



Research Article

**BEYOND PARTICIPATORY MANAGEMENT OF FISHERIES IN THE BRAZILIAN AMAZON:
ADAPTING MODELS TO REALITY**

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ABSTRACT

Participatory management approaches promote the idea that success in natural resources management requires engaging with and providing benefits for local communities. However, participatory approaches are neither consistently successful nor free from controversy. Recent studies assessing the characteristics related to success and failure typically ignore the social and political context of local communities. To address these issues, we use a comparative analysis of community-based fisheries to evaluate adaptations aimed at improving management schemes, considering four domains (ownership, responsiveness, accountability, and perceived evidences). We evaluate outcomes about how local community characteristics affect these sources of improvement. Based on qualitative data (2009-2015) we find improvements in community ownership, responsiveness and perceived evidences for the management of fisheries. Findings indicate positive feedbacks within the management systems that have potential to strengthen perceptions of adaptive management framework. We suggest that enforced property right regimes, arenas for conflict resolution and adaptive management of connected knowledge systems can overcome many of the challenges faced by local communities to succeed in multiple domains of community-based management of fisheries.

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INTRODUCTION

Since the late 1970s, the preeminence of rational science has been assumed and transmitted to rural communities through hierarchically and technically oriented extension services. Fishermen and farmers are seen as either adopters or rejecters of technologies, but not as originators of knowledge and practices. This is known as the transfer of technology approach (Chambers and Ghildyal 1985). In the Amazon region, institutional changes in the mid-1990s promoted relevant policy shifts.

Structural adjustment policies enhanced management practices at the watershed scale, and a decrease in the provision of state services. This process opened opportunities for NGOs and grassroots organizations to take active roles (IBAMA 1995; Fischer and Mitlewski 1997; McGrath *et al.* 2008). Also, trends toward decentralization offer alternatives of greater accountability in fisheries management (Benatti 2005). A shift from the top-down transfer of technology approach to a participatory process coincides with many of these policy trends.

It is expected that participatory approach could cope with this policy shift and enhance the quality of projects (Luyet *et al.* 2012). Environmental information is likely to have a potential of application when perceived by community users (Castilla *et al.* 2015).

Fisheries management in the Amazon now is being supported through participatory approaches (participatory management is interpreted here as a practice of empowering members of a group, such as residents of a community or members of a local association, to participate in inter-organizational decision-making, see Crampton *et al.*, 2004). Studies have shown that participatory management can be critical to: (i) improving costs and benefits sharing (Castello *et al.* 2009); (ii) implementing and enforcing management regulations more efficiently than centralized agencies (Viana *et al.*, 2007); (iii) improving compliance with regulations, since the incentives to communities to manage their own resources sustainably are often high (Castello *et al.* 2011); (iv) improving knowledge, because local users can provide valuable knowledge (Oviedo and Bursztyn 2017); and (v) enhancing environmental institutions (McGrath *et al.* 2015). Participatory management and fishermen participation have evolved over time and are being adapted as local and regional public policies (McGrath *et al.* 1993; McGrath *et al.* 2008).

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Several initiatives have made significant changes by adopting a participatory approach (Santos 2005; Pinyopusarerk *et al.* 2014; Oviedo *et al.* 2015; Corbera *et al.* 2017). Without doubt, there have been relevant improvements in the development of participatory approaches to understanding the complexity of fisheries management (McGrath *et al.* 1993; Castello *et al.* 2011; McGrath *et al.* 2015), but some key issues remain a challenge for research and development. Understanding fishermen's perspectives has been a major influence on the development of participatory research methodologies (Ruffino 2011). Lack of data validating the outcomes of participatory management has led to conclusions that limit the ability for improvement of community-based schemes (Barret *et al.* 2001).

Many government agencies and NGOs are still bonded in a top-down and transfer of technology way of thinking, in which these institutions define priorities, generate technologies, and then transfer them to fishermen, regardless of whether the community is willing to adopt such practices. Luyet *et al.* (2012) argue that, in practice, participatory approach is still an expert-driven model with project leaders usually influencing the degree of stakeholder participation.

The participatory approach fails to confront the impact of power on relations between different groups within fisher communities, or between local people and external institutions (Pomeroy *et al.* 2001; Castro and McGrath 2003; Wang *et al.* 2018). Considering that participatory approaches do not address these issues of power, authors report that the participatory approach often faces many of the same challenges as conventional top-down or transfer of technology strategies (Scoones and Thompson 1994).

Crook and Sverrisson (2001) report that there are two steps in linking community participation to environmental outcomes: (i) by measuring the responsiveness of local decision-making processes to local needs, and (ii) by measuring the relationship between the degree of responsiveness and the evidence of outcomes. They define responsiveness as the achievement of consistency between community priorities and public policies. This is a key feature in local communities, where values such as allocation of assets, access of power, structure of local institutions, and mechanisms of social control reflect the appropriate balance of its members' needs. Due to lower transaction costs than those of external institutions, community associations may be more responsive to local conditions, better control natural resources, and have incentives to harvest resources sustainably (Ostrom 1990).

