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WOMEN, FISHERIES, AND FORESTS: CONTRIBUTIONS TO SUSTAINABILITY

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Abstract. Women activities from 9 Atlantic Forest communities and 7 Amazonian river stretches are analyzed. Areas studied include the coast of Rio de Janeiro State and São Paulo State, which have been visited in different years, since 1986. Amazonian areas include communities from the Araguaia-Tocantins Basin and from the Upper Juruá Extractive Reserve. Fieldwork was conducted at these areas between 1987-1997, where data were collected through interviews. The economic activities of women comprehend slash and burn agriculture, house/child care, manioc processing, handicraft, plant collecting, fishing and tourist house keeping, among others. At some sites, such as at Búzios Island (AF coast), young women avoid agricultural activities and concentrate on house and child care. At other sites, such as at Jaguanum island and at Picinguaba (AF coast), tourism pushed women to work as house keepers. Amazonian sites show similar trends, but some women also fish for subsistence. Propositions for local management seldom include women activities, but women may play an important role in traditional medicine, culture diffusion, food processing and trade. An approach based on multiple resource uses, and taking resilience as an analytic tool, among other ecological concepts, is proposed.

Introduction

In areas of high biodiversity, such as tropical regions, fisheries are usually integrated in a set of resource extraction, such as plant collecting, hunting, and extraction of other aquatic resources (such as chelonians), among others. This is the case of the artisanal fisheries found in the Amazon and in the Atlantic Forest coast (Brazil). Many Amazonian fisheries are included in protected areas, such as in Extractive Reserves, and Sustainable Development Reserves. Such areas are involved in co-management programs, and have been directing their fisheries either to subsistence (such as the Extractive Reserve of Upper Juruá, Acre State) or to a sustainable commercialization (such as the Sustainable Reserve of Mamirauá, Amazonas State). For details of such systems, see Begossi et al. (1999) and Begossi (2002).

In many cases, women play roles that are not explicitly considered in the co-management programs. The examples drawn from this brief study includes women activities along Amazonian rivers and in the Atlantic Forest coast. In order to drawn an ecosystem approach, some analytical tools from ecology are useful, especially considering the multi-species fisheries and multi-species resource uses found in tropical areas.

Procedures

Women activities from 9 Atlantic Forest coastal communities and 7 river stretches from 3 Amazonian sites (Araguaia , Tocantins, and Upper Juruá rivers) are analyzed. The areas studied include the coast of Rio de Janeiro

State and São Paulo State, which have been visited in different years, since 1986.. Amazonian areas include communities from the Araguaia-Tocantins Basin and from the Upper Juruá Extractive Reserve (rivers Juruá, Tejo, Bagé, S. João, and Breu), where fieldwork was performed between 1987-1997. Most data were collected through interviews (Table 1). Interviews in the Atlantic Forest coast included an effort to talk to all adults residents . Sampling efforts in the Amazonian rivers varied from 25% (Juruá river), 50% (Araguaia and Juruá tributaries), and 75% at Tocantins river (Figures 1 and 2).

Ecological concepts: livelihood, sustainability, resilience

Livelihood is a concept that has shown practical applications, because it links the various activities of people and their use of natural resources. Actually, this concept allows shifting scales from the individual, to the family and to the community level. For example, when approaching the use of natural resources at the livelihood level, individual tactics and decisions in the exploitation of natural resources are associated with family needs, and with family connections to the community. The concept of livelihood helps in the understanding of factors that influence the lives and well being of people; it is based around the dynamics of living and through the means to obtain goods and services (Soussan et al. 1999).

