Hum Ecol (2007) 35:623–638
DOI 10.1007/s10745-007-9132-7

Resource Conflicts: Challenges to Fisheries Management at the São Francisco River, Brazil

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Published online: 15 September 2007

Abstract The paper describes factors influencing artisanal fisheries at the São Francisco River in Brazil as an example of the challenges of managing socially and economically valued common-pool resource systems. A rapid assessment of problems affecting São Francisco River fisheries in 10 communities was carried out in 2003, representing the upper, middle, and lower river portions. Field visits, interviews, focus group discussions and a literature survey allowed us to map socioeconomic and environmental factors important to the fisheries, including conflicts and tensions between stakeholders. Federal, state, and municipal governments, industries, farmers, hydroelectric companies, and urban and rural populations all have a stake in river use. Traditional fishers are the most disadvantaged of these stakeholders. With declining fish populations, most of the fishing communities surveyed are now poor, socially excluded, and with few alternative livelihood options. The stakeholders involved in access and use conflicts are artisanal fishers, professional fishers, sport fishers, farmers, enforcement and regulatory agencies, and hydroelectric companies. Traditional fishers have close ties to the river and its environment and they are usually not invited to contribute to resource management decisions. We recommend changes to management structures involving the fishing communities that are essential to resolve the major conflicts and to improve equity and sustainability of artisanal fisheries.

Keywords Artisanal Fisheries · Resource Conflicts · Common-pool Resources · Brazil

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Introduction

Small-scale fisheries throughout the world are collapsing due to ineffective governance (Mahon 1997; Berkes *et al*. 2001), an increasing number of resource users competing for resources and space, and economic globalization that usually excludes traditional fishing communities (Nielsen *et al*. 2002). Government policies for managing small-scale, artisanal[1] fisheries have for many decades been top–down and centralized, largely leaving fishing communities out of the process. This undermines the legitimacy and efficacy of resource management (Nielsen *et al*. 2002).

Fisheries are complex arrangements of social and ecological systems, uncertain, unpredictable, and cross-scale in nature (Wilson *et al*. 1994). Small-scale artisanal fishing is usually a multi-species, multi-gear activity that contributes to food security as part of multifaceted livelihoods (Berkes 2003), as well as being important for the

[1] defined primarily by the low level of energy used in the technology employed

cultural sustenance of these communities (Diegues 1995; Berkes 2003). They are classic examples of common-pool resource uses (Berkes 1989; Feeny *et al*. 1990), which may have a variety of different ownership/access regimes (McCay and Acheson 1987; Berkes 1989; Ostrom 1990; Bromley 1992; Ostrom *et al*. 2002). Open access systems (i.e., a common-pool resource system lacking a management regime) present considerable challenges—particularly in terms of resource depletion and conflict between stakeholders. They are also prone to fail through a so-called "Tragedy of the Commons" (Hardin 1968), where individual users see no advantage to conserving or managing the resource sustainably. Top–down management has not resulted in sustainable, socially equitable fisheries in these situations (Berkes 2003). Participative co-management arrangements, in which resource management is shared among the state, local resource users, and other stakeholders, incorporating fisher's local knowledge, characteristics of the resources and the social groups involved, have been proposed (Berkes *et al*. 2001). Understanding the conflicts and relationships among stakeholder groups and other factors that may affect fisheries are fundamental steps towards building such arrangements.

This paper characterises social–environmental conflicts and other factors associated with the commercial and the artisanal fisheries of the São Francisco River in Brazil. The work, funded by the Canadian International Development Agency (CIDA), is part of a project between World Fisheries Trust, the Federal University of São Carlos, the Federation of Artisanal Fishers of Minas Gerais, and governmental partners, which aims to promote sustainable livelihoods and conservation (i.e., appropriate use) of water and fisheries resources of the São Francisco River through the creation and implementation of a co-management model.

Background

The São Francisco River flows over 2,800 km north from its source in the mountains of the State of Minas Gerais in central Brazil, through semiarid and arid *Cerrado* and *Caatinga* ecosystems in Minas Gerais and Bahia, east through deep canyons of coastal mountains between the states of Sergipe and Alagoas, and through floodplains into the Atlantic Ocean. Flood-pulse ecosystems, with seasonally flooded lagoons and riparian forests, have historically created abundant and diverse fish populations. The Pankuraru, Pancararé, Atikum, Kimbiwa, Trukas, and Kiriri indigenous people lived in this watershed until the arrival of the Portuguese in the early sixteenth century. Their population declined with the spread of infectious disease, the introduction of slavery, and armed conflicts with the *Bandeirantes*. The first riverine settlements were established during the colonial period, at Penedo, Pirapora, and São Francisco, part of the first continental European colonization routes in Brazil when the São Francisco River was known as the "River of Unity". The valley now contains large and small urban centers, mining, farming, hydroelectric generation, and both rich and very poor communities. The river has provided resources to sustain fishing livelihoods throughout much of this time, and has shaped local culture, characterized by hardship and endurance (Felicidade *et al*. 2001). Thousands of families in the watershed traditionally depend on the river's resources (Godinho and Godinho 2004).

All fishing resources of public waters in Brazil are governed by *de jure* state property regimes (Brazilian Constitution, Article 24). According to the legislation, no one with a fishing license can be denied access to the fishery resource. However, ineffective management strategies and inefficient regulation enforcement, often because government is understaffed and lacks infrastructure, turn fisheries into unprotected *de facto* open access systems in most of the country. The most recent threat to small-scale traditional riverine communities relates to the federal government's contentious regional development effort to divert water from the São Francisco catchment by constructing two canal systems connecting the arid north and northeastern part of the country. Although the idea of diverting water from the São Francisco river dates back to the nineteenth century, only in 2003 did the current president Luis Inácio Lula da Silva, initiate the implementation of this mega project. Opinions about the development are quite divergent. Whereas the Government argues that the project would benefit a population of 12.5 million with water from small dams and the conversion of intermittent to perennial rivers; concerned social and environmental movements maintain that only 5% of the diverted water would be used to benefit the population, with the balance directed to export oriented agro-industrial uses. They argue that the high cost (12 billion Reais) does not justify the possible gains (Suassuna 2005), and promote other small-scale projects that could help local populations adjust to water scarcity, for example by building more and decentralized water cisterns, artesian wells and with improving water management.

Research Methods

Ten fishing communities/municipalities were visited in the states of Alagoas and Minas Gerais during June and July of 2003. In each locality, we conducted a *rapid assessment* of resource use, conflicts and management, local capacity and social organisation based on Rapid Rural Appraisal methodology (Chambers 1980). Rapid assessment is a tool to reveal the needs of the community and it contributes to the identification and mobilization of social capital for

community development (Kretzmann and McKnight 1993). In our praxis we value local knowledge and recognize its potential to contribute towards sustainable resource management. The locals' perceptions of problems, barriers and assets were carefully recorded during the interviews. Our study primarily used *qualitative* research methods inspired by *appreciative inquiry* and *asset-based* research (Foster and Mathie 2003), *capacity assessment* (Markey *et al*. 2001), and participatory research (Martin and Sherington 1997). This approach best reflects our understanding of valuing the communities' capabilities and is of course subject to the expected level of bias inherent in the methodology. The following questions were central to our analysis (Gutberlet and Seixas 2003):

- What are the current trends and threats in the livelihoods of traditional fishing communities in this river basin?
- What are the major conflicts over water and fishing resources?
- What are the current strengths and capacities of the communities regarding resource management?