Defined property rights (i.e. access, withdrawal, management, exclusion and alienation) for participatory management schemes are also important because communities feel secure in their ownership over natural resource harvests (Ostrom and Schlager 1996). Secure property rights guarantee more control to the community, allow resource users to manage better, and can contribute to sustainable outcomes (Agrawal and Ostrom 2001). Also, community ownership provides a better understanding of the complex social-ecological system and enables to monitoring more closely than an external players can (Ostrom 1990; Fitzgerald 2013).

The accountability of community associations might, therefore, influence natural resource management directly and indirectly, by affecting confidence (Nelson and Agrawal, 2008) and minimizing illegal practices (Smith *et al.* 2003).

Like other forms of cooperation, projects related to participatory management of natural resources, where attitudes and behaviors are key factors, require conditions of accountability (Ostrom *et al.* 1999). Participation without locally accountable management systems is simply not community participation (Ribot 1999). Local-level accountability is significant to local people because they have more direct contact and access to the members and representatives. Many apparent participatory approaches centralize natural resource regulation, where government institutions are not responsive but, rather, are centrally controlled (Ribot *et al.* 2006).

Participatory process is even more challenging when it is based on local knowledge, because there are barriers to incorporating traditional knowledge in the management plans (Castello *et al.* 2011). They report that greater participation of fishermen in fisheries experimentation will lead to technology development processes better adjusted to local conditions. Castello (2004) presents an example from the Amazon floodplain, where successful innovations in fisheries management have arisen from researchers introducing suitable techniques for assessing fish stocks built upon fishermen's knowledge and observational skills.

Considering these controversies unresolved, this article explores a better understanding of the characteristics associated with the effective implementation of fisheries management projects. Here, we address these analyses by developing a comparative database of community-based management initiatives identified in the Amazon floodplain, where we evaluate outcomes according to domains (ownership, responsiveness, accountability, and perceived evidence) by assessing responses from fishermen about how features of community characteristics affect measures of improvement.

METHODS

This article describes the characteristics of community-based fisheries management to make decisions, to create and implement rules, and to assess the outcomes of management measures. We use descriptions of ownership as the property rights regimes that explain the relationships between actors with natural resources (Bromley *et al.* 1992). The different regimes of property rights reflect the decision-making process between community users and institutions (Agrawal and Ostrom 2001). We adopt the concept of a bundle of property rights (Schlager and Ostrom 1992) to examine how they are distributed in five operational-level rights (access, withdrawal, management, exclusion, and alienation). Complementing the bundle of property rights, we use the bundle of powers (Ribot and Peluso 2003) embodied in various mechanisms and social relations to assess people's ability to benefit from fisheries. Inside the domain of power, accountability reflects the control community association have over fishery resources.

We use descriptions of accountability as a set of mechanisms designed to make sure rules are implemented and performance is monitored (Weber 2003). In this article, the characteristics of control and collective goals that emerge are used as patterns for qualitatively evaluating the degree of responsiveness assumed to communities. Finally, an evidence-based approach was assessed based on the level of interaction between community users and technical advisory personnel, and the implementation of local monitoring systems.

Field data were collected through a review of the case studies related to fisheries management in the state of Acre (Figure 1). Data collection took place between 2009 and 2015. Semi-structured interviews were performed with community members and external agricultural extensionists (a 30-day field trip in each case study). The questions covered in the interview were: Are communities deciding on the management of fisheries? Who has ownership of the fisheries resource? What is the role of government agencies? What is the level of participation (and decision-making) by the communities over management measures? Are management measures being monitored? Do the monitoring data feedback management measures? Who is enforcing management measures? Do the benefits reach the community? What are the accountability mechanisms of fisheries management? Are the community association and/or government agencies) accountable to the people affected by their activities? A total of 129 interviews were conducted.

A standard narrative guides case description to facilitate interviews transcription and expressions identification. Qualitative data analysis software MaxQDA was used to manage and code transcribed interviews (Verbi 2017). Thanks to the use of tools for text exploration (i.e. counting, coding, word frequencies), we composed a lexical of categories. The analysis of the emerging categories led to the identification of outcomes of social rules (Geertz 1989) which supported the description of the community-based management schemes. These categories can be grouped as domains of community-based management of fisheries (i.e. ownership, responsiveness, accountability and perceived evidence), which repeatedly came up as important to the respondents. For quantitative analysis, the lexical presents a classification scheme based on which the frequency of categories is determined.

Between 2014 and 2015, a 3-day workshop was held in each case study involving around fifteen fishers and government agents to set and assign outcomes (improvement, partial improvement, no change and decline) for each domain of community-based management of fisheries for the periods before and after the management system. All the participants composed a group involved from the beginning in the management system and built a procedure to reach consensus for each domain assignment (Van den Hove, 2006). As divergence occurred during the value assignment, the participants applied unlimited rounds of negotiation to reach consensus.

