (Nunan 2006), among other conditions (Pomeroy et al. 2001).

Participatory conservation is even more difficult when it is based on local knowledge, because there are obstacles to "the effective incorporation of traditional knowledge in the design and implementation of conservation and development projects" (Schmink et al. 1992). One obstacle is that knowledge tends to be heterogeneous among the population, as it depends largely on practice, history, and culture (Berkes et al. 2000; Hiraoka 1992; Davis and Wagner 2003). Another is that local knowledge is dynamic and hybrid, as it evolves constantly because of changing resource use practices and availability of new knowledge and technologies (Sears et al. 2007). Perhaps an even larger obstacle is that the inclusion of both local peoples and their knowledge in natural resource management strategies is relatively new, and is certainly still at an early stage. Consequently, most of today's scientists and managers, who were trained following the conventional (top-down) scientific-technocratic approach to natural resource management, lack familiarity with the use of local knowledge in participatory conservation approaches. This is problematic for natural resource management and conservation initiatives, no matter how good their intentions are.

How adequately is local knowledge being used in participatory conservation in the *várzea*? It is very important to answer this question, because local people in the *várzea* are thought to possess much more knowledge of the environment than many other Amerindian groups (Hiraoka 1992). Furthermore, there are plans to use their local knowledge in participatory conservation schemes in large geographical areas of the *várzea*, such as for example in the Lower Amazon (McGrath et al. 2008). Nevertheless, there are no systematic studies assessing the use of local knowledge in participatory conservation schemes in the *várzea*. Most studies and experiences have focused on selected "successful" communities, a problem that also occurs worldwide (Barret et al. 2001; Agrawal 2001).

## 2 Methods

We contribute to the above-reviewed body of knowledge by describing and discussing a case in which the local knowledge of fishers was integrated into a participatory conservation scheme that subsequently has been established in a large number of communities in the *várzea*. Our case study is the management scheme for the pirarucu (*Arapaima* spp.) in Mamirauá, because it recently has become one of the most significant developments in participatory conservation based on local knowledge in the *várzea*. The scheme is large in scale, has integrated the knowledge and skills of expert fishers, and has been included in state regulations as the only alternative

for legally fishing pirarucu. In describing and discussing this case, we focus on two main questions: "How did local knowledge help promote resource conservation?" and "What are the principal needs, if any, for improving the effectiveness of the scheme with respect to the use of local knowledge in resource conservation?". Thus, we purposely did not address many other important issues related to participatory conservation, such as economic incentives, inter-institutional trust, or group cohesion, even though we acknowledge their powerful roles. Previous analyses of the same case focused on historical and economic issues (Viana et al. 2004), and the evolution of its institutional design (Castello et al. 2009). We considered those issues only where they were relevant for answering our two research questions. Our overall goal was to derive generalizations from this case that can be useful for promoting the effective integration of local knowledge in participatory conservation schemes in the *várzea*. We described the case based on a review of the literature, new information and data, and our personal direct observations. The first and third authors worked at the Mamirauá Institute for Sustainable Development, and hence were involved directly and indirectly in the case since its early development in 1998.

## 3 The Pirarucu Fishery in Mamirauá

### *3.1 The Study Area, Its People, and the Pirarucu*

The study area is the Mamirauá Sustainable Development Reserve (from now on referred to as Mamirauá), which is located at the confluence of the rivers Solimões and Japurá in the Amazon Basin, State of Amazonas, Brazil (Sociedade Civil Mamirauá 1996). Mamirauá was created to protect biodiversity through participatory natural resource management: local inhabitants were granted exclusive rights of use over the natural resources in exchange for their commitment to use them in a sustainable fashion. Mamirauá is managed by the Mamirauá Sustainable Development Institute, which carries on multidisciplinary research and extension activities with local communities. The livelihoods of local communities involve agriculture and extraction of natural resource products: mainly fish, game, and timber, that usually are traded for consumer goods with commercial intermediaries (Moran 1984).

Fishing the pirarucu is very important for the local inhabitants in Mamirauá (Queiroz and Sardinha 1999). It may constitute up to 40% of the total fish catch, and it is a highly specialized activity, as only 10% of all fishers produce about half of the total catch of pirarucu (Queiroz and Sardinha 1999). The pirarucu breathe air obligatorily, coming out to breathe every 5–15 min (Castello 2004; Lüling 1964). Furthermore, they have small home ranges (Queiroz 2000; Castello 2008a), making them suitable for small-scale (community-based) management strategies. Much of the interest in fishing pirarucu comes from the fact that they can grow up to 3 m in length and 200 kg in weight (Queiroz and Sardinha 1999; Arantes 2009), are vulnerable to fishing when they breathe and reproduce (Castello 2008b), and yield large, tasty fillets that bring high prices in the market.

### *3.2 Attempts to Manage the Pirarucu*

The pirarucu in Brazil went from being the most important fishery of the Amazon (Veríssimo 1895) late in the nineteenth century to being overfished and even non-existent in some regions in recent years (Isaac et al. 1998; Queiroz and Sardinha 1999; Goulding 1980). Pirarucu landings and the average size of captured individuals declined dramatically in the last 50 years (see Castello and Stewart, In press), to the point that now the pirarucu are included in the Red List of threatened species (IUCN 2006). However, a major issue is the lack of data on pirarucu populations, which hampers understanding of their situation.

Government-run management of the pirarucu in Brazil has been ineffective. A minimum length of catch (1.5 m) and a closed season (December–May) were implemented by the regional environmental agency IBAMA. In 1996, IBAMA attempted to control the pirarucu fishery by banning it in the State of Amazonas. This was justified because "the pirarucu is a species under advanced state of over-exploitation" (Viana et al. 2004). The ban on pirarucu fishing, however, exempted cases of a scientific or experimental nature. But lack of human and financial resources has impeded proper enforcement of those regulations (Bayley and Petrere Jr. 1989). The attempt was undermined further by the technocratic structure of IBAMA, which prevented local fishers from participating in the management process (Isaac et al. 1993). Consequently, management of pirarucu, as well as of most fish species in the Amazon, historically has been a "cops and robbers game," with fishers harvesting illegally much of the time.

In Mamirauá, an initial attempt to manage pirarucu populations began in 1996 with the formalization of the reserve's management plan, which contained species-specific provisions for the pirarucu (Sociedade Civil Mamirauá 1996). However, that attempt also proved ineffective. Monitoring data showed that about one-third of the pirarucu catch early in the 1990s were longer than the legal length limit, and fishing was done irrespective of the closed season (Queiroz and Sardinha 1999). In 1998 monitoring data showed essentially the same patterns of lack of compliance with management regulations (Viana et al. 2004). Therefore, pirarucu fishing in Mamirauá remained illegal and widespread, largely because the pirarucu was too important for local fishers economically. The Mamirauá Institute ran a local system of rules enforcement, but it was not sufficient to curb the then existing levels of illegal fishing.

### *3.3 Participatory Research and Management of Pirarucu in Mamirauá*

The Mamirauá Institute began a new attempt at promoting sustainable fisheries in Mamirauá in 1998 by combining research and extension efforts. The attempt was made in four traditional fishing communities of the reserve, where pirarucu fishing

was important culturally and economically, and where fishers were eager to conserve their fisheries (Viana et al. 2004).

In 1998, research focused on developing a stock-assessment method based on counts of the pirarucu at the moment of their aerial breathing. Fieldwork and discussions with local fishers indicated that it should be possible to count the pirarucu, but only a few fishers agreed. Many scientific methods for counting wildlife (e.g., Buckland et al. 2001) do not apply to the pirarucu, which limited the possibilities of an accurate census. However, after six months of fieldwork, one fisher was identified who was amenable to the idea of counting the pirarucu. Finally, in 1999, counts of pirarucu done by fishers from Mamirauá in closed lakes were compared with the mark-recapture estimates of abundance for the same populations (Castello 2004). The counts were done in a way that allowed the fishers to use their skills while following a simple procedure. The procedure merely established the maximum size of the areas to be included in the counts (2 ha), two size classes for the pirarucu (Juveniles as 1–1.5 m in length, and Adults as >1.5 m), and a period of time (20 min) during which the counts were done. The counts turned out to be highly correlated with the mark-recapture estimates of abundance ($r = 0.98$), indicating that they were accurate. In 2000, the possibility of training fishers from different regions to count pirarucu was tested. After receiving a short training, the ability of other fishers to count pirarucu was assessed in a way similar to that of the fishers from the Mamirauá Reserve. Counts of pirarucu and mark-recapture estimates of abundance were again highly positively correlated, indicating that other fishers also could count the pirarucu, and that, to some extent, the method could be passed from one fisher to another. Fishers claimed that they count the pirarucu by differentiating among surfacing individuals based on subtle visual and acoustical cues, and by identifying "waves" of surfacing pirarucu in which all individuals surface more or less together. The fishers reported also that only those fishers who have dedicated several years to fishing pirarucu using artisanal methods, such as harpooning, have the skills necessary to count the pirarucu. One advantage of the counts of pirarucu made by the fishers is cost-effectiveness. We previously estimated that the counts of pirarucu were approximately 200 times faster and cheaper than the mark-recapture method used by Castello (2004).

At the same time that research on pirarucu was being done, many important extension activities focused mostly on increasing the fishers' profits and improving the organization of the fishers (Viana et al. 2004, 2007). Technicians of the Mamirauá Institute thus identified alternative potential buyers, and the informal organization of the fishers was formalized as an Association of Producers. The Associations of Producers allowed the fishers to deal with buyers in more distant places, and, among other things, required the fishers to commit to obeying regional fishing regulations and local decisions made by the Association. These developments were timely because in 1999 the Mamirauá Institute developed and implemented in those four communities an experimental resource conservation scheme. The essence of the scheme was that counts of pirarucu were done annually, used to determine fishing quotas, and then used to request harvesting permits from IBAMA. Thus, counts of pirarucu done in one year were used to determine fishing quotas for

the following year, first through negotiations between the fishers and technicians of the Mamirauá Institute, and then through negotiations between the former two and IBAMA (Viana et al. 2004). Those counts of pirarucu were done by fishers from the same four communities whose capacity to count the pirarucu accurately already had been shown with mark-recapture estimates of abundance (Castello 2004). In the first couple of years, the fishers accepted adhering to the fishing quotas that the technicians proposed, and that they had initially considered being too small, only because it was expected that identification of new potential buyers and markets would allow for selling prices higher than in previous years (Viana et al. 2004).

The management scheme has been run in the four communities in Mamirauá as described above for 10 years now, and it has produced positive results. Some of the main results are summarized as follows (see Fig. 1):

1. The number of fishers participating in the management scheme more than doubled. We suggest that this is indicative of increased participation of the fishers in the management process in terms of compliance with the regulations. Anecdotal evidence indicates that the number of offenses decreased as the ecological and economic benefits became evident (Viana et al. 2004; Castello et al. 2009).
2. The combined population of Juveniles and Adults of pirarucu increased severalfold (see Fig. 1). And the observed population growth trends shown in Fig. 1 likely are real. For one thing, previous studies have suggested that no other factor

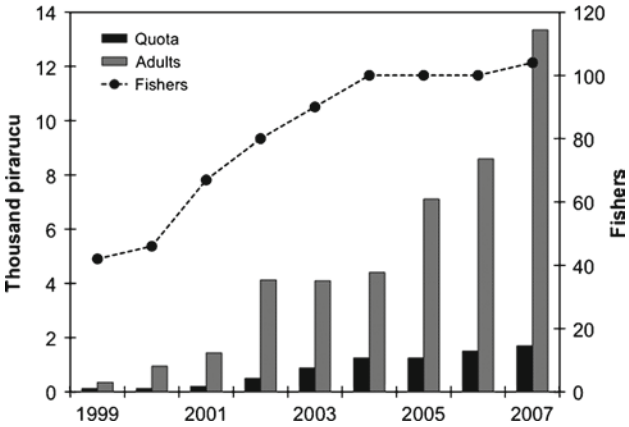


**Fig. 1** Trends in the abundance of the adult pirarucu population, fishing quotas, and number of fishers from four communities participating in the management scheme in Mamirauá. Data from 1999 to 2001 are from Viana et al. (2004). All other data were obtained from the Mamirauá Institute. Estimates of the Adult population of pirarucu stem from counts made by local fishers using the method proposed by Castello (2004). The counts were done during the dry season in all lakes and water bodies within the management area that contained pirarucu. The official fishing quota for most years was about 22% of the number of Adult pirarucu counted the previous year (Castello et al., in review). Data on fishing quotas are based on the officially authorized fishing quota, although in some years the actual harvested quotas were slightly less

(e.g., environment) affected the local pirarucu population (Castello et al., In review). For another, most fishers involved in counting pirarucu in those communities had the accuracy of their counts assessed by comparison to mark-recapture or total catches, and technicians from the Mamirauá Institute have accompanied the fishers during census work to avoid possible cheating. Lastly, a previous study found good congruence between counts of pirarucu in Jarauá and another independent index of population abundance, catch per unit effort (CPUE). Mean CPUE of pirarucu in Jarauá during the fishing season increased fourfold, from 4.41 kg/fisher/h for the years 1995–1997 to 17.25 kg/fisher/h in 2003; and counts of pirarucu increased fivefold, from about 2,200 pirarucu in 1999 to about 11,500 in 2003 (Castello et al. 2009).

3. Finally, the harvest quotas increased several fold, allowing for increased income for the fishers (Viana et al. 2007).

## *3.4 Large-Scale Implementation of the Management Scheme*

From the year 2000 on, an increasing number of communities in Mamirauá began managing the pirarucu using that scheme. Several fishers from Mamirauá spontaneously requested that the Mamirauá Institute implement the conservation scheme in their communities. The number of communities involved thus increased from four in 1999 to 16 in 2005 (see Fig. 2, Arantes et al. 2006). There also has been

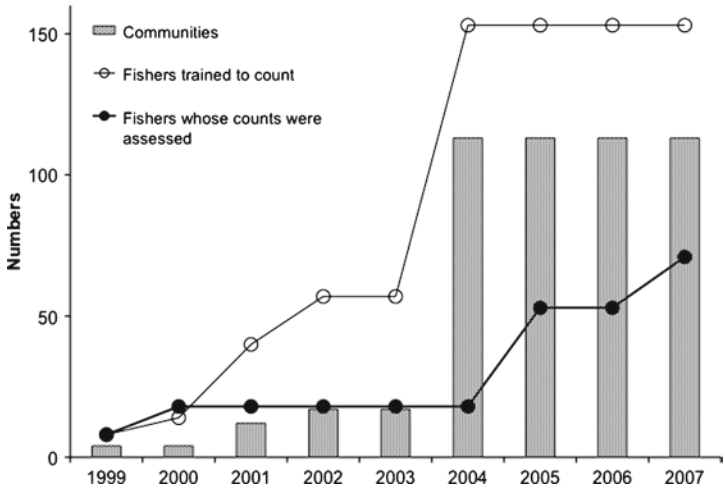


**Fig. 2** Trends in the implementation of the management scheme for the pirarucu, showing numbers of communities involved, of fishers trained to count pirarucu, and of fishers whose capacity to count the pirarucu were accurately assessed. The number of fishers from communities near Fonte Boa that were trained to count pirarucu was estimated based on the number of communities involved (see text)

implementation of the management scheme in the city of Maraã. There are data showing that the populations of pirarucu have followed trends similar to those presented in Fig. 1 in most similarly managed areas (see Arantes et al. 2006).

This increase in the number of communities involved was matched to a certain extent with the training of fishers in counting the pirarucu. In 2000, 12 fishers from three regions were trained, and the accuracy of their counts was assessed by comparing their counts to the mark-recapture estimates of abundance of pirarucu calculated for the same populations (Castello 2004), as presented earlier. In the years from 2000 to 2004, however, although various fishers were trained to count the pirarucu, they did not undergo assessment of their counting ability (Fig. 2) because of the great labor and costs involved in conducting the mark-recapture work.

In 2005, technicians from the Mamirauá Institute created a new approach to assessing the counts of pirarucu. The counts now were compared to the catches of all pirarucu, using large seine nets in the small and closed lakes of the region (Arantes et al. 2007). This approach proved to be effective at assessing the accuracy of the counts while demanding considerably less effort than mark-recapture work. In developing this approach, Arantes et al. assessed the counts of 34 fishers from Mamirauá, and found that the counts of most of them varied less than 20% around the number of pirarucu caught in the lakes, and that there was considerable variation in accuracy among the fishers (Fig. 2). They found also that the individual tendencies of the counts tended to neutralize each other when considered in groups, producing unbiased population censuses (varying only ±5% of the value of the total catches). This was encouraging, because fishers work in groups when they conduct population censuses, and because it ensured that the fishers had the skills necessary for the functioning of the conservation scheme. Following this work, additional fieldwork in 2007 led to the assessment of the counts of 18 more fishers from local communities (Caroline C. Arantes, unpublished data), showing essentially the same results found in the earlier 2007 work. This resulted in an accuracy assessment of the combined counts of 71 fishers, all from Mamirauá.

In 2004, the conservation scheme for the pirarucu was implemented in 96 communities near the city of Fonte Boa, this time involving a government-run institute, Instituto de Desenvolvimento Sustentável de Fonte Boa (IDSFB). That initiative was supported by a new state regulation that specifically allowed the harvesting of pirarucu by fishers that do population counts. According to official reports, the population of pirarucu in the area of these 96 communities has been increasing, and local fishers have been receiving the monetary benefits from the harvest quotas (Garcez et al. 2005). Fishers from these communities near Fonte Boa have reportedly been trained to count the pirarucu using only the method proposed by Castello (2004). Unfortunately, however, data on the actual number of fishers from communities near Fonte Boa trained to count pirarucu are not available. We estimated that at least one fisher for every community involved was trained to count the pirarucu. In Mamirauá, the number of fishers trained to count pirarucu in each community is always greater than eight. Therefore, the following estimate is conservative. Given that 96 communities implemented the management scheme, the number of fishers trained to count pirarucu must be at least 96, and probably more.

An even larger issue is that those fishers from communities near Fonte Boa have not undergone assessments of the accuracy of their counts, as have the 71 fishers from Mamirauá (Fig. 2). Therefore, it is impossible to know if the fishers involved have the knowledge required to do accurate counts of pirarucu, and most importantly, if pirarucu populations in those 96 communities actually are being conserved (Garcez et al. 2005). Certainly, it is important that those local communities be involved in conservation schemes such as this, but as discussed below, further investigations need to make sure that the pirarucu actually are being conserved.

# 4 Discussion

## *4.1 The Contribution of Local Knowledge*

There certainly have been several factors that contributed much to produce the generally positive resource conservation results observed in Mamirauá. One such important factor has been the institutional support provided by the Mamirauá Institute to the fishers, which helped identify new markets, improve their organization, and emphasize the importance of complying with minimum length of catch and closed season regulations (Viana et al. 2004). Other social and economic factors were extremely important in the pirarucu management scheme described, as well as in other participatory conservation schemes worldwide (Berkes 2004; Castello et al. 2009; Western et al. 1994).

Nevertheless, the fishers' knowledge provided a necessary determinant of success in the pirarucu management scheme. Without counting the pirarucu, it would be nearly impossible to manage the pirarucu as fishers do in Mamirauá, because they would not be able to regulate exploitation levels (i.e., fishing quotas) based on stock size – that is, of course, given existing limitations in terms of human and financial resources in the region, which is typical of that of developing countries (Sagar 2000). It was only when fishers' counts of pirarucu were incorporated in the management scheme that sustainable exploitation of pirarucu occurred. This is something that neither IBAMA nor the Mamirauá Institute had been able to promote before. The fishers' knowledge provided a cost-effective method to assess pirarucu populations that contrasts markedly with the two most used methods to assess fish populations. The large geographical areas impede the use of such methods as mark-recapture, and the decentralized and illegal nature of the pirarucu trade (Bayley and Petrere Jr. 1989) make it impossible to collect data on pirarucu catches at major landing sites.

The ability of fishers to accurately count the number of fish – which live underwater – is atypical. Therefore, one should not be inclined to think that this kind of local knowledge is very common in other areas. However, we believe that it is a good example of the possibilities opened by consideration of local knowledge. The method of counting the pirarucu was developed by integrating the fishers' ability to differentiate among (seemingly identical) pirarucu individuals with a standardized

("scientific") procedure. In his paper "Ignore Fishers' Knowledge and Miss the Boat," Johannes et al. (2000) gave various examples of cases in which scientific knowledge reached misleading conclusions because of failure to pay attention to knowledge held by local fishers.

However, care is needed in considering fishers' knowledge and its utility in management. The case of the pirarucu fishery in Mamirauá shows that only a few fishers have the type of knowledge and skills necessary to effectively promote participatory conservation schemes. In Mamirauá, the proportion of fishers that can count the pirarucu accurately probably matches the proportion of fishers specialized in pirarucu, about 10% (Queiroz and Sardinha 1999). When attempts were made to identify fishers that could and would be willing to participate in research, only one fisher out of several was identified who was amenable to the idea of counting the pirarucu. Similarly, the assessment of the accuracy of the counts made by the fishers individually (Arantes et al. 2007) showed that fishers who were not specialized in pirarucu did not count accurately. The need to recognize "experts" in natural resource use was discussed by Davis and Wagner (2003), who proposed a method of identifying such experts based on interviews of community members. Huntington (2000) suggested an approach somewhat similar to that of Davis and Wagner (2003), and summarized methods of documenting local knowledge.