Meetings and open-ended semistructured interviews were held with the heads of local and state fisher organizations (*Colônias, Federação* and *Associações de Pescadores*), government agents responsible for the enforcement of regulations from the Brazilian Agency for the Environment and Natural Resources (Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis, IBAMA), the State Institute of Forests (Instituto Estadual de Florestas, IEF) of Minas Gerais, the Environmental Police of Minas Gerais and Alagoas, representatives from City Halls, municipal secretaries, local leaders, university professors, environmentalists, and NGO representatives. We further carried out open-ended semistructured interviews with fishers (including fisherwomen) and family members who we encountered randomly, to explore the socioeconomic and environmental universe of local communities (Fig. 1). Several governmental and non-governmental organizations were contacted for the rapid assessment (Table 1). A total of 46 key informants from a diversity of organizations were interviewed in addition to 42 fishers and their families. Interviews were carried out individually or in small groups and lasted from 20 min to 2 h. In addition, we also consulted published and unpublished documents and academic literature. The qualitative data analysis was based on triangulation. All assertions made about the fishery system are based on the responses of at least three interviewees.

It is important to note that the objective of this inquire was to provide information on (1) resource conflicts and other social–environmental problems and on (2) needs and strengths of fishing communities in order to assess their potential to engage in fisheries co-management[2]. We recommend further research into conflict mapping, and identifying and assessing collaboration among stakeholders, since this may also provide useful information for the establishment of comanagement arrangements. Additional research may particularly investigate new opportunities that emerge from the diverse use of the river's resources for stakeholders other than fishers.

Fig. 1 Interview with traditional fishers at the São Francisco river bank, near Três Marias (MG) 2003 [Photo by Gutberlet, 2003]

Results

Prevailing Fishing Practices

We found distinct reservoir and riverine fisheries within the São Francisco catchment, each with their specific target species and fishing gear. Riverine fisheries of the mid-high São Francisco target migratory fish species[3] such as the characids *curimbatá* (*Prochilodus marggravii* and *P. affinis*), and *dourado* (*Salminus brasiliensis*), and the catfish *surubim* (*Pseudoplatystoma coruscans*), whereas the reservoir fishery of Três Marias relies on the peacock bass *tucunaré* (*Cichla ocellaris*), the small catfish *mandi-amarelo* (*Pimelodus maculatus*), and the *curimbatá*. River fisheries in the lower

[2] Of course, such communities have also many weaknesses such as practicing predatory fishing, but we deliberative chose to focus our research on strengths that may contribute to co-management assuming that communities' weaknesses will be dealt with during the phase of building community capacity for co-management as proposed by the WFT project mentioned at the beginning.

[3] Fish species that undergo extensive seasonal migrations, usually as large schools, from feeding habitats to upstream spawning locations.

Table 1 Institutions and Organizations Contacted During the Survey

Locality	Institution
Tres Marias (MG)	CMM—Companhia Mineira de Metais (VM—Votorantim Metais Ltda.)
	Federação dos Pescadores de Minas Gerais
	Colonia Z 5
	City Hall
Pirapora (MG)	City Hall
	UNIMONTES (University)
	Movimento São Fransisco de Assis (NGO)
	'Oia o Chico' (NGO)
	Cooperativa de Produção Artesanal de Pirapora (COOPARTE)
	Secretaria Municipal de Meio Ambiente
	Secretaria Municipal de Ação Social
Buritis (MG)	ABIMA Associação Buritinense Integrada do Meio Ambiente
	IEF—Instituto Estadual de Florestas
	SEMA—Secretaria Municipal de Meio Ambiente
São Francisco (MG)	Colonia Z 3
	IEF—Instituto Estadual de Florestas
	Filhos do Novo Chico (NGO)
	Secretária de Saúde e Meio Ambiente
	Secretaria Municipal de Ações Comunitárias
	CODEMA: Conselho de Desenvolvimento do Meio Ambiente
	CMDR: Conselho Municipal de Desenvolvimento Rural Sustentável
	EMATER—Empresa de Assistência Técnica e Extensão Rural de Minas Gerais
Januária (MG)	City Hall
	CBHSF – Comitê da Bacia Hidrográfica do São Francisco
	SESC Minas Gerais
Pedras de Maria da Cruz MG)	Associação de Pescadores de Pedras de Maria da Cruz
	City Hall
	EMATER—Empresa de Assistência Técnica e Extensão Rural de Minas Gerais
Xingó	Instituto Xingó
Entremontes (AL)	Associação das Bordadeiras Entremontes
Piranhas (AL)	Colonia Z 25
	City Hall
Penedo (AL)	Federação dos Pescadores de Alagoas
	Grupo de Mulheres Pescadeiras de Penedo
	IPMA (NGO)
	CODEVASF—Companhia de Desenvolvimento do Vale do São Francisco

São Francisco are dominated in volume by *curimbatá* and the anchovy *pilombeta* (*Achoviella* sp.), though *surubim* and the freshwater prawn *pitu* (*Macrobrachiumú carcinus*) are the most valuable targets (Sato and Godinho 1988; 2003).

There are two major seasons in the São Francisco fisheries: the dry "clear water" season, when fish are less readily captured; and the rainy "dirty water" season, when fish are more abundant, water level is higher, floodplain lagoons are flooded, and many species make spawning migrations. Fishers use different gear and strategies for each season (Thé 2003; see Table 2). Some common practices in Minas Gerais are: (1) A "floating gillnet" fishery carried out with three or four gill nets (about 50 m each) with a mesh size of 18–20 mm tied one to another, with buoys every 10 m, used primarily to catch large *curimbatás* during the period of dirty waters. (2) A "*rela*" fishery that targets *tucunaré* in the reservoirs using gillnets strung across a bay at the water surface with plungers and other noise-making mechanisms used to startle the fish. The *tucunaré* tend to try to escape in surface waters and are caught in the nets, whereas native fish species escape in deeper waters (Thé 1999). The fishery is considered "predatory" and illegal, as no escape hatch for the fish is provided, but is also promoted as an exemplary selective fishery for an introduced species (Thé 2003). (3) Rotational fishing (*pesca em rodada*) is a method typically applied in communities located on smaller tributaries, particularly in Minas Gerais. In Buritis, for example, fishers go upriver by truck with their boats, and then slowly drift downriver for 3 or 4 days fishing with castnets. The same term, *pesca de rodada*, is applied to fishing in a traditional, though illegal, cast-net and trap fishery in the rapids at Buritizeiro (Thé 2003).