Other ecological concepts have shown their utilities when dealing with people and with the use of natural resources. Examples are the concepts of sustainability and resilience. Sustainability may be seen as a goal, more than a rigorously defined concept. Sustainability comes from a fine (low) to a coarse (high) scale: local sustainable regimes may be a foundation to support global sustainability. Global sustainability is not

only based on sustainable local regimes but it requires institutional shifts at global levels as well as in order to be achieved or maintained (Begossi 1999). Resilience facilitates links among people, resource management, and cultural capital because it may be enhanced by LEK (Local Ecological Knowledge) or by TEK (Traditional Ecological Knowledge), when this kind of knowledge has shown to be ecologically safe.

Sustainability has promoted links among many disciplines, such as ecological economics, human ecology, conservation, sociology and demography. Christensen et al. (1996) stressed that sustainability became a goal for natural resource management agencies, in spite of obstacles. These obstacles are: a) inadequate information on biological diversity; b) widespread ignorance on the function and dynamics of ecosystems; c) openness and interconnectedness of ecosystems at other scales; and d) public perception that immediate values out-weights the risk of future damage in the ecosystem. Sustainability has driven efforts towards sound ecological practices by pushing communities, academic staff, NGOs, and governmental initiatives to promote local participation in the exploitation and management of natural resources.

Resilience describes the speed with which a community returns to a reference state, or its capacity to absorb changes (Table 2). Schlapfer & Schmid (1999) and Pimm (1991) define resilience as the rate at which an ecosystem variable returns towards a reference state following a perturbation, and resistance as the degree to which an ecosystem is changed, followed a perturbation. A high resilience means a quick return to normal conditions; resistance depends on whether de system is simple or complex[1] (Pimm 1994). More diverse

[1] Complexity is defined by Pimm (1979) as the number of pairs of species interactions in the system. Complex communities are affected by species loss, for example, from the top of the food web, because secondary extinctions propagate more widely in complex rather than in simple systems. Simple communities are more sensitive to the loss of plant species rather than complex communities, because in simple communities consumers are dependent on a few species and may not survive species loss (Pimm 1994).

ecosystems might be more resistant to perturbations, changing less in response to perturbations (Tilman 1997). Odum (1953), MacArthur (1955) and Elton (1958)[2] observed that the larger number of species in an ecosystem, the greater the number of species interactions, the greater the number of alternative pathways, and thus a greater resistance to perturbations. According to Pimm (1991) a measure of resilience may be the speed in which a variable that has been displaced from equilibrium returns to it; long returns times mean low resilience (it is measured as a rate of change). Holling (1992) defined cycles in terms of functions, such as exploitation, conservation, release, and organization: resilience should be determined by release and re-organization sequence. Golley (1993) describes resistance and resilience as factors that represent how an ecosystem might respond to or recover from a disturbance. Berkes and Folke (1998) consider resilience as a measure of the magnitude of disturbance that can be absorbed before the system changes its structure: it may be a measure of the buffering capacity of the system. McCann (2000) defines resilience as the return time after a perturbation to an equilibrium or to a non-equilibrium attractor. Perturbations are too common in ecological systems and populations at equilibrium are not usual (Rosenzweig 1995). These definitions eliminate a false debate considering significant differences in the definitions of resilience coming from different approaches in ecology. Both evolutionary and ecosystems approaches take into account the buffering capacity of the system, or take in consideration a measure of the scale of the disturbance as the core of the resilience concept. Ecosystem changes after the disturbances may reveal a variety of different outcomes in accordance to both schools.

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2 These well known early ecologists are mentioned in a variety of articles such as in Lawton and Brown (1994), McCann (2000), Pimm (1994) and Tilman (1997), among others.

Diversity and Resilience

Species diversity is vital to the resilience of ecosystems to perturbations; simple ecosystems, such as arctic and deserts are often vulnerable to species losses (Mooney and Ehrlich 1997). Interactions are very complex and we still know only a bit of ecological processes. How is diversity related to ecosystem functioning is not clear. For example, the relation of diversity to primary production[3] has been noticed in ecological studies. Primary productivity can be positively or negatively correlated with diversity: at global scales it tends to be positively correlated, but there are examples of aquatic systems in which it is negatively correlated, such as when algae productivity increases due to nutrients, followed by a decrease in algae diversity (Huston 1994). In general, a greater diversity leads to a greater productivity in plant communities, greater nutrient retention in ecosystems and greater ecosystem stability (Tilman 2000).

