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Ambivalent Enforcers. Rules and Conflicts in the Co- Management of Brazilian Reservoir Fisheries

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1. Introduction

About 12% of Brazil's total area, comprising nine states in the country's Northeast, is semi-arid. Droughts, which in the past have periodically wiped out large populations of local residents and driven millions from their homes, have been a frequent phenomenon well into our days. The damming of rivers and the creation of reservoirs has been and still is the state's major policy instrument against droughts. Today there are about 60,000 reservoirs with an inundated area of circa 800,000 ha in the so-called "Polygon of Droughts". Their main purposes are water storage for agricultural and domestic use during the annual dry seasons and prolonged periods of drought, river flow regulation to allow for irrigated cultivation of perennial crops, and fisheries and aquaculture.

While some claim that the hydraulic infrastructure provided in the past has been insufficient and almost insignificant in the face of existing necessities (MACEDO 1996), others have pointed out that engineering measures *per se* are not sufficient to resolve water scarcity and its effects on the rural economy (KEMPER 1996). What is needed, they argue, are institutional improvements in aquatic resources use and management. This has become even more pressing as the National Department of Works Against Droughts - DNOCS, the federal organisation responsible for constructing and operating large reservoirs as well as managing the natural resources associated with it, has been forced to steadily withdraw from these tasks over recent years, due to drastic cuts in finance and personnel.

Emphasis is now being given to participatory and integrated forms of catchment-wide aquatic resources management. In Brazil's Northeast, the Ceará Reservoir Fisheries Project - PAPEC has been among the first to establish co-management of natural resources on a catchment basis. At present, PAPEC is considered a reference project for similar endeavours by various organisations on state and regional levels. Yet, its outcomes and sustainability are now endangered by conflicts among resource users who find it difficult to implement their own management rules and regulations. These conflicts have come as a surprise: A high degree of participation of users in resource management decision-making and the homogeneity of the user group suggested a less conflicting implementation of management proposals. The paper focuses on the analysis of the conflict and on the social and ecological dynamics influencing conflict management. It also describes and analyses the ambivalence in efforts shown and results obtained by resource users in enforcing rules set by themselves.

2. Ceará Reservoir Fisheries Project - PAPEC

As part of a larger project of technical co-operation between Brazil and Germany in artisanal fisheries development, PAPEC was established at two reservoirs of the Curu River watershed in the northeastern state of Ceará in 1990. Project activities were later extended to a total of five reservoirs (see *Map*). Today, the project is a collaborative undertaking of several governmental and non-governmental organisations on federal, state and municipal levels, coordinated by a joint committee. Brazil's federal environmental agency IBAMA and GOPA-Consultants, on behalf of the German Agency facilitate its implementation for Technical Co-operation - GTZ.

Ceará is one of the poorest states in the *Nordeste*, with 93% of its area being semi-arid. At the same time it contains more than half of all reservoirs in the Northeast. While most of them are small, the 7,500 public and private reservoirs larger than 5 ha amount to a total waterspread of about 140,000 ha. Their fish production capacity is estimated at 20,000 t/year. This potential, however, is underdeveloped, largely due to poor fisheries management, coupled with inadequate infrastructure. The actual reservoir fish production is in the range of 10,000 t/year only (CHRISTENSEN 1996). This needs improvement, as fisheries is of considerable importance to rural communities, providing one of the few sources of income during the long dry seasons.

In fact, aquatic resource development and management had been initiated long before the project's beginning. Reservoir fisheries development goes back as far as 1945, when an important fisheries and aquaculture research station was founded at Pentecoste reservoir. The organisation of reservoir communities was a major emphasis of the Catholic Church in the 1970's and 80's. And IBAMA's office at state level had promoted several reservoir fisheries development activities over a number of years. So the project took up the strands of earlier initiatives with a view to develop reservoir resources in an integrated and participatory fashion. In doing so, it changed its own objectives from mainly technical to institutional development and from predominantly fisheries-oriented to integrated reservoir resource management.

3. Reservoir Fisheries Co-management

An important instrument in aquatic resource development has been the setting up of reservoir co-management cycle. In doing so, emphasis was given to the integration of elements such as environmental awareness creation, fisheries research, and community organisation and aquatic resources management. The interface between fisheries and other productive activities at the reservoir was highlighted. Furthermore, integration of resource management at local and regional, i.e. watershed, levels was stressed.

Figure 1 provides an overview over the various steps that make up the co-management cycle. Environmental awareness creation is the starting point for both community organisation and community-based aquatic resource management. Training in aspects of community organisation contributes to the strengthening of individuals and their associations, enabling them to interact more efficiently between themselves and with government institutions. Here, community members not only concentrate on questions of natural resource management, but on provision of social infrastructure and alternative employment as well. Promoting institutional arrangements for natural resource management on local level, the project encourages community associations to hold regular meetings, which periodically culminate in a reservoir-wide fisher congress (*congresso de pescadores*), during which a fisheries agreement (*acordo de pesca*), that summarises community management proposals, is discussed and voted. Subsequently, this agreement is submitted to IBAMA for ratification. Hence reservoir co-management presently established is of the *advisory* type, where users advise the concerned authorities on decisions to be taken, which are subsequently endorsed by government (SEN and NIELSEN 1996).