## *4.2 The Effectiveness of Pirarucu Conservation*

The pirarucu management scheme developed in Mamirauá shows that it *can be* very effective at promoting resource conservation. The most important evidence in this regard is that the population of pirarucu in the four experimental communities grew several fold (Fig. 1). As explained above, our previous work indicated that this observed population increase likely was the result of the management scheme described (Castello et al., In review; Castello et al. 2009). That increase in the pirarucu population has allowed for increasing fishing quotas, which, in turn, have been providing fishers with increasing monetary returns (Fig. 1, Viana et al. 2004).

However, it is uncertain whether the scheme for pirarucu management is effective in the many other communities where it was implemented. The principal problem is that there is no evidence that the fishers involved in the pirarucu management scheme in communities near Fonte Boa have the capacity to do accurate population censuses. This makes it impossible to know if the involved fishers can adequately use the management scheme, and if they are doing so successfully. As explained in our case study, assessments of the accuracy of the counts of pirarucu were done only among the fishers belonging to 16 communities and one city from Mamirauá, but not to those several other fishers from communities near Fonte Boa (Fig. 2).

Unfortunately, this uncertainty regarding the effectiveness of the management scheme for the pirarucu is similar to that regarding the effects of participatory conservation schemes worldwide. Lack of data validating the effects of participatory

conservation schemes has rightly led to conclusions that "the success of community-based schemes so far has generally not matched the fanfare" (Barret et al. 2001). That is a critical issue in the use of local knowledge in participatory conservation, and it is largely overlooked. There certainly is awareness about this type of issue among scholars (Davis and Wagner 2003), but not so much in conservation practice.

A key challenge in the management scheme for pirarucu is assessing the heterogeneity of local knowledge and ensuring the involvement only of individuals with a desired level of expertise. At present, the mechanisms needed to monitor these issues already have been developed but have not been implemented satisfactorily. The regulation that established that local fishers can fish the pirarucu legally only requires that the fishers do counts of pirarucu. But there are no legal mechanisms to ensure that the involved fishers possess the knowledge needed for accurate counts. In practice, this could be done with the cost-effective approach developed by Arantes et al. (2007), which uses total catches of the pirarucu in small lakes to assess the accuracy of the counts of the fishers. Thus, further progress in this front is possible, but it has not yet been reached because of lack of recognition of the importance of resource monitoring. Without sound resource monitoring, participatory conservations schemes miss one of the pillars of resource management (Walters 1986).

### *4.3 Improving the Use of Local Knowledge in Participatory Conservation*

The preceding sections have shown that much of the potential of the management scheme for the pirarucu is not being realized because of poor understanding and use of local knowledge in participatory conservation schemes. In this sense, to help promote the more effective use of local knowledge in participatory conservation schemes in the *várzea*, we offer three recommendations:

1. Systematic and cost-effective approaches to assessing local knowledge need to be developed further and applied routinely. To achieve that, however, care is needed in determining levels of local knowledge because of its dynamic and hybrid nature (e.g., Sears et al. 2007). Also, further understanding of natural resource use practices and their accompanying knowledge base is needed. One way to promote this could be through inclusion of local knowledge in scientific and administrative educational curricula.
2. Participatory conservation based on local knowledge must incorporate mechanisms that both assess the heterogeneity of local knowledge and ensure the inclusion of "knowledgeable" resource users. Simultaneously, training and other means of knowledge transfer must be considered.
3. More broadly, it is key to monitor the effectiveness of participatory resource conservation schemes. One of the strengths of local knowledge is that it tends to

be based on empirical observation and experience. Yet, we have shown that there is a need for more empiricism in determining if participatory conservation schemes that are based on local knowledge in the *várzea* actually are producing the resource-related goals they were developed for.

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# The Political Economy of Resentment: A Result of Public Policies That Become Government Policies?

**Ronaldo Lobão**

**Abstract** The mechanism responsible for the shift of public policies into government policies is a neocolonialist political cosmology which, through the manipulation of representations of time and space, has crystallized social identities which were constructed in a "top down" fashion. Life histories, which were sustained by naturalistic traditions and forms of knowledge – geared towards probabilities – became confronted with knowledge forms that were oriented towards the future, towards universalism, and towards predictability. Places that were lived in with affective ties with the material environment became indeterminate spaces, goods subject to the diffuse interests of a surrounding society that is planetary in scale. The result is, then, a shift from public socioenvironmental policies – understood as policies rooted in society at large – to government development policies – seen as policies supported, implemented, or endorsed by government.

**Keywords** Resentment • Socioenvironmental policies • Conservation units • Sustainable use environmental units • Neocolonialism

## 1 Preamble: Regarding the Hierarchical Character of Brazilian Society

The question of nature's place in the encounters and environmental policies developed, defended, practiced, or simply studied in a relational society such as our own was raised some time ago by Barbosa and Drummond (1994).

This relational perspective corresponds to a symbolic representation of society in which particular values regarding individuals and personhood are embedded. In Brazil, worldviews are constructed upon representations of such values as

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**Fig. 1** Gradient of instrumentality vs. "personalness"

honor, prestige, hierarchy, kinship, godsibship (*compadrio*), and personal relations (Barbosa and Drummond, 1994). While juridical, political, and economic institutions of an individualistic and liberal bent flourish in our country, their actual functioning tends to privilege relationships of a personal and/or hierarchical nature.

In Brazilian social grammar, space becomes the locus where this relational logic is made clear. For example, "street" and "home" are polar universes of signification. People are the focus of the "home," as are affective relationships and, within this locus, conflict administration processes activate a repertoire of values that are based upon private rules which, in turn, are rooted in the personal relationships between the various parts of the household. On the flip side of the dichotomy, the "street" is the place where universal rules and individuals reign, where conflict resolution is achieved through impersonal mechanisms and the corresponding order-producing structure is the State.

Where, in this model, can we place Nature, understood here as natural space, unmodified by the hand of man (or nonanthropomorphized space)? In graphic terms, let's say that our vertical axis corresponds to a continuum measuring instrumentality, while the horizontal axis is a continuum measuring "personalness." When we look at the "home" pole, we see a low degree of instrumentality and a high degree of personalness; while at the "street" pole, the values of these characteristics would be reversed. "Natural" space can be seen as enveloping both these poles and is represented by a maximum degree of instrumentality and a minimum degree of "personalness." The big issue currently facing us, given this structure, is that a significant portion of the Brazilian environmentalist movement is attempting to establish the "nature" pole as something that contains a minimal degree of instrumentality (Fig. 1).

## 2 Brazil's Extractive Reserves

I should make it clear that the object of the present study is no particular extractive reserve, but extractive reserves (RESEX) in general, understood here as a set of passions, actions, and norms which characterize a multisited public policy. I ascribe to the belief that distinctions exist between *public* and *government* policies (Allegretti, 2002), with the first group understood as policies rooted in society at

large, and the second and opposite group as policies supported, implemented, or endorsed by government.[1]

I am well aware of the fact that the RESEXs are also the result of a particular set of struggles to protect certain ways of life, lived within a given set of spaces. Amazonian rubber tappers, for example, organized themselves and fought against development models which didn't recognize local space, rejecting government politics which did not see them as active subjects. The results of this struggle led to the formation of policies based on the then-current understanding that true power was locally rooted.

Emotional relationships with the forest and its correlated phenomena, its *topophilia* (Tuan, 1977), were central to this resistance struggle. Other key elements were particular forms of traditional knowledge regarding natural resources – knowledge that had been constructed through years of sociocultural reproduction within and around a given environment.[2] A third, perhaps more polemical, element in this struggle were the identities said to be shared by the actors involved in the process. Whatever their personal trajectories were (indigenous peoples, the children of the WWII "rubber soldiers," or emigrants from the arid Northeast), all of these different types of actors portrayed themselves as "rubber tappers" (*seringueiros*). This, in fact, was their "collective consciousness" or "self-representation."

Though they involved new spaces and actors, the RESEXs maintained the conjugation of a given space and a certain form of naturalistic knowledge as the factor that was to determine the policy's implementation in a given region. For example, the fishermen of Arraial do Cabo (RJ) with their drag nets, the Soure (PA) salt marsh gatherers, and the canoe fishers of Corumbau (BA) were understood as being alike not only in their determination to fight for their "space," but also in the function of the "artisanal" manner in which they extracted resources from the local environment. This connection between human groups and the places in which they worked and/or were situated lost its central importance in the territorial aspects of government policy, which formed "protected areas" and "nature conservation units."

I believe that this shift occurred because certain tactical aspects of the Acre rubber tappers' fight were converted into strategic government objectives as time went by. The ideological structuring of space as a reflection of *Gaia* (undifferentiated space) rather than *Rhea* (lived-in space) led to local groups indentifying themselves through a legalized or "registered" identity and no longer through their connections to a particular space.

Traditional knowledge thus became disconnected from sustainable practices and, given that sustainable development looks to the future, conservation science became the instrument through which predictability was to be anchored. Traditional knowledge,

[1] Aside from this distinction, I would suggest a further classification based upon the delegation of power and the meaning in which it is delegated. In this fashion, we can thus conceive of public policies in which the State delegates power to civil society as well as the other way around. The same concept can be applied to government policies. In terms of ideal types, we can think of public policies as those in which power is centered within society, whereas government policies are those in which power is centered within the State.

[2] One must remember, in this context, Godelier's teaching that tradition is not simply repetition.

by contrast, is linked to the past, and its mechanisms are based upon prognostics that each person uses to calculate their decisions.

The "alliance of the forest peoples" thus gave way to a pact between a series of actors who were firmly rooted in the present, an indistinct "generational pact" which understood the defense of renewable natural resources and the environment through the lens of a perspective that took the well-being of future generations as its organizational matrix. The collective rights of groups were transformed into a set of diffused rights that, in conjunction with a series of powerful key concepts such as "environment" and "sustainable development" (among others), ended up transferring political action to the hands of the government and its representatives

I believe that this shift has provoked, and is still provoking, a series of inconsiderate acts and moral insults (Cardoso de Oliveira, 2005), which have ended up awakening a feeling of deep resentment (Lobão, 2006). These sentiments can be easily perceived in testimonies regarding the results of government policies in the many spaces where they were put into action: "*there's no oversight,*" "*IBAMA [the government environmental agency] does nothing,*" "*RESEX is like an unwanted child: the government birthed it but doesn't want to raise it.*" This does not mean, however, that Brazil's traditional populations have turned against RESEX. The dominant feeling seems to be that "if it's bad with RESEX, imagine things without it." But how did this shift take place? How has the "politics of resentment" become so quickly rooted in this field?

In my opinion, the mechanism responsible for this shift is a neocolonialist political cosmology that, through the manipulation of representations of time and space, has crystallized social identities which were themselves constructed in a "top down" fashion (Lobão, 2006). Within this cosmology, time and space are manipulated in a "top down, outside to inside" manner through such concepts as conservation units, protected areas, biodiversity, sustainable development, empowerment, participatory management, and associativism, among others.

In this situation, life histories, which were sustained by naturalistic traditions and forms of knowledge and geared towards probabilities, became confronted with knowledge forms that were oriented towards the future, towards universalism, and towards predictability. Places that were lived in with affective ties with the material environment, the *topophilia* (Tuan, 1977), were transformed into *protected areas*, *environment*, and *conservation units.* They became indeterminate spaces, goods subject to the diffuse interests of a surrounding society that is planetary in scale. In short, they passed directly from the local sphere to that of the global.

In order to continue living in these new spaces, their residents were forced to incorporate identities which situated them as distinct from the surrounding national or regional populations, for only certain ethnic groups (Indians or *quilombolas*) and "traditional peoples"[3] are allowed to inhabit protected areas (whether these are Indian lands, Quilombo territories, Units of Conservation, etc.). Aside from adopting a new identity, local groups seeking to continue their residence in protected areas needed to incorporate new discourses, new forms of social organization, and new productive practices; and these, furthermore, are necessarily geared towards the future and controlled by the dictates of conservational science.

[3]I discuss this concept further, below.

The evidence which supports my hypothesis comes from my accompaniment and reconstruction of the Extractive Reserves (RESEX) up until the moment in which these were put under the control of the Directory of Socioenvironmental Development (DISAM) of IBAMA in 2005. Below, I offer up a brief synthesis of the material that I have presented in depth elsewhere (Lobão, 2006).

## 3 The Development of Extractive Reserves

The present reconstruction is based upon the reports of individuals who have followed the Extractive Reserve concept from its formulation as a policy up until its implementation in Arraial do Cabo in 1995. From 1996 on, I was able to conduct direct ethnographic observations of the agents active in this field. Our initial focus here is the Xapuri Valley in Acre and, in the reconstruction which we offer below, Chico Mendes serves as a central focus, which has permitted us a wider scope in our understanding of the mosaic of influences which have worked upon the RESEX policy and their subsequent effects.

In the graphic representations presented below, I have sought to consider the communicational spheres – or the social spheres – which were formed in every encounter in this field, and which exerted differing influences at the micro, medium, and macro levels (Apel apud R. Cardoso de Oliveira, 1996).[4] The two-dimensional presentation below (Fig. 2) uses the vertical axis to represent spatial distance and the horizontal

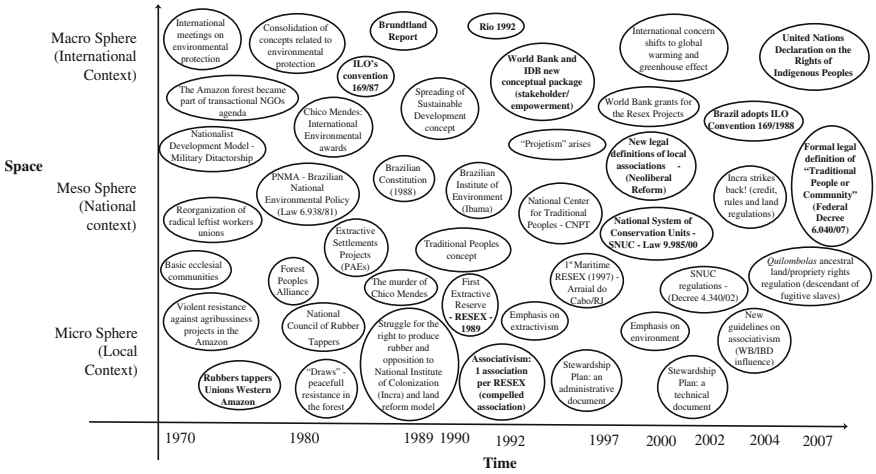


**Fig. 2** Representation of the trajectory of the extractive reserves

[4]K.-O. Apel, "A necessidade, a aparente dificuldade e a efetiva possibilidade de uma macro ética planetária da (para a) humanidade," in Revista da Comunicação e Linguagem, n$^{os}$ 15–16 – Ética e Comunicação - 1992, pp. 11–26.

axis to represent evolution over time. Time "speeded up" (Sahlins, 2004) during 1988–1989, when the first RESEXs were created, and also in 2000, when the Law for the National System of Conservation Units (SNUC) was promulgated.

In my reading, I researched some conceptual nodes that could be interlinked within the context at hand. I took *associativism* as my first example, with Christian Base Communities (CBC) as a reference. These were a reaction to the period of suspended rule of law during the Brazilian dictatorship, and were quite active in the rural zone, though they were also present during the reorganization of the combative union movement in more urbanized areas. Another pole were the antiagribusiness movements in the Brazilian northwest and the struggle against the bosses in the Alto Juruá rubber-tapping circuits. Conflicts in the Xapuri region were the fruit of early organization by local rubber tappers.

The initial result of these struggles was the consolidation of the Forest Peoples' Alliance, which sought to organize Brazil's indigenous peoples in defense of their interests in the national constitutional congress. The Rubber Tappers' National Council (CNS) was also founded at this time. Simultaneously, local contexts began to be affected by international organizations which sought to defend the Amazonian Indians, and which began to sue international financing agencies. In the larger international scenario, the concept of the *environment* began to be affirmed as a sort of return to or reconstruction of a paradise lost (Merchant, 2003). *Sustainable development* also became conceptually established at this time, forming a Janus-like duo with the *environment:* one face looking towards the future and the other towards the past.

The CNS positioned itself in opposition to the National Colonization and Agrarian Reform Institute's (INCRA) land policies, especially with regards to the splitting up and individual allotment of lands (Allegretti, 2002). The rubber tappers defended the concept of Federal control of lands, which would then be utilized by local populations. The Extractivist Settlement Projects (PAE) carried out by the government were inadequate responses to this movement's concerns. Finally, in the National Environmental Policy of 1981, the RESEX concept found institutional expression in the Units of Conservation of Ecological and Social Interest.

The second part of the 1980s was a decisive moment in this field. Chico Mendes' rise to (inter)national fame as leader of the movement and his subsequent assassination, the establishment of the new Brazilian constitution, and the foundation of IBAMA occurred, one after the other, in a short period of time. However, it was only with José Sarney's presidency that the first four RESEXs were created at the beginning of 1990 (Cunha and Almeida, 2000).

Preparations for the Eco-92 conference in Rio de Janeiro brought new elements into play. In 1992, the National Center for the Sustained Development of Traditional Populations (CNPT) was created and directly linked to IBAMA's directorate. CNPT consolidated the emphasis on "modern" extractivism and brought two new concepts into the policy field: *sustainable development* and *traditional populations.*

The new policy's benefits were not limited to rubber tappers and nut gatherers, and under it, the number of social groups that could apply for protected status as dedicated traditional extractive populations grew exponentially. The extractivist model enshrined in public policy during this period, however, continued to be focused upon local habits and knowledge. One document, in particular, became paradigmatic,

synthesizing traditional techniques and modern renewable resource management practices within the RESEX network: the *Use Plan.* This was an "administrative" document, to be presented to IBAMA by the local population and then ratified as a governmental document.

The use plan was to be put together by the reserve associations. These were entities specifically created in order to undertake comanagement of a conservation unit and which would be signatories to a Cessation of Use Contract in some imagined future. The statutes of the reserve associations were to define exactly who belonged to the local population[5] and, in many cases, these associations became confused or intertwined with the local residents' associations. Originally, this was not a problem, but as the policy began to be applied to peoples and spaces which had histories of local organizations different from those involved in the first few RESEXs, the association itself began to become a source of conflict and discord.

At the same time, new concepts began to take hold in the *development community* that impacted upon those people and groups seeking credit with multilateral financing agencies. These concepts were *stakeholder*, *empowerment*, and *participatory management*, among others, along with the aid model known as "projectism" (Pareschi, 2002).

In the field of policy management, emphasis had shifted from extractivism to the conservation of nature and biodiversity; and the Use Plan, originally understood to be an administrative document, became the Management Plan – a technical document. The management of a given RESEX passed to a partnership with a Deliberative Council in which local populations, in most cases not even completely recognized by council members, were in no way central to the decision-making process.

## 4 Some Reflections: Looking at History as Culture and Vice Versa

The several trajectories and positions that I've presented here (including my own) are anchored in the Western scientific perspective. Our posture has been a neocolonial one, in spite of our best intentions. We seek to link the *local* to a universalized *global* that is, in and of itself, the reflection of Western cultural ideals. We want to respect traditional forms of knowledge, as long as they become transformed into goods within our Western regime based on private ownership of property (Kirsch, 2004), and are subordinate to scientific knowledge regarding conservation and biodiversity.

We offer groups social inclusion and visibility, as long as they accept a subaltern position. We also make ample use of that process described by Edward Said as "superior positional flexibility," in which certain forms of cultural expression are valued in detriment to others according to (and which amplify and reproduce) power imbalances (Said, 1994).

[5] At Arraial do Cabo, the criterion stipulated by the Management Plan of 1997 was that the individual had to be "fishing for ten years and voting for five in Arraial do Cabo" (query Ibama/MMA, 1997).

We do all this because, in truth, we believe that social movements must be conduced to link the local and the global and become socially visible. We believe that these groups should construct themselves mimetically, using our society and our values as their model. The juridical and legal universe is translated in order that rights may be protected. However, its multiple meanings and the discursive implications of the new concepts that it imposes are not made entirely clear in such a way that local groups can conduct autonomous evaluations. In other words, these groups are presented with "recipes" through which they might achieve immediate goals, without any explanation of what those goals might imply, further down the road or in connection with other emerging phenomena.

Today, there are signs that some sort of reaction is finally taking place and it is up to us to correctly discern its meaning. Some land-based RESEXs contain local groups which are in the process of creating even more diacritically-based identities with an eye towards being embraced by ever more tutelary policies. Certain marine RESEXs have also seen the creation of collective diacritical identities where, earlier, the only identity admitted was that of the individual fisherman or woman. Orphans of "projectism," stripped of both a usable present and future, have begun to turn to projects themselves as a source of resources, abandoning local extractive activities.

The market that offers itself to these peoples is a market that obliges them to accept a self-identification as "poor," quantifying that which is not quantifiable. It's a market that does not listen to them as hyposufficient groups, which needs assistants and translators, so that these peoples can supposedly be seen and heard in national society. Within this scheme of things, these peoples' places will always be reduced to certain delimited areas and their forms of knowledge will be classified as "nonsustainable" and thus in need of substitution by practices which are sustainable (even though we well know that our own daily practices are far from sustainable themselves).

We often forget that these multiple possibilities also apply to ourselves, and I thus want to make it clear that this is not the case in the present text. Critiques of the unexpected results of long-term political practices almost always tend to focus upon the lives and practices of "others." Looking at it from another perspective, I believe that a reflexive view regarding the historical trajectories of both the groups and the policies involved in Brazil's extractive reserves, as well as regarding the participation of outside groups, can increase the possibility of mutual comprehension and emancipation.

