Common Property Resource System in a Fishery of the São Francisco River, Minas Gerais, Brazil

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Abstract

*Studies of local natural resource management institutions have contributed to many co-management agreements around the world and also have demonstrated how communities interact with their environment through their culture and social organization. **C**ommon **P**roperty **S**ystems (**CPS**), which define duties and rights in the use of natural resources, are examples of these interactions. But as Ostrom (1990, 14) notes: "getting institutions right . . . is a process that requires reliable information about time and place variables, as well as a broad repertoire of culturally acceptable rules." One of the potential benefits of co-management institutions is the inclusion of a variety of information systems and knowledge bases. For example, local users have intensive knowledge and understanding about day to day local uses and conditions, whereas national governments and international NGOs have more global knowledge and financial and administrative resources to tackle large-scale scientific research.*

In this paper, we examine the role of local ecological knowledge in the management of a common pool resource, the artisanal fishery at Buritizeiro in Minas Gerais, Brazil. The research was carried out between 1999 and 2001 with seven field trips of 15 days each. Open and structured interviews were conducted, complemented by direct observation of the fishing activity. During three field trips, the fishery yield was recorded for 175 fishery shifts.

Approximately 30 fishermen share the rights to access and use of four principal fishing spots in the rapids. In addition to operational rules, decision-making rules related to management, and exclusion and alienation rights have been developed. Local ecological knowledge has helped the fishermen identify most productive fishing spots, has been instrumental in determining the limits of the CPS area, has maintained fishery yield (average: 7.29kg/fisherman/day), and has provided the basis for institutional rules regulating the spatial and temporal limitations for each user. As the number of resource users has increased over the years due to the lack of other job opportunities in the region, this CPS has demonstrated flexibility in the rights to access and use, avoiding conflicts among the users and ensuring its longevity. The success of this CPS can help in the development of appropriate policy for fishery co-management plans in this area.

Keywords: *commercial fishery, artisanal fishery, common property systems, local regulations, fishery production, management of fisheries' resources*

Introduction

Studies on regulations established by local communities for the use of natural resources have been fundamental to proposals for participatory management. Such regulations, supported by local knowledge and practices, reflect the social organization of the community and how it relates to its environment. This relationship can be inserted in the context of desired common resource property, which defines rights and restrictions relative to their use (Ostrom 1990, 1992; Berkes et al. 1998). The term "common property" refers to the assemblage of regulations and rights established by a local community for the use of a particular common resource. McKean (2000) defines regimes of common property as informal collective institutional arrangements that regulate the access, use, management and ownership of natural resources.

Common property is the concept developed around the hypothesis posed by Hardin (1968) in his article on the "tragedy of the commons," in which he claims that farmers, herders, fishermen, and other users are inevitably "condemned" to exploit to extinction common resources upon which they depend. Hardin believed that, in the case of making use of common resources, individual interests would overcome the interests of the collective. To resolve the "tragedy of the commons," the author proposes total centralization of management by the state or privatization of the natural resources.

Hardin's (1968) argument of the "tragedy of the commons" has been used by many researchers and specialists in natural resource management as a basis for creating management plans. In these, the command and control of the use of natural resources is generally centralized in government organs, in a process of imposing solutions for resource use by external authorities, without any participation by the communities of local users (Ostrom et al. 1999).

While some uses of common pool resources have resulted in the loss of a considerable portion of the resource, studies have demonstrated that various communities have organized themselves to manage common resources in a collective and long-lasting manner, by way of sustainable social and ecological relationships (Ostrom et al. 1999; Holling et al. 1998; Berkes 1996). In these cases, rights of access to and use of the resources are divided among a limited number of individuals, by way of a combination of regulations that establish rights and responsibilities (McKean 2000; Ostrom 1990). According to Ostrom et al. (1994), common pool resources are natural or anthropogenic stocks that are usable for a long time and share two characteristics: a) it is very expensive to develop institutions (norms and regulations) that exclude potential beneficiaries, and b) units of the resource obtained by a user are no longer available to other users (Ostrom et al. 1994).

Recent publications on common pool resource use contain vast empirical information on how communities and governments around the world are using common property institutions to facilitate and guarantee functional management of natural resources (Agrawal 2002). In this paper, we are defining the set of fishing community regulations and rights in the use of the natural resources as a **C**ommon **P**roperty **S**ystem (**CPS**).The significance of CPSs is that they represent localized solutions, developed by users over time to deal communally with the use of a resource, its division, and eventual conflicts (Berkes et al. 1998).

As an example of CPSs, the freshwater fishery that occurs in the river rapids in the town of Buritizeiro represents the most complex and structured set of regulations present on the São Francisco River within the state of Minas Gerais. The objective of this paper is to describe and interpret the informal laws that regulate this fishery, with the purpose of supporting this locally developed social organization.