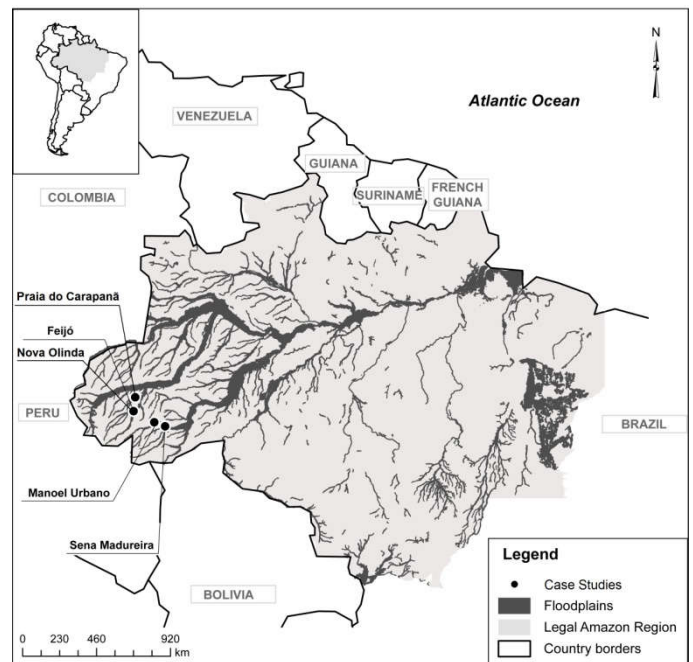


Figure 1 Case studies in the state of Acre, Brazilian Amazon

In addition to the interviews and the 3-day workshops, our research considered direct observation (Bogdan 1972) based on notes taken during events (between 3-5 events per case study), such as fishermen's union assembly, municipal fisheries' forum, and community meetings that occurred throughout the compilation of our case studies. Technical reports produced by government agencies and NGOs about each case study were also assessed. A review of relevant fishery policies and norms was undertaken to identify the fishery's legal and institutional framework in each case study.

RESULTS

The management of fisheries in the Amazon have played a central role in the economy and subsistence of rural populations. The intensification of commercial fisheries and government policies, during the 1970s and 1980s, contributed to increased demand for fish and pressure on community lakes. Concerned with the depletion of their fisheries, communities started to pressure the National Environmental Agency (IBAMA), during the 1980s and early 1990s, to block commercial fisheries and negotiate fishing rules. IBAMA's ordinance 29/2003 acknowledged community-based of fisheries and opened the way for their integration into the formal regulatory structure. By the early 2000s IBAMA's co-management policy was fully operational with numerous regulated fishing agreements in the Brazilian Amazon.

Since 2017, fisheries management policy is shared between the Ministry of Environment and the Ministry of Agriculture and Livestock. The federal Law 140/2011 specified that the rights to regulate fisheries in the state domain belong to the state government which can exert them or grant them to local institutions. The fishery state Law (i.e. Acre's Normative Regulation 08/2015) and the resulting Administrative Decrees (i.e. Acre's Administrative Decree 53/2015) regulate fishing agreements. Additionally, the management of fisheries inside Indigenous Lands (ILs) is coordinated by the National Indian Foundation (FUNAI). In the case of *Arapaima gigas* management, policies for harvest season, minimum size, and total moratoria have been established in Acre state (IBAMA

Administrative Decree 01/2008, IMAC Administrative Decree 198-199/2008 and 53/2015). The regulation and enforcement, both in community areas of fishing agreements and ILs, are under responsibility of the state (i.e. Acre Institute of Environment - IMAC) and federal (i.e. IBAMA) government. Table 1 presents a summary of the results of the community-based management of fisheries in the case studies.

Ownership

In Sena Madureira, Manoel Urbano and Feijó, a set of fishing agreements are coordinated by the Municipal Fishermen’s Union, and in Nova Olinda two other lakes are co-managed with the Kaxinawá indigenous communities, where the major objectives are to manage *arapaima* (except in Sena Madureira), reduce overharvesting and provide greater benefits to local users. Community meetings and municipal forums (inter-organizational arena involving government agencies, local institutions, community associations and residents) are mechanisms for debating and taking decisions about the right of ownership over access and use of fishery resources. The resulting versions of fishing agreements are approved and published by the state government (IMAC).

a set of rules established by riverside communities in order to define access to and forms of use of the fishing resource in a specific region” (IBAMA 2003). However, respondents from Sena Madureira and Manoel Urbanoreport that the conflicts with outsiders continue in a similar pattern to the period before the creation of the fishing agreements. In these two case studies 79% of fishermen do not feel secure with the right of ownership over fishery resources. They have reported that fishing agreements were published but enforcement was reduced because state government considered that fishermen would take-over of the inspection of lakes. In ILs (Nova Olinda and Praia do Carapanã) users decide upon management rules, within legal limits, based on a management plan regulated by the federal government (FUNAI).

Indigenous Land is a portion of the national territory, owned by the Union, inhabited by indigenous communities, which develop their productive activities for social and cultural reproduction. This specific type of land tenure reflects an original and collective nature.