## 5 Some Final Considerations and a Few Conclusions

It is perhaps best to look at Brazil's socioenvironmental movement as a double movement. From an environmental perspective, it seeks to increase, conserve, and value heterogeneity. From a social perspective, however, it is best understood as a complex series of linkages between different cultures that seeks to homogenize via State and scientific tutelage.

According to the most recent Brazilian legislation – *Decreto* (Decree) 6.040/2007[6] – traditional peoples and communities are defined as:

> "... culturally differentiated groups which see themselves as such, which possess their own forms of social organization, which occupy and utilize territories and natural resources as a condition of their social, cultural, religious, ancestral, and economic reproduction, utilizing forms of knowledge, innovations, and practices which are traditionally generated and transmitted" (Art. 3º).

Heterogeneity is obviously the defining mark of the groups that fit the above definition. Here, their diacritical nature in relation to their social surroundings is understood from the outside in. Furthermore, they should have enough of a degree of internal cohesion that knowledge transmission from one generation to another is principally carried out within the group in function of its own traditions. Finally, this traditional form of living is not in and of itself necessarily primordial: it is enough that it merely be "of the group" itself, that is, shared by them as a sort of "sameness" (Bauman, 2001).

However, all the public policies that are directed towards these groups seek to provide for their sustainable development – a concept, it should be remembered, which is not endogenous to the groups themselves. Furthermore, in order to create benefits and meet needs, these policies are integrated into a model of planning which, while it is participative, introduces homogenizing tools and procedures which not all groups are willing or able to acquire or assimilate. It thus becomes necessary for the groups to either subject themselves to tutelage (at the hands of the State or civil society groups) or for their leaders and representatives to learn and share a new degree of "sameness" with the surrounding society.

Given the trajectory described above, I believe that we are currently on the road to creating a politics of resentment instead of a politics of recognition and/or redistribution. In a society where the instrumental use of natural space is understood as positive, untouched nature is hardly a sacred myth: it is a form of violence.

But we can also recognize that past differences and local knowledge are legitimate – strong enough, perhaps, to confront the concept of submission to the future. We can understand that to respect difference does not mean to recognize it as the beginning of a mimetic process whose end is a copy of ourselves. We can choose, after all, to let life be lived in all its transforming plenitude.

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[6]This decree deals with the sustainable development of traditional communities.

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# Comments on Socioenvironmental Conservation Strategies in Protected Areas of the Amazon *Várzea*

**Cristina Adams**

**Abstract** Significant advances have been made in conserving the floodplains of the Brazilian Amazon in the last decade. The Mamirauá and Amanã Sustainable Development Reserves (SDRs) in the Middle Solimões are the best examples of success in the implementation and management of sustainable use protected areas. This chapter discusses some of the reasons for their success and the difficulties of applying Mamirauá and Amanã SDRs models elsewhere, using commons theory as a theoretical framework. It also brings to light the main lacunas raised for discussion by the participants at the roundtable *Socioenvironmental Conservation Strategies in Protected Areas*, as well as the recommendations for socioenvironmental conservation strategies in protected areas on the Amazonian floodplains.

**Keywords** Amazon • Floodplains • Protected areas • Commons theory • Conservation

If we take as our measure the number of protected areas earmarked for sustainable use (Sustainable Development Reserves—SDRs, and Extractivist Reserves—RESEXs), significant advances have been made in conserving the floodplains of the Brazilian Amazon in the last decade. Created to cushion growing anthropic impacts on floodplain resources and the heightened risks facing riverine communities, these protected areas (PAs) stand a better chance of being implemented effectively at already occupied sites than do strict use units. The pursuit of the much sought after goal of sustainability is by no means automatic and requires such considerable financial, technical, and institutional investment that success stories are the exception rather than the rule. Despite the paucity of examples, I believe some

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broad comments can be drawn, especially from the Mamirauá experience, using commons theory as a theoretical framework (Berkes 2005, Nagendra and Ostrom 2007), and this is precisely my aim in this chapter. Both the papers that were presented at the meeting on *The Amazonian Várzea: The Decade Past and the Decade Ahead*, held in Manaus (2006)—many of which are included in this volume—and the discussions that followed those presentations, offer an extraordinary opportunity to explore progress and limitations in the search for resource conservation and sustainable management. This chapter is based largely on points raised in the Manaus presentations and discussions as well as on my own observations of the projects mentioned.

There is no doubt that the best examples of success in the creation and management of a sustainable use protected area are the Mamirauá and Amanã SDRs in the Middle Solimões. As Queiroz and Castello et al. show (in this volume), the management strategies implemented for fisheries and logging in these reserves have not only realized success in biological terms, but have also resulted in higher average incomes for the families involved, and brought down infant mortality rates within the perimeters of the reserves. Another factor in the success of the Mamirauá experiment has been the request by the communities from the environs of the reserve to engage voluntarily with the participative management systems. However, given the singularities of this implementation process, we are highly unlikely to see more SDRs in the mold of the Mamirauá/Amanã Reserves implanted in the Amazon Region. Not only was the political and historical moment of the creation of the Mamirauá/Amanã SDRs particularly opportune,[1] allowing for the categorization of a new type of PA and the demarcation of such a vast area, but there was also a steady and considerable stream of financial and highly qualified human resources into the project. Furthermore, the population density of the area (even after the increase that followed upon the creation of the SDR) is comparatively low and the region is considered highly productive from the biological point of view, which contributed greatly to the implementation and success of the natural resource stewardship strategies.

On the other hand, if there is little likelihood of the Mamirauá/Amanã model's being repeated *in totum* elsewhere, the participative natural resource management experiments conducted at these SDRs serve as a barometer of the main conditioning factors and difficulties which attempted implementation in other areas would be likely to face. Among the most important determinants, we could mention: (1) the existence of residents with stewardship expertise in the target resource; (2) the clear identification of the stock being harvested/extracted, and the definition of the sustainable rates of this extraction (which entails scientific research); (3) constant monitoring of stock and reliable inventories of target species compiled by the producers; (4) compliance with the minimum size/age limits prescribed for the

[1] Still under the influence of the National Congress of Parks in Caracas (1992) and Rio-92 (Naughton-Treves et al. 2005) and of the creation of the Centro Nacional de Desenvolvimento Sustentado das Populações Tradicionais—CNPT (National Centre for the Sustainable Development of Traditional Populations) (see Lobão, in this volume).

resource, prohibition of extraction at certain times of the year and in certain places, and respect for the extraction quotas; and (5) the existence of a highly efficient participative system capable of ensuring the equitable sharing of the benefits and the proper functioning of the instruments of governance.

Among the main difficulties faced in achieving acceptable levels of sustainability in sustainable use PAs is the need to create strong bonds between the formal institutions (nongovernmental and governmental organs) and the local populations through the empowerment of the latter and the nurturing of a relationship of mutual trust. The more communities involved, the greater the challenge. In many cases, the existence of striking cultural differences between the communities can be an obstacle to the creation of the SDR and to compliance with the rules established therein (an example would be the differences between indigenous and *Caboclo* communities). An additional aspect worth highlighting is the time it takes to identify and train the experts in target resource management and monitoring and for their performance to be tracked, appraised, and ratified using scientific methodologies. Lastly, another worry is the existence of freeriders, who use the resources but disregard the rules and collective agreements, such as timber and fish poachers from outside the PA, or even rogue residents who defy the established norms, because curbing their activities is costly and labor intensive.

In some cases, defying the established norms can be a rational behavior if one takes into account the opportunity costs of keeping with the collective agreements versus extracting resources that have a high market value, even if this activity is illegal. Another related issue, especially for sustainable use PAs situated in less isolated areas and not so productive as Mamirauá-Amanã, is the opportunity costs of alternative income activities found outside the protected area. As long as the opportunity costs are higher outside, it will be very difficult to develop and maintain a sustainable management of local resources.

The points raised above allow us to touch upon other themes correlated to and permeating the debate on the presence of human populations inside protected areas. The first is the value of traditional wisdom versus scientific knowledge in natural resource conservation. The case of the giant arapaima fishermen, for example, reveals, on the one hand, the importance of traditional knowledge in defining strategies for monitoring fish stocks, and on the other, that this knowledge is not distributed homogeneously among the population. In addition, the effectiveness of traditional knowledge as a conservation tool and its replicability in other locations and situations should be carefully studied (Lobão, in this volume, and Naughton-Treves et al. 2005). One way or another, the Mamirauá example proves that both knowledge types should be allied in constructing management plans for the conservation of the natural resources of the Amazonian floodplains.

Another theme that undoubtedly requires delicate handling is the danger of generalized discourse on the efficiency of awareness campaigns through environmental education. Giant (refers to the common name of the fish) arapaima fishing and logging in Mamirauá testify to the fact that the patterns of unsustainable use of these resources did not change after the implementation of environmental education and awareness programs, much less after discussions with local leaders, the usage

agreements, and the publication of a management plan. Effective change occurred only once productive management came into play and the new system began to generate economic returns for the local producers. Otherwise put, nothing really changed until the benefits started to outstrip the costs (Berkes 2005, Nagendra and Ostrom 2007). It is therefore important to seriously discuss adopting statistically-based continuous evaluation methods to ascertain the effectiveness of environmental education programs inside PAs in order to inform the decision making on these initiatives and their reassessment if and when necessary.

Ironically, the case of Mamirauá/Amanã also poses problems derived not from failings in the implementation of the participative management model, but from its success. By creating better conditions for the riverine communities through higher domestic incomes and quality of life, the SDR ends up becoming a hub that draws people in from the surrounding communities, leading to a greater population density that can overburden the reserve's capacity. Improved conditions can also lead to changes in patterns of consumption and even erode the traditional knowledge that sustains community stewardship, as suggested by Castello during discussions in Manaus (pers. comm., 2006). One of the traditional residents of the Mamirauá SDR, a hunter and expert in giant arapaima fishing (and a key figure behind the method used to count the fish) obtained such a dramatic rise in income from the success of the participative management plan that he was able to buy a house in town and move there definitively in order to raise his children, to whom he has not passed on the traditional knowledge he inherited from his father.

One of the solutions to the problem of newcomers migrating into sustainable use PAs would be to extend the participative management model to the buffer zones. This expansion would also increase the supply of managed products, met in turn by a growing market, which would keep prices down and help avoid overextraction. However, the examples raised during the conference showed that the cons may outweigh the pros in this case: e.g., technically incorrect management, inefficient monitoring mechanisms, deficient legislation, projects more susceptible to local political mismanagement, and the need to include other links in the production chain (Nagendra and Ostrom (2007). On the other hand, Mansfield's warning (2004) that the tragedy of the commons was being transformed into the "tragedy of free access" underscores the need for more research on the institutions and power relations that govern the way the floodplain resources outside the reserves are allocated under the free access regime, because, given the sheer vastness of the *várzea*, not all floodplain regions can be placed under communitarian management. It must also be remembered that the traditional riverine activities, now incorporated into the discourse of sustainability, were forged within a context of socioeconomic exclusion, and we should not underestimate the influence of regional, national, and global factors on these apparently stable systems (Nugent 2003: 198–9).

By the same token, the ecosystems under protection are not isolated, self-contained systems, especially in such a changeable environment as the floodplains, but are subject to annual flows of matter and energy, and covering a vast area (300,000 km$^2$) (ProVárzea 2009). In this sense, the management of sustainable use protected areas in the region also needs to consider the threat of externalities at

different scales, such as water pollutants, invasive species, smoke from forest clearings, global warming, and globalization (Brondízio et al. 2009). On the other hand, the creation of sustainable use PAs might have impacts in other places (or "leakage"), as fishers or loggers move to other unprotected areas to continue with their unsustainable activities.

An appraisal of the last decade shows that some formal institutions (Mamirauá Sustainable Development Institute—IDSM) and informal structures (community agreements and organizations) achieved greater success than the conservation and sustainable management initiatives of their governmental counterparts (IBAMA, Amazonas State government), which can be explained by the fact that the former are not only closer to the resources in question, but also more flexible, diversified, and open to feedback from the environment (Berkes 2005). Nevertheless, a challenge that still needs to be addressed from a management perspective is to consider the existing dynamic linkages between levels (Cash et al. 2006). In a recent article, Brondízio et al. (2009) call attention to the need for institutions at (and linking) multiple levels of social organization in order to guarantee the long-term protection of ecosystems and overcoming the problem of focusing on only one or two levels in policy design.

But if communitarian management of shared resources is no across-the-board panacea (Nagendra and Ostrom 2007), a workable combination of different resource appropriation regimes must be found in order to ensure the most adequate use of floodplain biodiversity (Ostrom and Nagendra 2006). In this sense, it is important to broaden the range of resources being managed, which is currently limited to a handful of wood and fish (particularly the giant arapaima) species, and include all of the subproducts each can yield (e.g., alligator = leather and hide). Furthermore, as efforts are currently concentrated in certain areas and types of PA category, the conservation drive on the floodplains also needs to better evaluate geographic range, taking into account the regional distribution of the biodiversity patterns. Nonetheless, perhaps the main threat to floodplain biodiversity conservation remains hunting (and overfishing), where control has shown little progress over the last ten years, even with the implementation of sustainable use protected areas. Some advances that have been made include an increase in our knowledge of the most widely hunted species, the type of management employed and its productivity, the origin of the produce, and the markets for which it is destined. The difficulties yet to be overcome include deficient/outmoded legislation; variable interpretations of the legal wording when the legislation is enforced; the nonuse of existing scientific knowledge on the biology of the species in question; lack of official support for sustainable management; the state's ignorance of the production chain; less than efficient monitoring; and the nonexistence of clear legal tenure for the communities.

Moreover, while comanagement has ensured better livelihoods as measured by social indicators in some of the communities, the floodplains are still beset by a chronic lack of infrastructure and state attendance to the basic needs of the riverine population, such as healthcare, sanitation, and education. Therefore, the link between conservation and poverty reduction envisaged by the International Union

for the Conservation of Nature (IUCN) (Scherl et al. 2006) will have to tackle the difficulties posited for the Amazonian *várzea* by Fearnside (in this volume).

In summary, the success of the SDRs at Mamirauá and Amanã in managing numerous species would appear to have been achieved because the areas enjoy many of the conditions Nagendra and Ostrom (2007) identified as facilitating the transformation of free resource access into a comanagement system: (1) the rules are known and understood by the majority of the users, considered legitimate, and therefore respected and monitored accordingly; (2) the limits for each resource are clear; (3) the resource can be monitored at a low cost; (4) socioeconomic and technological change over time has been moderate; (5) social interaction within and between the communities has been maintained, thus strengthening bonds of trust; (6) external users can easily be excluded from the use of the resource; and (7) infractions are monitored and punished. It is obviously well nigh impossible to encounter all of these factors in a real situation, but when at least some of them are in place, successful community management becomes a more attainable goal.

However, despite the valorization and heightened visibility of traditional/local knowledge over the last ten years, and of its importance to the implementation of sustainable management models,[2] Lobão (in this volume) draws attention to critical aspects that, given the eagerness to accentuate the advantages of community management inside PAs, rarely receive due attention. These systems can sometimes shift some of the economic costs and responsibility onto the communities, while other stakeholders withdraw or minimize their management roles (Naughton-Treves et al. 2005). This is precisely what occurred with the lay monitors (Voluntary Environmental Agents) posted at the sustainable use PAs—a clear case of a responsibility that ought to belong to the state being foisted upon the population. Worse still, the system is inefficient, as its reports lack public credence (Lobão, in this volume). The Deliberative Councils created by the National System of Conservation Units (SNUC), though an advance in participative management, can clash with other forms of communitarian stewardship. Only time will tell if the councils in Mamirauá represent a step forward or backward in relation to the former annual assemblies (Queiroz, in this volume). Another potential problem Lobão identifies (in this volume) is the heterogeneity of the definition of the term "traditional populations" in Brazil (Federal Decree 6.040, July 2, 2007)—which can be applied by self-description (as by the caiçaras, rubber tappers, etc.) or on the grounds of ethnicity/historical debt (Indians and *Caboclos*)—and of the rights this confers in terms of access to shared resources.

Tackling all of these problems on the Amazonian floodplain presupposes a bedrock of information and scientific data on the *várzea* that simply does not exist. In this light, the main lacunas raised for discussion by the participants at the roundtable *Socioenvironmental Conservation Strategies in Protected Areas*, and which hold

[2] According to Naughton-Treves et al. (2005: 231), more than half of the protected areas in Brazil under state or federal jurisdiction belong to the sustainable use category (IUCN categories III-IV), as opposed to the indirect use categories (I and II). For a critique of the use of the IUCN categories in the creation of protected areas in different countries, see West et al. (2006).

equally true for the rest of the Amazon and perhaps even for Brazil as a whole (the same goes for the recommendations below), were:

1. Ignorance of the effective stage in PA creation, especially in the state category;
2. Limited knowledge of the impact (positive and negative, social and environmental) participative management systems are having outside the Mamirauá area;
3. Complete lack of knowledge as to the impact (positive and negative, social and environmental) participative management systems are having on the tribal societies in Indian Reserves;
4. Lack of indicators and assessment protocols (on both the local and regional scales) to measure the impact of participative natural resource management models and of human presence on the floodplain resources inside the PAs, which would allow us to gauge the degree of sustainability over time and to compare different areas within the *várzea* region; and
5. The tendency of scientific research and public policy to underestimate the nutritional and epidemiological aspects of life in the Amazon, both inside and outside the Protected Areas.

Within the framework of issues discussed in this chapter, a number of recommendations for socioenvironmental conservation strategies in protected areas on the Amazonian floodplains were suggested by the researchers and administrators present at the event:

1. The creation of new PAs on the floodplains as part of a coherent protected area system that considers variations in the regional biodiversity patterns and local needs and conflicts;
2. Evaluation of the impact of the creation of the Consultative Councils (SNUC) on the management of natural resources inside the PAs of the Brazilian *várzea;*
3. Reassessment of the role of the Voluntary Environmental Agents in monitoring sustainable use PAs and in the use of Verification Reports as tools for collating environmental information, which could be used in the development of environmental sustainability indicators;
4. More funding for scientific research, enlarging the base of socioenvironmental information, and consolidating existing knowledge on the Amazon floodplain, including its support capacity;
5. Extension of the scientific studies measuring the impact of participative sustainable management systems on human populations and natural resources to other areas beyond Mamirauá, including Brazilian Indian Territories;
6. Development of indicators and protocols for evaluating both the impact (on the local and regional scales) of participative management systems on the natural resources, and the human impact on floodplain resources, inside and outside the protected areas;
7. The reformulation of the existing legal devices regulating the use of natural resources (e.g., guardian of resources, hunting legislation, and the inclusion of penalties for breach of communitarian fishing agreements);

8. Strengthening of inclusive public policies (access to education, healthcare, basic sanitation, and digital inclusion) for riverine communities in general and those located inside protected areas;
9. Stimulating state investment in local chains of production; and
10. Finding participative ways to tackle the problems of increasing population density and of changes in local/regional circulation versus the capacity of the ecosystems encompassed by the PA to support those changes.

In conclusion, suffice it to say that the creation and implementation of 100% sustainable PAs in the Amazonian *várzea* is a target yet to be reached. In the current situation, a cost/benefit analysis that considered the volume of financial investments channeled into the Mamirauá SDR since its creation would most likely find that participative management is still being subsidized by external funding. This situation will only really change if ecosystemic services and the valorization of natural resources could be factored in, but as such services and resources do not yet figure within the market logic, the maintenance of sustainable use PAs remains an open question. Furthermore, whilst average incomes may have grown 110% in Mamirauá in the space of a decade, they remain low and subject to wide intracommunity variations (Queiroz, in this volume, Lima 2006). Moreover, average income cannot be used as the sole indicator of development. The sustainable management of natural resources can readily sustain rural lifestyles, but can rarely provide sufficient surplus to push rural smallholders across the poverty line (Naughton-Treves et al. 2005: 243). In order to achieve that goal, public conservation policy on the Amazonian floodplain will have to be accompanied by inclusion policies for the riverine populations.

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# Part V

# A Tribute to José Márcio Ayres

**Ana Rita Pereira Alves**

**Abstract** José Márcio Ayres was one of the most respected Brazilian scientists in the area of biodiversity conservation and the recipient of many prestigious prizes in his field. A biologist and primatologist, José Márcio Ayres held a Bachelor's Degree from the University of São Paulo – Ribeirão Preto, and a Master 's Degree from the Amazon Research Institute – INPA in Manaus where upon graduation he was hired as a researcher. Three years later he entered the University of Cambridge where he received a Ph.D. The subject of his doctoral dissertation was the uakari monkey, a species endemic to the Mid-Solimões River, Amazonas, which he saw for the first time in a German zoo. His PhD dissertation covered the life of the species, as well as the geology and ecology of the area occupied by the animal. He created a new category of conservation unit in Brazil, "The Sustainable Development Reserve" which guarantees the permanence of human communities inside the conservation area. He also created The Mamirauá and Amanã Sustainable Development Reserves in the middle Solimões area in the state of Amazonas. In1999, José Márcio Ayres created the Mamirauá Sustainable Development Institute currently under management by the Ministry of Science and Technology of Brazil

**Keywords** Primatologist • Brazilian scientist • Sustainable Development Reserve • Ecology • Environment conservation

To speak of Márcio, for one who knew him, is easy, because he was a person who left an immense contribution to science, and because he loved and was greatly dedicated to nature. We could say that he was much more preoccupied by questions related to the conservation of the environment than with his own life. People who had the privilege to know and work with him are represented in this book, presenting

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remembrances of both his life and his scientific works not merely in homage to Márcio, but also so these recollections may serve as examples to young researchers with an interest in environmental conservation.

