

Survival strategies of human riverine populations in southern Brazil floodplain systems

Estratégia de sobrevivência de populações ribeirinhas em planícies de inundação do sul do Brasil

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Abstract

Wetlands provide important resources to riverine populations. However, almost half of the world's wetlands disappeared in the last century. The diminishment of these ecosystems compromises the sustainability of many regions of the planet, including South America. This study aims to identify survival strategies of riverine populations to withstand the hydrological disturbances during a hydrological cycle in a southern Brazil wetland. The study populations maintain the stability of their social structures by producing an identification process through representations of floods and droughts. This knowledge is of relevance and can establish useful principles that can be used to ensure local sustainability of resources. The dependence of riverine populations on the natural resources, their management strategies, and sometimes their isolation, make these traditional populations important elements in conserving these natural systems. These aspects should be taken into account by decision-makers, and should be included in development-oriented policies adopted for the region.

Key words: riverine populations, survival strategies, wetland, flood, stability.

Resumo

As áreas úmidas oferecem recursos importantes para as populações ribeirinhas. No entanto, praticamente a metade das áreas úmidas do mundo desapareceu no último século. A degradação desses ecossistemas compromete a sustentabilidade da maioria das regiões do planeta, incluindo a América do Sul. Este estudo tem por objetivo identificar as estratégias de sobrevivência das populações ribeirinhas para suportar as perturbações hidrológicas ao longo de um ciclo hidrológico em áreas úmidas do sul do Brasil. A população estudada mantém a estabilidade de suas estruturas sociais por meio de processos de representação das inundações e secas. Essas informações são importantes e podem estabelecer princípios úteis que podem ser empregados para garantir a sustentabilidade local dos recursos naturais. A dependência das populações ribeirinhas aos recursos naturais, as estratégias de manejo que desenvolvem e, algumas vezes, seu isolamento fazem dessas populações tradicionais importantes parceiros nos esforços de conservação desses ecossistemas naturais. Esses aspectos devem ser considerados por tomadores de decisões e devem ser incluídos no desenvolvimento de políticas orientadas para essa região.

Palavras-chave: populações ribeirinhas, estratégias de sobrevivência, áreas úmidas, inundação, estabilidade.

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Introduction

Wetlands are important ecosystems given that they present high productivity and high biological diversity. They also provide important resources to human populations (e.g. water, energy, food, fish, fuel, fiber, recreation, transport, and crop production) that ensure their survival in a given area (Marques, 1995; Taylor *et al.*, 1995; Bixler and Morris, 2000; Sampaio *et al.*, 2006; Ambastha *et al.*, 2007). However, almost half of the world's wetlands disappeared in the last century due to agricultural and urban development (Shine and Klemm, 1999; Ambastha *et al.*, 2007). In Europe, the situation is critical with the loss of almost 2/3 of wetlands by the beginning of the 20th century (Santamaría and Klaassen, 2002). The loss of wetland systems threatens human population sustainability in many areas of the planet, including South America.

One of the main hydrological characteristics of South America is the existence of large wetlands (Neiff, 2001). Brazil has approximately 50% of the total inventoried wetland area (Naranjo, 1995). In southern Brazil, approximately 72% of the wetlands are smaller than 1 km² (Maltchik *et al.*, 2003a). This is a consequence of strong habitat fragmentation due to agricultural expansion, especially rice plantations (Gomes and Magalhães, 2004). Conservative data indicate that approximately 90% of the wetlands have already disappeared in southern Brazil, threatening the biodiversity (Guadagnin *et al.*, 2005; Rolon and Maltchik, 2006; Panatta *et al.*, 2006, 2007; Guadagnin and Maltchik, 2007) and the sustainability of many riverine populations that rely on resources derived from wetlands for their survival.

The integration between human populations and wetlands is old, dating back to the Egyptian and Mesopotamian civilizations, which relied on floodplain areas for their

agricultural practices and cattle raising (Ribeiro, 1978). In countries like India, the great majority of inland wetlands are temporary and/or man-made. They have been traditionally used and managed by local human populations (Ambastha *et al.*, 2007). Similarly, many modern cities have also been developed in the margins of large rivers, and these systems became the main pathway to the exchange of goods (Silvano and Begossi, 1998; Costa-Neto *et al.*, 2002). In southern Brazil, human populations have long been associated with wetlands, since the arrival of the first European settlers, which used the rivers as a way for transport. Such populations established themselves in the margins of the rivers and rely on these systems until present time, mainly for their agricultural practices (Gomes and Magalhães, 2004).