So far, all community management proposals have been ratified by IBAMA and thus become fisheries legislation. The process of elaboration of management proposals is by now well established at community level and has become part of its calendar of routine activities. This is not yet the case for IBAMA, the organisation that has the exclusive attribute of natural resource use legislation. Its support depends largely on the goodwill, comprehension and inter

est in community-based management by individual civil servants concerned. This somewhat ambivalent attitude is further aggravated by the fact that the organisation favours generally applicable and easily controllable rules instead of the myriad of locality-specific regulations emanating from the participatory process.

Reservoir fishers are partly or wholly, though mostly informally, involved in most important management functions, such as *policy decision-making, data gathering, regulating fishery access, rule enforcement, habitat protection and restoration, and resource use co-ordination* (PINKERTON and WEINSTEIN 1996). Applying the usual evaluation criteria of *sustainability, efficiency and equity* (see SEN and NIELSEN 1996), the co-management of reservoir fisheries in the Curu river basin can be considered largely a success. Reservoir fishers, as well as other users, have taken over greater responsibility and thus, *stewardship* over the resource. The management process has become *resilient*, as users react to changes in the resource and its exploitation. Data collected has provided quantitative insights regarding the *efficiency* of community-based management. An increase in landings of some indigenous fish species has been observed and is being attributed to the maintenance of gear

restrictions and closed areas and seasons during spawning periods (*improved net returns to fishers*). User *representation* has undoubtedly improved through participation in user organisations and institutions, so has *process clarity*. Though no changes in income *distribution* can be attributed to co-management, increased access to social infrastructure and services (e.g. education; health posts; electricity; water supply; etc.) and a more equal distribution of benefits from such non-natural resources can definitely be booked as success points on the co-management side. (BARBOSA and HARTMANN 1997)

All this being the case, it is not easily understood why conflicts in implementing community proposals, and here in particular problems of compliance with community-set rules, do exist at all, and why community members don't seem to be able to defend their decisions, to the extent that the entire co-management system is in danger.