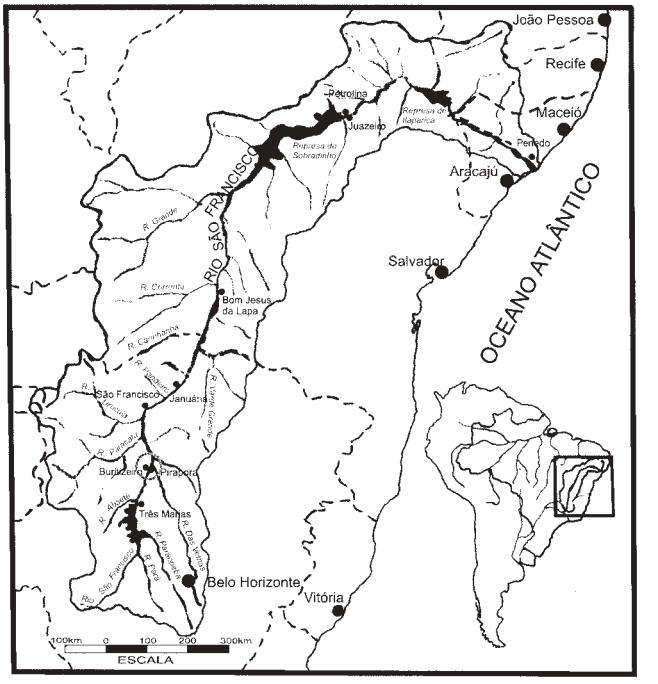

Figure 1. Map of the São Francisco River showing the location of the study site (circled). Source: Pedro Ekman, www.sfrancisco.bio.br.

Characterization of the Study Area

The São Francisco River flows northward from springs of the Serra da Canastra (latitude 20˚ 15' South) through the central mountains of Minas Gerais and over the central plateau of Bahia before turning northeast and eastward through the states of Pernambuco, Sergipe, and Alagoas, and the coastal mountains and coastal plain, to its mouth on the Atlantic Ocean (latitude 10˚ 30' South). The river thus extends 2700 km through five Brazilian states, three to four climatic zones, and some of the historically, culturally, and politically most important regions of the country. It is traditionally divided into Upper, Middle, Sub-middle, and Lower segments (PLANVASF 1989), reflecting geographically distinct regions. The rapids of Buritizeiro, the area of this study, are at the northern (downstream) end of the Upper segment (Figure 1).

The Upper river segment is 630 km long, representing an elevation difference of 700m. The Três Marias reservoir is located 130 km upstream of Buritizeiro/Pirapora, but otherwise the river in this segment consists of fast waters with numerous rapids.

The area has a humid tropical environment, with a rainy season between November and April. The annual rainfall in the area is 150-200 cm, with an average temperature of 23-25˚C. The cerrado steppe is the predominant vegetation (Sato and Godinho 1999).

The municipality of Buritizeiro was established in 1962, and now has a population of approximately 26,000 inhabitants. Only 2,000 people, however, are registered workers, reflecting the enormous lack of formal employment in the region (CODEVASF 2001). Valencio et al. (2003) in their socio-economic study of fishermen of the Upper and Middle São Francisco River, reported 50% of the families have a per capita income of less than half minimum salaries, and only 19% have per capita family incomes of one minimum salary or more.

In terms of education, 28% of the fishermen have never attended school and 65% have only four years of school. Only 9% of fishermen have completed schooling beyond the primary level (Valencio et al. 2003).

Materials and Methods

Data was collected between February 1999 and February 2001 in seven field trips, each, on average, 15 days in duration. During the first trips, freestyle or open interviews (Mello 1995) were carried out with 26 fishermen, supplemented by direct observations of the fishery and fish sales. In subsequent visits, more structured interviews were carried out with the fishermen, based on information gathered in the early interviews and focusing on fishery strategies and the CPS. The productivity of 175 fishing shifts was monitored on consecutive days during three-week periods in the months of July and September, 2000 and February 2001.The fishery catch was weighed by species group with dynametric spring balances with capacities of 1, 5, 10 and 50 kg. The fishery techniques, equipment, timing, and landing sites associated with each catch statistic were also recorded, along with the number of fishermen.

Results

Common Property System

The CPS studied is situated in an 800m stretch of the rapids of the São Francisco River where it flows between the municipalities of Buritizeiro and Pirapora (Figure 1). The area is divided longitudinally down the middle, so that the fishermen in this study, from Buritizeiro, only fish in the "Buritizeiro" portion of the rapids. About 30 fishermen regularly fish here, 80% without professional fishing licenses. This is due to the total prohibition of fisheries in rapids by Article 4 of Portaria no. 466 (08/11/1972) of SUDEPE (now replaced by IBAMA) which established the regulations for inland freshwater fisheries.[3] At the time, fishing in rapids was considered too efficient by the government, and was believed to lead, potentially, to overexploitation of the fishery. As the activity is now illegal, the fishermen of the rapids cannot demonstrate their fishing livelihood to the appropriate authorities — a requirement in Brazil for getting a professional fishing license. Thus, the fishermen also do not receive the compensatory payments during fishing closures and pensions that other fishermen are entitled to. Although the state police have attempted to enforce the prohibition of fishing this set of rapids, sometimes with violent and humiliating methods, the fishermen have continued fishing these rapids "illegally" for the last 30 years.