Table 1 Summary of case studies.

| Kaxinawá Nova Olinda Indigenous Land | Kaxinawá Praia do Carapanã Indigenous Land | Municipality of Sena Madureira | Municipality of Manoel Urbano | Municipality of Feijó |
|------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Communities sampled | | | | |
| Formoso and Nova Olinda | Água Viva, Mucuripi, Povo Junto, Carapanã, Goiana, Nova Vida, Segredo do Artesão, Morada Nova and Cocameira | Mariomba, Bom Jesus and São José | Lago Novo, Santo Antonio, Lago Grande, Santarém and Bela Vista | Extrema, Cancão, Pedro Paiva, Santa Julia, Sacado, Mucuripe Velho, Sabiaguaba, Porto Rubim and Santa Julia |
| Number of fishermen | | | | |
| 93 | 113 | 89 | 120 | 165 |
| Number of interviewees (community members and external agents) | | | | |
| 14 | 15 | 35 | 21 | 44 |
| Size of the community management area (hectares) | | | | |
| 501,3 | 400,7 | 130,4 | 232,8 | 481,4 |
| Production systems | | | | |
| Household family farming, complemented with raising small animals, fishing, extractivism and hunting. | Household family farming, complemented with raising small animals, fishing, extractivism and hunting. | Household family farming, complemented with raising small animals, cattle ranching, extractivism, fishing and hunting. | Household family farming, complemented with raising small animals, cattle ranching, extractivism, fishing and hunting. | Household family farming, complemented with raising small animals, cattle ranching, extractivism, fishing and hunting. |
| Fishery production (estimated by respondents) | | | | |
| Annual catch: 15ton year ⁻¹ (multispecies fishery) <i>Arapaima</i> annual catch: 670 kg year ⁻¹ | Annual catch: 23 ton year ⁻¹ (multispecies fishery) | Annual catch: 8 ton year ⁻¹ (multispecies fishery) | Annual catch: 17 ton year ⁻¹ (multispecies fishery) <i>Arapaima</i> annual catch: 2 tonyear ⁻¹ | Annual catch: 35 ton year ⁻¹ (multispecies fishery) <i>Arapaima</i> annual catch: 2.5 tonyear ⁻¹ |
| Communal or individual ownership/use | | | | |
| Communal use, artisanal fishermen, Indigenous Land set aside for communities with exclusive rights over fisheries (access, harvest, management, exclusion) | Communal use, artisanal fishermen, Indigenous Land set aside for communities with exclusive rights over fisheries (access, harvest, management, exclusion) | Smallholder use (public land - floodplains), artisanal and commercial fishermen (local market). Clear property rights over access and harvest; limited rights over management; and no exclusive rights of fisheries | Smallholder use (public land - floodplains), artisanal and commercial fishermen (local market). Clear property rights over access and harvest; limited rights over management; and no exclusive rights of fisheries | Smallholder use (public land - floodplains), artisanal and commercial fishermen (local market). Clear property rights over access and harvest; limited rights over management; and no exclusive rights of fisheries |
| Management model | | | | |
| Ethnozoning with four managed lakes, government regulation for <i>arapaima</i> fishery | Ethnozoning with nine managed lakes | Two fishing agreements with three managed lakes | Three fishing agreements with five managed lakes, government regulation for <i>arapaima</i> fishery | Six fishing agreements with six managed lakes, government regulation for <i>arapaima</i> fishery |
| When the management system was started | | | | |
| 2011 | 2013 | 2003 | 2003 | 2010 |
| Social organization | | | | |
| Leaders from communities of Nova Olinda and Formoso, Kaxinawá Association of Formoso Community, and community data collectors (02 fishers) | Association of Kaxinawá Producers of Praia Carapanã (ASKRA), community group of lake assessment | Sena Madureira Municipal Fishers’ Union | Manoel Urbano Municipal Fishers’ Union, <i>Arapaima</i> Fishers’ Association | Feijó Municipal Fishers’ Union, community working group for <i>arapaima</i> management and community data collectors (06 fishers) |
| External agent introducing initiative | | | | |
| National Indian Foundation (FUNAI), Special Secretariat of Indigenous Health (SESAI), Feijó Municipal Fishers’ Union and NGO | National Indian Foundation (FUNAI), Special Secretariat of Indigenous Health (SESAI) and NGO | State government (SEAPROF) and NGO | State government (SEAPROF), National Environmental Agency (IBAMA) and NGO | State government (SEAPROF), National Environmental Agency (IBAMA) and NGO |

Fishing agreements are defined as “a set of specific norms, resulting from consensus agreements among the users of fishing resources found in a certain geographical area, or [...]

rights are imprescriptible. Indigenous communities have gained the power to develop management rules for the

fisheries within their boundaries, to decide whether or not artisanal exploitation would take place, and to zone protection and subsistence lakes. 100% of respondents from ILs recognize their land tenure and ownership over fisheries resources.

Responsiveness

The members of the Fishermen's Union in the municipalities of Feijó, attending formal meetings, can propose rules and annual fishing quota to be approved by the state government. The board of the municipal Fishermen's Union and state government agents coordinate a minimal agenda of community meetings to discuss issues related to fishing. 55% of respondents were unaware of those meetings and discussions about fishing agreements, and when asked about the content of these agreements, 72% of respondents reported current rules involving managed lakes. More than 80% of respondents reported the absence of conflicts, both internal conflicts (among residents) and conflicts with outsiders.