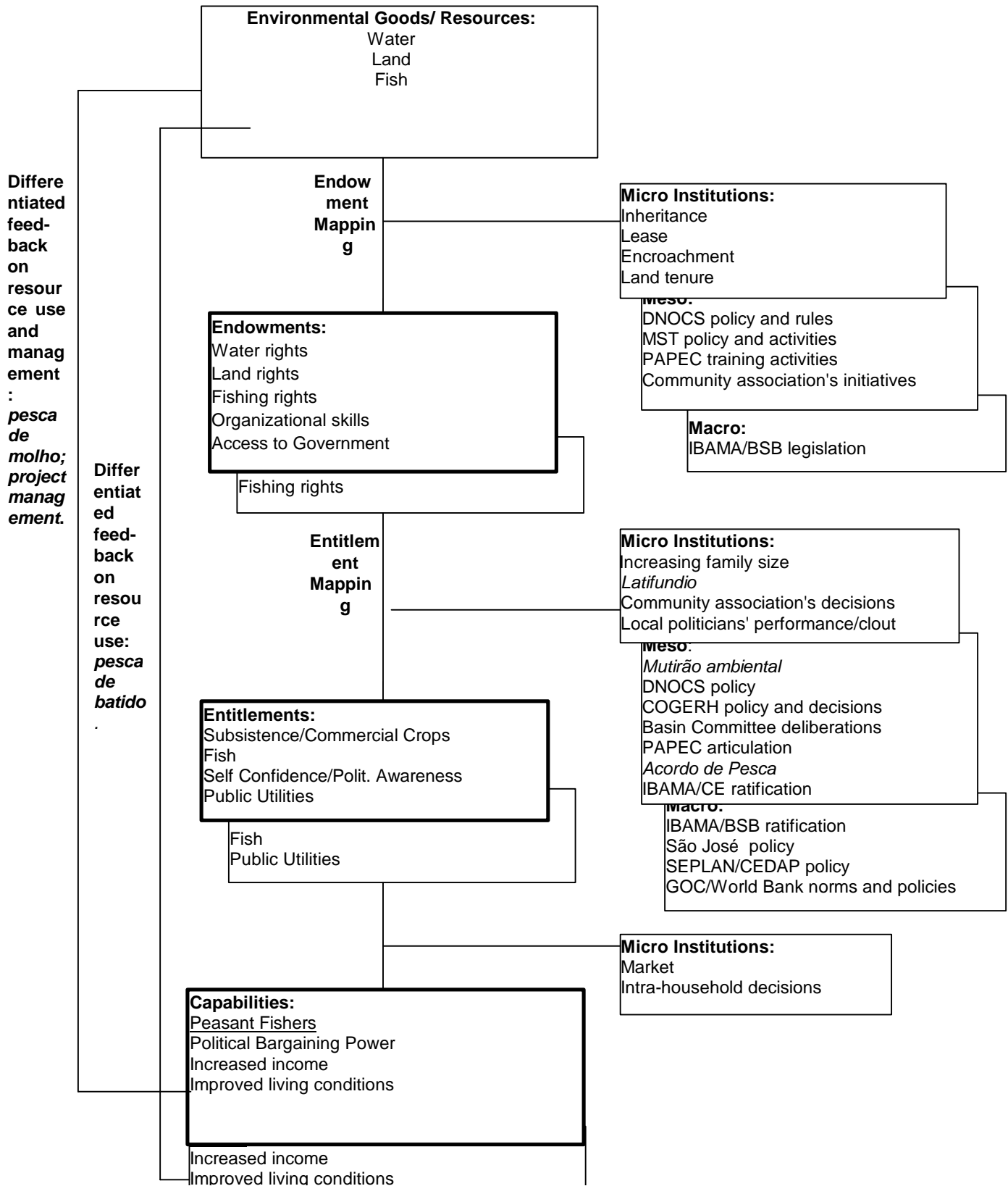
4. Conflicts and Conflict Management

Looked at superficially, the conflicts, which revolve mainly around a particular form of fishing with gill nets as an active gear, locally called *batido*, are simply conflicts of *internal allocation* within a specific fishery between different user groups and gear types (CHARLES 1992). Yet, it seems that the situation is more complex, and conflicts, that express themselves as fishery conflicts, have a number of other ingredients. Similarly, conflict management strategies seem to be subject to phenomena originating from the wider reservoir resource system. In analysing the conflicts at hand, we start with a description of the reservoir resource system. In doing so, we attempt to apply the environmental entitlements framework as proposed by LEACH, MEARNNS and SCOONES (1997a and 1997b).

4.1 The Resource System

Figure 2 provides a schematic presentation of the environmental entitlements framework applied to the Curu valley reservoir resource system. In short, the environmental entitlement framework emphasises the dynamic processes (*mapping*), by which social actors, who have rights and resources in principle (*endowments*), take effective command over such resources (*endowments* become *entitlements*) and ultimately derive *capabilities* from resource use. The processes are mediated by *institutions* at different levels (LEACH, MEARNNS and SCOONES 1997a and 1997b). The bundle of resources available at the reservoirs for use by local residents is made up of water, land, and fish.

**Figure 2:
Environmental Entitlement Analysis: Reservoir Resource Use**



Water

Due to climatic conditions, Ceará is chronically short of water. The state's territory is almost completely classified as semi-arid. While annual overall precipitation is around 750mm, it is unevenly distributed over the year. Only about 8% of the rains that fall are effectively utilized for agriculture, as well as to fill rivers, lakes etc. This is mainly due to high evaporation and low water-storage capacity of the soils. Over the past century, federal and state agencies have tried to solve this problem by building dams to catch water during the rainy season and store it in reservoirs for distribution in the dry season and during recurring drought periods. So water as a resource is, at least in part, provided through human intervention. Not all of the water stored in reservoirs, and to which local residents theoretically have access, becomes indeed available as entitlement. It is, quite to the contrary, destined mainly for the usage by urban consumers as well as irrigation farmers downstream from the dam. This demand, coupled with frequently insufficient rains, contributes to the periodic recession of reservoir waters by up to 90%. Water level recession seriously jeopardizes both upstream agriculture and fisheries. Water becomes an entitlement through water management measures undertaken by DNOCS and the state's Company for Water Resources Management - COGERH, who decide on the amount of water available for different users. Until recently, DNOCS, as the *owner* of the reservoirs and its associated natural resources, had the uncontested formal responsibility to operate and maintain the physical infrastructure and to administer and manage the natural resources resulting from it. In 1994, it started to share this task with the state's Ministry of Water Resources. With the creation of Curu Basin Water User Committee by the state government in late 1997, all water users are now involved in resource use decision-making.

Land

There are two categories of users of upstream natural resources, peasant fishers (*vazanteiros*), who combine agriculture and fishing and full-time fishers (*pescadores*). Due to the particular layout of properties (*lotes*), peasant fishers usually work only a small part of their plots of around 10 ha leased from DNOCS, encroached upon or inherited. Plots contain two types of land: a major part of dry-land (*sequeiro* or *roçado*), and a limited area at the reservoir's edge, where crops are cultivated making use of residual soil humidity, which becomes available with sinking water levels (*vazante*). Most of the lands are used for subsistence production of beans, maize, manioc and fodder (33%) and 26% for cultivation of subsistence and commercial crops; about 26% of lands are said not to produce anything (CNBB 1994). Agricultural incomes are small, if they exist at all.