Darwin (1872) already suggested that ecosystem productivity depended on biodiversity; after the seventies, McNaughton (1977, 1993) expanded on the diversity-productivity hypothesis (cited in Tilman 1997). Biomass stability, one aspect of ecosystem stability, is enhanced in complex systems, because the number of competitive interactions between plant species generates this result, and not the number of species per se (Lawton and Brown 1994). A recent article, by Wilsey and Potvin (2000), showed that the effects of plant diversity on plant productivity are associated with evenness, rather than with species richness. In experimental plots, they found that the relationships between total productivity and evenness tended to be more linear than were relationships between productivity and species richness. Actually, recent advances indicate that diversity, per se, is not the driving mechanism of stability: it depends on the ability for communities to contain species, or

functional groups, capable of differential responses. These views are consistent with the ideas of Odum, Elton, MacArthur and May) (*the greater connectance drives community and ecosystem stability)* (McCann 2000).

The greater stability of more diverse systems is due to three factors:1. differences among species make them to respond independently to environmental variability; 2. Species often compete within a trophic level, showing a negative covariance that reduces variability, increasing thus stability; 3. Community abundance increases as diversity increases (Tilman 2000). Because empirical evidence shows that communities may be dominated by weak trophic interactions, the removal of any species can lead to profound changes in the community structure, increasing the probability of destabilizing the dynamics of the ecosystem (McCann 2000). Some mechanisms, such as *'extinction debt'* or *'Moran effect'*, explain how a small change can cause an ecosystem to collapse. The 'extinction debt' suggests that after the extinction of a species due to ecosystem changes (such as habitat loss), extinction continues to occur because the competitive interactions continue; the 'Moran effect' suggests that after a change, the synchronization of population dynamics (an artifact of nonlinear competitive interactions) may collapse (O'Neill and Kahn 2000). Actually both hypothesis suggest that small changes affect the current balance of biotic interactions, leading to large changes in the ecosystem. Humans promote ecosystem perturbation, through the extraction of natural resources, cultivation, and deforestation, among others, affecting thus ecological stability. Human effects include the loss of stability, loss of species, and as a consequence, loss of complexity (Pimm 1994).

The study of the relationships between biodiversity and ecosystem processes is an effective catalyst in linking the ecology of individuals, communities, and ecosystems

[3] The rate of energy flow through all the plants in the ecosystem (Rosenzweig 1995).

(Purvis and Hector 2000), including the human use of the environment. Resilience is approached through different levels of analysis, such as through population level (Pimm 1994) or ecosystem level approaches (Holling 1992). Resilience makes strong connections among management and human ecology, because it is directed to evaluate responses to disturbances. Responses may include what is commonly referred as TEK (Traditional Ecological Knowledge) or LEK (Local Ecological Knowledge). When using the term LEK, local ecological knowledge, I am in fact referring to the cultural capital used by a population in order to deal with the environment. It may include, for example, the knowledge on plants and animals, food taboos, cultivating methods, medical folks, and fishing tactics and gear. It does not mean a static reference to behavior. Actually, behavior may change fast in face of circumstances, adapting people to respond to new variables. Behaviors may show a slow change, too, expressing conservative traits that may be not useful under environmental variables (*cultural inertia*, Boyd and Richerson 1985).