The notion of ecosystem where organisms living in an area interact with the flow of matter and energy (e.g. Odum, 1988) leads to the idea that human social systems are also integrated to the ecological systems (Duncan, 1961). Therefore, human populations should be endowed with survival strategies that parallel to those found in the living organisms (Holling and Goldber, 1971). Many human populations around the world have learned to extract goods from marginal systems without further degradation (Diegues, 1992). Scientists have recently begun to demonstrate how local peoples can teach new models for sustainable use and management of natural resources. Their ancient traditions, developed through millennia of experience, observation, and experimentation, have relevance in providing options for the future of the Planet (Posey, 1990). This social perspective includes the way people perceive, use, allocate, transfer, and manage their natural resources (Morin-Labatut and Akhtar, 1992).

Such perception justifies that human populations may be regarded as

possessing survival strategies comparable to those found in the living organisms (Holling and Goldber, 1971). In this framework, social systems are unities endowed with strategies that warrant the stability of their social structures and organizations. This is particularly interesting in wetland systems, where the alternation between dry and wet periods forces human populations to adopt strategies of resistance and/or resilience that enable their long term persistence in these ecosystems. The main hydrological characteristic in southern Brazil wetlands are the hydrological extremes: dry and wet phases. These events are regarded as the main forces in the organization of aquatic communities in wetland systems (Junk *et al.*, 1989). However, studies that analyze the survival strategies of riverine populations to disturbances by floods and drought are scarce in that part of the country. Nonetheless, the framework of policies for conservation and restoration of wetland systems must consider the adaptations and survival strategies of human populations, as they will be affected by such policies (Thé *et al.*, 2003).

The presence of established human populations in riverine systems in southern Brazil is an indication that such populations have developed important survival strategies along with a strong ability to perceive and interpret the hydrological disturbances as opportunities to maintain the stability of their social structure and organization. Under this view, this study aims to identify survival strategies of riverine populations to withstand the hydrological disturbances (flooding and drought) during a hydrological cycle.

Methodology

The study was carried out in the lower reach of the Sinos River in São Leopoldo municipality, southern Brazil (Figure 1). The Sinos River

is a seventh order permanent river (Strahler, 1952) in the Jacuí/Guaíba catchment. The annual precipitation in the Sinos River catchment area (ca. 4,000 km²) ranges from 1,200 to 2,000 mm per year and is well distributed along the year. The increase in discharge due to high precipitation originates a series of flooding events resulting in the temporary inundation of the floodplains.

São Leopoldo municipality is located in a wetland area of 348.54 ha (103 wetlands), corresponding to 3% of the municipality area (Maltchik *et al.*, 2003b). Most wetlands are smaller than 3 ha belonging to the catchment area of the Sinos River. The population of the São Leopoldo municipality is of approximately 215,362 inhabitants, with an urbanization rate of 99.7% (IBGE, 2007).

A total of 38 individuals from 19 families were selected from the three study human populations over the Sinos River (Figure 1). All residencies were located close to this river (maximum distance of 300 m) and remained isolated during the flooding period. The inundation period varies in the region, depending on the magnitude of floods, between 7 and

90 days. Major sources of income in all the surveyed settlements are cattle growth, recycling of residuals, brick building and agriculture. The study populations survived mostly from small-scale agriculture and cattle and goat growth for subsistence. The families interviewed occupied areas between 2 and 5 ha, generally inherited from relatives. Individuals were natives from the area and have long had their lives linked to riparian zone. The sampling was stratified per age (adolescent, adult and elder) and gender. Each person agreed in writing to participate in the survey. Data collection was qualitative through simple observation and semi-structured interviews. Interviews were performed between March 2003 and May 2004, being more intense during the hydrological disturbances. Information was registered by taking notes and tape-recordings.

Interviews included a range of topics related to the survival strategies of the riverine families. Qualitative analysis of the information was based on the interpretation of the data informed, on the individual and family perspectives, historical information and literature on the subject (Triviños, 1995).

Results and discussion

The riverine populations studied undertook major changes in their settlement patterns across the occupied wetland. In the past, they would occupy areas close to the river, as navigation was the main means of transportation in the region. Also, the floodplain was used for agriculture and cattle growth. In more recent years, new settlers occupied the floodplain areas but without any specific interest on its use. In most cases, these people could not establish themselves in towns and moved to the floodplain area as temporary location. As soon as they found a place to live, they would move back to the cities and towns of the region. In spite of that, the interviewed people were long-term residents of the floodplain possessing strategies for persistence developed after many years living in the region.

