

Polycentric governance and collective action in socio-biodiversity value chains in the Amazon

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Abstract

There are complex social dilemmas involved in the governance of common property resources. In this sense, a series of theories have been developed to explain these dilemmas and propose solutions. For this analysis, we used the theory of polycentric governance with the objective of understanding how collective action are articulated in value chains of socio-biodiversity products in the Amazon. We use a qualitative approach, through in-depth interviews with the main actors in the chain, focusing on the case of *Arapaima gigas* sustainable management in the state of Amazonas. We have verified that this process emerges from self-organized groups within communities, which come together to manage the resource and ensure its reproduction continuity. Rules are defined by the members of the collective action, based on a relationship of trust and cooperation among members. Management stages involve a combination of technology and traditional knowledge. Several organizations are involved in institutional multi-layers to create horizontal governance arrangements that act on *Arapaima gigas* value chain. This management strategy has been generating positive results, improving aspects related to supply, prices, commercialization, producers' income, and improvement of human well-being in these communities.

Key words: Collective action; Pirarucu; *Arapaima gigas*; Polycentric Governance; Value Chains; Amazon.

1 Introduction

Amazon socio-biodiversity products' value chains extensively involve common property resources, which demand specific governance arrangements centred on collective action that contribute to such chains' performance improvement (de Carvalho Reis Neves et al., 2019). A series of research papers and case studies analyzing collective action' importance is available, mainly focusing on the establishment of producers' associations and cooperatives in the regions where socio-biodiversity products are cultivated (Cammelli et al., 2019; Castro et al., 2015; Costa et al., 2020; Futemma et al., 2020; Silva et al., 2019). Nonetheless, there is a research gap around the role and importance of meso-institutions – organizations acting as the interface between macro-institutions (regulations) and micro-institutions – in this process. After all, why

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is that some collective actions are successful while others are not? Our hypothesis is that meso-institutions have a relevant part in this process.

Reflecting upon this question, this study concentrates on pirarucu (*Arapaima gigas*) value chain. Pirarucu is a fish natural from the Amazon and Tocantins-Araguaia basin, which is important for the preservation of ecosystems involving the region lakes, as well as for the communities making their livings from the species fishery (Governo do Amazonas, 2021). In the mid-1970s, pirarucu was endangered due to over-exploitation, and this has led to the implementation of restrictive measures and ultimately to the prohibition of the species fishery in the Amazonas State in 1996³, exceptions only in duly licensed Management and cultivation areas (Arantes et al., 2010; Gonçalves et al., 2018). In the early 2000s, a few management and Management measures started to be implemented, focusing on sustainable pirarucu exploitation (Gonçalves et al., 2018; Hora, 2020), gathering stronger communities' involvement and evidencing collective action and more relevant participation of meso-institutions.

Trailing that path, this article seeks to answer the following question: How collective action are articulated in Amazon socio-biodiversity products' value chains? To answer that question, we analyze the pirarucu value chain in the State of Amazonas, as the species is representative of the region socio-biodiversity.

The study is based on the logic of collective action, on the polycentric governance theory, and on the new institutional economy. Specifically, we approach meso-institutions aiming at analyzing horizontal governance arrangements touching common goods in Amazonas State pirarucu value chain (Ménard, 2014, 2018; Ostrom, 1990, 2010, 2020). Moreover, we seek to understand factors that contribute to this chain's sustainability, including the institutional environment in which those actions are being carried out, the key actors involved in the articulation of collective action, and how rules are defined by the groups taking part in Management.

The relevance of this issue is evidenced by the discoveries of empiric studies warning about the ineffectiveness of policies centered in the existence of common resources. Such studies highlight the importance of adjusting institutional rules to a specific socio-ecologic environment, and this involves the study of factors that foster or hinder the rise and robustness of self-organized efforts in multi-level polycentric systems (Ostrom, 2010). Thus, we infer that the implementation of these rules will be better if a facilitator (meso-institutions) that allows it to happen at a lower transaction cost is present. Meso-institutions may have the role of

³ Ibama Ordinance no. 8/96.

translating, monitoring, enforcing, and incentivizing (see Ménard, 2018). Here we shed light on how this facilitator uses a negotiated translation to enable expectations and interests alignment to the implementation of collective action in pirarucu chain.