José Márcio Ayres, though born a Brazilian and a Paraense, was a citizen of the world. He was also one of the most respected and honored Brazilian scientists in the area of the conservation of biodiversity. While still young, he became one of the most acclaimed Brazilian primatologists. He had demonstrated an enormous curiosity for various subjects, especially biology, from early youth. He asked so many questions of such a variety that he tired his friends and family. From early on he was known for his intelligence and his playful spirit.

During his school years he was always up to something with his friends and became known as a master of high-spirited jokes. Good-natured and a friend to all, he was so well-known for his mischievous nature that when he approached a group, they were immediately wary, knowing that he was planning some prank. To pull off a hoax at the expense of his friends was one of his favorite pastimes. He was obviously interested in primate behavior from a very early age.

In 1976 he graduated as a biologist from the University of São Paulo in Ribeirão Preto. At 20, he became the director of the "Cava do Bosque" zoological area in Ribeirão Preto, his first paid employment, and soon his gift for research became obvious. Shortly thereafter, he began a Masters in Ecology at the National Research Institute of Amazonia (INPA) where he started to orient his career toward the management of conservation areas that could reduce the threats faced by Brazilian biodiversity. After completing his Masters, he was contracted as a researcher by INPA in Manaus, and three years later left for England to earn a PhD at Cambridge. For his doctoral thesis he decided to study the uakari monkey that he had seen for the first time in Germany, a species endemic to the mid-Solimões region, in the state of Amazonas. To do this research he lived isolated in the field for two years, and produced a work of high quality that covered not only the entire life of the species, but also the geology and the ecosystem of the area it occupied. The final result of that doctorate was the realization of his dream; that dream materialized as a territory of 1,124,000 ha: the Mamirauá Sustainable Development Reserve (RDSM).

The struggle for the creation of the reserve was formally initiated in 1985, when the proposal for the implementation of an area for the protection of the white uakari was delivered to the Special Secretariat for the Environment. Five years later, by decree #12,836 on March 9$^{th}$, 1990, the government of the state of Amazonas legalized the creation of the Mamirauá Ecological Station. But a problem remained. The category of "Ecological Station" demanded that any resident population leave the area. But Márcio demonstrated to both the scientific community and to leaders of public institutions engaged in environmental issues that to preserve the natural environment without taking into consideration the human species was not worthwhile. Márcio argued that "keeping the *ribeirinho* populations there, especially in this case, will result in a distinct improvement in monitoring that cannot be carried out in an effective manner even by the relevant federal institutions."

Victory came in 1996. The area was proclaimed a "Sustainable Development Reserve," a designation that guaranteed the permanence of the local population. Research in the RDSM was making giant strides, but Márcio's horizons had no limits. And, as his mind and body were unable to rest, he created in 1998 the Amanã Sustainable Development Reserve, connected to Mamirauá and much larger in area (2,350,000 ha). The biological and social research efforts that were being conducted in Mamirauá were applied also to studying Amanã.

Mamirauá and Amanã claimed a great amount of attention in both national and international media, and in recognition of this, the Brazilian government, through the National Council for Scientific and Technological Development – CNPq, responded to Márcio's request and in 1999 created the Mamirauá Institute of Sustainable Development (IDSM). Today the IDSM is managed through a contractual agreement with the Ministry of Science and Technology (MCT).

Márcio was a famous scientist, a highly skilled person, modest, friendly, and humble, who to his great credit, never discriminated between the powerful, the famous, and ordinary folk. He was a joker, very inquisitive, and with a brilliant mind; and these qualities permitted him, in only 49 years of his well-lived life, to bring about numerous great advances for the benefit of environmental conservation.

One of his greatest legacies was to have formed a solid team of researchers, admirers, friends, and collaborators to carry on his ideals and continue his mission.

With his high spirits as a characteristic trait of his personality, Márcio lived and faced challenges with good humor, seeking to reach his goals, and inspiring all around him.

Some of his last words show perfectly what a tireless fighter Marcio was: "The battle against cancer has made me change my vision of the project. I now understand that beyond my own efforts in conservation, one of the greatest contributions that I can offer is to make sure that the causes for which I have fought become truly independent of the efforts of any single individual. During the days that I left to get treatment in New York, I witnessed my colleagues carry the work forward. This was most gratifying. Much of the work that we have done together to protect natural resources and construct a base for a more effective conservation strategy is today well-engrained in society. It will not be easy to give ground."

In fact, looking at the determination with which the team is working in the IDSM and is helping the Institute move forward at a rapid pace, it is obvious that there is no possibility of retreat. The dream that Márcio dreamed has became a reality.

# The Contribution of Márcio Ayres to a Transdisciplinary Approach to Conservation[1]

**Deborah Lima**

**Abstract** This chapter is an homage to primatologist and environmentalist Márcio Ayres. An account of Márcio's life is given, focusing on his role in the creation of a new model of conservation unit in Brazil, the Sustainable Development Reserve. The Reserve is based on a transdiscipinary approach to conservation, and represents a step forward to a new understanding of the relation between people and environment. However, the vision of conservation put forward by this proposal is still impaired by the vocabulary in use today. The terms "biodiversity" and "traditional people" are discussed as a pair of words that express resistance to proceed in new ways of thinking about sustainable ways of living, such as that promoted by the work of Márcio Ayres.

**Keywords** Conservation • Mamirauá • Márcio Ayres • Sustainable Development Reserve • traditional populations

A transdisciplinary approach means, in a few words, a perspective that goes beyond, and in this sense transgresses, conventional disciplinary boundaries in order to place in relation fields of knowledge that do not usually conflate. My homage to Márcio Ayres focuses on his rare capacity to go beyond disciplinary conventions in order to put forward new forms of scientifically-based approaches to the conservation of nature. Márcio lived in a period of paradigm change in conservation that is still in progress today. Since the eighties, the international agenda for conservation has abandoned its focus on endangered species and started to adopt a transdisciplinary perspective that acknowledges the necessity of dealing

[1] I thank Nelissa Peralta, of the Mamirauá Institute, for translating the original Portuguese version.

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directly with social matters. This was based on a consensus that conservation and "social justice," in a broad sense, are goals that, when put together, mutually strengthen each other.

No doubt his most significant legacy in this direction was the definition of a new type of conservation area, the Sustainable Development Reserve. The history of this creation reveals the importance of a transdisciplinary approach (and a personality as well) that is necessarily creative and unconventional. Times of paradigm change are times of uncertainty, but also of revelation. Creativity and unconventionality are qualities much needed to carry out the definition of new paths in such periods.

Márcio's creative leadership and his sense of opportunity emerge from the history of the creation of the Sustainable Development Reserve (SDR), since this is not a deliberate or linear history. It did not happen that one day, in his office, Márcio decided to resolve the problem of the threat of extinction of a species of primate–the white uakari—by creating a reserve identical to what today is the SDR. The consolidation of the SDR model was the result of a long process, marked by the leadership of a person who understood the chance that the moment offered, and knew how to act, combining principles, ideals, and objectives with the opportunities which were open to him at the time, and which he also helped to create.

The path begins with the proposal sent to the then National Environment Secretary (SEMA) for the creation of an area of protection for the white uakari, followed by the decree that transformed the entire range of this species into a state Ecological Station, and the design of a project—the Mamirauá Project—geared toward the implementation of the Mamirauá Ecological Station. The Project ignored the restrictions that forbade the presence of people in this type of protected area—at the time called an area "of indirect use"—until the state of Amazonas validated the model developed by the Project: the Sustainable Development Reserve. The category was also later legitimized at the federal level, with its inclusion in the National System of Conservation Units (SNUC), and was considered a protected area of "sustainable use." In addition to this, Márcio fought to create another SDR, the Amanã, adjacent to Mamirauá and to the National Park of Jaú. Finally, his efforts were to provide long-term security to the two SDRs, creating a model of mixed institutional management—a civil society organization attached to the Ministry of Science and Technology. This entire trajectory proceeded from his initiative, his ability to perceive chances and to act upon them. He made the changes and the arrangements necessary to guarantee the success of each project, and in the end, to reach his first, but not necessarily his most important, objective: to protect the white uakari from the threat of extinction.

Although the protection of the white uakari was his original goal and it presents itself as the final result of this long innovative process, a mix of ecological and social concerns always guided Márcio's accomplishments. I am referring not only to those social concerns regarding the local people residing in the protected area, but also concerns about the people who worked with him and to whom he was exceptionally generous, offering chances and opening doors to assistants, students, and colleagues. We may observe a mixture of social and environmental awareness (thinking of the social in a broad sense) by listing, in reverse order, the objectives

behind his main accomplishments. The Mamirauá Institute was created in order to guarantee the activities of research, monitoring, and outreach work—crucial for the effective management of the Reserves—and to establish good working conditions for the large team of professionals recruited. With the effective management of the Reserves, action was taken so that local residents had their standards of living improved, and had guaranteed rights to stay in the area and exploit the natural resources by means of sustainable management systems, based on original scientific research. This in turn resulted in a reduction of deforestation and the maintenance of ecosystem flows, guaranteeing the conservation of biodiversity in the extensive *várzea* area, which was the original goal: the preservation of the habitat of the white uakari, and the survival of the species.

If the white uakari took Márcio to *várzea* forests, as the poet Thiago de Mello once observed, the forest established a challenge between locals and conservation, in the sense of their being opposed to one another but having to live together within the same conservation strategy; and Márcio coordinated this situation with an acute sense of equity and social justice.

Márcio was a great primatologist. He initiated his career in this specialty and left a relevant contribution to Brazilian primatology. His most important studies were the ones resulting in his Masters thesis—on two species of the genus *Chiropotes* (*C. satanas* e *C. albinasus*)—and his doctoral thesis, on the *Cacajao calvus calvus,* the *várzea*'s white uakari. As a result of these, and other field experiences in the Amazon, Márcio developed important theoretical analyses, like the one on the role of rivers in the distribution of species, which Miguel Pinedo-Vasquez will present later in Chapter 24. He was recognized as a senior primatologist both in Brazil and abroad while still alive, being elected to membership in the Brazilian Academy of Science and in the Linnaean Society.

Primatology led him to conservation, and conservation led him to position himself politically in favor of a socially concerned environmentalism, which in turn led to intense involvement in related national and international forums. As an environmentalist, he was faced with the challenge of creating a structure to manage the financial resources, infrastructure, and a team of professionals involved in the efforts toward the practical realization of his goals. The passage from the academy to conservation was thus a logical transition led by his thematic choices and the sociopolitical context of his time. His conservation work was also broadly recognized, as his many conservation awards, and his space in the specialized media demonstrate (space which he used to guarantee further support for his conservation ideas).

If primatology was the starting point of his career, it was also early on—still as an undergraduate student—that Márcio took a critical position toward social inequalities, and participated, during the military dictatorship era, in the student movement inspired by Marxism. What I mean by citing this is that his concerns about social justice were manifested diversely, according to the demands of the time, and responding to the opportunities granted by each context. In his heart, Márcio was a nonconformist, and if he abandoned revolutionary ideals, it was because the times had changed. (We may say, however, that he did not abandon the ideals of his youth completely, because an SDR has, as its essence, a revolutionary

character.) We observe different reactions due to different conjunctures. During the military dictatorship, there was no place for criticism, for change, or a space for those who wished to participate in the construction of society. It was a time of an authoritative state and of censorship. In such a context, there was no option for change or a horizon for transition, except by means of a substitution of the "system." When transition again became viable, the communist utopia had already been aborted. Many tried to redirect the ideal of building a society with social justice toward a feasible direction, and Marcio stood among those.

In the international conservation sphere, the political democratization of the eighties was expressed in support of the presence of human populations inside protected areas, and conservation itself moved from a disciplinary toward a transdisciplinary paradigm. In Brazil, the growth of participation of civil society and social movements helped to form the so-called third sector, which assumed an important role in conservation. New NGOs inspired social and environmental activists to gather around common projects, creating the basis of Brazilian socioenvironmentalism. During this time, the conditions for the creation of the Mamirauá Project were produced, and the Project was the origin of the Sustainable Development Reserve model. (At the same time, the first Extractive Reserve was created, partners in the same national and international political conjuncture).

The ten-year period from the beginning of Márcio's doctoral field studies (1983) to the elaboration of the Mamirauá Project (1992) is part of an important transition. During this time, three events had a major impact on the international conservation scenario: the Third World Congress on National Parks in 1982, with the theme "Conservation for Sustainable Development;" the publication of the Brundtland Report, "Our Common Future," in 1987; and the UN Conference on Environment and Development, in Rio, 1992. The international agenda promoted the pursuit of *sustainable development.* The idea came up as a solution to what was previously thought impossible: the conciliation (and not choice) between conservation and development. Everyone expected, and to a certain extent still does, that this abstract formula, expressed in terms of "sustainable development," would take shape. The Sustainable Development Reserve is a concretization of this abstract concept. But there are other practical accomplishments, and they differ only in terms of the weight given to the different components of the formula, either more developmental (economic or social) or more environmental.

In the Sustainable Development Reserves, however, there is a special assurance, shared with other types of protected areas of sustainable use, that the ideal of sustainability will be achieved. In these territories, sustainability is guaranteed by law. These conservation areas constitute small islands, where it is possible to implement an ecological government, in the midst of unregulated areas, where the logic of the market is imposed above the (common sense) conservation logic. In this sense, Sustainable Development Reserves, as well as Extractive Reserves, have a revolutionary character, since they are concrete life experiences in territories destined by law to be sustainable.

In the initial proposal for the Mamirauá Ecological Station presented by SEMA, the map of the Reserve did not have the present natural frontiers of the

Solimões, and the Japurá and Aranapu rivers, i.e., what today constitutes the focal area of the Mamirauá Reserve. The proposed territory comprised a polygon formed by land boundaries that divided and left out all human settlements. If implemented like this, Mamirauá would have been yet another protected area created to save a species of animal from the threat of extinction through the elimination of the human presence from its habitat. Although this extreme recourse is sometimes necessary in situations of extreme pressure, total preservation areas represent a pessimistic view, reinforcing the opposition between humans and all other species while renouncing attempts to establish a new basis for integrated coexistence or to transform the current relations between human and animal domains. Such a vision is an outcome of our western ontology, rooted in a Jewish-Christian theology that separates culture and nature and thinks of the latter as having been created to serve man, the cultural being.

In opposition to this pessimistic idea of conservation, we can place positive socioenvironmental experiences such as Mamirauá and Amanã, since they anticipate the possibility of a radical transformation. Instead of reinforcing the perception of a cleavage between human life and environmental equilibrium, the sustainable use reserves propose a step ahead in the direction of conciliating these two objectives. The importance of this proposition of paradigm change toward transdisciplinarity must not be underestimated. To think of these protected areas only as a strategy for the conservation of biodiversity is to underestimate them and to fail to recognize the ontological challenge they represent.

In the context of a renovation of conservation policies as lived by Márcio, there were two new terms, which are now consolidated: *biodiversity,* meaning a new perspective and interpretation of the need to preserve nature; and *traditional populations,* representing the inhabitants of protected areas "with people." The first term is an academic expression that prevailed in conservation policy. It denotes richness and natural heritage, but it is more explicit than the word *nature* to imply a conjunction of species—with the exclusion of one, the human species. The term *traditional population* is also part of an international terminology that we have incorporated into our vocabulary since the 1980s, as a strategy to justify human presence in protected areas. Despite strong criticism against its utilization, the term was maintained and had so many repercussions that today there is a national movement of peoples in Brazil that have recognized themselves as being traditional and claim special rights based on such identification. In other words, the academic concept gained social reality. On the other hand, characterizing these peoples by referencing tradition is only coherent with a type of thought both critical and submissive to the idea of a modernity distanced and alienated from nature. The term "traditional population" appeared in the context of broad conceptual revision, which included in the same reflexive movement both the conservation model and the very notion of modernity. This period was marked by another important factor at the time of the creation of the Sustainable Development Reserves—the fall of the Berlin Wall in 1989.

To name the inhabitants of protected areas "traditional populations" is a way to exclude them from the modern condition, thus situating them closer to nature, as a

means to justify their presence in protected areas. Our representation of "them" gives meaning to their insertion, as mediators between development and sustainability, between the human condition and nature; to carry out, as if in retrospect, sustainable ways of living. Instead of looking ahead, and calling them postmodern or neotraditional, giving new meaning to these words, we use a historical reference and call them traditional, as if they were in a previous stage of social development, and in this sense we resuscitate the evolutionist label "primitive population" from the very beginnings of anthropology.

To think of inhabitants of sustainable reserves as "traditional" delays the advance of the provocative proposition that socioenvironmentalism represents. In order to proceed with the construction of transdisciplinarity, we need to go beyond the notion of inhabitants as guardians of biodiversity, since this is a conservative vision, one biased along disciplinary divisions corresponding to a modern vision of nature and culture (represented by the pairing of "biodiversity" and "traditional population"). The academic divisions in the SDRs separate social and natural sciences, while keeping the focus of participation of traditional populations restricted to a political dialogue, preparing inhabitants for the implementation of sustainable management systems. In order to continue moving towards a transdisciplinary paradigm, as suggested by the SDR, we have to proceed with efforts and the will to integrate these three domains, which, although interrelated by the idea of biodiversity, are still strictly separated. Today, social scientists "take care of" traditional populations, who are the guardians of biodiversity. Biodiversity in turn is the object of natural scientists. If in order to establish the basis for a horizontal relation between these domains of thought and action, we need a common conceptual language, which we are far from achieving. It is necessary to start by recognizing that our own terms used in the sustainable development discourse express our restrictions in relation to the presence of people in protected areas. Our words reveal a resistance to giving free rein to transdisciplinarity. The association between biodiversity and traditional population is complementary, not only in the sense of the role that each represents for the existence of the other, but also in being the terms that correspond to the contemporary way of expressing the relation between nature and culture in these protected areas, much clearer in relation to its restrictive aspect. As representatives of a model of nature and culture in protected areas of sustainable use, biodiversity and traditional population correspond to the exclusion of the human species from nature, and a population detached from modernity. Using these words, we are saying that the reality of sustainable reserves is too distant from us, from the modern way of life. It is a way of stating that is impossible to create conditions among ourselves to formulate a sustainable way of living.

Recently the regulation of SDRs within the National System of Conservation Units made visible a debate about the purpose of this type of reserve—whether to preserve biodiversity or to promote sustainable development. There is a dispute among professionals for the hierarchical position of their objects of study. Márcio Ayres is cited often as having one view or the other. I think it would be dangerous to pursue such a debate. But considering only concrete facts, the SDR and the Mamirauá Sustainable Development Institute (MSDI), the impression is

that he did not distinguish between "the one and the other," as if it were necessary to define the relative importance of the one to the disadvantage of the other. I think that he valued the combination of the two, and such a combination is transdisciplinary. If, however, the transdisciplinary context was created and it exists, one cannot deny that there is in fact an intrinsic difficulty in the intellectual coexistence of social and natural scientists, not only at the MSDI, but also in the international conservation environment as a whole. In relation to our most important pair of sustainable reserves—the SDR and Extractive Reserves—we may think that in Extractive Reserves the relation of priorities of these scientific areas is reversed, perhaps even due to the different origin of its main academic protagonist (the anthropologist Mauro de Almeida). In both cases, the result is the same *socioenvironmental* combination. The dispute over priorities, corresponding to the problem of separation between the terms biodiversity and traditional populations, suggests the necessity for a deep discussion about the more basic premises of our disciplinary ideas. Paraphrasing Gregory Bateson, it is necessary to move towards an "ecology of mind." We find ourselves in this epistemological impasse, from which we may work to define routes toward a transdisciplinary ecology.

An SDR constitutes a large step in this direction. It was created in the transdisciplinary spirit, by a personality that knew how to perceive opportunities and helped to define environmentalism in a phase of transition. Márcio's biography mirrors the direction taken by conservation itself: in life, he moved from a concern with the preservation of a species of primate to a transdisciplinary vision of conservation, reuniting social and environmental objectives, to formulate an integrated strategy of socioenvironmental work. The example of freedom of thought came from his family environment. His father, Manuel Ayres, was a doctor, a geneticist, and he participated in public administration, contributing to more than one state institution; he works now mainly as a statistician. In a parallel trajectory, Márcio was a "doctor of the environment," an academic and a definer of environmental policy models, passing through the same areas of work as did his father.

Márcio was a rare personality, capable of uniting many people around his projects, infecting them with his motivation (and humor), and administering the abilities of each one, valorizing the best of what they had to offer, to form a team dedicated to contributing to the achievement of the goals he pursued. Consistent with his concerns about sustainability, he left a solid institutional structure for continuing his projects.

Nevertheless, to continue his style, the rigid continuation of his deeds is not demanded. Instead, we need the maintenance of a flexible way of thinking to guarantee that convention does not overcome the creativity of new solutions to the problems and challenges that the passing of time produces. The creation of the SDR is an accomplishment on the road to transdisciplinarity. For this, and for many other contributions in this sense, I would like to express gratitude and recognition for his enormous effort to open new paths, uniting great teams, and giving space to professionals from different areas to interact, moving toward a dialogue that does transcend disciplinary boundaries.