When treating human ecological communities, the analysis of the impact-response mechanism is oversimplified when the attributes of stability are reduced to one factor, such as to resilience[4], because the mechanisms of resistance are skipped. Resistance includes behaviors that might represent, in some circumstances, an obstacle for the system to change. For example: behaviors avoiding the consumption of a species (a taboo) if helping in maintaining a species in the community should be associated with resistance, rather than associated with resilience. Behaviors that cope with changes, such as building local management (extractive reserves in Brazil) should be associated with resilience. Behaviors

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4 (Berkes and Folke, 1998, and Proceedings of IASCP 2000, Bloomington, Indiana, USA: there are papers addressing resilience, and looking for links between ecological, social and institutional systems (Papers & Abstracts, The Eight Biennial Conference of IASCP, May 31-June 4, 2000).

that maintain the system should be associated with resistance, both (resilience and resistance) helping in the maintenance of stability.

The Rural Inhabitants of the Brazilian Atlantic Forest Coast – (the Caiçaras) - and of the Amazon – (the Caboclos)

Areas of high biodiversity in Brazil comprehend especially the Atlantic Forest, Amazonian sites, and cerrados (savannah). Rural populations that depend on the local natural resources for their livelihood live in most Brazilian high biodiversity sites. Caiçaras live in the southeast coast of the Atlantic Forest and caboclos for example are located in Amazon. Caiçaras and caboclos are rural inhabitants that descend especially from Native Indian and from Portuguese settlers. African influences are also found everywhere. Their basic lifestyle has been published elsewhere[5] including plant uses, cultivation, fishing as an important source of cash and as one of the main sources of animal protein. Hunting is less frequent, and environmental legislation may have been responsible, at least partially, for a decrease in hunting activities among the caiçaras.

Populations living in high biodiversity environments, such as the Atlantic Forest, have activities associated with the use of natural resources. The importance of local plants for medicine, food, construction and handicrafts is represented by a high diversity of plants mentioned as used in the Atlantic Forest (Begossi et. al., 2002). Fish is also an important source of animal protein for the local population, representing, for example, 68% of the animal protein consumed at Búzios Island and at Gamboa, Itacuruçá Island (Begossi 1998b). Even in urbanized sites of the Atlantic Forest coast, local inhabitants use the local environmental variability through a detailed knowledge, only known because there is a

close interaction between the local population and the environment. Among caiçaras, market features, such as fish prices, support a dilemma between consumption and cash ('to eat or to sell') in relation to aquatic organisms. Begossi and Richerson (1992) analyzed such a dilemma at Búzios Island, taking optimal foraging models as tools of analyses. For example, some fish mentioned as very appreciated by families in interviews at Búzios Island

Outcomes are different for the different areas. In the Atlantic Forest coast, caiçaras show a low level of organization, compared to Amazonian caboclos (rubber-tappers) (Begossi, 1999). Rubber tappers built Extractive Reserves as a form of local management (co-management). Fishers from the Mamirauá Sustainable Reserve are active in the management of local lakes (Begossi, 2002). The different outcomes obtained by caiçaras and caboclos represent different levels of resilience in each of the systems.

Woman within fisheries

Woman activities in both Atlantic Forest coast and Amazonian sites comprehend slash and burn agriculture, house/child care, manioc processing, handicraft, plant collecting, fishing and tourist house keeping, among others (Figures 2 and 3). Men are usually engaged in fishing and agriculture. Hunting is also observed, but usually in a subsistence level in the Upper Juruá and in the Tocantins river (Figure 5). Among women, thee is a tendency to move from agricultural activities to house care (Begossi, 1996). At Búzios Island, for

[5] Data collection and procedures are described, for plants: Begossi et al. (1993, 2002), Figueiredo et al. (1993, 1997), Hanazaki et al.. (1996, 2000), and Rossato et al. (1999); for fish/fishing: Begossi (1998a,b, 2001).

example, older women work in agriculture, compared to young women that concentrate on house care (Anova I, $p < 0.01$).

At Jaguanum island and at Picinguaba (AF coast), tourism pushed women to work as house keepers. Amazonian sites show similar trends, but some women also fish for subsistence. Propositions for local management seldom include women activities, but women may play an important role in traditional medicine, culture diffusion, food processing and trade (Figure 3).