Our proposition is that collective action implemented in pirarucu Management through self-organized groups – in which meso-institutions play, beyond their incentive and rule translation duty, a role in chain coordination – bring better results in terms of equal income distribution and well-being for involved communities.

The remainder of the paper is organized as follows: Section 2 describes collective action, polycentric governance, and the importance and functions of meso-institutions. Section 3 depicts pirarucu value chain. Section 4 details the study area and methodology. Section 5 reports main results from the analysis of the interviews carried out with actors and meso-institutions involved in the chain. Finally, Section 6 concludes the paper and provides policy implications.

2 Collective action, Polycentric Governance, and meso-institutions

There are complex social dilemmas involved in the governance of common property resources, requiring a detailed study on the difficulties involving said dilemmas. It can be said that this concern was first expressed by Gordon (1954) and Scott (1955), who studied the over-exploitation of fishery resources. Hardin (1968) followed, when proposing the greatly spread “Tragedy of the Commons” concept, bringing attention to the indiscriminate use of finite resources as if they were infinite while trying to maximize individuals’ benefits. For the author, this was a human problem pertaining to the “class of problems with no technical solution.”

Gordon (1954) suggested the implementation of mechanisms for protecting and regulating common property resources as means to minimize the effects of this exploitation with no impact awareness. Later on, theories developed along this path have pointed private control through clear property rights definition (Sinn, 1984; Smith, 1981), or through public governance (Carruthers & Stone, 1981) as a solution. However, defining property rights of non-static goods and common property goods, like water or fishery proceeds, is a complex task (Ostrom, 1990a).

In this direction, Elinor Ostrom proposes the collective action of self-organized groups as an essential part of the solution for problems arising from complex social dilemmas, as those involving the use of common property resources. In her research she sustains that, on top of the difficulty of establishing private property rights over common property goods, a government

that proposes one-size-fits-all policies, applicable to anyone regardless of the context, may not be the most efficient alternative in those cases (Ostrom, 2009; Skjølsvold, 2010).

Nevertheless, when dealing with collective action there is a core issue that seeks to explain why individuals engage in groups and choose to cooperate, even while facing a series of social dilemmas. In Olson's (1965) vision, the logic behind collective action lays on the disjunction between individual and collective rationalities. That is, from the collective rationality point-of-view, the ideal situation is the one in which all individuals cooperate, bringing bigger gains to the group. On the other hand, from the individual rationality point-of-view, even with some benefits coming from cooperating at minimum cost, the individual acting rationally, might choose not to cooperate in some cases, particularly when the use of goods is granted to them, regardless of their contribution to such good provision.

In this way, when dealing with goods whose characteristics are not appropriable – that is, it is not possible to distinguish those contributing to the provision from those who do not contribute – and the bigger the group, the bigger are the incentives to desertion. Under these conditions the “free rider” and “rent seeker” (who appropriates the income) characters emerge. Facing this dilemma, as a way to solve this problem, Olson (1965) suggests that members decide whether they will or will not contribute to the common good's provision: negative selective incentives (coercion) should be offered to non-cooperating members, or positive selective incentives (material or symbolic rewards) should be given to the ones who choose to contribute.

With a singular eye on collective action, Elinor Ostrom has developed her polycentric governance theory observing the fact that collective action involves complex social dilemmas that might not get untangled by incentives (positive or negative) for individuals to decide to cooperate, as proposed by Olson (1965). Notwithstanding, it involves a whole institutional apparatus which shapes human behavior, understanding that individuals are limitedly rational and, in many situations, apply basic rules – heuristics – learned by them over time and relatively functional within a given environment. Thus, Ostrom aimed at identifying a set of rules that worked in different ecological, social, and economic environments, but found out that specific rules associated to success or failure broadly varied among settings.