Houses and residential plots are considered by most as owned, though hardly anybody has a land title. Agricultural lands are said to be owned by only 40% (Caxitoré) and 6,25% (Pentecoste) of peasant fishers (ESPLAR 1991). Indeed, land tenure is quite obscure. While at Pentecoste landowners were compensated for lands flooded by the reservoir, at Caxitoré the land question remains unclear until today, that is, 36 years after construction of the dam. Thus, most residents live on lands owned (or, at least, confiscated) by DNOCS and subsequently leased out to or encroached upon by peasant fishers. However, due to the lack of enforcement on the part of DNOCS with regard to

collecting user fees or evicting squatters, lands become in fact privately owned and are "sold and bought" by and between occupants. Lately, this includes "sale" to outside landowners (*latifundiários*), who agglomerate individual plots to form large land holdings for planting of fodder and raising of cattle. Apart from DNOCS' office at Pentecoste, where users of DNOCS plots are registered and where they are supposed to pay their fees, there are a number of other organizations, which play a role in the control of access to lands in the valley. Among them are the Rural Labourers' Union (*Sindicato dos Trabalhadores Rurais*) and the Movement of the Landless (*Movimento Sem-Terra-MST*), who select the beneficiaries of land reform projects, of which one is located at Pentecoste reservoir.

Fish

Not all local residents do have access to land. In fact, fishers, who mainly come from peasant fisher families, have usually lost effective access to cultivable land. This has occurred as a result of ever increasing family sizes, concentration of lands in the hands of ranchers, or the breakdown of agriculture resulting from droughts. While most congregate in urban centres at the periphery of the reservoirs, some have become members of the land reform project at Pentecoste. At present, the Brazilian law guarantees open-access by anyone to all public waters, as long as she/he is licensed and respects national fisheries law. While in the past DNOCS registered fishers, today IBAMA/Ceará is issuing fishing licences. As a result of PAPEC's activities, local citizens' associations are increasingly involved in managing reservoir fisheries, negotiating use rules and access to the resource.

Similarly to water, fish are only partly a naturally provided environmental good. Since the 1930's fish are stocked in the reservoirs, and today 70-80% of landings consist of species which have been introduced and acclimatised in these waters (BARBOSA and HARTMANN 1997). The regular stocking of fingerlings of Tilapia (*Oreochromis niloticus*) by DNOCS at localities selected and in numbers determined by fisher communities is one of the main fisheries co-management measures.

Fishing is important for local residents both as a source of food and income. Fishers fish mainly for their own consumption (42%), 40% for subsistence and commerce, and 2,5% fish commercially; only about 10% of reservoir residents don't fish at all (CNBB 1994). While only 43% of residents have no fishing incomes, such incomes are, however, slightly smaller than those realised in agriculture (CNBB 1994).

Fishing at the reservoirs is done by a variety of fishing techniques and gears (LEITE BARROS *et al.* 1990). Fishers using gill nets usually have a small number of pieces of net of a variety of mesh-sizes (usually one piece each of about 100m length of mesh-sizes 7-12mm) to allow for the capture of the main species of fish occurring in the reservoir. Surface or bottom-set monofilament nylon gill nets, locally called *galão*, of about 100 m length and a mesh-size of 50 mm are used to fish for *Sardinha* (*Tripurtheus angulatus angulatus*); mesh-size 60-80 mm to fish for *Pescada* (*Plagioscion squamosissimus*); mesh-size 90-160 mm for *Curimatã* (*Prochilodus cearensis*); *Tilapia* (*Oreochromis niloticus* and *Tilapia rendalli*); and *Tucunaré* (*Cichla ocellaris*).

Two fishers usually set gill nets as passive gear in late afternoon and left in the water (*de molho*) until early next morning, when they are collected. During peak fishing-season nets are also set during the day. Fishers using this technique usually feel harmed by drive-in fishers and handliners using juvenile fish for bait. Gill nets are used as active gear in a drive-in fishery, *batido*, where, during daytime, gill nets are set in shallow waters which fishers strike with poles or paddles to frighten fish into the nets, after which the net is emptied and immediately reset. Handlines, *linha solta*, are an important gear to catch *Pescada* and *Tucunaré* in the deeper waters in front of the dam. While handliners are criticised by other fishers for fishing with alevins as live bait, they themselves feel harmed by drive-in fishers and gill netters fishing the same fish swarms congregating over temporary refuges, locally called *coitos*. Floating handlines, *bóias*, are used to catch *Traira* (*Hoplias malabaricus*). Other gears are cast nets, *tarrafas*, to catch a variety of fishes and freshwater prawns, *Camarão* (*Macrobrachium* sp.) and traps, *covos*, to catch freshwater prawns. Fishing with spearguns, *arpão*, by skin-divers, mainly for larger-sized *Tilapia* and *Tucunaré*, is considered harmful by all other fishers.

Not environmental goods, but still important resources are PAPEC's leadership training and training in organizational and group formation skills and the formation of revolving funds for small enterprises in reservoir communities. This coincided with the launching of a large programme of financing of productive activities through community associations, jointly funded by the Government of Ceará and the World Bank (*São José*)¹. Although, officially, these funds are channelled exclusively through community associations, and proposals sanctioned strictly on their merits, local politicians have a strong say in getting projects approved.

4.2 The Conflict

Putting aside smaller animosities between different types of fishers, the main controversy and conflict bearing upon reservoir fisheries co-management revolves around fishing with gill nets as active gear, i.e. the drive-in fishery locally called *batido*, and the maintenance of periodically or permanently closed areas.