In terms of relation to natural resources, women play a pivotal role in the knowledge, use and transmission of medicinal plants (Begossi et al., 2002). Such key relationship with this natural resource might help the inclusion of women in co-management programs.

In a recent research project, in a urban small-scale fishing community, in the coast of Rio de Janeiro, women have been apparently successful in the marketing of fish, as fish buyers (Figure 6). The details of such a trade, and the variables related to woman decisions to adopt such activity, should be studied in order to understand the possible pathways towards management.

The more resilient social-ecological system, the higher ability to absorb large shocks. Therefore, management that builds resilience can sustain social-ecological systems in the face of unpredictability. In that sense, diversity of species, of knowledge, and of institutions have the potential to contribute to sustainability (Folke et al., 2002). *In face of such concepts, how can women resilience, within the activities that surrounds small-scale multi-species fisheries in tropical ecosystems, be estimated, or evaluated ?*

In spite of being responsible for 25% of the world fisheries there is no adequate data and information about women in fisheries (Pereira, 2002). Considering the research carried out in fisheries, Latin America also does not seem to show a high availability of studies compared to other regions of the world (Figure 7).

Gender, considered as the relationship between man and woman, has its roles defined within the society (Williams, et al., 2002). Small-scales fisheries from tropical countries, besides gender relationships, have to respond to a dynamic of livelihoods embodied by complex and dynamic ecosystems. Special attention to these small-scale fisheries is increasing, as noted in the concepts associated with processes of certification (Wilson et al., 2002). In that sense, the associated ecological and economic variables should play a key role in building resilience towards a sustainable management.

Conclusions and Propositions

1. Agriculture: there is a tendency to woman to leave agricultural activities.
2. An increase in activities such as house care, house keeper, and tourism related activities in the Atlantic Forest coast is observed.
3. Medicinal plants are an important woman knowledge, and such activity provides a link with other activities (such as health care and diffusion of knowledge).
4. Women seem to be successful traders in urbanized fishing communities, such as at Itaipu, Rio de Janeiro.
5. A set of activities are found in tropical fisheries, and the analysis of its resilience and sustainability should take in account the features of high biodiversity ecosystems found in small sclae fisheries of tropical areas.
6. An effort to conduct a diagnosis of the role of women and its activities in tropical small scale fisheries is needed.

7. In face of relative scarce studies on small scale Latin American fisheries, a particular effort should be made in that area, in terms of research projects.
8. A research project setting up sample areas in Africa, Asia, Central and South America, as well as Oceania should be carried out. A selection of small-scale fisheries in these areas should include rural and urbanized settings.
9. Research projects should include:
   - Features of the environment
   - Use of natural resources and associated diversity
   - Economic activities by women in those small scale communities
   - Market capacities
   - Current Management and its association with resilience.
10. Taking into account the integration of livelihoods in tropical ecosystems, and the small-scale fishery as a multi-resource extraction, it should be expected that a high ecological-economical resilience should lead to sustainability. Therefore, identifying the variables involved in the decision-making process of woman that live in these areas should be a core for research projects.

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Table 1. Interviews carried out in communities of the Atlantic Forest coast and in Amazonian river stretches .

Local	Interviews	Families
Atlantic Forest coast		
Búzios Island	**39**	**44**
Vitória Island	**4**	**12**
Puruba Beach	**12**	**14**
Sertão Puruba	**20**	**22**
Picinguaba	**47**	**70**
Casa de Farinha	**12**	**17**
Gipóia Island	**19**	**22**
Jaguanum Island	**48**	**100**
Itacuruça I. (Gamboa)	**16**	**26**
Amazonian Rivers		
Araguaia	**57**	**72**
Juruá	**35**	**140**
Tejo	**20**	**80**
Bagé	**10**	**20**
São João	**9**	**18**
Breu	**3**	**6**
Tocantins	**175**	**140**

Table 2. Examples of stability related concepts. Based on Putman and Wratten (1984) and Schlapfer and Schmid (1999).