While fishing is typically a male profession, women are also involved. Members of the women fishers association in Penedo, for instance, were engaged in promoting and improving women's involvement in artisanal fisheries. On the lower São Francisco, in Penedo (Alagoas), women use dip nets (*puça*) to catch fresh-water shrimp (*pitu*) and gillnets (*rede de travessia*) to catch fish (Montenegro *et al.* 2001).

Fishing Territoriality

In Minas Gerais, most fishing activities, including reservoir fishing, follow a system of "open access," although there are some exceptions. Fishers camp in small groups next to the fishing spots they are familiar with, resulting in informal territories along the river called *acampamentos* (Fig. 2).

More specific common property systems have evolved in some river portions in the municipalities of Pirapora and Buritizeiro (Thé and Nordi 2006), and near the "beach" in the municipality of Januária. These systems include access rules and regulations for resources use, classified by Ostrom and Schlager (1996) as operational rights and decision-making rules, which correspond to rights to resource management. So far, these local rules have not been considered by the government as a form of legitimate community resource management (Thé 2003; Thé and Nordi 2006).

Table 2 Fishing Techniques Used on the São Francisco River in Minas Gerais (Based on Field Observations and Thé 2003)

Technique	Folk Species	Season	Location	Description by fishers
Caceia—drift gillnet	*Curimatá, dourado, surubim, piranha, matrinchã, pirá*	Primarily during migration when water is turbid, but can also be used all year	In the middle of the river or between the middle and the river's edge	"A net requiring two fishers in the boat, while one rows, the other releases the net slowly into the water with a buoy at one end until it is all stretched out across the river. It is then let drift downriver with the boat for about 1000m or until the net gets caught on a tree trunk. At this time, one fisher rows against the current, while the other collects the net, removing the fish"
Tarrafa—cast-net	All fish species	Throughout the year, both with turbid and clear water	Close to the river margins, from the shore and banks, and in the bush and shallow bays	"A net in the form of a sack, with a rope attached to its middle to pull it from the water and remove the fish. Used to catch bait and, with mesh sizes of 6 or 12 mm, for catching larger fish"
Pinda or *Anzol de Galho*—set hooks	*Surubim, dourado, piranha*	Best in turbid water	From riverbanks and margins	"The hook with live bait is tied to a branch with a long line. ...here, the "*pinda*" is the "hook of the branch" ... "*pinda* with a head" or the "*caçador*—hunter" is the same without being tied to a branch—... this could be with a rod stuck in the river bank and the hook in the water".
Linhada, *linha* or *anzol*—hook and line	*Dourado, surubim, piranha*	Mostly during the clear water period, but also at any time of the year	In the middle of the river or from its banks	"Hook and line, used in the hand, with the boat stopped in the middle of the river or on the river bank, without a specific location ... bait can be anything—a worm or a *mandi* catfish, secured until a fish bites"
Terreina	*Dourado, piranha, surubim, mandim*	Any time of the year, but mostly during clear water period when the river is low	Anywhere in the river, but mostly in the middle	"Live bait, white *mandi* catfish, or spiny *mandi*, a hook and a hand-line ... the line is jigged to make the bait fish make sounds—with each jig the fish screams and the *dourado* comes to the sound. If the *mandi* stops singing it needs to be changed. It is done with the boat drifting downstream and the motor turned off"
Aço—Steel	*Dourado, piranha, matrinchã, mandim, gongo*	During migration with turbid water	From the middle of the river to the margin, in shallow areas or areas with rocks and shallow bays	"Steel hooks held together by wire. Used in the middle of the river ... used from November to February, or all year for those that don't use nets"
Grozeira	*Mandim (gongó), surubim, piranha, matrinchã*	All year, any season	Both from the margin and in the middle, mostly in deep areas	"A line full of hooks below the water—with a buoy and tied to a rock on the bottom ... for catching *mandi, matrinchã, dourado* and piranha"
Currico	*Dourado*	In clear water	In the middle of the river, from the shore, or any location	"Spoon with about 20 metres of nylon line—pulled along the surface of the water with the spoon spinning and shining—similar to artificial bait, only works with the boat moving"
Rodada	*Dourado, Piranha.*	In clear water	In the middle of the river, but also in any other locations	"Similar to the "*terreina*" but with a different bait such as *piau, sarapó, matrinchã*... arriving at a location by boat, the motor is turned off ... the hook with bait is thrown over and jigged with the boat drifting

Table 2 (continued)

Technique	Folk Species	Season	Location	Description by fishers
				downstream ... this is different from the *terreina* because it is a different bait ...the piau does not scream, but also catches the *dourado*". (Três Marias)
Arpão, Fisga – harpoon and gaff hook (Três Marias)	*Dourado, surubim, curimata*	Clear water	Margin, shallow water, any areas	"A shaft with a triple hook embedded in the tip and a hole for a buoy line in the handle —the speared fish tries to run away towing the line and buoy ... used together with a night–light"
Tarrafão— Big cast-net	*Surubim, dourado,* any fish	In turbid water	In any location, mid-river and along the edge, in rapids, falls, and springs	"A cast-net with a double mesh that is trawled along the bottom"

Stakeholders Involved in the Use and Management of Fish and Water Resources

A variety of stakeholders are involved in the use and management of the river's resources.

Fisheries

The river's major fisher groups include licensed professional fishers, informal commercial fishers, and sport fishers. Licensed fishers include traditional families that have practiced the profession seriously for many years or several generations, individuals forced into the profession "temporarily" for the lack of other income options, individuals attracted by the unemployment benefits when fishing is closed during the migratory season, and a variety of other individuals who obtain licences (illegally) to be able to use gillnets for sports fishing and/or gain unemployment or other benefits. A "professional" licence stipulates that the holder makes their primary income from fishing, but many pursue other subsidiary livelihoods, particularly during fishing closures, and have floodplain agricultural plots.

Fig. 2 *Acampamento* near São Francisco (MG). [Photo: Gutberlet 2003]

Agriculture

Farming is practised along most of the São Francisco river. In the higher and middle São Francisco, cattle ranching is the predominant traditional activity, but there are also orchards and annual and perennial plantations. Eucalyptus, soy, coffee, and localized intensive agriculture of other food crops is increasingly practiced. In the lower São Francisco, large-scale sugar cane plantations were one of the early economic drivers with European colonisation, and continue to be the prevailing and expanding land use. Water is drawn from the river and reservoirs for agriculture, some larger-scale farmers dam up flood-plain lagoons for irrigation, and riparian vegetation may be removed by livestock or for crop plantations. Farm owners include powerful political and juridical figures, as well as large industries, in addition to local influential leaders and long established ranchers.