Drive-in fisheries are known the world over, both in marine and inland waters (BRANDT 1972). According to local sources, the *batido* was started by itinerant fishers to catch *Tilapia do Nilo*, after these were introduced and stocked heavily in the reservoirs in the early 70's (Francisco Carlos Bezerra e Silva, personal communication). *Batido* was vetoed by DNOCS from the beginning, based on general observations of harmful effects, such as disturbance of feeding and breeding habits. On the other hand, fish are said to get accustomed to it. *Batido* fishing has seen some technological development since it was first introduced. The technique evolved from beating the water with a wooden stick, to fixing a metal blade to its top and, finally, to using a wooden stick with a wooden cylindrical vessel fixed on the upper end, which is

¹ The programme envisages the funding of community action directed at three areas, i.e. a) productive activities, b) implantation of public utility infrastructure, and c) support to community facilities. Loans are to be paid back by the beneficiaries to the local community association, which establishes revolving funds for further activity funding. Loan repayment in *São José* projects has been problematic, which is in sharp contrast to the community revolving fund set up by PAPEC, where there are practically no defaults.

vertically thrust into the water. The latter's local name, pronounced "*Tchee-boongg!*", is the onomatopoeic expression of the sound it produces. Scratching a stone against the side or bottom of the canoe can produce a similarly frightening noise. According to DNOCS' Director of Fisheries and Aquaculture, the prohibition of *batido* is implied in the existing fisheries legislation (*Decreto-Lei 221* of 1967) under the general ban on any kind of pollution, including "*poluição sonora*", i.e., sound pollution (José Napoleão de Carvalho, personal communication).

In fact, everybody confirms that *batido* is a very efficient fishing technique. As such it is considered a cheap fishing method, requiring less amount of gear. A gill net used in *batido* mode is said to catch about four times as much as compared to it being used as passive gear. However, *batido* fishing is also said to be very tiring, requiring more dedication than passive gillnetting, hence being "nothing for lazy fishermen".

An examination of the characteristics of *batido* fishers and those who fish with passive gear (*pesca de molho*) provides the following profiles:

<i>Pescador de Batido</i>	<u>Rural:</u> Younger fisher; doesn't own land; fishes all over the reservoir; usually doesn't participate in community association. <u>Urban:</u> Owns little fishing gear, runs high risks of gear theft; fishes all over the reservoir; spends money easily; is more consumption-oriented; usually doesn't participate in community association.
<i>Pescador de molho</i>	Older; owns more fishing gear; peasant fisher; leaseholder of DNOCS land; <i>vazanteiro</i> ; fishes in immediate neighbourhood; member of community association.

In 1997, at Pentecoste most fishers fished with set gill nets (42%), followed by *batido* (37%) and handlines (16%). However, disaggregating these values according to urban and rural communities, *batido* is the most important fishing method in urban communities (42%), followed by handlines (27%) and set gill nets (21%).

Hardly anybody, including *batido* fishers, denies that this technique is harmful to reservoir fish stocks and, consequently, to reservoir fisheries as a whole. The conflict, thus, is between those who want to see *batido* completely banned and those, who see it as an important means for gaining a livelihood.

4.3 Conflict Management

Conflict management strategies adopted by fishers are twofold: a) the adaptation of community-based fisheries legislation to conditions influencing rule compliance, and b) the active involvement of community-members in rule enforcement.

4.3.1 Adaptation of Community-based Legislation

From the outset, community-based reservoir-specific legislation aimed mainly at the enhancement of conditions for stocks to reproduce and mature. This might be, at least partly, attributed to PAPEC's environmental education campaigns. Proposals included measures to protect the *Piracema*, the seasonal spawning run of migratory fish (e.g. *Curimatã*), the closing of areas to protect species that reproduce throughout the year,

such as *Tilapia*, the restriction of mesh-sizes to prevent the capture of juvenile fish, the ban on drive-in and speargun fishing to protect breeding and feeding fish, and the stocking of advanced-size alevins of *Tilapia*. On the other hand, the taking up of activities by PAPEC was interpreted by some as "the return of the state".² Being the more legalistic and authority-oriented group of reservoir residents that were attracted to the project, it is not surprising that the results of the first fisher congress at both Caxitoré and Pentecoste reservoirs were an almost complete return to DNOCS' legislation.

However, Figures 3 and 4, which present the evolution of community-based fishery regulations at Caxitoré and Pentecoste reservoirs, show a constant reduction, both in number of rules as well as area covered, of community management measures over the period 1992-1996/1997. The following factors have influenced the reduction in prescribing and implementing rules by reservoir communities.

Difficulties in rule enforcement

The most important cause for changes in community rules has been the difficulty to enforce them. For example, the overall ban on drive-in fishing initially decided at Pentecoste and Caxitoré in 1992 was rapidly substituted by the designation of a number of areas where fishing was temporarily or permanently restricted (closed seasons, prohibition of gear), when fishers convinced themselves that, though requested, an increase of enforcement action by IBAMA would be unlikely. Besides being mostly located at the mouths of small streams (*corregos*), which are important for fish as prime sites for food and shelter (PETRERE 1996), the main parameter in delineating these "protected areas" was the ease, with which they could be controlled by community members.