# Márcio Ayres: New Approaches to the Conservation and Management of Protected Areas in Amazônia

**John G. Robinson and Helder L. Queiroz**

**Abstract** The first reserve recognized by Brazilian legislation in 1996, the Reserva de Desenvolvimento Sustentavel (RDS) Mamirauá, arose from the vision of one man: Márcio Ayres. The reserve was designed to conserve biodiversity by involving the local *ribeirinho* population in participatory management of natural resources through the development of effective and legitimate governance institutions, scientifically grounded management plans, and economic support for human livelihoods. These structures reflect Marcio's own personal preoccupations: a love of Amazonian ecosystems, particularly the flooded forests; a deep respect for the power of scientific knowledge to inform decisions; and a dedication to the people of the flooded forest.

**Keywords** Márcio Ayres • Sustainable development reserves • Participation • Flooded forest • Scientific knowledge

Change is the result of more than individual actions. New ideas, new ways to do things, new institutions, new approaches—they all come from collective discussions, thoughts, and actions building on one another, analysis following experimentation, successes building on failures. But some people have a disproportionate impact on the way things happen and what results. Márcio Ayres was one of those people; and his engagement with conservation in the Amazon, and his championing of a uniquely Brazilian approach integrating protected areas and rural development, would legitimize the idea of the "Sustainable Development Reserve," and establish a powerful and enduring model for conservation.

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Márcio´s name will always be inexorably linked to Mamirauá and the flooded forest of central Amazônia. What he was able to accomplish there arose from what he was and what he brought to bear. At his core, Márcio was a scientist, and the scientific approach would inform his actions over the years. In 1975, Warwick Kerr invited him to be a staff member at the Instituto Nacional de Pesquisas da Amazônia (INPA). Manaus was a great base for a young primatologist, and Márcio was able to study *Saguinus bicolor* and *S. midas* tamarins almost in his backyard. His studies of bearded saki monkeys (1977–1979) would take him further afield, to the Rio Aripuanã in southern Amazônia, and he would bring back his Masters thesis, "Observações sobre a ecologia e o comportamento dos cuxiús (*Chiropotes albinasus e Chiropotes satanas*)," awarded by the Federal University of Amazonas. His academic advisor was the great scholar Paulo Emílio Vanzolini, who Márcio was later to honor by naming a new species of squirrel monkey for him (*Saimiri vanzolinii*; Ayres 1985). For his PhD, Márcio attended the University of Cambridge in England, working under David Chivers, but his heart remained in Amazônia, and he undertook studies of the white uakari in a new place—Mamirauá, which he had first noted in a publication coauthored with Robin Best in 1979. His dissertation, awarded in 1986, entitled "Uakaries and the Amazônian flooded forest" established him as a preeminent primatologist in the field.

From the start, Mamirauá would pull Márcio further and further from the halls of academia. Inspired by the area since his first visit, Márcio and the nature photographer Luis Claudio Marigo in 1982 petitioned the federal government (specifically the Secretaria Especial de Meio Ambiente—SEMA) for the area to be protected. The resulting 260,000 ha reserve, the "Estação Ecológica do Lago Mamirauá" was officially created in 1983. But the reserve was on paper only, with no management authority; and by 1986, with the abolition of SEMA as part of a governmental reorganization of the Instituto Brasileiro de Desenvolvimento Florestal (IBDF), even the paper establishing the reserve was lost in the mists of governmental bureaucracy.

Márcio's thinking about conservation, and how protected areas should be managed, would change during the subsequent period between 1983 and 1985, when he was studying the uakari monkeys in Mamirauá. During his primatological studies, Márcio developed a deep respect and concern for the *ribeirinhos*, the people of the flooded forest. Many *ribeirinhos* were increasingly economically and politically marginalized by commercial development in the Amazon basin, and the people living between the Solimões and the Japurá rivers were no exception. Márcio recognized that the *ribeirinhos* depended on the integrity of the ecological system, and they had an interest in its conservation. Increasingly, Márcio would marry his interests in the conservation of the natural world with his concerns for the people who lived in that world, and he would bring to bear the tools of his trade—science. The result would be a new model for conservation in the Amazon.

On his return to Brazil in 1986, Márcio joined the Museu Paraense Emílio Goeldi, taking over the direction of the Núcleo de Primatologia, where he was to meet and supervise many of his future collaborators. Márcio continued his scientific research in Mamirauá, and it was through the Museu Goeldi that Márcio would propose

to the state of Amazonas that a reserve around the Mamirauá be reestablished. In March 1990, Amazonas State responded by decreeing the Estação Ecológica Mamirauá. In and of itself, this decree was noteworthy. Not only did a Brazilian state bring a federally protected area under its administrative jurisdiction, but it also hugely expanded the area to 1,124,000 ha. Márcio (in a letter to JR, May 8, 1990) noted "by coincidence, it englobes the entire range of the white uakari." We can be assured that this was no coincidence at all (!), and it provides a glimpse of what would become Marcio's legendary ability to build coalitions in support of his vision.

The year 1990 was also when the strands of Márcio's interest in science, conservation, and rural development all came together. Márcio had long encouraged colleagues from around the world to visit Mamirauá. In June 1990, W. D. Hamilton, whose theory of kin selection had revolutionized sociobiology, spent two weeks in Mamirauá with Márcio, and began an involvement with the site that would last Bill Hamilton's lifetime. Over the next 15 years, dozens of international researchers would collaborate with an even greater number of Brazilian scientists. Mamirauá would be the cradle of a plethora of firsts: the first study of white uakaris (*Cacajao*) in the wild; the first socioecological study of the three-toed sloth in Amazônia; the first ecological study of *Arapaima* fish in the wild; the first long-term study of black caiman (*Melanosuchus niger*) in the wild; the first radio-telemetry study of the river dolphins *Inia* and *Sotalia*; the first long term ecological study of manatees (*Trichecus inunguis*) in Amazônia; the first behavioral ecology study of Amazonian electric fishes. 1990 was the same year that Márcio joined the Wildlife Conservation International in New York (later the Wildlife Conservation Society), and would eventually become its Carter Chair in Rainforest Ecology. WCS is a conservation organization with an interest in conserving wild lands and wildlife, and it was interested in supporting conservation efforts in Mamirauá. WCS worked with the Museu Goeldi to submit a proposal to the British Overseas Development Agency (ODA)—a government agency with the mission of international rural development—to support the preparation and implementation of a management plan for the Estação Ecológica Mamirauá. The conservation of Mamirauá and the sustaining of the lives of its inhabitants were becoming both national and international efforts.

Right from the start, the management plan for the Estação Ecológica Mamirauá recognized the importance of the area for conservation and also the rights and livelihood needs of the indigenous *ribeirinhos*. Central to the plan's strategy was the zoning of the reserve, thus allowing a range of different uses and activities. The responsibility for decisions on how to zone different parts of the reserve, what management systems to put in place, what to protect and what to use, would fall to the local communities. The role of science was to provide the information so that decisions were made on the basis of scientific knowledge.

The reserve was zoned into areas for permanent settlement, for subsistence use, and for protection. Use areas were further subdivided into lakes for fisheries, areas for forestry and wildlife exploitation, and areas of ecotourism. Fully protected areas provided refuges for exploited species, and reserves for species of conservation concern, and opportunities for scientific research and monitoring. The broad management goals across the reserve were to (1) reduce the conversion of natural habitats

inside the reserve, (2) encourage the use of natural resources (fisheries, timber, wildlife, and non-timber forest products), but at sustainable levels, and allow the recovery of the natural populations, and (3) adapt local harvest by local communities to minimize environmental impact while channeling economic production into social betterment. By managing natural systems, and improving the quality of life of the *ribeirinho* communities, the aim was to reduce human pressure on the natural systems.

It is the governance structures developed at Mamirauá that are truly innovative, and reflect Márcio's understanding of the need to integrate conservation with the needs of local communities in a context of scientific knowledge. When Mamirauá was established by the state of Amazonas, it was agreed that management would involve both the state government and representatives of civil society. To that end, Márcio and his colleagues founded an NGO, the Sociedade Civil Mamirauá (SCM). This mechanism allowed the active involvement of the local communities in the management of natural resources and the administration of the protected area. The principle was that rules and regulations over common-pool resources would be decided democratically, as they affect all residents and other social actors in the vicinity of the protected area. This idea followed the approach developed by the Catholic Church, which had used this method of community organization in the middle reaches of the Solimões river over the preceding decades.

Management structures were originally developed at two levels. The first was the sectors, each composed of geographically clustered communities, which were charged with managing common resources. Community leaders met every three of four months to deliberate on zoning, protection, and surveillance issues within each sector. The second was the General Assembly, where elected representatives of each sector and each community met once a year to discuss the management of the protected areas with the other institutions with interests in the reserve. Only community representatives had the right to vote in general assemblies, although invited participants took part in discussions. Between 1993 and 2005, the General Assembly was the most important forum for decision-making at Mamirauá. More recently, in compliance with the current legislation creating the Brazilian National System of Protected Areas (SNUC, approved in 2000–2001), the General Assembly has been replaced by a Deliberative Council. With about 20 seats, the Council is chaired by the representative of the environmental authority of the state of Amazonas (IPAAM-SDS). Fifty percent of the seats are assigned to representatives of the local communities, their associative bodies and grassroots organizations; while the other 50% are held by representatives from the federal government, law enforcement agencies, universities, SCM and the Mamirauá Institute, and the private sector.

The result was management that was good for the conservation of natural resources and good for human livelihoods. Compliance with the plans for natural resource management and adapting traditional management techniques built back fish stocks, controlled exploitative logging practices, reduced the conversion of forest land, and rebuilt populations of species of conservation concern. New economic activities (such as ecotourism and new agricultural products) were introduced.

Products from the reserve were more effectively marketed, and specific market niches were developed. The result was an increase in average household income, better access to healthcare and clean water, and an improved quality of life.

The management model for protected areas developed at the Estação Ecológica Mamirauá proved to have wide applicability across Amazônia, and now into other parts of Brazil. Like the protected area systems of many countries, historically Brazil had established reserves in Amazônia with the expectation that eventually parks and protected areas would not include resident human populations (the exceptions to this were the indigenous reserves, but the only resident populations in these areas were the indigenous residents; and much later, the extractive reserves). Yet this approach was difficult in many parts of Amazônia, where people lived within the boundaries of parks and protected areas, where they often had customary or traditional rights to land and resources, where removal of resident human populations was unfeasible or unethical, and where national and state governments did not have the capacity to manage the protected areas.

The efficacy of the Mamirauá model was recognized in 1996 when the new category of reserve was established by the State of Amazonas: the Sustainable Development Reserve. The Reserva de Desenvolvimento Sustentavel (RDS) Mamirauá was its first expression. The reserves were designed to conserve biodiversity without the removal of the resident human population by involving local people in participatory management. The Reserves recognized that the nonsustainable use of natural resources degrades biodiversity and threatens the livelihoods of people, and that resident rural populations have legitimacy and rights to their natural resources. Building on the lessons learned from the Estação Ecológica Mamirauá, the concept of the Sustainable Development Reserve recognized that effective management first required the prioritization of the resource rights of resident people over "outsiders" or "nonresidents" (which effectively excludes capitalized commercial operations which act as "free riders"). As management structures are strengthened, this categorical exclusion can be replaced by more subtle rules that seek to avoid competition and social conflict between residents and outsiders, often allowing outsiders access to resources in specified zones. The Reserve concept also encourages the development of effective and legitimate institutions to manage resources through (1) appropriate combinations of legislation and law enforcement, (2) scientifically grounded management plans, and (3) technical support.

Much of the success of Mamirauá was a consequence of the model itself-participatory conservation by poor rural populations; the development of effective and legitimate institutions; appropriate combinations of legislation and law enforcement; scientifically grounded management plans; the creation of new economic vehicles; etc. But Mamirauá was also a success because it involved a multitude of different institutions, global, national, and local. As a result, science flourished, local institutions were built, economic experiments were developed, and political alignment happened. Funding and support, both technical and scientific, came from Amazonas state, Brazilian federal authorities, institutes and foundations in Brazil, and international foundations and agencies. The creation of this network was the work of an individual, a variable both intangible and difficult to replicate. Márcio had

a wonderful ability to enlist support, from both the governmental and nongovernmental world, from inside and outside of Brazil. As a member of a prestigious Brazilian research institute, and a staff member of an international NGO, Márcio was able to draw upon expertise and capacity when needed, both nationally and internationally. Márcio was the charismatic and sympathetic focus for Mamirauá. Amalgamating all that support was a special gift, and Márcio used it very efficiently.

Sustainable Development Reserves are now a recognized and effective conservation unit within Brazilian legislation. In 2000, the category RDS was made a part of SNUC (the Brazilian system of conservation units). Today there are at least 20 RDSs in Brazil, with at least three outside of Amazônia. RDSs have been created by municipalities, states, and by the federal government. The RDS as a conservation unit is a legacy of Márcio Ayres, who recognized that it is possible to integrate the goals of protecting nature and supporting human livelihoods in rural settings. Central to that integration was the role of scientific knowledge, which informed decisions and allowed decision makers to assess and analyze the consequences of their decisions.

# The River-Refuge Hypothesis and Other Contributions of Márcio Ayres to Conservation Science

**Miguel A. Pinedo-Vasquez and Liliana M. Dávalos**

**Abstract** For more than a century, biogeographers have sought to explain the large number of species found in Amazonian forests. The role of rivers as barriers to dispersal was recognized early on and this was the first evolutionary hypothesis to explain Amazonian diversity. Most of the recent debate on speciation in the Amazon has focused on the role of Pleistocene refugia. The methods of refuge biogeography helped shape early conservation priorities in Amazonia, although actual plans did not directly depend on the conceptual strengths or weaknesses of refugia biogeography. These approaches viewed people mostly as threats, though not always explicitly. Based on his work on primate distribution, Márcio Ayres formulated a synthetic speciation theory, the river-refuge hypothesis. The river-refuge model successfully resolved some of the historical and technical challenges of the earlier hypotheses. His work in *várzea* conservation, informed by this conceptual breakthrough, recognized that the maintenance of processes is at least as important as species numbers in prioritizing action. The work of Márcio Ayres broadened the scope of conservation in Amazonia by moving beyond the model of people-as-threats, and this was as great a conceptual contribution to conservation as anyone could make.

**Keywords** Refugia • River-refuge • Speciation • Connectivity • Conservation of dynamics

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## 1 Introduction

Marked differences in species richness and composition between different regions of the world motivate all biogeographic theories (Croizat 1981; Darlington 1957; Morrone and Crisci 1995; Prance 1982). The humid forests of the Amazon, home to thousands of plant and vertebrate species, captured the attention of the first biogeographers precisely for this reason (Wallace 1876). The continuity of Amazonian forests, however, proved puzzling from the beginning. Unlike island archipelagoes, such as the Galapagos or Hawai'i, Amazonia seemed to lack the isolating barriers that would explain differentiation into species (Wallace 1881). Although gradients in precipitation could explain biotic turnover across regions in Amazonia, they still cannot explain the central question of Amazonian biogeography: speciation (Haffer 1997).

Alfred Russell Wallace himself advanced a first explanation for speciation in Amazonia: the river hypothesis (Wallace 1853). The network of Amazonian rivers developed as recently as the Pliocene and Pleistocene (over the last five million years), leading Wallace and subsequent authors to propose that riverine barriers separated once continuous populations, leading to differentiation and, eventually, speciation (Bates 1863 Mayr 1942). The natural breaks that rivers and floodplains produce in the forest would amount to a species pump (Capparella 1988). The main criticism against early versions of the river hypothesis is that the forest, rivers, and floodplains developed together, so that the model of large continuous populations suddenly partitioned by incipient rivers was flawed (Fjeldså 1994; Patton et al. 1994). Current variants of the river hypothesis rely on recent changes in river courses, or dispersal across the river barrier to explain isolation on opposite banks. The distributions of species, subspecies, and morphs of butterflies, birds, and primates have all been thought to support the river hypothesis (Bates 1863; Capparella 1988; Hershkovitz 1977).

The most prolific of the Amazonian speciation hypotheses over the last 40 years is not concerned with the role of rivers, but rather with the formation of isolated forest enclaves or refugia (Haffer 1969; Vanzolini and Williams 1970). The refugia hypothesis posits that dry climate associated with glaciations made Amazonian forests recede into relatively small refugia. During interglacial periods, when humidity rose again and the forests grew back, isolated distinct species then expanded from the refuges where they had evolved (Haffer 1969; Vanzolini and Williams 1970). Criticism of this hypothesis mounted as it became clear that most species differentiation predates the Pleistocene glaciations (Ribas et al. 2005; Whinnett et al. 2005). Proponents of refugia argue that the relationship between climate, forest cover, and Amazonian speciation extends back to the Tertiary, so that the hypothesis can explain diversification at different temporal scales (Haffer 1993). Identifying the refugia has also proved difficult for biogeographers; refuges did not match across taxa (Oren 1982). Additionally, proposed plant refuges were found to be artifacts of data collection (Nelson et al. 1990), and vertebrate refugia roughly correspond to areas of endemism also isolated by rivers or corresponding to rainfall gradients (Endler 1982; Hayes and Sewlal 2004).

Both climate change and river dynamics have had effects on the distribution of Amazonian forests and their biota. Márcio Ayres and colleagues formulated a synthesis of the river and refugia hypotheses: the river-refuge model (Ayres and Clutton-Brock 1992). This hypothesis argues that during glaciations, Amazonian forests contracted but did not fragment. The contractions reduced forest cover at the headwaters of the Amazonian rivers, effectively isolating populations downstream. By identifying current areas of endemism as the major refugia and recognizing the intertwined history of forests and rivers, this hypothesis builds on criticisms of previous models. The distribution of primates and birds has been used as evidence for the river-refuge model (Ayres and Clutton-Brock 1992; Capparella 1991; Martins et al. 1988; Wallace et al. 1996).

The debate on Amazonian speciation spans the careers of some of the best biogeographers of the last century, but its interest extends beyond the discipline and has practical consequences. From the beginning, the discussion on the conservation of Amazonian forests was colored by speciation models – particularly the refugia hypothesis – and predictions of the model sometimes determined the designation of protected areas (Lovejoy 1982, 1983). In this light, speciation hypotheses are not just models of how history has shaped Amazonian biota; they are also blueprints for a future of conservation under human stewardship (Lovejoy 1982). At the same time, speciation hypotheses are not the only consideration in protecting Amazonian forests, nor have they been the most important variable in any such decision (Lovejoy 1983). In this paper we examine how hypotheses of speciation helped shape the Amazonian conservation agenda, with a particular focus on the work of Márcio Ayres and colleagues. Ayres was extraordinary in his profound interest in theoretical issues and appreciation of their importance in defining conservation goals, while he also engaged in applied conservation work in Amazonia. His theoretical and practical preference was to be inclusive, to appraise the possibilities of multiple causation, and use every opportunity for effective conservation. By assessing his approach to conservation of the *várzea*, perhaps the most dynamic and complex environment of Amazonia, we ask how his theories influenced current discussions on conservation.

## 2 Implications for Conservation

### *2.1 A One-Way Street between Speciation Theories and Amazonian Conservation*

In 1981, when one of the most influential studies on Amazonian conservation was completed (Wetterberg et al. 1981), the refugia model was the dominant hypothesis in speciation studies. With its focus on narrowly endemic species (as opposed to broadly distributed species), its insistence on a general biogeographic framework across many taxa (as opposed to the status of one or a few populations), and its

appeal to an independent value system (history or, in the case of conservation, the protection of species), the refugia hypothesis itself was a precursor of subsequent assessments. The endemic, multitaxa, value-maximizing approach to Amazonian conservation was an innovation at a time when most conservation efforts were focused on flagship species and struggling to defend nature for nature's sake (Wetterberg et al. 1981).

Refugia offered theoretical support to conservation decisions that had to be made with whatever data were available (Oren 1982). Conservationists quickly realized that data on even intensively studied Amazonian birds and butterflies were scarce compared to, say, the North American or British breeding surveys. If history had shaped Amazonian biotic communities in such a way that the ghosts of speciation past determined its areas of highest diversity, conservation of refugia is justified, as the general speciation model would also have affected other groups of plants or animals (Lovejoy 1982). But the connection between refugia and Amazonian conservation only went so far: conservationists realized early on that the process of generating diversity, although critical in shaping a general conservation approach, was not as important as the fact of diversity (Lovejoy 1983). Protected areas could be, and were, justified on the basis of the species found in them, independently from how those species got there (Wetterberg et al. 1981).

Amazonian conservation benefited from the conceptual innovations of refugia without committing to the speciation model itself. To this day, conservation prioritization proceeds by using the tools first applied by refugia theorists: the distributions of many endemic or threatened species and the criterion of maximizing the number covered by areas at different scales (Williams et al. 2002). When watersheds were introduced in Amazonian priorities as management units, they were justified by defensibility rather than by the emerging river-refuge hypothesis (Peres and Terborgh 1995). This confirms the independence of conservation from speciation mechanisms, while stressing the difficulties in translating a hypothesis into a conservation plan: defensibility characterizes a forest only insofar as people enter the picture.

The variable missing from speciation hypotheses and yet crucial to any biogeographic analysis – whether conservation-related or not – is the people of Amazonia. Plant refugia were correlated to accessibility, the establishment of research centers, and sampling (Nelson et al. 1990). Bird refugia also reflect these biases (Nores 1999), which in turn correspond to how people have colonized the region. For biogeographers, the collecting localities and samples provided accurate measures of diversity, at least until the biases were quantified. But conservationists knew from the outset that these areas were properties, part of development plans, colonization frontiers, or indigenous territories (Peres 2001). These were human landscapes, even if the stated goal of some conservation plans was to transform a landscape into a reserve for the "absolute" protection of the biota (Peres and Terborgh 1995). The awareness of people in conservation is pervasive; it has to be, since one of its premises is the anthropogenic threat. Threats are always on the brink of transforming an ecosystem and reducing its biodiversity unless something is done to stop them (Burgess et al. 2006; Pitman and Jorgensen 2002). Threats are the catalyst that inspires conservation plans and justifies their urgency. It is at this point that the

relationship between speciation theories and conservation matters the most, and the next section will explain why.