The majority of fishermen studied (64%) are between 30 and 50 years old, 20% are between 20 and 30 years old, and 16% are above 50 years old. Only 12% of the fishermen have fishing as their only source of income, as 88% have income from other professions (*bicos* such as mason, electrician, farm worker) — to help sustain their families. In terms of time active in the rapids fishery, 23% have fished here for less than 10 years, 41% for at least 10 years, and 36% for 20-30 years.

Four fishing sites are recognized in the "waterfall" (*cachoeira*), as the rapids are known to the fishermen — the *Cabeça do Rêgo* (Channel's Head), *Toma Banho* (Have a Bath), *Pedra do Descanso* (Rock for Resting), and *Barbaio* (Figure 2). Each site has a set group of fishermen associated with it that have access and use rights for specific hours. According to the fishermen, this arrangement originated when fisheries in the rapids became illegal in 1972. Before this prohibition, only the older fishermen with licenses fished in

Figure 2. Fishing sites in the "waterfall" of Buritizeiro, São Francisco River, MG. Sites 1 and 2: "Pedra do Descanso" and "Barbaio"; site 3: "Toma Banho"; site 4: "Cabeça do Rêgo." Source: Alexandre Godinho 2002.

the "waterfall." At the time, one site, the *Pedra do Descanso*, was used by only one fisherman. The other sites were used by all of the fishermen, but these entered the "waterfall" only in pairs, according to the order of arrival. After the prohibition, various fishermen stopped fishing for fear of prosecution. The access and use rights for the fishing sites thus passed to newer fishermen that, while without a fishing license, had the approval of the older fishermen to participate in the fishery as helpers and apprentices. These rights thus became consolidated, as they were passed to sons, nephews, grandsons, and younger fishing friends. The new fishing order established in Buritizeiro made the access to fishing sites more restrictive than before. In response, the "fisherman in waiting" position was created amongst the users. This position is a fisherman without current full access rights but with a junior joint right to a particular fishing site together with the principal "owner." The fisherman in waiting has to remain behind the owner of the site and fish only those fish that escape the efforts of this owner, or he waits for the owner to finish his activities in a particular location before starting to fish. In either case, *ir na aguarda* — "go to wait" means to await the movements of the "owner" fisherman. *Ir na aguarda* is also one of the regulations that maintain social relations of the fishery stable, as it serves to minimize or eliminate conflicts.

The regulation of *ir na aguarda* does not eliminate the principle of excluding potential users, a characteristic of common property systems. We confirmed by direct observation that to *ir na aguarda* a candidate needs to have the permission of the proprietor fishermen.

For all of the locations in the "waterfall" (*Cabeça do Rego*, *Toma Banho*, *Pedra do Descanso* and *Barbaio*) there are entrance hours for each fishing session (Table 1) which lasts, on average, 50-60 minutes each, but can be longer if production is high.

Table 1. Entry hours that regulate fishing shifts on the "waterfall" of Rio São Francisco, MG.

Daytime entry hours	Nighttime entry hours
9am, 12pm, 3pm	6pm, 12am, 3am, 6am

The principal motive given by the fishermen for spatial and temporal segregation of the fishing sites is that these are the "locations where fish pass in the waterfall." Independent of the fishing site, the fishermen need to respect the established entry hours and duration of the fisheries (Table 1). Of the three hours to which each fisherman has the rights, about two must be reserved to allow the waterfall to "rest." The reasons for the "rest" period seem to be associated with local ecological knowledge that the fishermen possess about the time that must be given to the fish to get out of imprisonment amongst the natural obstacles of the rapids and time for the fisherman to recover from physical exertion. The fishermen go to fish standing up, jumping from rock to rock and battling the current, which is very strong in these locations. At each entry time, therefore, there is about one hour of fishing and two hours of resting. In addition to the above functions, this can also be understood as a resource management measure, as it limits the fishing time of each fisherman.

Figure 3. Fishermen using a "castnet" in the "waterfall." Source: Camila Michellin.

Figure 4. Fishermen baiting the fish trap, a fishing gear used in the "waterfall" of Buritizeiro. Source: Camila Michellin.