Recession of water level

Insufficient rains and high demand for water by users other than peasant fishers contribute to the recession of reservoir waters by up to 80-90%. In 1993 for example, the waterspread was reduced to 27% in Pentecoste and 37% in Caxitoré, affecting overall fish production, which dropped drastically. During drought periods, the maintenance of closed areas becomes obsolete, as they dry up. Even DNOCS' stern legislation foresaw the lifting of fishing during prolonged drought periods (DNOCS 1993). Still, it was precisely in 1993, that is, during the period of absolute minimum water level, that a maximum number of management measures was decided. While this might be attributed to a "co-management enthusiasm" prevalent at the time, fishers also have observed that, with the influx of water after a long drought period, reservoirs become "like new", that is, as fertile as they were after water was first impounded. Indeed, the falling dry of reservoir area and its renewed flooding contributes to a rise in productivity, and management measures, such as the protection of stocking areas,

² Between the *de facto* demise of fisheries management by DNOCS in the 80's and the initiation of community-based management resulting from PAPEC's initiatives in environmental education and community organisation, reservoir fishers had been left to their own devices for a decade or so. While this, apparently, had not lead to the apocalyptic outcomes predicted, a significant number of reservoir residents were, nevertheless, dissatisfied with having been abandoned by DNOCS. PAPEC, as a joint project of IBAMA and DNOCS, both known in the interior mainly as environmental control and enforcement agencies, was quickly, though unjustifiably, identified with those organizations' track records.

might indeed significantly boost fish populations. Another positive effect of water level recession is the stranding of *baronesa*, that die as beaches dry-up.

Water hyacinth

In 1994, the water hyacinth, *Eichhornia crassipes* (locally called *baronesa*), first appeared at Caxitoré reservoir with the rains after the drought years of 1992/1993. In 1995 it covered 20-30% of the reservoir, in particular shallow areas which are important breeding grounds of *Tilapia*. The growth of water hyacinth is boosted by nutrients that enter the reservoirs with the winter rains. The plant is almost useless, being turned into low-quality cattle fodder by peasants who have no access to other forms of feed. At first, it was believed that areas covered by water hyacinth would function as refuges for fish. It could be shown, however, that fish flee these areas, probably due to low oxygen and nutrient contents and lack of luminosity. In 1996, unsuccessful attempts were undertaken to remove the macrophytes manually. A steep decline in fish production by about 47% between 1995 and 1996 is attributed to large reservoir areas being covered by water hyacinth. Some of them were protected areas, which subsequently were given up. With the difficulties of reservoir access owing to solid *baronesa* carpets on the reservoirs northern bank, protected areas on its southern shore were given up in order to have access to the reservoir at all.

Changes in catch composition

Fishers at Caxitoré claim a "taking over" of the reservoir by *Tucunaré*. Since 1993, there has been a steep increase of occurrence of *Tucunaré* in Caxitoré reservoir³. It seems that *Tucunaré* actively competes with fishers for *Tilapia*.

Shift of emphasis in management objectives

With the availability of financial resources through the *São José* programme, emphasis in the associations' deliberations shifted from fisheries management to "management" of developing funds, i.e. elaboration of proposals, lobbying, and finally implementation of projects. So far eleven projects have been approved with a total value of US\$ 280.000. While 75% of funds is directed at the provision of social infrastructure, 25% is spent on the provision of fishing gear. Regarding the latter area of financing, funds are utilised for purchase of nylon thread which is used by local women in the fabrication of fishing nets. So the programme has not only significantly increased the amount of fishing gear available to individual fishers, but has also provided a source of income for women in peasant fisher communities.

Shift in attitude towards drive-in fishery (*batido*)

In 1997, Pentecoste reservoir was practically opened-up to *batido* fishing (with the exception of its "protected areas"). The shift in fisher attitude towards this dispute was due to a) the acknowledgement of the fact that *batido* simply could not be controled,

³ About ten years ago, the influx of *tucunaré* is said to have significantly contributed to a reduction by almost 60% of total catches from Pentecoste reservoir over a period of 4-5 years. GURGEL 1994 and PETRERE 1996 confirm the drastic impact of carnivorous fish such as *Tucunaré* on *Tilapia* and other fish populations in Northeastern reservoirs. Other factors that contribute to a loss in productivity and thus a decline in fish production are age of the reservoir, deforestation, increases in the natural rate of siltation due to inadequate agricultural and management practices, polluted run-off from chemically treated agricultural lands, etc. (PETRERE 1996).

and b) the effort by project members, who had started to look earnestly into aspects of conflict management, to discuss with community members differences in resource access and control (*entitlements*) as a reasons for gear choices.

Outcomes of community-based regulation

The main outcomes of community-based fisheries management, which have influenced the maintenance or demise of certain measures by fishers, have been the following:

- There are indications that the protection of spawning runs (*piracema*), by maintaining a closed season for fishing in river mouths and rivers, has significantly contributed to a steep increase of production of *Curimatã* (by about 100%) and the recuperation of these stocks in particular at Pentecoste reservoir after the drought of 1992-1994;
- No impacts of measures, such as gear restrictions, closed seasons and protected areas, have been observed on the important stocks of *Pescada* (which account for 30-40% of total catches). However, a twofold increase in *Tilapia* landings might be attributed, at least partly, to stocking of reservoirs with large *Tilapia* fingerlings and the simultaneous protection of stocking areas by local residents, from 1994 onwards.