### *2.2 Parks, Reserves, and Networks*

It was relatively common at the time of the first broad Amazonian conservation plans, and for the next 20 years, to designate maximally protected areas as "parks" (Peres and Terborgh 1995). Despite being almost current, the term was inherited from 19th-century colonial usage (Neumann 1996, 1997). Aside from the possible social or political implications this etymology has, it carries a particular view of ecosystems and ecological communities. If, as many before the refugia hypothesis thought, Amazonian forests owe their high diversity to the stability of conditions over long periods of time (Darlington 1957), then maintaining whatever those conditions are will achieve the goal of conserving species. If changes in climate, geology, or hydrology have driven speciation in the region, then it is the process of change and not the stability of conditions that is needed to conserve species.

Over the last two decades conservation plans in Amazonia have embraced networks and corridors, in recognition that it is a dynamic environment that needs conserving if we are to maintain both species and ecosystem function (or even the potential for evolution). At the same time, Amazonian conservation has departed even further from speciation hypotheses. This is in part because discussion on Amazonian speciation continues unabated (Nores 2004), and conservation can hardly be justified on the basis of controversial science. Instead, conservation plans continue to unfold based on practical approaches such as better sampling, extensive mapping, large conferences of experts on different Amazonian taxa, and, of course, an up-to-date measure of anthropogenic threats (Laurance et al. 2002; Laurance et al. 2000; Laurance et al. 2004). The looming threat of climate change has inserted itself into the mainstream (Laurance et al. 2004), but this has not renewed interest in speciation models, even though conservation really is about maintaining processes. And yet, even as an urgent measure to preserve the "last of the wild," plans for megareserves presuppose an understanding of both speciation and climate projections (Peres 2005). What would be the point of protecting an endemic-rich zoo that was expected to lose most of its species to increasingly arid conditions? If the future is what we care about, then the speciation process matters very much in our conservation choices.

## 3 Márcio Ayres on the *Várzea* and Conservation Science

Ayres acknowledged the conceptual and practical implications of the flood pulse concept in Amazonian ecosystems. The flood pulse concept links the maintenance of species diversity and ecosystem function to the seasonal cycles in the *várzea*

(Junk et al. 1989). In his own studies, Ayres had argued that the *várzea*'s landscape diversity results from the erosion, transport, and deposition of sediment that leads to the formation and erosion of islands, river channels, and lakes (Ayres 1986b). In turn, he observed that the biota of the *várzea* is adapted to its dynamic landscape and cannot survive without the river dynamics (Ayres 1986a; Ayres and Johns 1987). This intimate relationship with a biota that depends on change helped shape his hypothesis on Amazonian evolution and his conservation efforts.

The work of Márcio Ayres on *várzea* conservation highlights the complexity in defining, selecting, and establishing conservation areas. The river-refugia hypothesis broadened the scientific basis for conservation by incorporating simultaneous historical events into a single framework (Ayres 1986b; Ayres and Clutton-Brock 1992). The results of his work proved that fragmentation and recolonization are continuous processes that shape species diversity and relative abundance in the *várzea*. Data on the flora and fauna (in particular primates) showed that rivers function as ancient and present physical barriers, and as pathways enabling the dispersal of species enriching Amazonian landscapes. Based on this work, Ayres designed new methods to analyze how Amazonian biotas assemble over time. Ayres directly applied his theoretical findings by establishing the Mamiraua Sustainable Development Reserve as a corridor including all of the elements relevant to the *várzea*'s current dynamics, including people. The river-refuge hypothesis became, then, a practical conservation tool, rather than an abstract framework to explain diversity.

The insistence of Márcio Ayres on the need for conserving biological corridors or networks was at first challenging to the conservation community. How to accommodate local people that are affected directly or indirectly by the establishment of biological corridors or networks? His experience at Mamirauá showed that local people could be facilitators of, rather than an impediment to, conservation. Such an outcome, however, was not automatic and depended on trust built over the course of many years of research and conservation work on the ground. Just as the river-refuge hypothesis combined elements from competing biogeographic scenarios, his approach to conservation was synthetic and combined elements of radical preservationism with more practical conservation approaches. This approach reduced the scientific uncertainty surrounding conservation decisions, while maintaining the ecosystem function and species richness of a vast region. The work of Márcio Ayres broadened the scope of conservation in Amazonia by moving beyond the model of people-as-threats, and this was as great a conceptual contribution to conservation as anyone could make.

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# Part VI

# ProVárzea's Impact on Regional Development

**Mauro Luis Ruffino, Maria Clara Silva-Forsberg, Marcelo Derzi Vidal, Marcelo Bassols Raseira, Alzenilson Santos de Aquino, and Raimunda Queiroz de Mello**

**Abstract** The Floodplain Natural Resources Management Project (ProVárzea) was a project executed by the Brazilian government with support of international agencies aimed specifically to implement policies for the Amazon floodplains. ProVárzea managed to initiate an exchange of popular knowledge with scientific knowledge, organizing and checking information from these two different sources, encouraged the comanagement of local floodplain natural resources, created an opportunity for an exchange of information, and invested in people, not only in institutions, by promoting knowledge via training. The project has produced a change in the paradigm that used to rule environmental projects concerned uniquely with fauna and flora, has contributed to a better quality of life in the area, has

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minimized some uncomfortable situations, and has strengthened institutions in their right to question and demand actions from the government.

**Keywords** Comanagement • Fisheries • Amazon • Local development • Floodplains

## 1 Introduction

The project on Floodplain Natural Resources Management (ProVárzea) is the initiative submitted to the Pilot Program for the Conservation of the Brazilian Rainforest (PPG-7) by Brazilian Institute of Environment and Natural Resources (Instituto Brasileiro do Meio Ambiente e dos Recusros Naturais Renováveis – IBAMA). The ProVárzea project is coordinated by the Amazon Coordination Secretariat of the Ministry of the Environment, with the objective: *to establish the scientific, technical, and political bases for socially and environmentally sustainable conservation and management of natural resources of the várzea of the Central Amazon Basin, with emphasis on fisheries resources.* The emphasis on fisheries is consistent with the general objective of promoting the rational use of the floodplain resources to maintain this activity as the base of the diet and main source of income of the riverbank communities. Moreover, fisheries resources represent a synthesis of interactions among the diverse components of the floodplain ecosystem.

*The main problems addressed by ProVárzea include:*

1. Environmental degradation. The floodplain ecosystem is threatened by the destruction of habitats, lack of management of fisheries, and predatory timber exploitation. The destruction of habitats (especially removal of forest cover) for the production of beef cattle and buffalo reduces both food supply and habitat for fish, affecting severely the ecosystem's food chains, and having a negative impact on riverbank vegetation, mainly aquatic macrophytes. Direct consumption of this vegetation by buffalo, as well as trampling, results in the reduction of this type of vegetation, which is an important habitat for fish, mainly during the low-water season in the floodplain.
2. Overexploitation. Fish species that have suffered most as a result of fisheries include the piramutaba (*Brachyplatystoma vailantii*), tambaqui (*Colossoma macropomum*), and pirarucu (*Arapaima gigas*). These species have in common the fact that they are in high demand by consumers, reach relatively large sizes, and have low growth rates.
3. Social conflicts. The reduction of fish supplies has caused conflicts between the professional and small-scale *riverine* fishers over the right to use these resources. The meager governmental presence in the region has contributed to an intensification of these conflicts. In the absence of the government, local organizations (*riverine* communities) are developing management systems that are independent of the formal management system. Although these initiatives have positive and innovative aspects, they lack legal support, scientific bases, and mechanisms that would integrate them into a model for floodplain natural resource management.

4. Insufficiency of management systems. Although there are some basic studies on floodplain ecology (structure, function, and biodiversity), there is a lack of applied studies and effective management systems for this kind of environment. Consequently, natural resource practices currently in use tend to be extensive and involve little management. For example, despite its agronomic potential, floodplain agriculture is still in crisis—without solutions to environmental degradation, with low-profit margins, and with few markets for its products.
5. Absence of specific policies. Public policies concerning the Amazon have been neglecting the specifics of the floodplain ecosystem. In general, these policies (planning, agricultural development, conservation, monitoring and control, etc.) are excessively generic and focused on primary lowland rainforests. This is partly due to the fact that the floodplain area is small compared to the entire Amazon, but the floodplain indeed has great ecological and economic importance.
6. Ineffective management. In the floodplain area, the size of the area, the complexity of the environment, and the diversity of economic activities pose a great challenge for public administration. The current system, which is centralized and with little community involvement, has proven to be incapable of organizing the processes of settlement and the use of natural resources.

## 2 Intervention Strategies

In response to the problems of use and conservation of the floodplain's natural resources, ProVárzea has employed three types of interventions:

1. Production of strategic information to assist the creation of more specific and coherent public policies for the floodplain, with the support of Strategic Studies.
2. Development of innovative and economically, socially, and environmentally sustainable systems of managing the natural resources of the floodplain. This will be achieved with the support of the Promising Initiatives developed and implemented by floodplain residents, *riverine* communities, nongovernmental organizations and organized fishermen groups. These initiatives promote exchange of experiences, and provide technical assistance and the promotion of better practices.
3. Development and testing of a pilot integrated system, that is decentralized and community-based, of Monitoring and Control of the use of the natural resources of the floodplain, in two pilot areas, to produce and promote knowledge that can be used in floodplain natural resources management.

## 3 Main Results

The ProVárzea initiative took on an innovative role in the context of governmental strategies, and above all, changed an institutional paradigm, when it began to invest in people as changing elements that can provide sustainability (or not) through their use of the natural resources.

The principal advance made in influencing public policies was without a doubt ***the identification of common environmental issues among diverse policies that affect the Amazon floodplain***, particularly with regard to:

- *Legalization of land tenure in floodplain areas:* Proposals which were presented by the ProVárzea study have been discussed and accepted by the Federal Patrimony Secretariat (**Secretaria de Patrimônio da União - SPU**), the National Institute for Colonization and Agrarian Reform (**Instituto Nacional de Colonização e Reforma Agrária—INCRA**), and IBAMA. The rules and procedures were established, and the process started, in the states of Amazon and Pará.
- *Priority areas for the conservation of floodplain biodiversity:* These areas were identified by the study carried out by ProVárzea. Based on these results, it was proposed that in order to include most representative biological communities in protected areas, Conservation Units should be created throughout all floodplain areas of the Solimões-Amazon. The recommended minimum area in each zone would be: (a) estuary – 4,200,000 ha; (b) Almeirim-Santarém – 1,300,000 ha; (c) Santarém-Manaus – 2,250,000 ha; and (d) Manaus-Tabatinga – 4,600,000 ha. Following these specifications, discussions about these areas took place through public consultations in local seminars promoted by the project, which resulted in the designation of 18 areas in the Parintins/AM seminar, six areas in Tabatinga/AM, and seven areas in Santarém/PA, totaling 31 proposals for Conservation Units. These results were made available to the Amazon Region Protected Areas Program (Programa Áreas Protegidas da Amazônia), as well as to the National Council of Traditional Populations (Conselho Nacional de Populações Tradicionais—CNTP), and are providing support to the Ministry of the Environment (MMA) in the revision and update of the "Map of Priority Conservation Areas, Sustainable Use, and Benefit Sharing for Brazilian Amazon Biodiversity."
- *New proposals for organization of fisheries in the Amazon basin:* These were developed as a result of studies of the fisheries sector—of the great migrating catfishes and other fish species with market value—and culminated in the publication of a series of specific regulations for the closed season for tambaqui, and in the creation of a Committee for Sustainable Use and Management of Fisheries Resources in the Amazon Basin (Comitê de Gestão do Uso Sustentável dos Recursos Pesqueiros da Bacia Amazônica—CGBA), composed of government agencies, public administration agencies, the private sector, and nongovernmental organizations. Each of these entities has responsibilities that include: (1) to discuss, propose, and monitor the application of management measures for the sustainable use of fish resources in the Amazon basin; (2) to carry out analyses and maintain information systems of biostatistical data on the fishery resource of the Amazon basin, as well as on the economic and social components of fishing activities; (3) to propose ideas and express opinions about the terms of technical cooperation, including holding international meetings on fisheries resource management and related subjects; and (4) to monitor the implementation of work carried out by the Scientific and Monitoring Subcommittees and the Management Groups (Subcomitês Científico e de Acompanhamento e dos

Grupos de Gestão) of the states, and other instruments for advising and supporting the work of the CGBA.

With support to promising iniciatives, ProVárzea promoted the development of innovative management of floodplain natural resource systems that is environmentally, socially, and economically sustainable; and it fortified social organizations so that these subprojects could work as catalysts for change in their regions, and create methodologies and provide lessons that could be disseminated and multiplied in other areas and regions. Thus, ProVárzea promoted ***sustainability in multiple dimensions: social, environmental, economic, cultural, and ethical***.

In all, there were 25 subprojects supported by ProVárzea with R$10 million allocated for training, management, transportation, and marketing of products. Indicators of ProVárzea's successes up to now include the following:

- In all, 115,486 people were directly reached (about 13% of the population in the Amazon floodplain area) in 32 counties (*municípios*) of the states of Amazonas and Pará by ProVarzea-supported projects.
- About 100,266 ha of terrestrial and aquatic ecosystems were managed. A significant part of the managed water area is under the regulation of community fishing accords.
- A positive impact on the associative/cooperative process was also observed; new institutions were created by the projects or through their partners:
    - A cooperatitve for the production of natural aromatics, that is marketing its products in the states of Rio de Janeiro and São Paulo, has been established, and samples of its products have already been placed in Ireland, Germany, and US trade fairs.
    - Two fishermen's associations were created in the São Francisco River area in response to dissemination of the successes of a project implemented by the Movement for Fishers of Western Pará and the Lower Amazon (MOPEBAM); and four community associations were strengthened by the project overseen by the Federation for Social and Educational Assistance (FASE)—these associations today receive resources through subprojects approved by ProVárzea/IBAMA.
- The building of social capital through the enhancement of fishers associations increased, as evidenced in both financial terms and in the achievement of important social and political milestones, including the election of four Councilmen (*vereadores*) who were Board members of the Fishers Associations of Santarém (Z-20), Juruti (Z-42), Prainha (Z-31), and Óbidos (Z-19), as well as of a Secretary of Fisheries and 12 County Health Council members.
- An increase in women's participation; specifically, an increase of 32% in the number of women occupying directors' positions in community associations supported by ProVárzea.
- One hundred and fifty-six training courses were conducted by the projects, including training in regional cooking for food co-op members, environmental legislation, distillation and extraction of essential oils, management of lakes, the

setting up of demonstrations of forest management for timber, and others; the courses reached about 2,300 people.

- New management techniques were developed and improved, highlights of which included:
  - The management and marketing of freshwater shrimp (*Macrobrachium amazonicum*), resulting in a doubling of the average size of shrimp caught, a reduction in costs, and an increase of 67% in family incomes.
  - The management of native stingless bees (*Mellipona* spp.), with a focus on honey production and improvement in the pollination of natural forests. Today, there are about 1,200 beehives in standardized boxes that have been distributed and replicated in Parintins, Alvarães, Careiro da Várzea, Altazes, Maués, and Silves, in the State of Amazonas.
  - Extraction, improvement, and marketing of essential oils of floodplain plants—including cumaru, rosewood and white breu, puxuri, andiroba, and copaíba—that are used to produce soaps, candles, body oils, antirheumatic creams, incenses, and aromatic sachets. In all, ten new products were created, are being marketed, and are generating income for the communities.

In the area of development and testing of co-management systems for floodplain natural resources, ProVárzea ***promoted participation and social control*** as a way of sharing responsibility with the community in decision-making processes. These initiatives included, for example, community management of fisheries, which has further ***strengthened the National Environment System—SISNAMA.*** The goal of this program is the sharing and decentralization of the management of relevant policies among states and counties (*municípios)* through the development of mechanisms of monitoring and supervision. This allows for the participation of the community in the Environmental Volunteer Agents program, and enhances the efficiency of environmental agencies through the implementation of Integrated Environmental Defense Units (*Unidas*), that bring together IBAMA, military and civilian police forces, the *município* Secretariat of the Environment (*Secretaria Municipal de Meio Ambiente*), and the Port Authority (*Capitania dos Portos*).

Important progress in policies and legislation related to community management was also made. In general, changing processes focused on strengthening community participation in management. ProVárzea consolidated the process of community management of fisheries as a management instrument for the Amazon basin within the jurisdiction of IBAMA with the publication of the regulation "Instrução Normativa N°. 29" that regulates and recognizes fishing accords as instruments of fisheries organization and of joint management of Amazon fish resources. More than 400 people took courses on the subject, among them IBAMA environmental analysts, members of state environmental agencies, NGOs, and community leaders who promote the development of this system in other states of the Amazon region. The main limitation proved to be the organizational capacity of the group and not their technical capacity, because with strong community bases, the group will be able to better decide on technical issues. The problem of sustainable management

of natural resources is rarely one of lack of knowledge about environmental limitations. It is usually due to limited organizational capacity; and the challenge is to improve the capacity of communities to structure and create the conditions needed for relevant group action.

Beyond its support of projects, ProVárzea tested new models of floodplain natural resource co-management, with excellent results, including:

- The establishment of an interinstitutional system for supervision and monitoring —named the Integrated Environmental Defense Unit (UNIDA)—created in Santarém, but currently being expanded to other cities in western Pará.
- The promotion of popular involvement and community monitoring through:
  - The institutionalization of the Environmental Volunteer Agents Program by IBAMA with lessons learned from the project; and
  - The creation and strengthening of city councils on Sustainable Agricultural Development and the implementation of Municipal Plans for Sustainable Agricultural Development.

## 4 Conclusions

The ProVárzea project has invested more in people, since without them it would be impossible to achieve its goal: to encourage a more appropriate and sustainable use of natural resources. This goal usually does not motivate the working people of the *várzea* to act, because their priority is to produce, to be able to feed themselves, and to maintain a life with a certain amount of dignity. Interaction between the communities and the world of scientists and technicians does not happen without some silent conflict, although both parties seek a common objective: to help native plants and wildlife continue to serve more than one function, including the economic, ecological, social, technical, cultural, and esthetic. Sustainable management is nothing more than action based on planning and research for a balanced use and exploitation of the natural resources of the *várzea*.

The sustainable management of floodplain natural resources is based on the fact that the party most interested in biodiversity is always the one that most depends on it. Daily life in Amazonia, for instance, has resulted in the rural population's amazing closeness with local vegetation, native or not. The rural family relies on plants for medicine, food for both humans and livestock, construction materials for houses and other shelters, fuel, and even ornamental products.

Considering all this, ProVárzea managed to initiate an exchange of local knowledge with scientific knowledge, organizing and checking information from these two different sources. Because of ProVárzea, the management program, in one way or another, resulted in an increase in the income of the families involved.

Generally speaking, the ProVárzea project encouraged the co-management of local floodplain natural resources, which are the primary sources of subsistence and

income for local communities. Some areas have already felt an impact in their quality of life, through improvements in nutrition and income, due especially to better organized and sustainable means of production.

In working to enhance local social resources, the project created an opportunity for an exchange of information. It also strengthened the organization of civil society by training leaders, mobilizing grassroots organizations, encouraging the establishment of fishing accords, and by training voluntary environmental agents. ProVárzea promoted interaction between governmental organizations and communities. It helped restore the rights of citizenship and the concept of being a citizen, especially among fishermen.

The project has invested in people, not only in institutions, by promoting knowledge through training. There has been some obvious improvement in agricultural technologies, fisheries, project management, and the promotion of public participation. The impact has been positive in the areas of empowerment of people and improvement in a range of activities including ecotourism, fishing, environmental education, lake management, and the management of plant and animal species, including shrimp.

There was no direct support given to infrastructure. However, there has been some investment in equipment for the institutions responsible for subprojects in the "promising initiatives" category. A further impact on infrastructural investment can be expected in the future, however, when pressure from communities leads to investment by governments. Demands for health care, education, and basic civil infrastructure are inevitable.

What the project has not accomplished yet is a significant increase in the financial resources of floodplain inhabitants. However, it has triggered an increase in income through ecotourism and the marketing of essential oils in Silves, and shrimp and timber management in Gurupá, two Amazonian *counties.* Income was also generated from the keeping of stingless bees and the sustainable production of buffalo. These experiences might further aid in generating income in other parts of the floodplain through information exchanges supported by the project. But we emphasize that such successful experiments are local in scale and limited to particular circumstances; they will become sustainable only when they reach commercial scale, develop strategies for production flow, and gain access to markets, since marketing is one of the main bottlenecks faced by production systems.

In conclusion, ProVárzea is a project that has gained support among floodplain communities who have taken note of these positive project results. There is, however, the possibility of ProVárzea being regarded as an institution rather than a group of projects with a defined beginning and end. Generally speaking, the project has produced a change in the paradigm informing environmental projects that are focused exclusively on plants and animals. It has contributed to a better quality of life in the area and has eased some problems. Even if this could no longer be achieved, the program still has contributed to the empowerment of people and has strengthened the ability of institutions to question and demand action from the government.