Hydroelectric Generation, Irrigation, and Flood Control

Two companies are involved in the generation of electricity in the São Francisco basin: the Electric Company of Minas Gerais (Companhia Energética de Minas Gerais, CEMIG) and the São Francisco Hydroelectric Company (Companhia Hydroelétrica do São Francisco, CHESF). CEMIG is a partially privatized governmental company with operations in the upper São Francisco basin, including Três Marias—the first dam on the river mainstream. State-owned CHESF, the largest hydroelectric company of Brazil, owns and operates 14 hydroelectric plants, nine of which are located

on the mid and lower São Francisco River mainstream. The company generates electricity for 42 million people in eight states of the northeast of Brazil, and is very influential in decisions on development issues in the northeast region.

The Companhia de Desenvolvimento do Vale do São Francisco—CODEVASF, a federal government agency formed in the 1950s to promote the development of the São Francisco Valley, owns several dams that were built for flood control and irrigation. It also promotes and supports capacity building, aquaculture and research. At the Xingó dam, for example, CODEVASF operates a capacity building centre, a fish farming training station, and a fish processing plant together with CHESF, and in Três Marias a fish culture and limnology station is operated together with CEMIG.

Industrial Activities

The mining company VM—Votorantim Metais Ltda. (previously Companhia Mineira de Metais, CMM)—has been operating one of the largest zinc refineries in South America in Três Marias since the early 1960s. Ore is trucked several hundred kilometres from the Vazante and Paracatu regions of Minas Gerais (also in the São Francisco watershed). Water from the river and electricity from the dam are used in the refining process, and a significant workforce is employed locally.

Municipal Government

The local government in most cases is an important stakeholder in fisheries, in part because professional and sports fishermen and women are a significant component of the electorate. Most also draw water from the river and/or deposit sewage. Some municipalities had social programs in place targeting the fishing communities at the time of the survey. Others were experiencing financial and political crisis due to corruption scandals, nepotism, and other external factors and provided few or no initiatives for fishers.

Fisheries Regulations and Enforcement

Regulations for professional fishing in Brazil are set by IBAMA—part of the federal Environment Ministry (MMA). The Special Secretariat for Aquaculture and Fisheries (SEAP), holding a Ministry status, issues fishing licenses[4]. The constitution also allows each state to regulate fisheries in water bodies and rivers that are entirely in the state, as long as measures are more restrictive than the federal regulations. In Minas Gerais, the State Institute of Forests (IEF) sets state fishery regulations for both professional and sports fishing, which are enforced by the Environmental Police section of the state's Military Police. Both the IEF and the Environmental Police have offices in municipalities visited during the survey, though these are not present in all fishing communities. At the time of the surveys, most fishers considered IEF and the Environmental Police as repressive, and in many municipalities relations between fishers and these institutions were considered extremely poor.

IBAMA also has responsibility for enforcing its fisheries and environmental regulations and has bureaus in several municipalities. However, we found that IBAMA is not very active leaving enforcement of fisheries and water regulations, largely in the hands of the military police—despite state and federal regulations sometimes being contradictory.[5] We found no significant impact of SEAP on the São Francisco fisheries during our survey, other than its responsibility for issuing professional fishing licences.

Watershed management committees are part of a federal government policy for participatory water management that will eventually include assignment and collection of water-use fees. In some states, depending on local interest and activity, sub-basin committees on major tributaries or water bodies are also formed, which promise to better incorporate local needs and demands into aquatic resource management. Professional fishers are represented on both the main committee and subcommittees of the São Francisco, though fisheries are not yet a priority. These committees were relatively new at the time of the survey, and practical implications for day-to-day lives were not yet evident in the interviews. No overt regulatory impacts were cited in the interviews.

The federal National Agency for Water (ANA), the state Fundação Estadual do Meio Ambiente (FEAM) and the Instituto Mineiro da Gestão das Águas (IGAM) are also responsible for monitoring and regulating water quality and use in the study area, and the federal National Operator of Systems (ONS) regulates the operation of hydroelectrical facilities. However, the activities of these organizations were not evident to the public that we surveyed.

[4] SEAP was created in 2003, shortly before the survey, but fisheries development and regulations responsibilities have varied between the Agriculture and Environment ministries for many years

[5] The survey of this study triggered meetings in Minas Gerais between fishing organizations, IEF and IBAMA that by 2006, through follow-up activities of the project and its partners, have led to agreements between IBAMA and IEF for joint compatible regulations, developed participatively with the fishing community and enforced by an environmentally oriented fraction of the Military Police, which are recently becoming involved in community-based policing principles. Field implementation of these policy advances, however, was still slow.

Fishers' Organization and Participation in Decision-Making

Our interviews indicated that self-esteem among fishers and their families is generally very low. This statement is based on our observations and conversations with fishers throughout the fieldwork. Traditional fishers who have lived in the area for several generations do not have wide access to formal education, have limited financial resources, and do not have a strong political lobby. Fishers' interests are not well represented, and the participation in decision-making through council boards is low or nonexistent. Low formal education levels reinforce their social exclusion and prejudice against them. However there are recent examples of fishers mobilizing and exerting pressure for change. In some municipalities (Pedras de Maria da Cruz, Buritis, and Penedo, for example), fishers, both men and women, have become actively engaged in meetings and workshops to discuss and search for solutions to their problems. For instance, a Fisherwomen's Association has been created in Penedo with 24 women from 13 municipalities (Gutberlet and Seixas 2003). Nevertheless, the history of fishers' formal organization shows an overall low degree of mobilization (Fig. 3), and their participation in assemblies is relatively low compared with the total membership.

In Brazil, fishers are organized in so-called *Colônias*, at the local level, *Federations* at the state level, and a *Confederation* at the national level. Less formal fishers *Associações* also exist in some places. The mobilizing capacity, leadership, and level of response of the *Colônias* to fishers' needs vary between active and little engagement. According to the heads of several *Colônias* visited during the survey the number of unaffiliated fishers is quite high in some areas. These fishers, known as "*clandestinos*" (clandestines), or, in the lower São Francisco as "*gancheiros*" (free-riders) carry out their fishing activity and market their products as professionals, but do not pay membership fees, may not have a fishing licence, and may not follow fishing regulations.

Fig. 3 Group discussion with fishers in Buritis (MG). [Photo: Gutberlet 2003]

The interviews with fishers revealed a certain lack of confidence regarding some *Colônias* due to previous or current corruption and nepotism. In the municipality of Januária, for example, due to several corruption scandals, the ice factory is no longer working, the municipality does not support the fishers any more, and the Colônia is currently inoperative. We heard from the head of one of the *Colônias* that he did not issue memberships to his political enemies. Generally, fishers are sceptical about benefits of membership in the *Colônias*, though affiliation rates have grown since 2002, when the *Colônias* became one of the organizations in charge of distributing unemployment insurance to fishers (available during the migratory season of the fish when fisheries are closed by the federal government).

In Minas Gerais, the Fishers' Federation has undertaken important political steps, such as the organization of a public hearing on professional fishing at the Legislative Assembly of Minas Gerais in July of 2000 which helped overturn a proposed law that would have prohibited fishing with nets and thus eliminated most professional fishing. An alternative law (Law Number 14.181/02) resulted, which established a new policy for the protection of the aquatic fauna and flora and the development of fisheries and aquaculture in the state of Minas Gerais, including the concerns of professional fishers.[6] Despite these developments, the large majority of fishers did not actively participate in the policy and decision-making process of fisheries at the time of this survey.