4.3.2. Participatory Enforcement

In 1988, the National Environmental Council (CONAMA), an organization within the Ministry of Environment, created a legal instrument for the involvement of non-governmental environmental organizations in the enforcement of management rules in protected areas (*Resolução CONAMA N.º. 003*, of 16.03.1988). This was an important change from the previously held view of enforcement as the sole "privilege" of the state. The instrument foresees the adoption of a traditional form of cooperation in communal tasks, called *mutirão*, for purposes of environmental protection, consequently called *mutirão ambiental*. According to the resolution, such the *mutirão ambiental* is to be carried out, accompanied by police or other government enforcement personnel, by at least three persons, who have previously been trained and authorized to do so by the competent environmental authority. The participants will, when confronted with a breach of management rules, write out and sign a report (*auto de constatação*), which describes the circumstances of the infraction. This report will form the basis for legal proceedings to be initiated by the competent authority (CONAMA 1992). The objective in setting up *mutirões ambientais* is to attend through this mechanism fully to user demand for enforcement (SEMAM 1992). In other words, the important management task of enforcement passed on to user groups, mainly to make up for the lack of funds and manpower of the responsible authority.

Effective enforcement by IBAMA has been a long-standing request by reservoir residents. Indeed, the *lack of enforcement* and the existence of *water hyacinth* were said to be the two most important problems jeopardizing co-management of reservoir fisheries. Consequently, to lobby for more enforcement by IBAMA was included as a specific priority activity in the Pentecoste Community Action Plan (CAMPELO 1995). In replying to the demand, IBAMA made it clear, that such an increase was unlikely to happen. As in other cases of similar demands, the solution proposed was to embrace the idea of a *mutirão ambiental*. After discussing the pro's and con's of this

recommendation at great length, Pentecoste community leaders finally asked for a training course for potential participants in *mutirões ambientais*, which was held in June 1997. While accepting the CONAMA model in general terms, the project suggested to adapt it in the sense that emphasis was to be given to action by the community through its associations, as opposed to action by individual voluntary enforcement agents. It further highlighted the importance of systematic conflict management and resolution as an essential part of enforcement, as opposed to IBAMA's emphasis on fines, or in other words, on enforcement as a source of revenue.

A total of 23 community members were trained and received their credentials (an identity card and a jacket) as voluntary environmental agents (*agentes ambientais voluntários*). Most of the trainees were community leaders (60%), being members in various organisations. In their majority they were peasant fishers (65%) and fishers (18%). Educational levels were low, 47% not having completed primary school and 35% hardly able to write their names.

Since the *mutirão ambiental* was initiated in June 1997, the group of *agentes ambientais voluntários* has monitored reservoir fisheries constantly and maintained contacts with local residents, explaining management rules and their own role as voluntary environmental agents. During two joint missions, *agentes voluntários* and IBAMA enforcement personnel caught nine crews breaking management rules, and subsequently confiscated the gear and produce of the offenders. While most non-compliers claimed that they didn't know the regulations, others admitted that they broke the rules because others did so too. No reports were written out and thus no legal proceedings initiated. The fact that during the last joint enforcement mission no rulebreakers were apprehended has been interpreted as resulting from a leak of information by an *agente voluntário* to non-complying fishers!

Out of the original group, 65% still engage in "participatory enforcement", while 35% have dropped-out from the group. Their reasons are: dissatisfaction with present community fisheries legislation (18%); decline of the local fishery because of drought conditions (12%); lack of support from other community members; problems of personal relationship with neighbours and other community members resulting from being an *agente voluntário*; financial problems and others (6% each). Particularly the first-rated reason, i.e. dissatisfaction with regulations presently in force, deserves a closer look. Discussions with those concerned revealed a tendency of regarding protected areas as *community areas*. When protected areas were reduced as part of changes in overall reservoir management, members of communities concerned abandoned the scheme, as their specific interests were no longer part of the game.

All *agentes voluntários* stressed the fact that the rules proposed by the fisher congress and ratified by IBAMA were indeed well suited and without doubt the best result possible. However, some *agentes* questioned the need and justification for rule adaptations by subsequent fisher congresses, as they felt that frequent changes weakened the impact of rules decided upon. Furthermore, they pointed out that insufficient time had been allowed to really evaluate the effects of management rules on the fishery.

In suggesting improvements to the participatory enforcement scheme, *agentes voluntários* recommend, in order of priority, the following items:

- joint reservoir-wide enforcement instead of localised, community-based action;
- emphasis on informing and advising users on management rules and their justification;
- enforcement not only of capture but also of marketing of fish;
- application of fines in addition to confiscation of gear and produce;
- redefinition of the role of *agentes voluntários*;
- financial compensation for loss of fishing time while on enforcement missions; and
- effective collaboration between state enforcement personnel and voluntary environmental agents.