Floodplain management is directly connected with a decrease of poverty and vulnerability among the population. It builds social equality and enhances quality of life. However, such major impacts cannot be expected to happen during the life of the project, but, rather, in a near future. Such impacts include a better quality of

life for fishers, strengthened sustainable institutions, reduced vulnerability, and increased governmental effectiveness. ProVárzea has left a legacy of hope, new partnerships, and the promotion of stability.

## 5 Lessons Learned

- The project successfully discussed floodplain issues with its inhabitants, civil society, the private sector, and government officials using diverse methods and various appropriate tools (seminars, studies, published materials, inclusion of base organizations, etc.).
- Grassroots groups, such as fishers organizations, were greatly strengthened, and the project increased the involvement of women.
- A number of practices for managing natural resources by communities and counties (*municípios*) are being implemented.
- The use of a variety of tools and activities—research, seminars, workshops, articles, and the media—has led to a better understanding of the project at the regional level.
- The integration of different aspects of the project did not fulfill expectations because of late implementation and execution of some components and subcomponents, but also because of the great amount of teamwork required, as well as changes in donors and in local demands.
- The management philosophy behind the project, as well as the availability of resources, has caused the project to be regarded at times as an institution unto itself rather than as part of a government institution, namely, IBAMA.
- The connections among different levels of comanagement have not evolved as rapidly as expected, and much effort must still be put into expanding these connections.
- Large ambitious projects with a significant number of subprojects should be regarded as programs rather than projects; they can be successful, but require more time, especially when they involve other projects and contracts.
- The multiplicity of donors has promoted:
    - more legitimacy of the project in the eyes of civil society and the government;
    - different contributions in terms of emphasis, abilities, and points of view;
    - staff financial surveillance to keep the project going;
    - higher transaction costs in terms of human and financial resources (since each donor has its own financial system), as well as agreements and procedures carried out with the government;
    - disorganized project management planning by the donors, including disagreements about dates;
    - a clear view about how flexible donors must be towards their own administrative and financial procedures so that they can cooperate with other donors;
    - more management flexibility; however, it has also shown that it may cause the project to be too dependent on a single donor, without solving the problem;
    - understanding of the need to include donor issues like risks as part of the project framework.

# Guidelines for Public Policies and Investment in Science and Technology in the *Várzea*

**Maria Clara Silva-Forsberg**

**Abstract** This chapter summarizes and discusses some guides for an agenda for public policies and investment in science and technology on the *várzea* derived from all papers, sections, and debates that occurred during a conference on the matter. Also, it traces a short historical context of the investment in science and technology in the last decade in the Amazon, highlighting the demands and challenges that are to be faced in the development of the *várzea*. An integrated research agenda is presented with efforts to assess the many dimensions of conservation and development for the region. Finally, other detailed guides are stressed for each specific research area section, such as aquatic and terrestrial resource management, social and demographic dynamics, and socioenvironmental conservation strategies in Conservation Units (UCs).

**Keywords** Science and technology • Research agenda • Public policy • Conservation • Sustainable development

## 1 Introduction

The Amazon River floodplain (*várzea*), which covers part of the Brazilian states of Amazonas, Pará, and Amapá, as well as a part of Peru and Colombia, forms one of the richest ecosystem networks in terms of biodiversity and natural resource productivity. Supporting the survival of more than 1.5 million people, *várzea* areas cover around 6% of what is known in Brazil as Amazônia Legal. However, these areas are extremely vulnerable to environmental degradation. In the last several decades, the *várzea* has experienced rapid demographic and economic changes that have had negative impacts on its natural systems. At the same time, a few natural

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resource management projects have been developed in the *várzea*, including the Mamirauá Sustainable Development Reserve, designed and implemented by J. Márcio Ayres. Wide gaps in knowledge about the natural and human systems of this region still remain and need to be filled in to better inform specific political policies. This extensive area, for instance, is not yet differentiated from the *terra firme* in the census databases and analyses of the Brazilian Institute of Geography and Statistics (IBGE).

## *1.1 Challenges for a Science and Technology Agenda for Amazonia*

In the Amazon, the *várzea* system is rarely considered in the formulation of public policies, despite its socioeconomic, geographic, and ecological importance. It seems that Amazonia itself has not been adequately acknowledged by federal and state governments in formulating their science and technology (S&T) agendas. This region covers more than 60% of Brazilian territory, is home to more than 20 million inhabitants, and contributes 8% of the annual national GNP (Clement et al. 2003, Val 2004). As is aptly stated by Clement et al. (2003:29), "Brazilian investment in science and technology for the Legal Amazon is compatible with its status of 'colony.'"

Despite generating 8% of the Brazilian GNP, the Legal Amazon receives no more than 2% of investments in S&T, and a portion of the budget remains earmarked by the federal government for meeting budget surplus goals. According to a technical study by the Committee on Research and Development Activities of Amazonia (CAPDA), there was a budget credit of R$50 million accumulated at the National Fund for Scientific and Technological Development (FUNDCT) for Amazonia that was unspent by the federal government in the years 2003 and 2004. Of the R$17 million approved for 2007, R$3.5 million was still unspent in July 2007 (Paulo 2007).

The historically small investment in S&T in the Amazon region explains the poor infrastructure and scarce human resources available to develop and consolidate a technical-scientific base of human capital capable of active participation in the search for sustainable development of the region. According to calculations done by DECIT (2007, Figure 1: 159), Amazonia is home to only 12.8% of all Brazilian universities and research institutes, and includes around 5% of the research groups, scholars, and PhDs in all areas of knowledge in Brazil.

Costa (1998) in his analysis considered: i) the proportion of PhDs in the region as a basic reference for an established S&T capability, and ii) the proportion of population and GNP as indicators of social needs. He concluded that the Amazon presented the lowest ratio between the number of PhDs, and the population and size of the economy in the entire country. These findings are based upon data from the 1990s, when the proportion of PhDs to the Amazon population (0.04 for 1,000

inhabitants) was approximately 1/4 of the Brazilian average (0.17 for 1,000 inhabitants) and 1/7 of the best endowed area of the country—the southeast—with 0.3 per 1,000 inhabitants.

These low figures have not changed much over the last decade, with the graduate educational system in the Amazon including only ten federal universities, a few state universities, six EMBRAPA research centers, and three major research institutes maintained by the Ministry of Science and Technology (Val 2006). According to the CAPES website, in 2004 the region had 65 graduate programs, 17 of which were at the doctoral level, with around 1,000 PhDs in these institutions. Considering that 10,000 new PhDs graduate in Brazil every year, the Amazon claims only 10% of the PhD pool graduated in a single year, and has been unable to attract and establish doctors in necessary numbers to meet its needs.

Thus scientific work on the Amazon continues to be concentrated in the hands of foreign research groups, mostly from American and European universities. According to Val (2006), in the first 4 months of 2004 around 600 papers about the Amazon were listed by the ISI-Web of Science, but less than 20% of them had even one author living in Brazil. As he also speculated, it is possible that 80% of the papers would not be read by Brazilian researchers working in the region.

Despite the insignificant investments in S&T by Brazilian federal agencies, the governments of the Amazon states have finally started to play an important role in the scientific arena with the recent development of program investment in science. This is an important piece of good news for the development of a new scientific research agenda in the Amazon *várzea*. In 2004, the Fundação de Amparo á Pesquisa do Estado do Amazonas (FAPEAM) was created after decades of struggle by local scientists and other social groups. The FAPEAM invested R$17 million in 2004, and R$30 million in 2005, in several programs to support scientific projects (Silva 2007).

The state of Pará has slowly started waking up to the need to allocate larger investments to scientific production. In 1995, the state policy for S&T was formalized with the creation of the State Fund for Science and Technology (FUNTEC), the Science and Technology State Council (CONTEC), and the State Secretary for Science, Technology, and Environment (SECTAM), which is the agency in charge of the implementation of science policy through the Science and Technology Directorate. An institution with administrative and financial autonomy to support science and technological development was finally created on Jun 24, 2007, by Law # 061, published on D.O.E # 30973 on July 27, 2007, and named the Fundação de Amparo à Pesquisa do Estado do Pará (FAPESPA). Even though its creation came late—the 1989 Constitution of Pará State had defined the creation of FAPESPA within the CONTEC; Pará, 2003)—it is a promising initiative for advancing scientific production in the region.

With the creation of FAPESPA, it is expected that finally the Pará government will respect the law related to investments in S&T. Once, in the last decade (1997–2006), the financial resources applied to the matter were between 13% and 28% of the minimal budget stated by the Law (Silva 2007), with a total investment of R$19.2 million, an amount slightly higher than that invested by Amazonas state just

for 2004. However as emphasized by the governor of Pará at the Open session of the 59th SBPC Annual Meetings in July 2007, "We can only have a future in the Amazon region with higher investments in science and technology." She also promised to increase by a factor of ten the funds invested, citing the dire condition of the State of Pará in relation to access to potable water and sewage (Castro and Romero 2007).

## *1.2 Challenges for the Amazon Várzea*

A number of studies and research projects have been developed and published about the Amazon *várzea* over the last several decades. The Conference on Diversity, Development, and Conservation of the Amazon *Várzea*, organized in December, 1994, in Macapá, is a historical reference and starting point for *várzea* researchers. This event brought together a great number of researchers, conservation professionals, students, government officers, and nongovernmental agents to discuss and analyze the conditions of the *várzea*, its problems, and its challenges. The conference results were published in Padoch et al. (1999), which summarized much important knowledge about the *várzea* (see also Padoch and Steward, this volume).

By the year 2000, with the objective of reducing progressive environmental degradation of *várzea* ecosystems, the Natural Resource Management Project ProVárzea/IBAMA/PPG-7 was implemented to foster conservation and sustainable development in the floodplain (see also Ruffino, this volume). The ProVárzea program stimulated the participation of local communities in the development of several projects, including (a) the development of eight Strategic Studies, aimed at filling in scientific knowledge gaps; (b) support of innovative community projects in natural resources management, the "Promising Initiatives;" and (c) implementation of comanagement models. Thus the Project filled important gaps and offered to Amazon society new scientific knowledge and a set of public policy proposals. As part of its contribution, books, bulletins, technical documents, and videos were published and disseminated, including (1) *A Questão Fundiária e o Manejo dos Recursos Naturais da Várzea: análise para a elaboração de novos modelos jurídicos (*Benatti et al. 2005); (2) *Diversidade Socioambiental nas Várzeas dos Rios Amazonas e Solimões: perspectivas para o desenvolvimento da sustentabilidade* (Lima 2005); (3) *Manejo dos Grandes Bagres Migradores: Piramutaba e Dourada no Eixo Solimões-Amazonas* (Fabre, N. and Barthem, R. 2005); (4) *A Industria Pesqueira na Amazônia* (Almeida 2005); and (5) *O Setor Pesqueiro na Amazônia: Situação Atual e Tendências* (Petrere 2007). All these volumes have been made available for free download at www.ibama.gov.br/provarzea.

Much remains to be done before we can hope to achieve an adequate understanding of natural resource conservation and sustainable development in the *várzea*, and especially to have an impact on the quality of life of local human populations. Fortunately, many other initiatives and projects have been developed in

floodplain areas. The conference, "The Amazonian *Várzea*: The Decade Past and the Decade Ahead," was organized for the purpose of sharing and discussing the last 12 years' experiences and lessons learned about the *várzea*. In this paper I will attempt to summarize and briefly discuss guidelines for public policies and investments in S&T in the *várzea* that were mentioned in all the papers, presentations, and debates that occurred during the Manaus Conference.

## 2 Suggestions for a Research Agenda and Investment in Science and Technology

All *várzea* conference presentations, analyses, and debates emphasized the great efforts and advances that have been achieved in understanding floodplain human populations, and their patterns and uses of natural resources, as well as the results of the introduction of participatory approaches to natural resource management, decentralization of environmental governance or comanagement, and the significant numbers of new Conservation Units created along the *várzea*. It was clearly shown that the sustainable use of natural resources has been an effective strategy for the conservation of *várzea* biodiversity and the improvement of the quality of life in *várzea* communities. But it was also agreed that there still is a wide gulf between the knowledge produced about the *várzea*'s human populations and their quality of life. That is, all the knowledge gained from the area does not help to solve the problems and challenges of *várzea* residents. The poor conditions of basic infrastructure, or even a total lack of basic services such as education, health, fluvial and terrestrial transportation, and markets for local production, which have resulted in large-scale migration to urban settlements, were repeatedly cited. These factors have created more distance between *várzea* inhabitants and their productive base.

Consistently, all conference sections brought up the urgent necessity to define social, economic, environmental, and institutional indicators to monitor and evaluate the processes of socioenvironmental change in the area. In every region of the *várzea*, investment in a research agenda and institutional partnerships are needed to design, test, evaluate, and refine socioenvironmental indicators and methodological protocols, as is indicated in Table 1.

Beyond the agenda to design, test, and refine socioenvironmental indicators and methodological protocols, a large number of specific proposals for investing in scientific research were highlighted as priorities:

### *2.1 Social and Demographic Dynamics*

- Investment in nutritional and epidemiological assessment to do an effective evaluation of *várzea* populations' epidemiological status. The conference session rapporteurs emphasized that, "Amazon data demonstrated that the high level of

**Table 1** Proposal to invest in research projects for the *várzea*, common to all areas and sections

| Investments | Specific areas |
|---|---|
| To elaborate, test, evaluate, and refine social and environmental indicators to follow processes of change | (1) Socioeconomic and Demographic Dynamic:<br>– To elaborate indicators and method protocols to be able to evaluate the impacts of political and economic changes on the population's quality of life, as well as the interventions due to the welfare programs on the organization and social reproduction of the communities.<br>(2) Conservation and Aquatic Resource Management:<br>– To elaborate indicators based on common agreements among the scientific groups which can define the directions for baselines to determine the meaning of socioeconomic sustainability of productive initiatives and aquatic resources management projects—not only the fishing management, but also that related to wildlife species.<br>(3) Conservation and Terrestrial Resources Management:<br>– To define indicators of socioeconomic welfare and the environmental integrity of the products used directly and indirectly from the *várzea* forest ecosystems.<br>(4) Socioenvironmental Strategies in Conservation Units (UCs):<br>– To define indicators and monitoring protocols (on local and regional scales) to evaluate the impacts of the natural resource participative management models on and around the *várzea* UCs' natural ecosystems to allow both the temporal evaluation of the sustainability level of the areas, and to compare them with different areas.<br>– To define and apply nutritional and epidemiological indicators adapted for the Amazon reality. So far these issues have been underestimated as in research projects as on the public policy agendas, inside and outside of UCs. |

undernutrition is persistent. That status may be related to the instability of caloric resources (manioc production) and the incidence of several parasite diseases."

- Refinement and expansion of knowledge of demographic dynamics and their implications for social reproduction and quality of life (food security, health, education, and cultural capital), including the effects of changes in patterns of consumption and lifestyles of *várzea* populations.
- Increased investment in research about the internal dynamics of households, especially information related to gender relations, decision-making processes and on the impacts on household members of inclusion in development projects.

## *2.2 Aquatic Resource Management and Conservation*

- Support for studies on the impacts of climate change on the river flood pulse, with particular attention to testing the mathematical models presented by Junk et al. (this volume), concerning forecasting the intensity and duration of annual flooding based on climatic circulation data.

- Redirection of research initiatives on issues related to the development of new economic options in forest management, to cover, for example, the specific limits of permitted sizes for harvesting each timber species, as well as studies on the characteristics and recruitment rates of the principal wood species (seed production, germination success, etc.).
- Support for research on monitoring and evaluation of the processes of the legalization of land tenure in the *várzea* that have been managed and expanded by the Brazilian National Institute of Agrarian Reform and Land Tenure Regularization (INCRA). It is crucial to evaluate the impacts of these processes on the social and organizational conditions of the people involved as well as on the environments of the areas regulated.
- Expansion of knowledge on the monitoring and evaluation of alternatives for management of fisheries and the role of the State in coordinating individual management initiatives.

## *2.3 Conservation and Management of Terrestrial Resources*

- Support for ecological research projects on the effects of the industrialization of forest products and ecological services of the *várzea* on local community life and on the attributes of the ecosystems.
- Identification of the effects of different types of organizations (government and nongovernmental) on control and access to the products, benefits, and distribution of benefits made available through these organizations.

## *2.4 Socioenvironmental Conservation Strategies in Conservation Units*

- Investment in research projects on implementation of participatory models for natural resource management, and the effects implementation will have on ecological aspects of these units, including (a) the increase in population density, (b) changes in consumption and income levels, and (c) the erosion of traditional/local knowledge.
- Investment in studies on discrepancies among different participatory management models and the rules and norms established by the National System of Conservation Units (SNUC – Lei # 9985, July 18, 2000).
- Extension of research projects on stages of implementation of conservation units, mainly those pertaining to state-level categories.

## *2.5 Public Policy Issues*

- Inclusion of the *várzea* environment in the annual surveys of the IBGE (Brazilian Institute of Geography and Statistics), as a separate category from the *terra firme*.

- Definition of socioeconomic categories that would help the various agencies that deal with *várzea* populations in regional, national, and transnational political processes.
- Organization of a networked database, with all data gathered by the governmental agencies concerned with epidemiological surveys conducted by health agents, to provide the scientific community with health data to complement socioeconomic and demographic assessments of the *várzea*.
- Creation of an institutional network to share and publish public information about a variety of socioenvironmental aspects of the *várzea*;
- Design of institutional collaborative networks to share data on financial and human resources.
- Review of legal frameworks related to hunting and aquatic wildlife management, because legal difficulties have resulted from some shortcomings and out-of-date legislation. The current legislation has not been updated to reflect new scientific knowledge, and government officers are poorly qualified to deal with animal fauna custody chains.
- Review of the roles of Environmental Volunteer Agents (*Agentes Ambientais Voluntarios*—AAV) in relation to monitoring and natural resource control, because of questions of fairness in the transfer of a State responsibility to local residents, as well as because warnings issued by the AAV are not accepted as legal documents.
- Design of socioenvironmental educational programs appropriate for *várzea* populations involved in environmental projects, that explain how project benefits can help both them and nature through environmental improvements.
- Review of the concept of traditional population (*população tradicional*), understanding that classifications based either on occupational or self-identification (e.g., rubber tapper, Brazil nut collector) or on ethnicity have the potential to lead to problems in Conservation Units in relation to natural resource access.

## 3 Final Remarks

Apart from the successes of the conference in presenting, discussing, and systematizing knowledge about the *várzea* produced over the last decade, conference participants also succeeded in suggesting guidelines for a new agenda for science and technology, as well as a set of public policy proposals. Still, knowledge about the area needs to increase exponentially, and to achieve that, it is necessary to engage national (i.e., non-Amazonian) and international scientific communities and their aid agencies. As described above, the infrastructure and human resources available in the Amazon region, at least in the Brazilian Amazon, are not sufficient to respond to the major challenges for conservation and sustainable development of the region.

It is thus important that the institutions and the civil societies of the other parts of Brazil fully understand the interdependencies and the important impacts of

Amazonian ecosystems on their own environments, mostly in the southeast and central-west parts of the country. New research by Fearnside (2005) questions past ideas about the impact of deforestation on the Amazon hydrological cycle, including the notion that 50% of Amazon rainfall is carried out to sea by the Amazon River, and the other 50% recycled inside the Amazon region (Salati and Vose 1984). Today it is estimated that a significant part of the water vapor from Amazonia is transported to the south and central-west regions of Brazil, and on to Paraguay, Uruguay, and Argentina, while another part is transported across the Atlantic toward southern Africa.

Consequently, the rain that maintains the agricultural production and appropriate water levels in the hydroelectric plants that supply energy to cities like São Paulo and Rio de Janeiro originates in the Amazon hydrological cycle. According to some analyses, during the austral summer (December–March), around 70% of the rains that fall in the state of São Paulo depend on Amazon water vapor (Fearnside 2005:117). It is apparent that for the conservation and sustainable development of the entire, much broader, region, it is necessary to expand our knowledge of the complexity and interconnectedness of the many ecosystems, climatic regimes, and different levels of biodiversity. Thus, it must be in the strategic best interest of other parts of Brazil and other countries of the Americas to promote an agenda for science and technology for the Amazon, and for the Amazon River *várzea*, that encompasses a wide program of research and implementation of models and experiments in management and governance of natural resources, in order to promote the conservation and the sustainable development of the Amazon biome.

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# The *Várzea*: Old Challenges and New Demands for Integrated Research in the Coming Decade

**Eduardo S. Brondízio, Robin R. Sears, Celia Futemma, Andrea Siqueira, Rui Murrieta, Victoria J. Isaac Nahum, and Henrique Pereira**

**Abstract** This concluding chapter highlights the ways the past decade of research on *várzea* natural and social systems has informed and may inform management and policy decisions related to *várzea* society and environment. This chapter summarizes and responds to the main points in preceding chapters, examining the socioecological complexities of the *várzea*, production and conservation goals and strategies, and the evolution of institutional arrangements related to resource management and social welfare of the *várzea* people. Anticipating the decade ahead, this chapter suggests focused research on the question of what are the current and predicted future drivers of change on the *várzea*, and what is the suite of predicted outcomes. Adapting to climate change, accessing emerging markets for ecosystem

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goods and services, and strengthening institutions are some issues that should be explored to help policymakers and residents alike prepare for the decade ahead. The chapter recommends an exploration of a paradigm shift from centralized management, which has traditionally predominated in governmental institutions, to more coordinated policies.