Social cohesion amongst fishers seems to be much stronger in smaller and isolated communities, such as Buritis in Minas Gerais and Marituba do Peixe in Alagoas. In the majority of the other communities visited, individualistic attitudes appeared to prevail, with fishers trying to find an immediate solution to improve their livelihood, less based on solidarity and cooperation. During the interviews fishers expressed detailed local environmental knowledge, suggesting a deep connection with the place which provides for their livelihoods and culture. Although they may not always know the underlying causes, fishers clearly recognize changes over time in the quality of water and fish resources and they are continuously alert to changes relating to the river. For example fishers from the Colônia in Piranhas mentioned the formation of large quantities of mud (*lodo*), the lack of flooding (*enchente*), and the change

[6] The "decreto" prepared for the implementation of the new law was released shortly after this survey and once more prohibited fishing nets. The contacts between the police and IEF forged for this survey and associated project managed to overturn this aspect of the *decreto* in a participatory policy meeting, as well as defeating the issue again when it subsequently appeared in the published version of the *decreto* through a "bureaucratic error".

in the water flow as clear indications of recent environmental changes.

Conflicts and Challenges In Resource Use and Management

During the survey, fishers and their families were asked about their current economic constraints and assets, environmental impacts (Table 3), and conflicts over resource use and access.

Factors Affecting the Income of Fishers

Fishing is a significant economic activity for a segment of the population that varied in the different municipalities, but also culturally important to the communities in a broader sense. Although poverty is widespread in the fishing populations, income varies greatly geographically and seasonally (Table 4). Reservoir fishers in Três Marias, for example, achieved the highest income compared to the other communities, with potential earnings of up to four times minimum wages[7] in 1 month. Fishing expenses also vary according to the technique used. Fishers noted that in reservoir fisheries, those who own boats and gear have higher net incomes than those who work for middlemen. In some cases, like Três Marias, some fishers acknowledge that they have improved their income through better organization and marketing structures.

Costs and earnings of fishing in a different context are exemplified by the rotational fishing (*pesca em rodada*) in Buritis. Here, the cost of transportation and ice adds up to an average US$36/trip, and the earnings on such a trip (25 km) are between US$54 and US$143. Income varies seasonally. For example, during the clear water season, when fish are less abundant, prices in the town of São Francisco are high, but during the dirty water season, fish are more abundant, and the increased catch results in an income of up to R$120 (US$43) on a 'good fishing day', despite lower prices. Some fishers commented, however, that such 'good fishing days' are becoming rare in recent years.

Fishers' incomes generally decrease with growing distance from consumer centres. Communities on the lower São Francisco earn less than those of the mid-high river region, and poverty is much more marked. In Piranhas and Entremontes, for example, fishers in 2003 earned approximately US$7/week during the low fishing season, and US $29/week during high fishing season. The fresh-water shrimp (*pitu*) fishery, traditionally the main income source for this region, has almost disappeared over the last decade. Fishers comment that after the construction of the Xingó dam in 1994 "the river has never been the same again," with the turbidity of dirty water periods completely gone (see Montenegro *et al*. 2001, p. 3, who correlate the decreased fish catches with the construction of the dam, a recurrent theme in our survey). Our interviews in Marituba do Peixe, close to the mouth of the São Francisco River, indicate that the fishers' income before the construction of the dam was between US$54 and US$72 per day on a 'good fishing day,' whereas fishers now earn barely US $29/month. The local population clearly identifies the decrease in fish resources with the construction of the dam.

As a result of diminished fish catch, fishers look to other activities for supplemental income, such as aquaculture, temporary farm work, or subsistence agriculture along the river margins (where access is informally negotiated among fishers). Fishers earn around US$72/month (working 8 h/day) working in fish farming close to the Xingó dam, for example, and around US$9/day (US$180/month) working on sugar cane plantations in the lower São Francisco. Other contract farm labour usually pays US$4/day.

Consequences of River Damming for the Fishing Communities

Interviewees in the fishing communities regularly cited negative impacts of dams on the São Francisco River. One of the interviewed fishers explains "the life of a fisher is quite difficult; 1 day you catch; the other you don't. Everyday things become worse. Before the dam, I was able to catch 30 kg of fish; nowadays, if I catch 5 or 8 kg that is a lot." The principal impacts recognized are fish mortalities from turbine passage or turbine stoppages, the blockage of migratory routes and the regulation of flood pulses that would normally periodically connect floodplain lagoons to the river. These lagoons act as important seasonal nursery areas for migratory fish species. Before the Três Marias dam was built, many more active floodplain lagoons were present off the São Francisco downriver of Pirapora (Jiménez *et al*. 2004, p. 379), contributing to substantial fish productivity. In addition, the lack of the flood pulse allows sediment to build up in the river as sand beds, interfering with navigation and, according to the fishing community, with fish spawning.

In addition to changing water flow, dams and reservoirs also change the physicochemical characteristics of the water. In the case of Três Marias, this includes colder and clearer water relative to pre-dam conditions that probably inhibit fish spawning in the stretch of river between the dam and the next large tributary—Rio Abaeté. In the case of the lower São Francisco, according to the interview results with local fishers a series of upstream dams cause sediments to settle in their reservoirs with associated

[7] Monthly minimum wage set by the government was equivalent to US$72 at the time of the survey.

Table 3 Local Perception about Major Environmental Impacts in the State of Minas Gerais (MG) and the State of Alagoas (AL)

Environmental impacts	Number of municipalities affected in MG	Number of municipalities affected in AL	Total number of municipalities
Urban waste water pollution	7	4	11
Urban solid waste water pollution	7	4	11
Diminished population of native species	7	4	11
Damming of marginal lagoons	6	4	10
Water pollution due to agriculture	6	1	7
Predatory fishing activities	5	3	8
Deforestation in the watershed	5	2	7
Sedimentation and irrigation	4	4	8
Hydroelectric plant	1	4	5

impacts on aquatic life that are evident to the communities. Changes in water flow impact on the reproduction of many aquatic species. In Piranhas and Entremontes, the *pitu* fishery broke down as the *pitu* could no longer migrate downstream to the estuary for spawning. Fishers from Piranhas, Entremontes, and Penedo reiterated the disastrous consequences for fisheries of the Xingó hydroelectric dam.