However, several suggestions were reported to improve the management schemes (i.e. lake patrolling, improvement of community participation, accountability and revision of benefitsharing rules).

Regarding the *arapaima* management, income from fish sales is divided among members of management groups and community members, according to their contribution to collective actions. In Manoel Urbano, internal conflicts between the two community associations (municipal fishermen's union and *arapaima* fishermen's association) undermine the participatory and decision-making processes for collective goals. Community residents in managed lakes have been excluded as key players in the management plan of *arapaima* by neglecting their local knowledge and social practices. State government agents did not align with local management priorities, as the state's emphasis was aquaculture, while local users wanted to manage natural lakes (Table 1). Therefore, Manoel Urbano experienced a decline of *arapaima* stocks, due to the lack of enforcement of management rules. 60% of respondents reported a lower level of participation (and decision-making) from communities over management measures, and 69% reported that benefits do not reach the community.

In Nova Olinda and Praia do Carapanã, state and federal governments discuss management proposals with indigenous communities based on a process of broad debate and prior consent. An important rule observed in ILs is that sharing information and debating on fisheries issues must necessarily occur in all communities inside IL, prior to their implementation. Community leaders indicate focal persons in each community to monitor activities and relationships with external institutions. Indigenous communities are in charge of enforcement, but the actual legitimacy of this role depends on government support, especially financial resources for logistics and equipment costs. Regarding the *arapaima* management in Nova Olinda, income from fish sales is divided among families located in managed lakes.

Government enforcement (including patrolling) is absent in all case studies. However, monitoring the status of the resource is a practice among many community groups (i.e. Feijó and Nova Olinda). The proximity of users to the resource confers an

ability to observe day-to-day changes, either by the community or by selected fishermen.

Accountability

Respondents from Sena Madureira, Manoel Urbano and Feijó reported several mechanisms of accountability, such as municipal forums (78%), community assemblies (64%), benefit sharing of *arapaima* production (36%), and financial reporting of community associations (32%). The municipal Fishermen's Union is responsible for holding one assembly each year with members, mainly to present budgets and hear local concerns. In ILs (Nova Olinda and Praia do Carapanã), the main mechanisms of accountability of indigenous associations (or chiefs) to local users are the community's meetings and benefit sharing in which management rules are constituted and monitored.

In Sena Madureira, Manoel Urbano and Feijó, respondents reported internal conflicts about costs and benefits distribution across all community families because communities have no resources to implement and enforce management rules. This can be observed in Feijó, where fishing agreements established local communities as responsible for patrolling and enforcement. Government agencies have implemented a process for the approval of fishing agreements but have not adequately negotiated the transfer of power and local capacity for law enforcement. Thus, compliance with regulations is limited.

Regarding capacity building, many situations of training or communication of terms and concepts related to management of fisheries occur through simplification of training content (i.e., booklets, short meetings), but such practices are not always effective and lack fine tuning. 58% of respondents from these case studies reported that the training courses involve few fishermen. Only a small sample of the community members receive the materials distributed during the courses. Respondents argue that capacity building should be more continuous, involving young people, and integrating other community issues (i.e. agriculture, education). On the other hand, in ILs (Nova Olinda and Praia do Carapanã) capacity building considers other forms of knowledge and presents high level of participation. All materials and booklets used in the training courses are produced by locals, and the participants organize meetings after the training courses to apply (and disseminate) the practices and concepts discussed.

Perceived evidence

All the case studies presented a selection of management practices based on local ecological knowledge. These practices range from monitoring specific resources to ecologically sophisticated practices that respond to and manage freshwater ecosystems across temporal and spatial scales. In Feijó and Nova Olinda, monitoring systems of fisheries are being implemented and are supporting the adaptive management of fishing rules. A small number of indicators highlights management measures (i.e. number of *arapaima* adults as a reference for annual harvesting quota). Feijó and Nova Olinda implement a monitoring system of multispecies fisheries. Through the use of smartphones, the system supports the *arapaima* annual fishing quotas and legal harvest permits procedures (Oviedo and Bursztyn, 2017). In Sena Madureira and Manoel Urbano, the state government monitored fishing agreements (2003 to 2008), but the results

were not used or shared with the communities, leading to a failure in the use of monitoring data and adaptive management. Since 2009, state government and community associations have stopped data collection of managed lakes. In Praia do Carapanã, there is no monitoring of fish landing data. Community leaders and members are starting an environmental assessment of lakes and creating a management group that will coordinate actions in the future.

DISCUSSION

Table 2 summarizes the results collected with workshop’s participants about the four domains of community-based management of fisheries. It shows that community responsiveness resulted in a decline of fisheries management implemented in Manoel Urbano and Sena Madureira. Both cases also suffer from upward accountability. In Feijó, community responsiveness resulted in partial improvement of fisheries management which was also accompanied by a partial improvement in accountability mechanisms. Responsive communities and adequate ownership only exist in the case of ILs.