The only fishing techniques used currently in the waterfall of Buritizeiro are the *tarrafa* cast-net and the *colfo* fish trap (Figures 3 and 4). The *tarrafa* is used in all fishing events, cast several times. The *colfo* is a trap in the form of a bucket, used in only one location (*lanço*) of the Toma-Banho fishing site, where all the fishermen that contributed to the cost of the colfo can use it. "*Lanço*" refers to all the possible locations at a fishing site where a *tarrafa* can be cast. The

Table 2. Names given to fishing locations within the four fishing sites of the "waterfall" of "cachoeira" de Buritizeiro- MG.

"Toma Banho"	"Cabeça do Rêgo"	"Pedra do Descanso"	"Barbaio"
-lanço do colfo	-Lanço do buraquinho, buraquim	-lanço da entrada	-pedra comprida
-lanço do pulo	-pedra comprida	-buraco ruim	-pedra doce
-chiqueiro	-lanço do rebojo	-batente	-liso do barbaio
-lanço das duas pedras	-lajedo	-pedra rachada	-lanço da pinda/pinda de baixo
-batente	-buraco	-chiqueiro grande	-pedra do apuador
-rabo do colfo	-entre as duas pedras	-buraco de adão	-batente do barbaio
-pedra chata			-recanto
-sobradinho			-buraco do barbaio
-esteio			-lanço do rebojo
-pedra piau			

names given to the *lanço* can refer to the behavior of the fish (e.g. "rock of the jump," because the *curimbata* jumps when it gets there), distribution of the fish ("rock of the piau," because many *piau* can be caught here during low water), fishing technique ("*lanço* of the *colfo*," because this is where the trap is used), or behavior of the fisherman ("Adão's hole," as this is who discovered this *lanço*). Each of the fishing sites has a variety of *lanços*, all named by the fishermen, as shown in Table 2.

Shift Rotation at the *Cabeça do Rego*

Usually the fishermen of this fishing site have the right to its use one day per month; only a few have more than one day, having inherited or bought more time from former owners. The shift for every fisherman starts at 6pm of the determined day, and ends at 6pm of the following day. The routine of fishing and resting, described earlier, needs to be followed on every shift. We observed that other than the 6pm entry time (when different owners enter the waterfall), entry times were flexible, according to the individual fisherman. Every fisherman has his day of the month fixed, which is repeated every month.

Shift Rotation at the *Toma Banho*

The shift rotation at this site has entry times at 9am, 12pm, and 3pm. The fisherman that enters at 9am leaves at about 10am, leaving the site to rest for two hours and open for the next fisherman who will enter at 12pm. The same procedure is repeated with the remaining fishermen. Every fisherman has the right to one hour per week; in the case of overlapping time periods between two fishermen, they alternate every 15 days. Before 2001, the fisherman that wished to fish the 3pm period could extend their right to the following periods (6pm, 12am, and 3am), leaving at 6am of the following day. To gain the rights of access and use of all of these periods, the fisherman must be the first to arrive at the "waterfall" on that day and claim the shift. To do this, some sleep over night on the river margin below a tree, where, during the day, all of the fishermen tend to meet to wait for their respective shifts.

However, the rule for use of the nighttime shifts changed at the end of 2000. These shifts changed to belong to a group of fishermen that were added to the communal system as owners — a decision, according to depositions, that was taken during a conversation amongst the fishermen. According to the fishermen, the decision to include new "proprietors" at this site was made to help the unemployed, who were fishing loaned shifts or through the *ir na aguarda* rule.

Shift Rotation at the *Pedra do Descanso* and *Barbaio*

While these two sites are named differently for the purposes of the shift rotation, the fishermen consider them a single fishing space. The shift rotation at these sites has entry hours at 9am, 12pm, 3pm, 6pm, 12am, and 6am. The difference in the fishery of these sites compared to that of the *Toma Banho* is that here the fishermen fish in pairs, due to the great risk of accidents and difficult access. The fishery at these sites is always done with a rowboat, as it is very difficult to reach them on foot. Eleven pairs of fishermen were observed working the *Pedra do Descanso* and the *Barbaio*, the number of weekly entry hours varying greatly for each of the pairs during the study period. One pair had the maximum of 11 entries per week, and two pairs had only one entry per week. A further two pairs realized two entries per week, while the remainder entered to fish five to seven times per week. Only three pairs of fishermen alternated on the 3pm shift, each one fishing two days consecutively. The pairs that entered at 6pm could stay with the right to use these sites until 6am of the following day, however, on some days of the week the night-time shifts were divided into two with entries at 6pm and 12am.