**Keywords** Complexity • *várzea* • Institutions • Conservation • Natural resources

# 1 Introduction

It has become commonplace to talk about socioecological complexities around the world. Yet, if there is a place that deserves to be considered complex, it is the Amazonian *várzea.* Culture and nature, present and past, conservation and production, urban and rural in the *várzea* all defy everyday dichotomies. The chapters in this volume tell much about what it means to live in this tropical floodplain and to face all its contradictions, starting with the daily or seasonal flood pulse that defines the region.

The *várzea*'s long history of human occupation is a story of exploitation of natural resources and of different groups of people (Porro 1996; Roosevelt 1999), of the ups and downs of economic cycles and public policies, and of promises of sustainable development (Murrieta et al. 2009; Nugent 1993). The *várzea*'s natural beauty and abundance of resources continues to attract residents, despite its environmental risks (Chibnik 1994), lack of infrastructure and services, high incidence of health problems (Silva 2009), lack of insurance against the loss of crops, growing pollution in some areas and land tenure conflicts in others, and the invisibility of local people in the eyes of governments (Adams et al. 2009).

This volume presents a body of work that illustrates the socioecological complexity of the *várzea*, and some of the approaches taken by *várzea* residents, local and regional governments, and NGOs. In this concluding chapter we aim to highlight the ways this research has informed and may inform management and policy decisions related to *várzea* society and environment. We conclude with some recommendations for *várzea* research and action over the next decade.

# 2 Lessons Learned

## *2.1 Socioecological Complexities of the Amazonian Várzea*

The *várzea* is, above all, the interface between terrestrial and aquatic environments. The concept of the flood pulse, defined by a group of researchers led by W. Junk (at INPA), explains much of the complex dynamics of *várzea* ecotones (Junk et al.

1989). This phenomenon is essentially the alternation of aquatic and terrestrial environments in different seasons of the year, or, in the estuarine zone, at every tide. Differences in the intensity of the floods have important impacts on the lives of *várzea* residents and on their resources (agriculture, livestock, fishing, etc.).
While life in the *várzea* is as dynamic as the course of its rivers, much of today's economy, social organization, and politics (and by definition, landscape) in the region are rooted in colonial history (Harris 2009; Raffles 2002; Santos 1980; Weinstein 1983). Several chapters describe the contemporary heterogeneity of social groups, economic systems, institutional arrangements, and persistent social problems as reflecting the past to some degree. Harris early on in this volume sets up the discussion of *várzea* life and livelihood by highlighting an important aspect that characterizes *ribeirinho* people and helps them endure in this rich but unstable environment: these are the social networks and the social fabric of riverine families and communities, and their local knowledge.

As in other parts of the Amazon, the history of the *várzea* is punctuated by large and small economic booms and busts based on the region's highly productive ecosystems, some localized, some widespread, but all affecting the economy, society, and ecosystems of the *várzea*. Timber and non-timber forest resources, agricultural and agroforestry crops, and fisheries have sustained resident and itinerant populations on the *várzea* historically and today. Some of these booms have been marked by appropriate resource management, others by rampant over-exploitation through extraction. Recently the region has seen another kind of boom: the creation of environmental and indigenous reserves and protected areas, community-based projects, and localized government interventions (ProVárzea, ProManejo), all of which are influencing and will influence the region for decades to come (Adams, this volume).

Throughout the region, urban centers, large and small, have expanded, albeit at different rates (Browder and Godfrey 1997; Guedes et al. 2009; Costa and Brondízio this volume). In some areas of the central-western portion of the region, urbanization seems to play a major role in the decline of rural populations; while in the east, urban and rural populations are mutually supportive. In urban centers, where an informal economy dominates, unemployment is as high as in rural areas. Rural and urban environments and landscapes are intrinsically connected in the *várzea.* In the Lower Amazon, people move frequently between rural and urban areas, and between upland (*terra firme*) and *várzea.* Social relations based on kinship help to ensure social and cultural resilience and persistence. Urban populations depend on rural zones for food security; and rural families, in turn, benefit from family networks in urban areas to gain access to health and educational facilities and other services (Padoch et al. 2008). These rural-urban links range from very intensive and frequent to sporadic. Distances matter in the *várzea* and along its tributaries, influencing not only the presence of services and the reach of public policies, but also the economy of families who are burdened with high transportation costs (Parry 2009; WinklerPrins 2002).

In the western part of the Brazilian *várzea,* two other factors contribute to this movement: the creation of new municipalities attracting people to cities; and the creation of different types of reserves, forcing people out of rural zones. Since the

1990s and the beginning of the twenty-first century, a process of decentralization ("municipalization") has taken place in Brazil, including the Amazon region. Several chapters in this volume point out the positive and negative aspects of this decentralization of political power from federal to municipal levels, involving multiple public services: healthcare, education, social work, and transportation, to name a few. Edna Alencar (and Delma Neves during the conference) as well as Brondizio's chapter show that, in general, local administrators are not prepared to assume such responsibilities. Although the public sector is responsible for the majority of formal employment in the region, municipal administrations lack the ability to capture revenues from the wealth of resources the region generates, and they suffer from lack of qualified professionals who possess appropriate technical skills, as well as from high levels of chronic corruption.

## *2.2 Production and Conservation on the Várzea*

Our current knowledge of the *várzea* environment comes from a rich base of research in the evolutionary biology (Ayres 1995), ecology (Junk 1997), and hydrogeomorphology (Salo 1990; Sioli 1984; Sternberg 1975) of *várzea* ecosystems and waterways. Due to the hydromorphological and topographical complexity of the *várzea* landscape, *várzea* forests present a complex mosaic of vegetation types clearly differentiated along edaphic and topographic gradients (for example, Ayres 1995; Black et al. 1950; Campbell et al. 1992; Prance 1979; Puhakka and Kalliola 1992), and strongly shaped by anthropogenic influence (Raffles 2002; Raffles and WinklerPrins 2003; Brondízio 2008). These and other pioneering researchers showed that *várzea* landscapes are heterogeneous and dynamic, and as such present landscapes rich in renewable natural resources and ecological services. From families and communities, to absentee owners and "roving bandits" (in the sense of Berkes et al. 2006), to government agencies and corporate groups, many Amazonians depend on these *várzea* resources.

The constant change of ecosystem elements in the *várzea* through space and time is due not only to the natural flood pulse dynamic, but also to the production and extraction activities of residents and nonresident users of these environments. Historically and at present, *várzea* forests are shaped by adaptations and responses to shifts in markets, resource access rights, hydrological regimes, and economic and policy incentives. Changing economic cycles lead to shifting opportunities for those living along the floodplains, which, in turn, lead to a constantly changing landscape. World economic shifts and geopolitical events affected floodplain forests during the cacao cycle in the early to mid-eighteenth century (see Harris, this volume; Alden 1972), the rubber boom in the late nineteenth and early twentieth centuries (Santos 1980; Weinstein 1983), the barbasco and jute booms in the early twentieth century (Gentil 1988; Padoch and de Jong 1990; WinklerPrins 2006), and more recently the timber boom of the 1960s through 1980s (Barros and Uhl 1995; Pinedo-Vasquez et al. 2001), and the current açaí fruit boom (Brondízio 2008). The

extent to which these booms have been predictors of social organization, economic development, and land cover change continues to deserve attention. Likewise, a large gap exists in studies of the *várzea* on the upper Amazon region, especially in Peru, where the social, political, economic, and environmental realities are distinct from those on the Middle and Lower Amazon.

As illustration of the importance of integrated research, Arce-Nazario demonstrates the elasticity of land cover and how topography and hydrology interact with land use. In this volume, Arce-Nazario approaches this issue, showing that while the structure and composition of postagricultural forests of the *várzea* are largely determined by their management history as well as the natural flood pulse dynamic, in some cases extreme flooding events can erase the anthropogenic footprint on the forest altogether; this does not happen in *terra firme* forests. Pinedo-Vasquez and Sears (this volume) also show how residents play an active role in the restoration and protection of the *várzea* forests, reshaping degraded landscape elements into productive ecosystems, enhancing both their economic value and the intrinsic ecological value of the ecosystem.

Brondízio links açaí consumption patterns at local and global scales, rural household economies in the Amazon estuary, and *várzea* land cover change in his narrative of the açaí boom in this volume and elsewhere (Brondízio 2008). Of particular interest in this case is that while some rural producer individuals and households are benefiting from the growth of the açaí market, there is a notable absence of a transformation in the municipal economy and development. Municipal and regional governments are not only failing to capture the value of the booming industry through taxes and fees, but there is increasing evidence that the major profits are going to external players who are involved in the industrialization of the açaí business, rather than to producers and mid-level actors. Furthermore, the globalization of açaí fruit is putting pressure on its cost as a staple food of rural and urban populations.

There are various agendas for conservation and development at play in the *várzea,* which raise concerns about their long-term social and environmental outcomes. One important trend to watch is the growing emphasis on the industrialization of *várzea* crops, including açaí and timber. The *açaizaçao da várzea* during the 1980s and 1990s—increasing areas covered by stands dominated by açaí—is a phenomenon most prominent in the tidal estuary, and driven by local producers in response to market demand. Of concern is the shift from managing natural açaí stands using agroforestry techniques, to the establishment of large-scale monocultural açaí plantations—the process of *agronomização do açaí*, whereby the multifunctionality of the forest—the ecosystem goods and services discussed by Pinedo-Vasquez and Sears—disappear and the livelihoods of hundreds of small-scale açaí producers are threatened. Exclusive attention to single crops based on mechanized high-input production can have an impact on a variety of environments and resources of major relevance to the residents and the economy of the region. These works demonstrate how land use and land cover change relate to the transformation of the rural household economy and regional economic development. They also raise new research questions about the scale and socioenvironmental impacts of monocultural expansion along the floodplains.

The expansion of cattle ranching and forestry plantations for timber, heart of palm, and palm fruits along the floodplains opens new and important areas of research examining the interactions between changes in land use, habitat ecology, and hydrological conditions resulting from agroindustrialization. Furthermore, the health and ecological impacts from increasing pesticide and fertilizer use in the Amazon's booming industrial agriculture, including the boom in soybean planting along major tributaries (Fearnside 2001) in the region's floodplains, are still largely unknown.

The fate of animal resources is also a concern. In this volume Silveira shows that despite official prohibitions, the practice of hunting and the consumption of game are widespread in the Brazilian Amazon. He decries the lack of attention paid by public officers and politicians as well as by scientists to the illegal use of fauna. Even the animal populations long considered robust are now threatened by commercial and subsistence hunting. To ensure sustainability, hunting practices must guarantee the capacity for reproduction as well as maintenance of the genetic variability of species. However, the intersection of conservation policies, economic pressure, and species distribution and fluxes can produce unexpected results. For instance, there has been a translocation of illegal hunting of caiman and turtles from the Mamirauá Sustainable Development Reserve near Tefé, where enforcement of conservation regulations is effective, to the lower Purus, where there is still little control, despite the creation of the Piagaco-Purus reserve. Therefore, conservation is necessary and monitoring ought to be prioritized.

While decentralized monitoring of resource use is important, the authors in this volume (such as Ruffino and colleagues, and Ruffino this volume) discuss advantages and limitations over the use of "Volunteer Environmental Agents" (VEA). These are local residents trained to monitor and report environmental crime, but who lack the legal authority to carry out interventions, resulting in legal difficulties and often creating local conflicts. The authors suggest that conservation regulations be applied in a manner that more closely reflects customary systems prevalent in local communities; this change could enhance the work of local agents. The VEAs could then become important agents promoting conservation and productive management systems throughout the region, rather than being engaged primarily in surveillance of environmental crime. Regional-level monitoring of land use and deforestation, resource flows, and environmental quality is largely absent and should receive more attention during the coming decade. While the eyes of the government and the media closely and regularly follow environmental change along the so-called "arc of deforestation," the Amazonian floodplains remain only a secondary concern.

The need for indicators—social and ecological—for monitoring processes of change is called for by many authors in this volume. Reference points or benchmarks must first be clearly defined if we are to understand whether any new governance and other initiatives are effective and sustainable. The need to agree on issues such as the appropriate units for measuring and monitoring is obvious, and social indicators should be considered as important as ecological ones (e.g., Ritchie et al. 2000). Should benchmark surveys focus on individuals, families, or communities as their units of interest? What variables should a survey include? The problematic

nature of the concept of sustainability is also discussed, directly or indirectly, by several authors—which in turn raises the issue of the inclusion of a diversity of factors (social, environmental, economic, etc.), some of which will doubtless be found to lead to contradictory conclusions. In this sense, it seems clear that recommendations need to prioritize some objectives at the expense of others, and that this type of decision must be made in response to the needs of broader strategic and participatory plans at multiple levels and time scales.

Local knowledge and scientific research both support the importance of management to increase the economic and conservation value of the *várzea* landscape. The specific management objective, or suite of objectives, determines the structure and composition of the landscape—the forests, lakes, rivers—and regional land cover patterns. Research presented in this volume shows that local management strategies can yield positive results for both the well-being of residents and the conservation status of *várzea* landscapes. This is "production for conservation, conservation for production." To date, scientific knowledge and local management strategies documented by research have not been adequately recognized by conservationists and policy makers. We also should assume that any kind of choice may (and probably will) have some degree of loss (biological or cultural), even those choices which appear to be in accordance with environmental and local concerns (Murrieta et al. 2009).

## *2.3 Evolving Institutional Arrangements*

A critical factor in sustainable development in the *várzea* region is the institutional arrangements at the global, national, state, and local levels. Padoch and Steward in the introduction to this volume highlight several of the political, social, and economic processes that have driven changes in *várzea* society and landscape. In Brazil, national campaigns to alleviate poverty, including electrification and land tenure reforms, as well as grass-roots organizing, have transformed the lives of some communities on the *várzea*. In Peru, they indicate, development in the *várzea* suffers from the same institutional dysfunction that affects the region as a whole, driven in part by the historic violence associated with the Shining Path and currently with drug trafficking, and the dissolution of the Agrarian Banks in the 1990s. The evolution of institutional arrangements, when not imposed from the top down, occurs when people, communities, and institutions adapt to new constraints and opportunities.

According to McGrath, three principal historical facts mark the evolution of the management of *várzea* natural resources in Brazil: (1) the institutionalization of fishing laws and of forms of community control of fishing; (2) the introduction of Codes of Conduct to regulate the use and the impact of activities like agriculture, and especially livestock raising; and, more recently, (3) the establishment of Agroextractives Settlement Projects by INCRA for the transfer of use rights and governance of common property in the *várzea*. Fisheries and land tenure are treated here as illustrations of how evolving institutional arrangements are driving social and ecological changes in the *várzea*, and their limitations.

Due to the demands of local communities and the involvement of NGO projects and regional governmental institutions, management of some of the natural resources of the *várzea,* particularly of fisheries (Castro and McGrath 2003; Ruffino 2005), has changed in recent decades. This process has allowed for the institutionalization of participatory mechanisms of management and the decentralization of environmental management activities, the effects of which can be clearly seen in the legalization of fishing accords and the political and social control exercised by fishing councils along the Lower Amazon. These institutions and practices have been implemented in the region through programs such as ProVárzea (see Ruffino and colleagues this volume).

As an example of the effectiveness of the institutionalization of participatory mechanisms, Almeida in this volume reports that the introduction of participatory management approaches in these communities apparently increases the productivity of the fishery without increasing fishing effort. The gain stems from the elimination of competition from commercial and large-scale fishermen, who were expelled from the lakes following the regulation of fishing. Lessons can be learned from the participatory management of the pirarucu fishery in Mamirauá, as described by Castello in this volume.

On the other hand, some arrangements present operational and structural problems. Fishing accords ought to enhance the productivity of the fishery, but the formal rules imposed by IBAMA mandate the maintenance of open access to aquatic resources. For example, restricting access to lakes by commercial fishing fleets is prohibited by many communities. These fleets can only be banned from employing certain forms of fishing, including for example the use of dragnets, of boats larger than a specified limit, and fishing beyond a maximum quota per boat. These rules limit and dampen community involvement. According to McGrath, the local fishermen's transaction costs of maintaining the arrangements are not really compensated if the resources to be preserved are being shared with other fishermen (including urban commercial interests) who do not share the responsibility for conserving the fishery. It will be important, then, to identify the effects of different forms of institutional arrangements and social organization—for example, government versus civil society, formal versus customary rules—on the control of access to resources, production, and distribution of benefits to and among *várzea* residents. It will also be important to evaluate how similar or different arrangements might be instituted in other countries, especially Peru, with different histories of fishery policies and different political environments.

Another important observation made by chapter authors is that existing alternatives for fisheries management actually appear to "lack management." There is a need to invest massively in monitoring and evaluation activities, as well as a need for state coordination of individual initiatives. To achieve this, networks for institutional cooperation that include mechanisms for sharing data, financial resources, and human resources in the resolution of management problems appear to be key. The state should maintain the coordinating function of managing both land and water resources within the context of broader strategic plans, so that both formally protected areas and areas of economic use are managed in ways that respect both environmental limits and potentials and that correspond to the needs of each region and community.

Similar to fisheries in the depth of the challenge presented is the issue of land tenure on the *várzea*. José Benatti here explains the importance and implications of jurisdiction and regulation of floodplain areas for management, sustainable use, and conservation purposes. To legalize tenure in the *várzea*—for example, through the Agroextractives Settlement Projects—means also to legalize its occupation by the *várzea* people, in effect calling to attention their needs for health services, education, transportation, electricity, and other services by local, regional, and federal authorities.

The process of legalization of land tenure in the *várzea,* which in the past progressed slowly in regions such as the Middle and Lower Amazon, was recently transferred in Brazil to INCRA and is now rapidly changing legal cession of rights of use among families, communities, and state and federal governments in parts of the *várzea.* This policy has evident advantages, but also uncertain consequences. It recognizes the rights of traditional inhabitants and the use of resources by both individuals and the community as a whole. In some cases it stipulates an a posteriori legalization of community management plans. These can include both Codes of Conduct and fishing accords as part of the rules of access.

However, some authors, and current debates in parts of the region, express hesitation over the speed with which the Agroextractives Settlement Projects are being implemented and the implications of the necessary compromises embedded in the process. Arguments against a fast-track implementation of such policies include the lack of preparation of *ribeirinho* communities and local institutions to plan, implement, and monitor community management plans, and the need for more time to adequately organize themselves. It is possible that in some areas conflicts may grow rather than diminish. Furthermore, the history of agrarian settlements and land regularization throughout the Amazon during the past 40 years has been marked by disregard, abandonment, and recurrent cycles of land reconcentration. The authors in this volume agree, however, that these changes can be positive as long as they are participatory, monitored, evaluated, and adaptive as they develop, and provided with basic infrastructure and services.

In general, however, most authors call attention to the absence of municipal, state, and federal policies that might provide *várzea* places and people with better public services, legalization of land tenure, and support for production systems and commercialization. This volume confirms that the *várzea* is a place of sociocultural and biological diversity, with a long history of human occupation—but also a long history of political disregard.

## 3 The Decade Ahead

The authors and editors agree that this volume highlights only a subset of the issues that have long persisted in the *várzea,* and even fewer of those that are just now emerging. The region benefits from a rich research legacy, much of which has been underutilized in policy and practice. The environmental, social, political, and economic diversity and dynamism of this "heart of Amazonia" demand that

far more critical attention be paid and sustained by researchers and policymakers alike. Global, regional, national, and local economies and politics have found their way into the Amazon *várzea,* but the region, with its communities and resources, has realized little of the sustained research, recognition, and support that its centrality merits. The chapters of this volume help lay out an agenda—scientific, social, and political—that can both focus our attention on and broaden our view of the promises, needs, and challenges of the *várzea* in the twenty-first century.

An important question to explore in the next decade is what are the current and predicted future drivers of change on the *várzea*, and what is the suite of predicted outcomes. For example, it has been suggested that climate change can affect the flood pulse, in either a systematic or random form. To date, limited research has centered on the impacts of climate change in the region (such as Li et al. 2008), the different levels of social and ecological vulnerability, as well as the variety of solutions emerging at the local level (such as Isaac et al. 1998; Brondízio and Moran 2008). Important advances in the use of climatic circulation data are leading to the development of forecasting models at INPA that can predict both the intensity and duration of annual floods. These models can be used to forecast extreme changes approximately two months in advance, permitting the planning of compensatory measures, evacuation of residents, and management of *várzea* activities. There is a need for research that looks beyond national borders to understand the impacts of climate change on the region.

Similarly, in anticipation of emerging markets for ecosystem goods and services, it will be helpful to quantify biomass, biodiversity, and services of *várzea* environments. It will be useful to define the conservation value and the production value of local management systems as well as the intrinsic values of the várzea, its species and landscapes, to different sectors of society. These studies will help policymakers and residents alike prepare for emerging markets in these services, helping with reporting on compliance with conservation agreements, as well as in asserting their perspectives to the value of its resources and landscapes.

The complexity and dynamic nature of the region demand that state institutions be developed to fulfill these management needs, and that human resources be developed to monitor processes using diverse and appropriate indicators. While today, researchers have acquired considerable scientific understanding of *várzea* resources, we continue to lack the capacity to apply this knowledge to the development of new economic options. The *várzea* region, like the Amazon as a whole, still lacks a vision for the development of transformative economies able to add value locally and translate the wealth of resources exported from the *várzea* into lasting benefits and employment. This implies a paradigm shift from centralized management emphasizing the export of resources, which has traditionally predominated in governmental institutions, to more coordinated economic policies and more attention to the development of human and social capital. The effective presence of the state is a necessary element in a region with such limited services and infrastructure, but it should be transparent, and open to cross-sectoral and participatory approaches.

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