In target municipalities (Manoel Urbano, Sena Madureira and Feijó), community associations and Fishermen’s Union have a statutory right to manage fisheries but are not able to enforce that right. In the case of perceived evidences, the research detected improvement when there were more efforts put on the implementation of monitoring actions or adaptive management cycles. The improvements of fisheries management were supported to some degree, according to respondents’ answers emphasizing the importance of (i) capacity building of community users and associations; (ii) clear property rights regimes; (iii) equitable benefit sharing for community users; (iv) funds to cover collective priorities (i.e., community infrastructure, enforcement and accountability mechanisms); (v) engagement with local knowledge and cultural traditions; and (vi) active involvement of community members in different stages of management (project approval, implementation, evaluation and funding).

Table 2 The four domains of community-based management of fisheries.

| Case study | Ownership | Responsiveness | Accountability | Evidence |
|--------------------------------------------|---------------------|---------------------|---------------------|-------------|
| Kaxinawá Nova Olinda Indigenous Land | improvement | improvement | partial improvement | improvement |
| Kaxinawá Praia do Carapanã Indigenous Land | improvement | improvement | partial improvement | no change |
| Municipality of Sena Madureira | partial improvement | decline | decline | decline |
| Municipality of Manoel Urbano | partial improvement | decline | decline | improvement |
| Municipality of Feijó | partial improvement | partial improvement | partial improvement | improvement |

The bundle of property rights transferred to community members, as examined in our case studies, are central to successful ownership. Fisheries management is improved when implemented in communities with clear property rights regimes (Table 1 and 2). Fishermen reported (78%) that clear property rights are positively associated with the attitudes of community members and economic outcomes. Our research confirmed that obtaining access only and withdrawing operational property rights over fisheries may not encourage local fishermen to perceive long-term interests, as reported by Schlager and Ostrom (1992). Without operational property rights that allow effective management, local fishermen can

neither enforce rules nor work toward the improvement of the system.

In Manoel Urbano, internal conflicts (among residents) due to illegal access to fishing have increased as a consequence of the transfer of management rights without financial resources to carry them out, and without accountability mechanisms that would stimulate community associations and Fishermen’s Union to enhance management measures (Table 1). The conflicts between these two community associations (caused by power relations in decision-making, affiliation of new members, leading association) increased due to the lack of arenas for conflict resolution. In this case study, community internal differences negatively influenced the participatory management process. The literature reports there centralization of government ownership in both resource depletion and conflict contexts (Smoke, 2015). The lack of management rights resulted in most respondents (86%) relating the reduction of fish production in Manoel Urbano.

In Feijó and Sena Madureira, fishermen have exercised management by designing rules that define withdrawal rights, but they do not have the authority to decide who can and cannot enter managed lakes. Thereby, without property rights to exclude outsiders, local fishermen fear that any effort made to limit harvesting will benefit others who do not participate in the management system. While agreements specify how and when to fish, they cannot specify who can fish. Brazilian Water Law (Law 9.433/1997) considers all water bodies open to navigation, and this statement confuses two distinct issues: navigational rights and access rights to freshwater resources. Conversely, fishermen of Nova Olinda and Praia do Carapanã have exclusive rights over managed lakes due to legal regulation of ILs (Table 1). Indigenous communities design a series of management rights related to fisheries. The chiefs and community association that plan an ethnozoning system, limiting various types of access and withdrawal rights in distinct lakes, are exercising their fisheries’ management rights (Ostrom and Schlager, 1996) and improving fishing outcomes.

The management of *arapaima* is a promising initiative in the case studies. In this pilot initiative in the state of Acre, management groups were formalized as the municipal Fishermen’s Union and indigenous associations. These formal groups required that community members commit to enforce fishing rules. Thanks to the fishing agreements that users could control the *arapaima* stocks, the management groups are able to negotiate the possibility of legal harvesting with the state government authority (IMAC). IBAMA has banned *arapaima* fishing in the state but has made an exception in management plan cases. The management groups carried out annual *arapaima* assessments and used this ability to ensure ownership of fisheries and to generate information that supports accountability.

In the case studies of Manoel Urbano and Feijó, fishermen obtained good results in recovering *arapaima* stocks (Oviedo and Bursztyn, 2016), but the absence of property rights of exclusion also resulted in high investments in monitoring and surveillance. This was reported by respondents from Manoel Urbano (65%) and Feijó (33%), regarding the presence of illegal *arapaima* fishing by community residents. Since 2009, the state has given priority to an aquaculture program and canceled support for natural lakes management. Coupled with weak enforcement and the illegal market of juvenile *arapaima*

(created by local aquaculture farmers), this situation led to illegal access by community residents and population decline: that is, a reduction of 89.7% between 2009 and 2013 in Manoel Urbano (Oviedo *et al.*, 2015). This legal ambiguity between public policy and local demands allowed individuals to take advantage of different agendas to acquire short-term income returns, as well as not stimulating local users to seek long-term management goals.