Obtaining Rights to the Use of Fishing Space

Four ways to obtain rights for use of the rapids were found to exist:

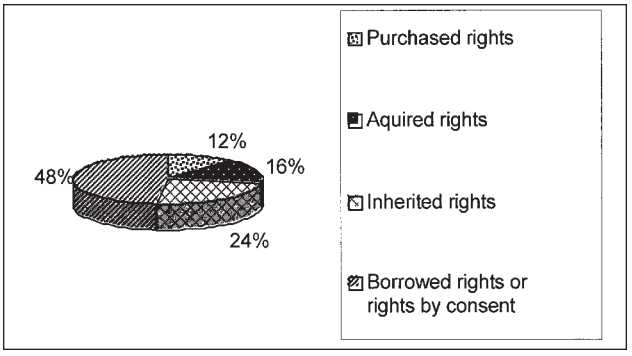

Figure 5. Proportion of fishermen in each classification of fishing right (access and use) in the "waterfall" of Buritizeiro, MG.

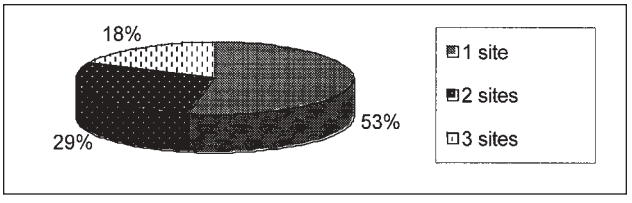

Figure 6. Proportion of fishermen with access rights to different numbers of fishing sites in the "waterfall"of Buritizeiro, MG.

a) *acquired right* — corresponding to fishermen that participated in the division of fishing sites and times shortly after the prohibition of fishing in rapids by accompanying older fishermen that abandoned the fishery with the prohibition;

b) *right by consent* — fishermen that borrowed the fishing time and site from the owners when these could not fish, in trade for half of the catch;

c) *purchased right* — fishermen that purchased fishing times from the owner of the site;

d) *inherited right* — a right to a shift inherited from the original fishermen.

As can be seen in Figure 5, most of the fishermen studied have the right to fish by consent/loan or by inheritance. With respect to the number of fishing sites per fisherman, we found that 15 had the rights to use only one site, eight had the right to use two sites, and five had the right to use all of the sites (Figure 6). This privilege of a few can be explained by acquired rights of the older fishermen of the "waterfall" or by rights by consent, where the hours and sites were borrowed from various fishermen owners that were away from fishing for various reasons during the study period.

Table 3 shows a summary of the conditions that are part of the model of use of the common property in Buritizeiro:

- the *rights* described above;
- the *obligations*, such as respecting the entry hours, time of fishing, and resting time common to all of the sites and respect for the rules of the shift rotation particular to each site;
- the *privileges* that appear to be related to the time spent fishing in this area (due to a concentration of fishing sessions by some fishermen on each site) and the relationship with the original fishermen; and
- the *mutuality* characterized by the lending of times to other fishermen (potential users) that are having financial difficulties and surviving only from fishing or by the inclusion of these fishermen as new owners, as happened at the *Toma-Banho* site.

Table 3. Conditions of use for fishing behavior sanctioned by the fishermen of Buritizeiro-MG.

RIGHTS	OBLIGATIONS	PRIVILEGES	MUTUALITIES
*Inherited right *Purchased right *Acquired right	To observe entry hours **Morning – afternoon** 9am – 12pm – 3pm **Evening – Night** 6pm – 12am – 3am – 6am	Advantage for some users who are fishing more times than others to common property system, decided by the owners group	*Substitution in the fishery/ right by consent *Inclusion of new users

Fisheries' Production in the Rapids of Buritizeiro

The records of mesh size of the fishing nets were impaired by resistance of the fishermen to provide proper information, which, according to our data, varied between four and 12 cm knot-to-knot. The average fisheries time was 70 minutes, ranging from 10 minutes to four hours. The longer time occurred only at sites "outside" of the waterfall. The production data for Buritizeiro, presented by fishery site, are shown in Table 4. The "outside sites" refer to other sites in the rapids where there are neither tenure systems nor temporal-spatial segregation. The production from these sites was

Table 4. Fishery productivity of the "waterfall" of Buritizeiro.

Fishing site	No Fishing shifts	Mean catch Kg/fisherman	Mean shift duration (min)	Mean productivity rate Kg/hour
"Lá Fora"	44	5.57	89	3.75
"Cabeça do Rêgo"	38	7	55	7.64
"Toma Banho"	30	4.12	54	4.58
"Pedra do Descanso" and "Barbaio"	52	10.13	63	9.65

surveyed to compare with the common property system being analyzed. The data demonstrated that, other than the *Toma-Banho* site, the common property sites were significantly more productive than the "outside" sites (Table 5). The tendency towards greater productivity from the common property sites corroborates the information of the fishermen that the fisheries sites in the "waterfall" are "where the fish pass" — (*local de passagem do peixe*), which contributes to the increasing expectations and success of the fishery. The greatest production was at the *Pedra do Descanso* and *Barbaio*, explaining why the greatest number of pairs divide the shifts here, some with greater privileges than others. There is an elevated potential for conflict in this area, but this has been mitigated by the established rules of access and use. As could be expected, the strategy to fish *na aguarda* — waiting for the principal fisherman to finish — was the least productive. In the 10 fishing events of this kind monitored, the mean production was 0.72 kg/fisherman and 0.76 kg/h. The average duration of shifts of fishing *na aguarda* was 57 minutes.