Concept	Definitions
Elasticity	The speed with which the system returns to its former state, following a perturbation.
Cyclical stability	The property of a system to oscillate around some central point or zone.
Resistance/Inertia	The degree to which an ecosystem variable is changed, following a perturbation. The ability to resist external perturbation.
Resilience	The ability of a system to recover and continue functioning after disturbance, even though it may have changed its form. The rate at which an ecosystem variable returns towards the reference state following a perturbation.
Persistence	The maintenance of the species composition of a community, considering that invasions and extinctions are rare enough.
Trajectory stability	The property of a system to move towards some final end point or zone despite differences in starting point.

Map showing study areas in Brazil (Fig.1)

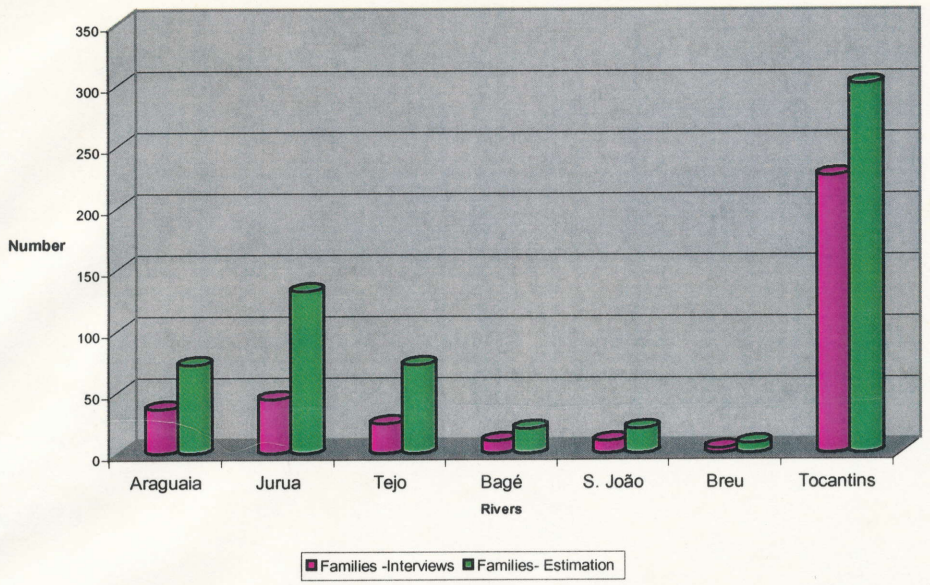

Figure 2. Interviews in the Amazonian rivers and estimated families.

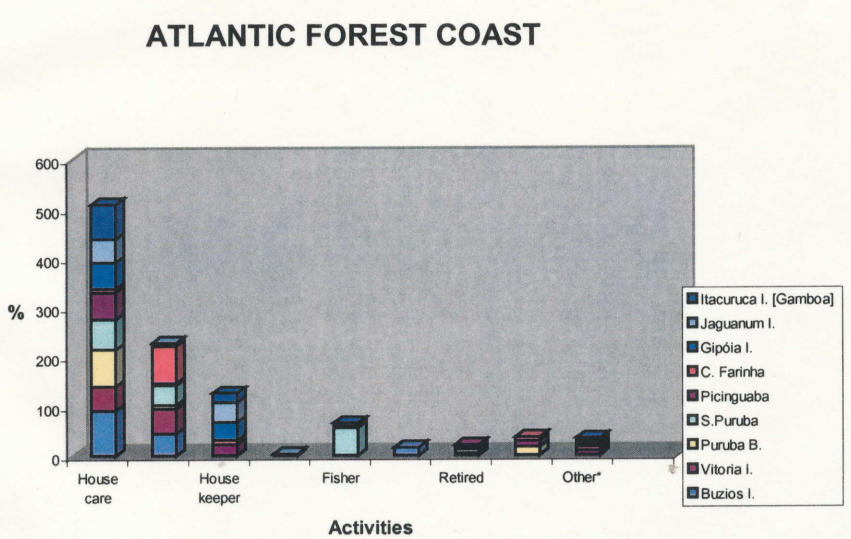

Figure 3. Woman activity in the Atlantic Forest Coast.