However, it is uncertain whether the *arapaima* management is effective in the managed lakes of Manoel Urbano, Feijó and Nova Olinda. The main challenge is the lack of precise data on *arapaima* populations (i.e. number of individuals, clear set of resource boundaries). This challenge was also reported by Barret *et al.* (2001) and Castello (2004). However, it is important to highlight that the fishermen's knowledge provided support to local conditions into fishing agreements, and this principle allows community responsiveness (Crook and Sverrisson 2001). With the incorporation of the *arapaima* counting procedures into the management scheme government agencies were able to perform policies and share power on decision-making (Ribot *et al.*, 2006).

The case studies demonstrate variations of responsiveness that are possible within the three outcomes (i.e., improvement, partial improvement and decline). In the interviews, fishermen participation and commitment (69% of responses) and more equitable benefit sharing (72% of responses) are considered prerequisites to attain primary outcomes through responsiveness. Nova Olinda and Praia do Carapanã illustrate responsive communities. In these cases, considerable powers of decision and rule-making over fisheries management have been transferred to communities (Agrawal and Ribot, 1999).

Governance systems in ILs vary considerably among the different indigenous people that occupied the Amazon region. In Nova Olinda and Praia do Carapanã, indigenous people are actively involved in identifying priority problems, and in planning and the implementation of specific actions (i.e., community mobilization, rehabilitation of target lakes, the formation of a group of managers). The governance system for management of fisheries has a two-tier structure, comprising the community chief and the community representative. In the beginning of management scheme, the community chiefs provide a participatory forum (i.e. process of broad debate and prior consent) for discussing issues of IL importance, and therefore prevents possible conflicts that management scheme may offer. In this paper, examples from these two case studies support the argument that the chiefs can play a positive role in enriching local knowledge and evaluating natural resource management as they review the laws relating to their property rights, and they elect the community representatives who will coordinate management schemes. It is important to note that the implementation of fishing agreements and management schemes in ILs are a hybrid of a decentralized model of fishery policy and a more centralized decision-making model.

On the other hand, Sena Madureira suffer critical problems regarding internal conflict resolution and patrolling, which undermine community responsiveness. The lack of access to power and non-occurrence of inter-community meetings enhances a significant limitation in the process of defining collective goals. The fishing agreements were defined top-down (with a strong imposition of the state government) since the regulation of these agreements community associations and

users presented a low degree of participation. If those fishing agreements reflect only the needs of some community members, the management rules reflect an imposition rather than a support (Ribot 2002).

In Sena Madureira, Manoel Urbano, and Feijó, members of the municipal Fishermen's Union are elected as individuals (not as community representatives). Government agencies regulate how much power control the municipal Fishermen's Union has over management activity, and this procedure limits accountability. Furthermore, the state government imposes limits on the municipal Fishermen's Union, as it nominates government officials who somehow control their autonomous powers. In these case studies, a government official who goes into an area for a day or two and speaks to a few fishermen is meant to be conducting participatory management. Further, community leaders and the board of the municipal Fishermen's Union are more accountable to government agencies and NGOs (e.g., progress reports, meetings, budget planning and reporting). These participatory approaches tend to control communities instead of empowering them. This rhetoric of participation was also reported by Ribot (1999) and Moon *et al.* (2017).

In Nova Olinda and Praia do Carapanã, some accountability mechanisms exist, such as prior consent protocol, community assemblies and budget reporting. Community associations have developed partnerships with federal and state government administrations around thematic projects ranging from *arapaima* management (stock-assessment, fishing quotas and harvest permits) to agroforestry production (traditional land-use systems where trees are managed together with crops and/or animal production systems). These projects have implemented values, such as the allocation of natural resources, infrastructure of local projects, financial planning and mechanisms of social control. This reflects the appropriate balance of these partnerships (Nelson and Agrawal 2008). Transaction costs are incurred in the implementation of project activities, such as costs associated to stock-assessment (data collection), costs required to community meetings and enforcement costs. Low levels of transaction costs as observed in ILs can increase the efficiency of the management scheme (Shahab *et al.*, 2018) and responsiveness (Crook and Sverrisson 2001).

Some of the complexities involved in the interaction of government agencies with community associations are explored in the case studies of Manoel Urbano and Feijó, which illustrate how the understanding of different forms of knowledge, power relations, and values are central to the analysis of fisheries management. The two community *arapaima* fishermen's groups were organized, as state initiatives, under a single unit for the goals of species management, following new legal regulations that called for the creation of management plans. Although each of the fishermen attributed a different meaning to their participation in the management scheme, and to the benefits they derived from it, their interests converged at certain points, addressing issues relating not only to the management itself but to community strategies. Thus, the management scheme comprised shared as well as conflicting definitions by the group members, involving issues such as size of the group, the definition of annual fishing quotas, and the relations they assumed with external institutions (i.e., government agencies and NGOs). They contested the ideas of government officials

who pressed them to expand their management area and enter into the state aquaculture business. However, during the process of interaction with government agencies and other users from the communities, the boundaries of the project (including the annual fishing quota) and their roles as managers were constantly redefined.