Introduced Species

There are many uncertainties associated with the introduction of non-native species from outside of the continent (*exotic*) or other watersheds of the same continent or country (*aloctone*) into aquatic environments (McCully 2001). These introduced species may contribute to the decline or extinction of native species through predation, competition for food and habitat, or the introduction of diseases or parasites not previously faced by native species. Among the most widespread aloctone species in the São Francisco River is the peacock bass *tucunaré* (*Cichla ocellaris*), originally from the Amazon River basin. This is a very efficient piscivorous species with parental care of its young, and has colonized the new still-water habitats created by dams, as well as many of the remaining floodplain lakes. Since 1984, when it started to appear in fishers' catches, the percentage of t*ucunaré* in the Três Marias reservoir fishery has been increasing considerably (Sato and Godinho 1988, 2003). Godinho and Godinho (2004) indicates the likely predatory pressures by t*ucunaré* on juveniles of native fish in the flooplain lagoons and Montenegro *et al.* (2001, p. 5) report a reduced catch of native species in the lower São Francisco river due to the *tucunaré*.

Pescada-do-Piau (*Plagioscion squamosissimus*) a croaker introduced from the Paranaíba River, is the most captured species in the Sobradinho reservoir. *Tambaqui* (*Colossoma macropomum*), a large characid introduced from the Amazon, was the third most captured species along the Lower São Francisco River (below Xingó Dam) in 1997. The African t*ilápia* (*Oreochromis niloticus*) is widespread in the Itaparica reservoir, and *tilápia* farming

Table 4 Regional and Seasonal Income Variations

Location	Income per week (in Real $)*		
	High fishing season	Low fishing season	No distinct fishing season
Tres Marias (reservoir fishers)			200 to 300
Tres Marias (river fishers)			100 to 200
Januária	90		
Buritis	150 to 400		
São Francisco	120 per day	20 to 90	
Entremontes	80	20	25
Piranhas			25
Marituba do Peixe			20

*1R$=0.36 US$ in July 2003

projects are expanding along the São Francisco River (Sato and Godinho 2003). While effects of these introduced species on native fish species are cited by community members, these species also contribute substantially to local fisheries.

"Predatory" Fishing

"Predatory fishing" is a term that is strongly embedded in a social, legal, and political context in Brazil, describing illegal fisheries or practices that damage fish stocks unduly. However, there is no clear definition and there are many different interpretations. Generally, it includes: practices that capture individuals before sexual maturity and before having reproduced at least once (e.g., undersize mesh sizes); practices that prevent at least a portion of a target group of fish from escaping (e.g., trawl and seine techniques—*arrastão* and *tarrafão*; completely closing off a river with gill nets); practices, such as improper harpooning and gaffing that wound fish without catching them; and fishing on particular concentrations of fish, such as at the base of falls or dams, at river mouths, or during spawning migrations.

Sato and Godinho (2003) consider predatory fishing to be a considerable problem throughout the São Francisco River. The examples most cited during the interviews with fishers are the use of mesh sizes smaller than allowed by legislation and the harpoon fishery. The "*rela*" fishery for *tucunaré* is also illegal and considered predatory. However, both the harpoon and *rela* fishery are also defended by many as efficient selective fisheries whose regulation is not logical—in the case of the harpoons, it is unclear why these are legal for sports fishing but illegal for professional fishers, and the *rela* fishery is thought to be a useful contribution to the control of *tucunaré*.

Stakeholder Conflicts

There are many different stakeholders involved in the use of water and fish resources of the São Francisco River, although not all are overtly visible. We mapped the principal stakeholder groups encountered during the survey and the conflicts between these (Fig. 4).

Fishers and Farmers Disputing for Water Resources

Conflicts between fishers and farmers were quite common throughout the region. The major reasons cited were: (1) the construction by farmers of irrigation dams on floodplain lakes, interfering with their function as nursery areas for fish spawning in the adjacent river; (2) the construction of irrigation dams on tributaries that prevent their use for fish migration and spawning; (3) the closing of access points on the rivers which were traditionally used by the fishers; (4) the perceived inordinate use of water from the river for farm irrigation, and (5) water contamination by agricultural toxins and animal manure. Many fishers are also aware of the indirect impacts of agriculture on the river, such as deforestation of the gallery and riparian forests, erosion of the margins, and river siltation.

Tension Between Fishers and Enforcement Agencies

In most municipalities, fishers and other interviewees mentioned conflicts between fishers and the Environmental Police. Some fishers reported cases of undue violence and disrespectful treatment by the police and several cases where gear and fish were inappropriately apprehended. Given the low average income of fishers, the US$250 fine for fishing with prohibited gear or during closed fishing season, according to the 1998 regulations, is unrealistic, and does not appear to work as an effective deterrent. Fishers recurrently talked about being punished unduly as resource predators while the high impact resource users, such as large-scale farmers, hydroelectric companies and sports fishers, manage to avoid the penalties.

According to interviews in Minas Gerais, conflicts between fishers, IBAMA, and IEF are very common. According to fishers, most rules do not take into consideration traditional knowledge reflecting the local environmental context. Restrictions on the fishing seasons, the gear permitted, and the species and numbers allowed to be caught are not always what local fishers believe is sustainable. Fishers, for example, consider the rainy season the period most suitable for fishing. However, state and federal government agencies prohibit professional fishing during most of this period to protect migrating stocks, even though the timing of the closures often is not appropriate to this purpose.

Conflicts Between Industry and Professional Fishing

In both states visited, fishers mentioned serious disputes between themselves and the hydroelectric companies (CEMIG, CHESF). They identified these companies as principally responsible for changing the water flow regime and thus reducing fish populations.

The construction of the Xingó dam created the most severe and contentious set of conflicts between fishers and hydroelectric power companies in the region. This dam has severely affected fisheries in downstream municipalities. As a result, fishers from the municipality of Pão de Açucar began to move into the fishing grounds of neighbouring Piranhas and Entremontes, generating additional inter-communal resource disputes. Also some fishers complain about water-related health issues in the municipalities Três Marias and Piranhas, next to the respective hydroelectric