The surveyed riverine populations have a strong sense of ownership. Their houses are strong reference to the family and the limits of their properties are based on landscape features, such as hills, depressions, and bush-lines of trees. Noda *et al.* (2001) found a similar approach in riverine populations in the Amazon “várzeas” (floodplains), where they also used landscape features to define the limits of their properties. Fences are used to prevent animals from entering other properties:

We only build a fence where there is a crop, so the cattle won't come in (Mrs. A., 40 years old).

The houses are usually facing the river and the wood canoe is an important means of transportation. The canoe is used for fishing and transport of people during inundation, when the houses become isolated from the main roads. Houses are built in the higher portion of the property whereas palafitte housing is built in lower portions near the river. In general, houses built in the



Figure 1. Location of the three riverine populations surveyed in the Sinos River basin in southern Brazil (State of Rio Grande do Sul).

lower portions of the watershed have two storeys to minimize losses during inundation. Interestingly, the second floor is used only during inundation periods. The height of the second floor and the palafittes are established based on historical data from previous higher floods:

[...] last year [2002] the flooding waters reached the first floor of the house [...] so we raised the floor some 30 cm (Mr. B., 60 years old).

In other floodplain areas, such as the Pantanal and the Amazon, palafittes are an adaptation strategy to the cyclic periods of flooding and drying (Castelnou *et al.*, 2003; Diegues, 2005).

Water for human consumption is collected from wells and usually used with no treatment. However, after inundation periods, the water is boiled given that its quality is compromised. During flooding, the water from the river inundates the wells making it temporarily inappropriate for human consumption:

When the flood is large, the water of the river falls into the wells and the water gets dirty and yellowish [darkened]. One can get stomach aches from this water; so we boil it before drinking [...] (Mrs. C., 37 years old).

During the dry season, the water from the wells that did not dry out is shared with other members of the community:

[...] I am out of water; I am pumping water from the river to wash the clothing, but to drink I get it from my neighbors (Mrs. C., 37 years old).

In traditional communities, water is a shared resource for common use (Diegues, 2005). Barbosa and Maltchik (1998) observed a strong sense of co-operation in the utilization of water in semi-arid riverine populations.

During the present study, several sources for subsistence were identified, such as agriculture, manufacturing of bricks (kilning), livestock, recycling, small-scale commerce, fishing, informal work and retirement pension. Commerce and trade enable a more ample range of resources. Kilning was in general a very specific activity, and therefore, individuals performing this activity were more dependent on commerce for their subsistence. Small-scale commerce and trade networks have been found to be important ways to access a wider range of products in other communities (Moran, 1994). The riverine populations studied grow mostly plant species that they identify as tolerant to wet conditions during flooding:

These tea plants are accustomed to the inundation, and will not die (Mrs. D., 65 years old).

The species the above interviewed person was referring to were *Maytenus ilicifolia*, *Campomanesia* sp., *Lepidium ruderales*, *Xanthium spinosum*, *Achyrocline satureioides*, *Bambusa* sp., *Aloe* sp., *Desmodium* sp., *Bauhinia candicans*, *Phyllanthus niruri*, *Symphytum officinale*, and *Mikania* sp. Plant species that do not withstand the inundation periods are grown in higher areas or, when possible, cultivated in vases over a wooden platform to avoid inundation:

[...] we plant them [vegetables] in vases, and when the flood comes we put the vases onto a small pier we build [...] (Mrs. D., 65 years old).

Those plants cultivated in vases are also used to replace crops which were lost due to the flood. Furthermore, the riverine populations take advantage of the periods when flooding events are less frequent, to grow species with short life cycles (e.g. manioc and corn). According to them, the growth of plants with longer life cycles is not possible due to the recurrent floods:

[...] we cannot grow them [plants with long life cycle] because the flood raises the water and kill all of them! (Mrs. E., 50 years old).

Such practices are in accordance to Noda *et al.* (2001), who claim that production in areas subjected to inundation follow a temporal pattern based on the knowledge on soil fertility and plants' reproductive cycles.

Logging on the riparian vegetation of both native and exotic trees is a common practice within the surveyed communities. The wood extracted is used mainly as fuel to wood ovens, but in areas where bricks are manufactured part of the wood is used to burn in the kiln ovens. Interestingly, the cut of entire trees is rare, and the interviewed people use mostly tree branches, what facilitates the re-growth and enables the sustainable use of these resources. Woody debris brought during high magnitude floods are also used by the populations studied.

Livestock is raised extensively in the fields and forests of the floodplain areas, and the ownership of the livestock is respected between the different communities. The livestock (cattle, poultry, and sheep) and its products (eggs, meat and milk) can be used as currency in the trade for other products during periods of hardship. This usually occurs during the drought:

[...] we exchange with neighbors things that we have in excess for things that we do not have (Mr. F., 72 years old).