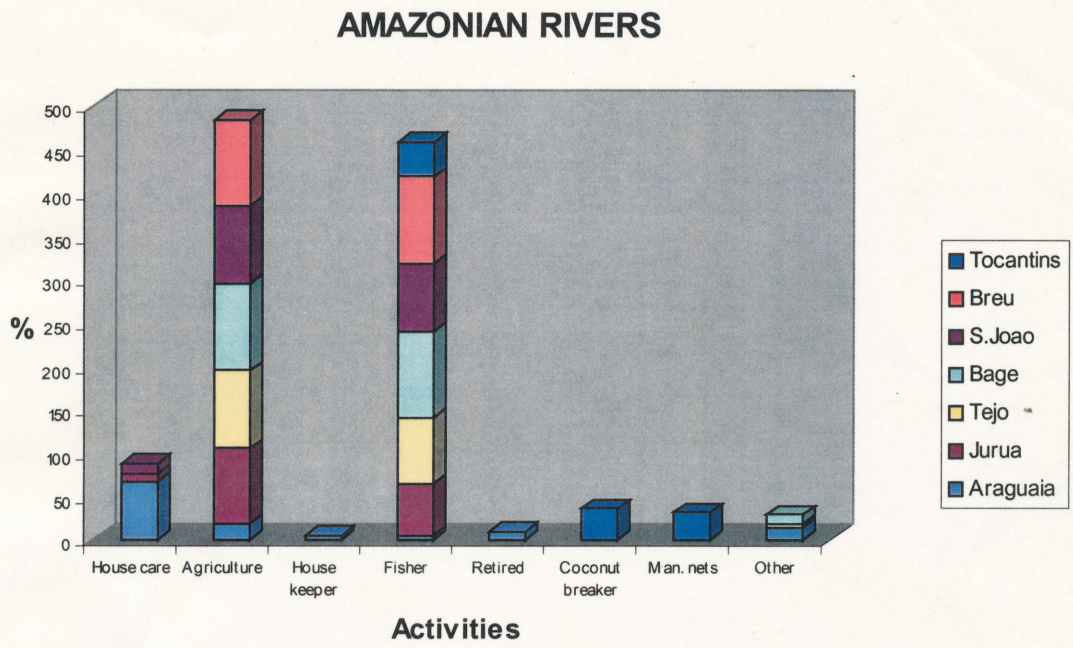

Figure 4. Woman activities in the Amazonian Rivers.