Information was also gathered on the source of the rights of use in 119 of the 175 fishing events (shifts) monitored. In 48 of these, the fishery was pursued by the actual owners. The remainder (71) was carried out within a loan system or through the right of consent. Of the 22 that borrowed the right from other owners, 14 owned rights of use or ownership of sites (purchased, acquired, or inherited) and only eight fished solely by virtue of borrowed or consented rights. This shows that, even with a complex system of subdividing the rapids of Buritizeiro, the predominant system is one of loaning — even those with ownership of rights also use loaned rights to fish.

Table 5. Statistical comparison of productivity of the fishing sites at the "waterfall" of Buritizeiro (Student's "t" test, significance level of $p < 0.1$).

Fishing site comparison	Student's "t" value	Probability level
"Pedra do Descanso" e "Barbaio" X "Cabeça do Rêgo"	0.51	p>0.1
"Pedra do Descanso" e "Barbaio" X "Toma Banho"	0.12	p>0.1
"Pedra do Descanso" e "Barbaio" X "Fora"	0.052 *	p<0.1
"Cabeça do Rêgo" X "Fora"	0.072 *	p<0.1
"Toma Banho" X "Fora"	0.82	p>0.1

* Significances values

Discussion

This description of the common property system of the Buritizeiro rapids of the São Francisco River described the manner in which the fishermen define the rights of access and use to the fishing sites. The most important operational levels of a CPS are the rights to access and use of the resources (Ostrom and Schlager 1996). The *access* that these authors refer to corresponds to the right to enter into a defined area and make use of the commonly owned resources non-exclusively (for example to take a bath in the river), whereas the *right of use* that they refer to corresponds to the right to obtain units of a determined resource or products from this area (e.g. capture fish, water). In the case of the fishermen that we studied, to have the right to access the fisheries' resources signifies access to the fisheries sites of a determined region. In the same manner, to have the right to take out or use the resources implies being authorized to catch or collect them from a determined area during a specific period and using specified technology (Ostrom and Schlager 1996). These authors also state that CPSs contain rules that are not only operational rights for access and use, but also rules for making decisions, corresponding to rights for management, exclusion, and alienation. The right to management corresponds to the right to regulate internal standards for use of the resources and to transform the resources to improve it. The right for exclusion refers to the right to determine who can access the resource and how this right can be transferred to another user. Finally, the right of alienation means that the rights of management and exclusion can be sold or leased.

Thus, a common property system corresponds to an ensemble of measures organized collectively, defining rights and responsibilities with respect to the use of the resources, usually including rights to access and to exclude other potential users, and to manage and sell the output of the resource. All of these forms of rights, for practice and for decision making, were verified amongst the fishermen of Buritizeiro, defined by the regulations of access and use and by the forms by which the rights to the fishing sites are obtained. Not all of the fishermen possess the two forms of rights, as is typical of CPSs (Ostrom and Schlager 1996). In the case of Buritizeiro, fishermen *na aguarda* and those that fish solely by way of consent (a loan of fishing rights) do not participate in the collective processes of making decisions or in elaborating rules on the use of resources. This is the responsibility of the "proprietors" of the waterfall — those that own fishing sites and fishing hours obtained through inheritance, "acquired" (apprentices receiving rights from masters or old friends), or through purchase. These "proprietary" fishers correspond to those identified by Ostrom and Schlager (1996) as members of the community who possess the rights to make collective

decisions about access, harvest, management, exclusion, and alienation.

The CPS of the fishing sites established by the fishermen of Buritizeiro, including an assembly of rules, norms, and even privileges, demonstrates that the management of natural resources is not only proposed and practiced in scientific literature, but can also be found in many local communities (see also, Berkes and Folke 1998; Ostrom and Schlager 1996; Agrawal 2002). This can be a way of diminishing pressure on the natural resource, and consequently, avoiding the degradation and disappearance of the fishing culture itself.

In Brazil, one of the most important examples of governmental recognition of local rules of access and use in fisheries and local management systems are the "fisheries agreements" of flood plain lakes in the Amazon area. These local regulations correspond with the community definition in which fishing gears and nets are allowed to be used. Now these community agreements are formalized as local laws by IBAMA — Brazilian Institute of Environment and Renewable Natural Resources (Castro and McGrath 2003).