Cattle are utilized for traction of carts, wool and food. Animals feed mostly on non-cultivated grass that grows in the inundated fields, but their feeding is supplemented with corn (*Zea mays*), manioc (*Manihot esculenta*), elephant grass (*Pennisetum purpureum*), and food left over after human consumption. The water used for animal consumption comes from the river, floodplain lakes or artificial reservoirs. During inundation periods,

younglings are given water from wells. According to the interviewed people, they are more sensitive to the variations in water quality.

Poultry is a common practice for subsistence of riverine human populations. Chicken are used not only for consumption but for sale as well, as showed by Siqueira *et al.* (1993) for the Igarapé do Paricatuba community, in the Island of Marajó (Pará, Brazil). According to these authors, some families grow livestock (e.g. pigs) not only for consumption and sale but to be kept as a commodity that can be exchanged for money on the local market (Siqueira *et al.*, 1993). Poultry and pigs are also grown free in the surrounding of their houses and fed with left over food from the family and sometimes pellets.

It was observed that buildings, such as the chicken coop, piggery, stable and hives, were built in higher places to prevent the loss of animals during periods of inundation. Ultimately, during periods of flooding, animals (mainly cattle) can commonly be relocated to neighboring properties that were not completely inundated by the floodwaters. On the other hand, in periods between inundations, individuals living in higher areas usually relocate their cattle to lower ground, where there is more pasture available:

[...] the neighbors help each other and make deals. Those who have land in higher ground sometimes allow their use by those in lower ground and vice-versa (Mr. G., 62 years old).

Such scheme brings mutual advantages to the populations involved, as the loss of livestock during inundation is not uncommon:

[...] during the last inundations, a cow got stuck in a mud hole. We tried to retrieve her but she fell on again, then the flood came and washed her away! (Mrs. H., 42 years old).

Traditional populations living on sea-shore and riparian areas frequently have fishing as an important activity (Cordell, 2001; Diegues and Arruda, 2001). However, fishing was a supplementary source of food in the Sinos River region. This is related to the fact that most of the surveyed families did not have appliances for preserving food like fish, such as refrigerators. Nevertheless, some families used underwater structures (made of scrap) in rivers and streams to stock live fish. Hunting was an activity in decline during the study period, although occasionally practiced by some of the inventoried communities. Hunted species included birds, mammals, reptiles and amphibians:

[...] we used to hunt alligators around here (Mr. H., 44 years old).

There are frogs [Rana spp.] to eat; some eat them [...] (Mr. H., 44 years old); *[...] some people hunt around here sometimes, capybara [Hydrochoerus hydrochoerus] to eat, and also the coypu [Myocastoridae]* [...] (Mr. H., 44 years old).

Flooding and drought events influence hunting strategies of the riverine communities studied. During the inundation period, terrestrial animals have to move due to the raising waters, and consequently tend to be more hunted, whereas during the dry period the main target are the aquatic birds which become concentrated in the drying wetlands.

Hunting and fishing are regarded as important activities in other riverine populations, providing food, medicine and goods (Siqueira *et al.*, 1993). The riverine community of Igarapé do Paricatuba, in the Island of Marajó (Pará, Brazil), has been found to hunt several species, such as the armadillo (*Dasypus* sp.), the paca (*Agouti paca*) and the opossum (Didelphidae), which are the most valuable game. In the present study, the armadillo and the paca were hunted mostly during the wet season, being found across the floodplain

areas. The opossum was found all year. The peccary (*Pecari tajacu*) and the deer (*Mazama* sp.) were also cited as important game species during the wet season. The agouti (*Dasyprocta agouti*), the iguana (*Iguana iguana*), the tortoise (*Geochelone* sp.), and the sloth (*Choloepus* sp. and *Bradypus* sp.) were found all year in the floodplain area and on higher ground. These animals were reported as being hunted only occasionally (Siqueira *et al.*, 1993).

During the flooding season, the study riverine populations are restricted to travel only by small watercraft. They also usually share their boats and homes during periods of inundation:

During flooding we have assistance of caicos – small canoes – from the neighbors when they pass by, or when needed we just call them and they will come to help us with their canoe (Mr. I., 56 years old).

Because the floodwaters frequently isolate these families, during the inundation period, the children often stay in relatives' houses so they can still go to school.

The knowledge of native populations is important and can be used to mitigate important events in the environment (Watson *et al.*, 2003), such as flooding and resource availability. They also establish useful principles that can be used to ensure local sustainability of resources (Begossi, 1995). The dependence of riverine populations on the natural resources, the management strategies they have developed, and sometimes their isolation, make these traditional populations important partners to achieve suitable efforts for the conservation of natural systems (Diegues, 2001).

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