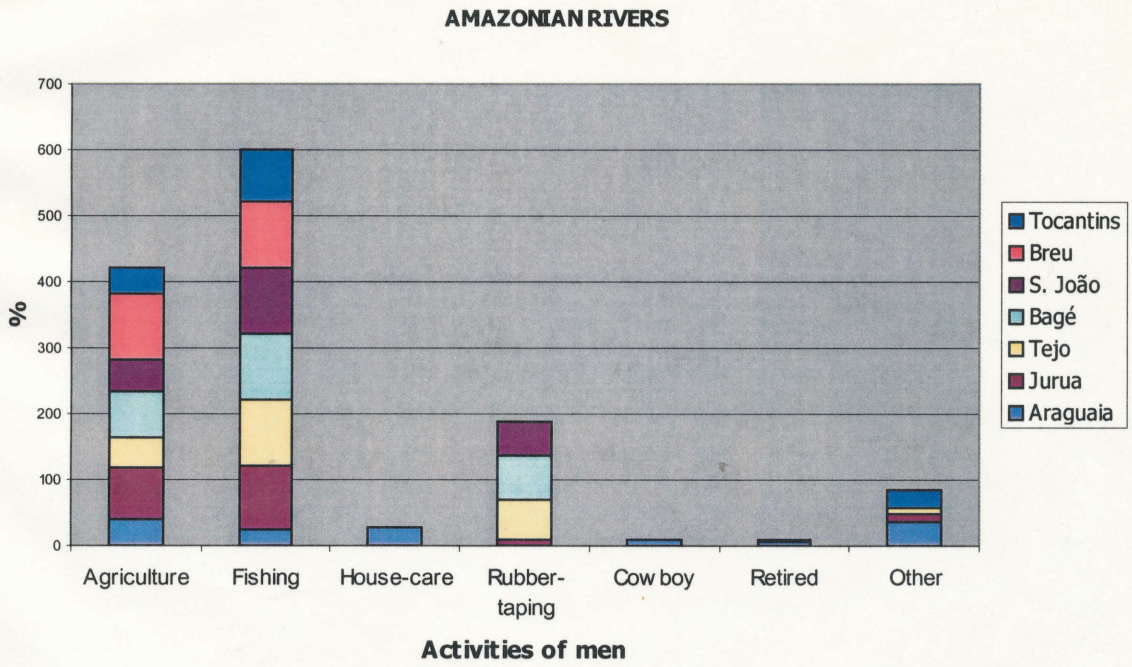

Figure 5. Man activities in the Amazonian rivers.

Figure 6. Women as fish buyers at Itaipu Beach, Rio de Janeiro, Brazil.

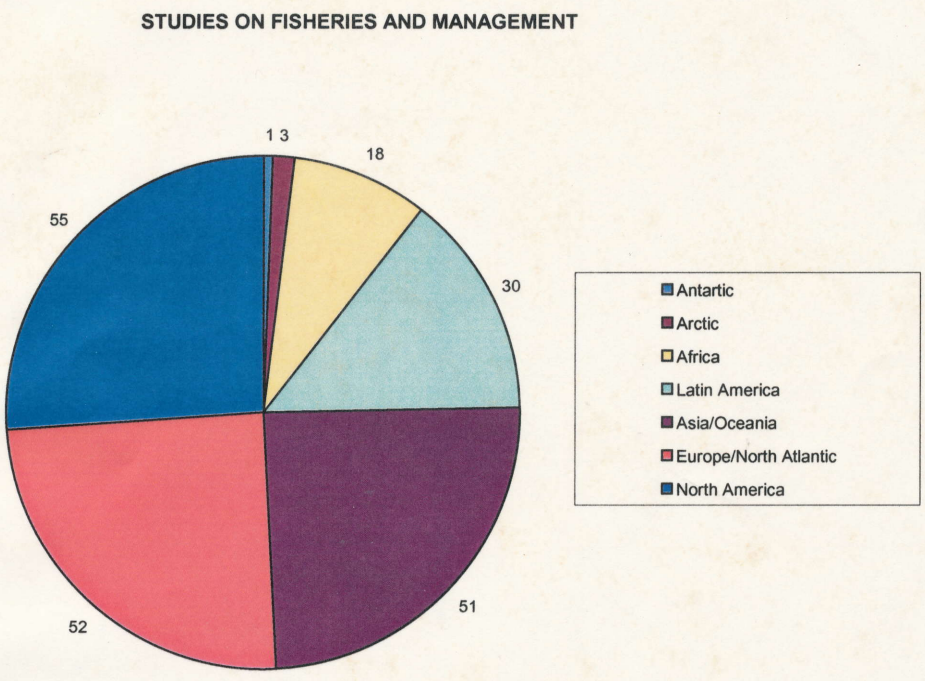

Figure 7. Number of studies in fisheries and management in 2000-2001 found for different areas of the world in the *Web of Science* (In: Begossi, 2002a).

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