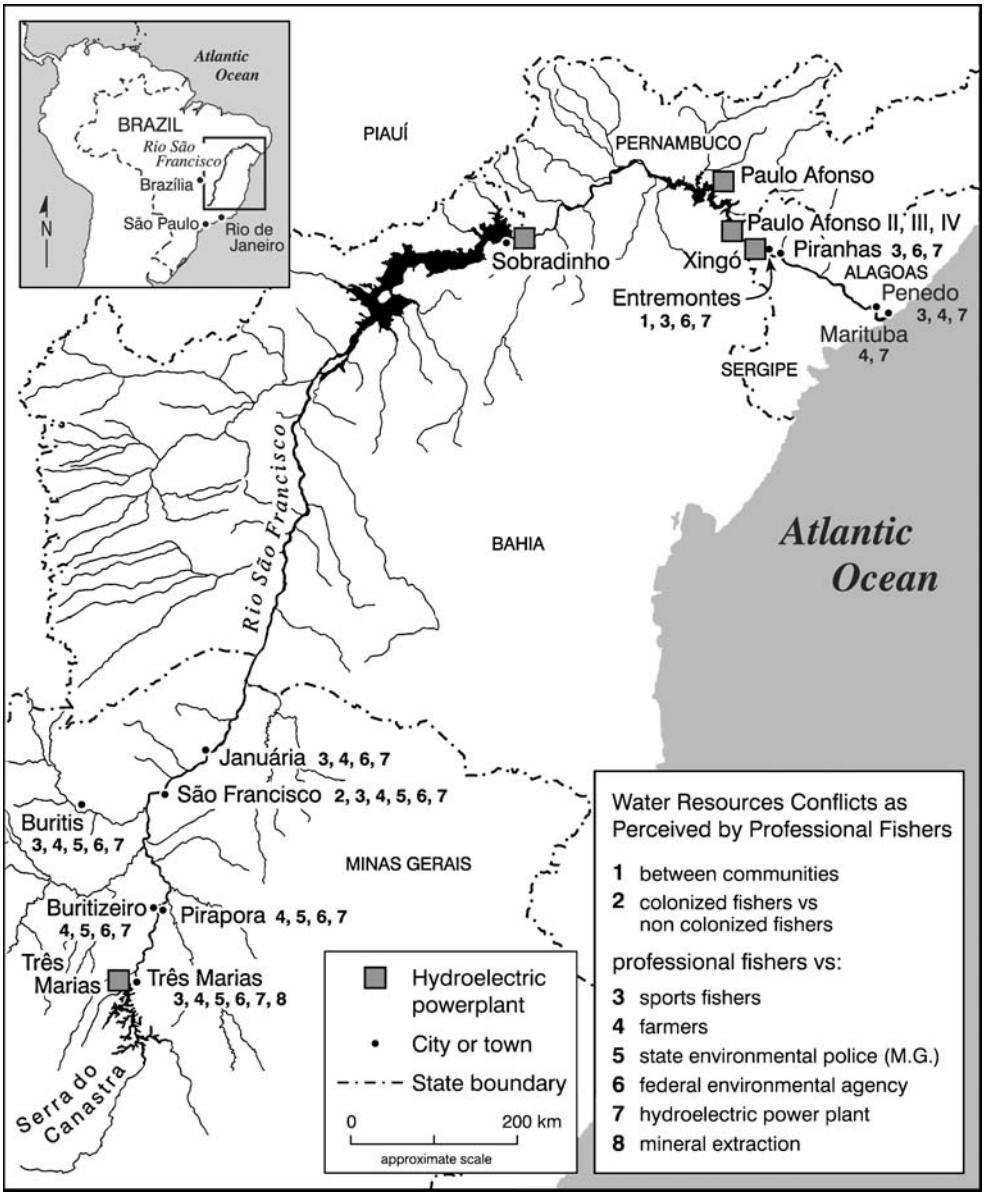

Fig. 4 Map of the principal stakeholder group conflicts encountered during the survey

plants, alleging that contaminants are discharged by the power plant during regular maintenance of the turbines.

The zinc refinery in Três Marias (VM) has a history of severe environmental impacts which have created conflict. Local fishers and residents repeatedly voiced concerns about toxic effects of water contamination by VM on both the fish and human population. While treatment processes for the tailings and returning water stream have been modernized, some operational problems remain as do substantial deposits of historical tailings. While the industry reports substantial gains in treating these problems, a large portion of those interviewed still perceive VM as major source of heavy metal contamination through effluent discharge and dust. Academics and environmental activists continue to express their concerns about the cumulative environmental impacts of the contamination. There are other polluting industries in Pirapora, such as the ceramics and garment industries, however the local population did not note these during the interviews.

Conflicts Among Fisher Groups and Between Fishers and their Representative Organizations

We observed conflicts between professional fishers and sports fishers over access to resources and to fishing spots throughout most of the study area. In Minas Gerais, for example, professional fishers using gill nets complain about sport fishers using harpoons and illegal long-lines. In Alagoas, conflicts arise mainly over the *surubim* harpoon fisheries carried out by tourists and some local fishers, negatively impacting professional fishers.

There seem to be fewer overt disputes between *Colônias*' affiliated and unaffiliated fishers. Unaffiliated fishers argue that the *Colônia* does not provide sufficient benefits to fishers nor does it pay attention to the needs of fishers. This problem was raised in all municipalities. Sometimes there are conflicts among different groups of professional fishers over the impacts of each others' gear. There are also conflicts between different regions of geographically large *colônias*; fishers living far away from the headquarters of the *colônia* feel neglected as they cannot participate in meetings and often receive important information delayed. In some cases, this dissatisfaction has resulted in the formation of breakaway or alternative associations (*associações*), such as the Ibiaí and Butitizeiro Fisher Associations.

Status differentials among fishers, middlemen, and *colônia* board members also appears, at times, to create conflicts. This seems to be related to social mobility when fishers become disconnected or alienated from their colleagues as they move up the hierarchy of the *colônia* creating an employer–employee relationship. The desire for status advancement seems to have contributed to an increase in bureaucracy in the *colônias* and disrupted the connection between the fishers and their representation in the *colônias* (Gutberlet and Seixas 2003).

Another source of conflict in the fisheries lies in the patronage system with fishers heavily dependent on middlemen of both sexes. The latter supply the fishers with boats, fuel, ice, and, in some cases, transportation to the fishing spots. In return the middlemen buy all catch at prices which they largely set or manipulate. Because fishers often cannot pay for their immediate expenses, they become indebted and locked into a cycle of dependency.

In our analysis, we identify several challenges to be overcome to better manage fisheries in the Sao Francisco river basin, including: (1) socioeconomic exclusion of fishing communities; (2) lack of mobilization and low level of representation of artisanal fishers within their own organizations and in other political spheres; (3) patronage systems; (4) a culture of corruption and over complicated bureaucracy in some *colônias* and within municipal governments; (5) stakeholder conflicts; (6) communication problems between fishers and different government agencies at all levels; (7) communication problems among government agencies, NGOs, and local populations, including fishers; (8) the ability of rich and more powerful stakeholders to influence politicial decisions; (9) lack of fish processing infrastructure, and (10) lack of engagement of municipal governments with environmental problems (Gutberlet and Seixas 2003).

In addition, the highly controversial plan to divert river waters is a major threat to the São Francisco river and its traditional population. The question of using water from this river to irrigate plantations in the semiarid Northeast region is a reoccurring issue and continues to stir heated and critical debate among environmentalists, academics, and organized civil society. During our 2003 survey the prospect of water diversion was repeatedly criticised by activists and academics, but was hardly mentioned as a livelihoods issue by the fishers themselves. From their point of view, there were more pressing or immediate survival issues. Today, with the transposition of water rapidly becoming reality, it is likely that traditional fishers are acutely aware of the threat it poses to them. It is expected that the transposition will alter the water flow and impact fisheries in the middle and lower parts of the river.

Discussion

Our findings highlight the vulnerability, disempowerment, and poverty of traditional fishers in the São Francisco watershed. It also highlights instances of environmental degradation, resource depletion and pollution threatening both the fisheries and human health. Fisheries are unsustainable under the conditions identified in our survey, where resources are endangered by overfishing, dam construction, pollution and other forms of environmental degradation. At the same time, fishers' livelihoods are threatened by declining fish stocks and low economic returns. They are largely disempowered due to prevailing patronage and top–down governance structures. These problems require urgent changes to ensure better resource conservation and livelihood security. The traditional fishers are the least empowered of all the contending stakeholders. Their survival will depend on changing fisheries management practices.