Territoriality is one of the behaviors studied in human ecology, and can be observed in the context of locally developed rules as defined boundaries, a principle for self-organized CPSs. In Buritizeiro, the territoriality and creation of the restricted use of common property is related to the productivity of the fisheries points, the knowledge of the fishermen about the locations that the fish use in the "waterfall," and the density of fishermen (both owners and non-owners). As this region suffers serious problems of unemployment, the CPS suffers mounting social pressure for access everyday, and it is increasingly difficult to limit the number of users with rights to access and use. As was observed at the fishing site, *Toma Banho*, the change in the rules for the shift rotation allowed the inclusion of new owners. This demonstrates that informal arrangements can respond rapidly to new demands, maintaining the stability of the system, while maintaining the consistent time of fishing — no new entry hours were added. Berkes (1986) also observed a change in the rules of the shift rotation of the boats of the communal fishery on the Turkish coast during his research, resulting from an increased demand in the users and the increased number of boats per fisherman, as the fishers' descendents demanded the right of access and use of the resource. According to the author, the fishers' perception was that the stability of the system would only be maintained if the rules of use were reinforced by all users, but even so, he did not predict whether or not the increase in user number would stimulate opportunists in the group.

Also, the local rules developed by fishermen for the Buritizeiro rapids, based primarily on setting specific times for users to fish, have resulted in controlled use of the fishery resources. The fishery yields from Buritizeiro rapids are very similar to the fishery yields from other communities in the São Francisco River, as is demonstrated in Thé (2003). For example, in the community of Três Marias, the average fishery yield was 8.0kg/fisherman/day (Thé 2003) and in the community of Januária, the average fishery yield was 4.0kg/fisherman/day. These rules have proven to be much more effective than the prohibition of a fishery in an area, as the local management of the resources has guaranteed the livelihoods of many families.

To understand the differences in rules, rights, and responsibilities in common property regimes, according to Ostrom (1990, 1992), it is necessary to characterize the type of resource and its area of occurrence, and then identify the population involved in its objectives. This allows the definition of the restrictions, sustainability, and potential of the ecological system and the demands of the social system under consideration. The rules of the agreements between the users cannot by immutable (Ostrom 1992), but must adapt to social and ecological changes, as in the case of the fishermen of Buritizeiro, which incorporated new members into the system — modifying the shift rotation at the fishing site *Toma Banho*. The constant monitoring of the resource and the application of sanctions against those that disrespect the rules of use, established in common accord, are fundamental to the fishery's sustainability and establishment of social relationships based on reciprocal collaboration. For Ostrom and Schlager (1996) participants of the communal systems share generalized norms of reciprocity and confidence that can be used as an "initial social capital" to guarantee the sustainability of the common property regime.

Often the monitoring is facilitated by the rules of use themselves. In Buritizeiro each fisherman or pair of fishermen has their proper hours for fishing. Thus, the monitoring occurs naturally because the fishermen are always being watched by their pairs, which remain ready on the river margins waiting for their moment to enter the "waterfall." Ostrom (1992) encountered a similar organization of the shift rotation in an irrigation system of the Karjahi in Nepal. The individual that is close to finishing his or her turn could try to extend his/her time or take more water, if it were not for the presence of the next user preparing his/herself for his/her turn.

Finally, the rights of the users to elaborate their own institutions should not be threatened by government authorities. Many communal systems of resource use, like the one in this study, are not legally recognized by local or federal governments. This is an authoritarian practice that needs to be rethought and transformed by means of dialogue between government institutions and local communities, considering the legalization of the local practices that can contribute to the conservation of the binomial of the artisanal fishers and the fisheries' resources.

Conclusion

Systems of common property, like the rapids of Buritizeiro, are important because of the nature of the rules for local use. These are expressions of the natural and locally constructed cultural capital that signify an integration of the physical and ecological environment with that of society and culture. Common property systems or regimes facilitate continual feedback between natural and cultural capital of the determined region, providing information about the state of the resources that are being explored by the community. In addition, these systems act in the reduction of conflicts that can exist between users of natural resources that are for common use. The rules of use developed and monitored by the community of fishermen of Buritizeiro, although illegal, have been responsible for the regulation of the fishery for approximately 40 years, rather than those developed by external authorities, and as such, deserve recognition by the government institutions. The forms of appropriation of the fishing sites, reported here, have guaranteed the practice of fishing in an organized fashion, avoiding conflicts among users and probably the overexploitation of fishery resources. The fishery yield of these fishermen is similar to that of other fishery communities of the São Francisco river in Minas Gerais state (for example, the average for the fishery yield of the community of Três Marias is 8.0kg/fishermen/day) (Thé 2003) despite diminished fisheries' resources in the region from the construction of the dam at Três Marias, disorganized growth in agriculture, and increased unemployment in the river communities — all of which have resulted in ecological and social impacts. In this part of the São Francisco river, the participation of artisanal fishing communities in governmental decision making processes related to the ecological, social, and cultural context of the fishermen is essentially for the correction of past mistakes and for the development of a sustainable fishery.