Another outcome reported by Manoel Urbano respondents is that when the state government removed its support of the management activities in 2008, community associations showed limitations in coordinating meetings for planning and benefit sharing. This result shows that state government's policy implementation is based on the leadership of its government officials (Moon *et al.* 2017), and it does not provide the capacity building of community associations and community leaders. With this, the decentralization proposal of fisheries, as envisaged in state legislation (i.e. fishing agreements), is limited because the strengthening of management skills and financial sustainability of community associations are not addressed.

The case studies of Nova Olinda, Manoel Urbano, and Feijó, demonstrate how validated access to knowledge can be applied to restore *arapaima* fisheries, particularly when a treaty exists (Ribot and Peluso 2003). Local data from fisheries management can be used by community associations and local institutions in meetings and participatory decision-making processes for management rules. The incorporation of perceived evidences into the fishing agreements (i.e. fish landing data and harvest level) permitted a more effective policy performance and decision-making process (Hockings *et al.* 2006).

In Feijó, evidence emerges as a result of the interaction and dialogue between different actors (i.e., fishermen, government officials and researchers) and networks of actors (i.e., community associations, research institutions), where they are actively involved in knowledge generation. As a leader from Feijó's Municipal Fishermen's Union reported, there was positive impact on *arapaima* production, where sustainable harvests have remained stable between 2012 and 2015. In Manoel Urbano, local monitoring supported the revision of fishing agreements (administrative decrees regulated in 2005), which were updated in 2008. On the other hand, in Sena Madureira, although the state government invested in a monitoring system between 2003 and 2008, the results were not shared with the fishermen, and the revision of fishing rules did not occur. As a consequence, the monitoring system was discontinued. The superficial participation, as reported by 88% of fishermen from Sena Madureira, does not address the interaction between local users and extensionists knowledge.

Respondents identified practices that provide evidences or other benefits, encouraging community users to improve fisheries management (i.e. benefit sharing, monitoring resource abundance and change, monitoring aquatic vegetation, protection of specific habitats, temporal restrictions of harvest, and meetings for fishing agreements' revision). These results comply with other studies (Berkes *et al.* 2000; Castello 2004) related to the use of local information to respond and manage ecological processes.

Many of the practices and evidence-based approaches recorded in the case studies are generally consistent with adaptive management (Berkes *et al.* 2000; Margoulis and Salafsky 1998). It is adaptive because it recognizes environmental

changes, requiring community users and site-specific knowledge to respond by adjusting management measures. In this sense, adaptive management may be viewed as the best framework for policy implementation because it includes community assessments as a requirement to obtain the annual authorizations for fishing and marketing of *arapaima*.

CONCLUSION

The design and management of fishery resources should consider a more consistent and effective involvement of those who are the target of such processes. Designing should not be a pre-defined path, but a process of adaptation. Thus, for improvement in fisheries management, it is important to foster more flexibility among community users, reducing tension and increasing dialogue during the different stages of the project. Regarding the process of engagement with local knowledge, the challenge for external institutions is to present scientific terms and concepts that make sense to local users. The adaptive management of connected knowledge systems improves when external agents (i.e. government officials) and fishermen or other community associations work together to solve specific management problems. Some case studies presented in this article represent examples of this collaboration.

Advocacy of simplistic model of extension is unable to account for the full range of social-ecological and cultural forces at work in the interaction of contrasting forms of knowledge. This means that local initiatives should not be regarded as "models" to be calibrated and then replicated elsewhere, but each one a case in itself. Unlike the usual practices of governments, development agencies, and NGOs, the improvement of community-based management is related to the assumption that tools and incentives to be provided must be tailor-made (constructed from the bottom-up). There is no generic solution, but rather specific procedures.

Governmental fisheries policies and their participatory processes can play a useful role if they facilitate the development of conflict resolution procedures and ensure legal enforcement for the fishing agreements. Management improvement is most likely to occur when communities participate in management measures design, establishment, daily management, monitoring and evaluation. Our case studies show the importance of management outcomes that include capacity building of community users, community associations and local institutions; clear property rights regimes; equitable benefit sharing; and engagement with local knowledge and cultural traditions.

The case studies suggest that balancing these outcomes can enhance the domains of ownership, responsiveness, accountability and perceived evidence, and lead to improvements in fisheries management, beyond the participatory approach. Efficient management depends on a commitment from the external institutions to devolve rights and responsibilities.

This comparative qualitative evaluation reveals findings about the importance of community characteristics in participatory management approaches. We highlight that proposed domains of community-based management of fisheries are critical to understanding the dynamics at the community level that can affect management outcomes. Future research can address important questions about mechanisms underlying outcomes, interactions among key features that affect the four domains of

community-based management of fisheries, conditions under which community participation is appropriate and sufficient, and procedures to achieving a higher level of participation.

The participatory approach has followed an agenda centered on structure organization determined by controlling forces, and this entails a hierarchical (and unbalanced) pattern. The beyond participatory management, by contrast, concentrates on the users and community characteristics. It involves a system centered on adaptive management and relations of power. Those wishing to move beyond participatory management can accept the definition of local users and external agents but must believe that they will be fulfilled in practice only when all actors consider development as a transaction process involving negotiation over divergent goals.

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