5. Concluding Remarks

This review of co-management of reservoir resources in the Curu basin leaves behind a complex, at times contradictory, picture. As in similar cases, co-management in the Curu valley has come as form of "crisis management", meant to closing a gap left by the withdrawal of government institutions concerned (MCCAY and JENTOFT 1996; SEN and NIELSEN 1997). It is seen as a mechanism to mobilising greater resources in a situation when more, not less, management is necessary. On the other hand, co-management offers local communities an opportunity to participate in affairs of their own interest. It contributes to their empowerment and to a strengthening of citizenship, *cidadania*, which are essential ingredients of a democratization process still in the making. However, reservoir sites are frequently arenas of intense state presence. Local residents and members of government agencies alike have accumulated experiences of intervention, which have left behind a *historical imprint* on their behaviour. This can be understood only when viewed in relation to collective and individual memories of state-peasant relations, local initiatives and inter-institutional struggles (see, e.g., LONG and VAN DER PLOEG 1989). We confirm LI's (1996) observation that, in general, local resource users do not demand autarchy and isolation, i.e. a reduced state, but rather a better state, one which would be more responsive to their needs and offered them access to the services and facilities they associate with development.

The resource system described comprises a complex bundle of endowments and entitlements shaped by ecological, social and political dynamics. It is the interaction among a multitude of institutions at different scale levels, but also ecological constraints, that influence resource claims and management practices and resulting user conflicts of and between different social actors. The environmental entitlement analyses contained in LEACH (1997b) deal with single-resource cases (e.g. land or ground water or game etc.). In order to demonstrate the interdependency existing within the system, we have attempted to present, within a single analysis, the entire multi-resource system in operation at the reservoirs. Use and management of a particular natural resource depends, or is linked, to the uses and management of other resources, including non-natural ones.

Involvement of resource users in rule formulation was expected to eliminate fishing methods perceived as harming the stocks and, in that fashion, improve the fishery, as people would not want to hurt themselves or each other. While users on many occasions speak with one voice, they differ in their effective control over resources, i.e. environmental entitlements. Yet, differential access to environmental goods influences the choice of resource use. *Pesca de batido* and *pesca de molho* are cases in point. Here, the way people choose to fish is to a great extent shaped by the institutional arrangements, through which they obtain endowments and entitlements to natural resources, i.e. fish and agricultural lands. This subsequently influences the environmental impact of fishing as a livelihood activity.

It seems that the impact of management on reservoir fisheries is limited. In the years after DNOCS' withdrawal and before the establishment of co-management, its lack had not led to the apocalyptic outcomes previously predicted. Similarly, the implementation of community-based management has not improved overall fish production. Indeed,

water level fluctuation is the factor that most influences the fishery. While recession of reservoir water levels is only partly attributable to resource use, its management lies outside the control of local fisher communities. It might be worthwhile to emphasize reservoir water management on a catchment basis as a promising strategy, as compared to managing fish capture at individual reservoirs. However, there may be difficulties in harmonizing this approach with other water uses (PETRERE 1996).

A quite different strategy manifests itself in the reactions of a number of individual as well as local groups of resource users towards certain community decisions on reservoir management. In fact, there is evidence of attempts to, unofficially but *de facto*, claiming local fishing territories in the disguise of establishing "protected areas". This strategy is certainly not catchment or reservoir-oriented, but community-oriented.

What, then, are the benefits of co-managing reservoir fisheries in the Curu valley? Undoubtedly, they are those which are usually mentioned: Social learning; participatory democracy; discursive design of management, i.e. coordinating actions through discussion; co-management as a route to community-based development, etc. (PINKERTON 1989; MCCAY and JENTOFT 1996).

SMITH (1990) points out that, in the final analysis, a management scheme is measured not by its internal consistency and potential for success, but by the extent to which people comply with it. Indeed, at Pentecoste reservoir co-managers are more worried about compliance, than about the adequacy of management rules. Though management rules have changed in the past, they hold all *acordos de pesca* as equally satisfactory, and would be happy if regulations would not be tinkered with constantly. The "fine tuning" of fisheries agreements, which is largely influenced by the project's emphasis on adaptive management, is being experienced as an often confusing and contradictory flow of rules and regulations, which contributes to a weakening of its impact.

The involvement of users in enforcement originates from scheme designed by the concerned authority to make up for its own generally poor performance in the light of budget and personnel constraints. However, enforcement has also become more important than it was before, and almost a question of honour for those engaged in co-management. It certainly is of crucial importance for its institutional sustainability. Preferring methods of negotiation and persuasion and referring to jointly agreed upon community rules, *agentes voluntários* practise compliance-based regulation, which is reactive, or responding to the community demands. In contrast, IBAMA enforcement personnel practise proactive, deterrence-based regulation, which is more legalistic and based upon penalizing those in violation, emphasizing fines and confiscation of gear and produce. Moreover, deterrence-based regulation takes the conflict out of the community, while the former tries to resolve conflicts within the community. On the other hand, this change of *locus* of conflict and conflict management has also led to severe role conflicts. The experience that they can become the *objects of conflict*, rather than mediators, once local customs are ignored, has provoked some *agentes* to drop out from the scheme.

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