Endnotes

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3. Decree of SUDEPE (Superintendence of Fisheries Development) no. 466, of November 8, 1972, regulating Law no. 10 of 11th of October, 1962: Article 4. Fisheries of all types are prohibited within 200 meters below and above dams, waterfalls, rapids, and fish ladders.

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References

Agrawal, A. 2002. Common resources and institutional sustainability. In E. Ostrom, T. Dietz, N. Dolsak, P.C. Stern, S. Stonich, and E.U. Weber (eds.), *The Drama of the Commons*. Washington D.C.: National Academy Press.

Berkes, F. 1986. Local level management and the commons problem: A comparative study of Turkish coastal fisheries. *Marine Policy* 10, 215-229.

Berkes, F. 1996. Social systems, ecological systems and property rights. In S. Hanna, C. Folke, and K.G. Mäler (eds.), *Rights to Nature. Ecological, Economic, Cultural, and Political Principles of Institutions for the Environment*, 87-107. Washington D.C.: Island Press.

Berkes, F., I. Davidson-Hunt, and K. Davidson-Hunt. 1998. Diversity of common property resource use and diversity of social interests in the Western Indian Himalaya. *Mountain Research and Development* 18, 1, 19-33.

Berkes, F. and C. Folke. 1998. *Linking Social and Ecological Systems: Management Practices and Social Mechanisms*. Cambridge: Cambridge University Press.

Castro, F. and D.G. McGrath. 2003. Moving toward sustainability in the local management of floodplain lake fisheries in the Brazilian Amazon. *Human Organization* 62, 2, 123-133.

CODEVASF. 2001. *Almanaque Vale do São Francisco*. Brasília, Distrito Federal.

Cordell, J. 2001. Marginalidade Social e apropriação territorial marítima na Bahia. In A.C. Diegues and A.C. Moreira (eds.), *Espaços e Recursos Naturais Comuns*, 139-160. São Paulo: Nupaub-USP.

Godelier, M.1986. *The Mental and the Material: Thought, Economy and Society*. London: Verso Press.

Hardin, G. 1968. The tragedy of the commons. *Science* 162, 1243-1248.

Holling, C.S., F. Berkes, and C. Folke. 1998. Science, sustainability and resource management. In F. Berkes and C. Folke (eds.), *Linking Social and Ecological Systems: Institutional Learning for Resilience*, 346-366. Cambridge: Cambridge University Press.

McKean, M. 2000. Common Property: What is it, what is it good for, and what makes it work? In C. Clark, M. McKean, and E. Ostrom (eds.), *People and Forests: Communities, Institutions and Governance*, 29-51. Cambridge, MA: Mit Press.

Mello, L.G. 1995. *Antropologia Cultural: Iniciação, Teoria e Temas*. Rio de Janeiro, Brazil: 6ª edição Vozes, Petrópolis.

Ostrom, E. 1990. *Governing the Commons: The Evolution for Collective Action*. Cambridge: Cambridge University Press.

Ostrom, E. 1992. *Crafting Institutions for Self-Governing Irrigation Systems*. São Francisco: ICS Press.

Ostrom, E., J. Burger, C.B. Field, R.B. Norgaard, and D. Policansky. 1999. Revisiting the commons: Local lessons, global challenges. *Science* 284, 278-282.

Ostrom, E. and E. Schlager. 1996. The formation of property rights. In S.S. Hanna, C. Folke, and K. Mäler. (eds.), *Rights of Nature: Ecological, Economic, Cultural, and Political Principles of Institutions for the Environment*, 127-156. Washington D.C.: Island Press.

Ostrom, E., R. Gardner, and J.M. Walker. 1994. *Rules, Games and Common-Pool Resources*. Ann Arbor, MI: University of Michigan Press.

PLANVASF. 1989. Programa para o desenvolvimento da pesca e da aquicultura. In *Plano Diretor para o Desenvolvimento do Vale do São Francisco*. Brasília, Brasil: CODEVASF.

Sato, Y. and H.P. Godinho. 1999. Peixes da bacia do rio São Francisco. In *Estudos Ecológicos de Comunidades de Peixes Tropicais*, 401-413. São Paulo: Ed. USP.

Thé, A. 2003. *Conhecimento Ecológico, Regras de Uso e Manejo Local dos Recursos Naturais na Pesca do Alto-Médio São Francisco, MG*, 199. PhD Thesis, Post-Graduation Program in Ecology and Natural Resources, UFSCar, São Carlos, Brazil.

Valencio, N., F.L.S. Leme, A.A. Martins, R.C. Mendonça, S.A.T. Gonçalves., J.C., M.I.R. Mancuso, I. Mendonça, and S.A. Felix. 2003. A precarização do trabalho no território das águas: limitações atuais ao exercício da pesca profissional no Alto-Médio São Francisco. In H. Godinho and A. Godinho (eds.), *Águas, peixes e pessoas no São Francisco das Gerais*, 1st edition, 405-428. Belo Horizonte: Cegrac.