Managing the Commons of the São Francisco River Basin

Throughout our study we observed that several common-pool resources with distinct characteristics were managed under different property regimes. Despite the fact that all water and fishing resources are legally state property, we observed that in some areas they are managed in practice (1) as common property regimes with local rules (e.g., fisheries in Buritizeiro and Pirapora); (2) as private property (e.g., farmers damming tributaries and marginal lagoons within their farmland); and (3) as *de facto* open access, as practised in most areas of both the upper-middle and low river basin.

There is unlikely to be a single management arrangement that accommodates all the social and ecological complexity of the river basin. Nevertheless, our rapid assessment indicates two recurrent key issues that need to be satisfied in any functional management arrangement: (1) local

relevance of management, and (2) social inclusion of fishers, both within fisheries management and within the socio-economic context of the localities where they live.

Local Relevance

Our findings show that a great diversity of stakeholders and conflicts over resource use take place at different geographic scales. Except for a few informal local arrangements (e.g., those in Buritizeiros and Pirapora), most of the fishing rules and regulations are decided at state or federal levels. There is a need to create new management regimes that take into account the local specificity of smaller ecosystems, the demands and knowledge of local fishers, and the characteristics of the migratory stocks being fished. In other words, in face of such social and ecological complexity, different cross-scale institutional arrangements should be crafted to manage a diversity of ecosystems within the basin area.

As noted by Berkes (2002, p. 293), "Cross-scale institutional [arrangements] mean something more than management at several scales, isolated from one another. Issues need to be considered simultaneously at several scales when there is coupling or interaction between [both space and time] scales". This is particularly true for fisheries of migratory species, where a single stock may be fished independently by several communities during their migratory movements. Management institutions need to be linked horizontally (across space) and vertically (across levels of organization) to be effective. For government agencies the horizontal linkages observed in the study area are weak due to lack of funding and infrastructure. Vertical linkages did not exist at the time of the survey, as local institutions (*colônias*, informal associations, other community groups) unfortunately were not involved in forming the management directives issued by state and federal entities. Localized management information and interests were thus not utilized, contributing to the alienation and hostility of many stakeholders. Berkes (2002) discusses several institutional options that can foster cross-scale vertical linkages, including co-management, multi-stakeholder bodies, Citizen science, and policy communities. All focus on involving resource users and the general public in management, providing mechanisms to integrate local and scientific knowledge and engaging local communities in the responsibilities of sustainable management.

Kalikoski *et al*. (2006) in a review of 106 references in the literature on fisheries co-management in Brazil observed that although it has been relatively easy to create different forms of co-management arrangements, the biggest challenge is to implement and maintain these arrangements in the long term. Their analysis shows that factors which advance co-management arrangements in Brazil include: (1) strengthening local institutions through outside support as well and endorsement from inside the community; (2) increasing productivity of co-managed resources; (3) expanding existing community-based or co-management projects; (4) Government legitimizing pre-existing informal agreements on resource access and use; (5) implementation of ecologically sound enterprises based on both scientific and local ecological knowledge; (6) reinforcing pre-existing conservationist aspects of community culture, and (7) development of adaptive management practices.

Kalikoski *et al*. (2006) also point (as do) to challenges in advancing co-management arrangements in Brazil including: (1) existing interest conflicts, both inter and intra-community; (2) socioeconomic marginalization of fishing communities; (3) lack of recognition (and use) of local ecological knowledge in formal management; (4) market constraints for co-managed products; (5) underpaid fishers due to price control by middlemen; (6) vulnerability of fishing communities due to climate variability and lack of public policies for emergency situations; (7) overfishing, pollution, environmental degradation and "predatory fishing"; (8) institutional misfit in fisheries management; (9) lack of power devolution to communities for co-management; (10) lack of social cohesion in certain communities; (11) fishing communities mistrust of government institutions in charge of management; and (12) lack of clear and appropriate rules for sustaining fisheries.

Overall, there are two important lessons learned from this review that should be taken into account in planning and implementing fisheries co-management in Brazil, and most likely elsewhere. First, fishing communities are not homogeneous and have vastly differing levels of preparedness with which to engage in co-management. Hence it is vital to understand and strengthen fishers' capacity for co-management and to encourage their empowerment. Second, the preparedness of government agents to engage in co-management arrangements is relatively low given the history of centralized decision-making in Brazil (as in many countries). Hence, it is absolutely necessary to build the capacity for co-management into government agencies.

Social Inclusion

The social exclusion of professional fishing class is one of the principal impediments to cross-scale management linkages. This exclusion is evident in our survey through the relatively low level of mobilization and participation of fishers in decision-making. Many factors contribute to exclusion: (a) pervasive low levels of formal education, hindering access to information and participation in decision-making; (b) lack of concern on the part of government agencies (federal, state, and municipal) for artisanal fisheries and the well-being of fishing families; (c) establishment of top–down fisheries policies, with no consultation with fishers; (d) more powerful river resource

users, such as farmers, hydroelectric companies, and mining industries, that historically have imposed their interests on public policies to the detriment of the fishers; and (e) overly severe enforcement of fisheries regulations (considered inappropriate by many fishers), including exorbitant fines and/or confiscation of fishing gear.

Improving social inclusion starts with building the capacity of fishers to participate in cross-scale institutional arrangements and strengthening local level institutions to help them to do so. Actions include teaching fishers to read and write, educating them on their rights and responsibilities, and fostering self-esteem and citizenship (*cidadania*). Capacity building and attitudinal change must also take place among government staff and other stakeholders. For instance, regulatory government agencies (e.g., IBAMA, IEF, municipal secretaries) must initiate change towards shared decision-making that includes fishers and the policing agencies and their practices. IEF and IBAMA need to become more accessible, community oriented and educational.

In conclusion, this study investigated the complex, and conflict-loaded socioeconomic and environmental situation of artisanal fisheries of the São Francisco River, which may continue to deteriorate unless management mechanisms are improved. We believe that improved cross-scale institutional linkages, primarily vertical linkages that include fishers and improve their social status are the most likely management processes to result in better and more equitable sustainable fisheries in the region.

Acknowledgements We thank all fishers, their families, and communities, as well as the municipal and government agents that participated in the surveys, including Raimundo Marques of the Federation of Professional Fishers, Barbara Johnsen and Carlão of the Environment Secretary of Três Marias, and Sineide Montenegro and Fatima Sá of the Federal University of Alagoas (UFAL). The fieldwork was supported by World Fisheries Trust, the Federal University of São Carlos (UFSCar), and the Federation's *Peixes, Pessoas e Agua* Project through CIDA funding, with counterpart support of field activities by the city of Três Marias and UFAL. Ana Thé was supported by FAPESP and the Post-graduate program in Ecology and Natural Resources of UFSCar.

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