According to Ostrom (2010, p.13), there are no specific rules determining the success or failure of a given organization that had been developed by users of a common resource. Nonetheless, she lists a series of principles – that she labeled as “design principles⁴” – which

⁴ Updated list developed by Michael Cox, Gwen Arnold and Sergio Villamayor-Tomás (2009).

may be seen in self-organized institutions that endure over time. They are: 1A. User Boundaries; 1B. Resource Boundaries; 2A. Congruence with Local Conditions; 2B. Appropriation and Provision; 3. Collective Choice Arrangements; 4A. Monitoring Users; 4B. Monitoring the Resource; 5. Graduated Sanctions; 6. Conflict Resolution Mechanisms; 7. Minimal Recognition of Rights; 8. Nested Enterprises. These principles are an attempt of summarizing the key factors – identified in the analyzed empirical studies – that affect the long-term survival chances of robust institutions developed by the users of a resource amid their self-organizing efforts.

Ostrom also presents a structure, developed along other scholars, named by her as Institutional Analysis and Development (IAD), to enable researchers to analyze systems that consist of a group of variables. Each of those variables, in their turn, can be unpacked multiple times, depending on the issue at hand (Ostrom, 1990, 2005, 2010). In the IAD structure center lays the concept of an action situation that is affected by external variables, as illustrated by Figure 1.

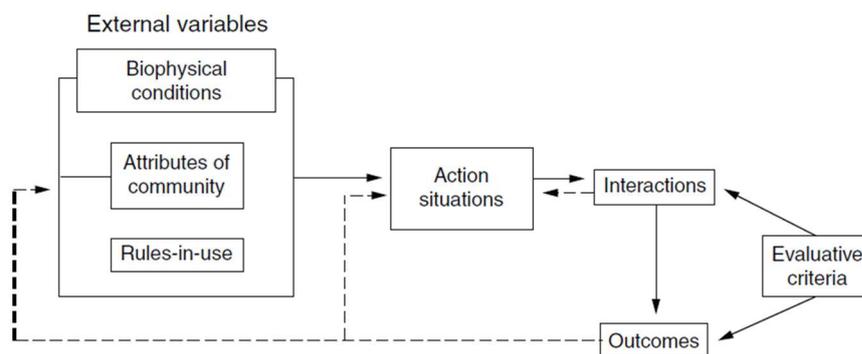


Figure 1 – IAD Framework

Source: Ostrom, 2005, 2010.

The broad categories of external factors affecting an action situation on a given moment include: (i) *Biophysical conditions*, which in some analyses are narrowed down to one of the four good types – common property, public, club, or private goods; (ii) *Community attributes*, which may include the previous interactions record, internal homogeneity, or key-attributes heterogeneity, and the knowledge and social capital of those who may participate or be affected by others; (iii) *Rules-in-use*, which specify the agreements made by the members, and may evolve over time as they interact to change rules in a collective choice or a constitutional choice configuration.

As pointed out by Ostrom (2010), the set of external variables impacts an action situation to generate interaction patterns and results that are assessed by the participants in that

situation (and, potentially, by scholars), and retro-feeds both external variables and action situation. On its turn, the action situation represents the arena in which individuals interact on their own, or as organizations' agents focusing on results for themselves or for the communities to which they belong. Nevertheless, there is complexity in this process, as such interactions happen in a context embedded in social dilemmas and biophysical restrictions (McGinnis & Ostrom, 2014).

This framework has served as foundation for several empiric studies carried out around the world, to show there are “bottom-up” actions that are effective in common resources management, as well as to identify the key factors or variables contributing to the robustness of collective action and, hence, of polycentric governance. Moreover, the structure has inspired the proposition of broader models, specially from the understanding that, in a common resource context, individuals deal with a bigger number of variables. Thus, the author proposed the social-ecological system (SES) framework to connect IAD and its interactions and results at micro-level, to a broader set of variables observed in the field (Ostrom, 2010) – with structures on second and third layers – to enable more detailed analyses of the assessed systems in different contexts, as thoroughly described by McGinnis & Ostrom (2014). SES works as a diagnostic tool, offering precise guidelines on how to evaluate social and ecological dimensions that contribute to resources sustainable use and management (McCord et al., 2017; Van Laerhoven & Barnes, 2014).

Throughout the development of her theory, Ostrom highlights the importance of the institutional environment and stresses that one-size-fits-all, top-bottom established policies, may not work for the whole context, as institutional rules must be adjusted to each specific socio-ecological environment, considering its idiosyncrasies. Building on that, we call attention to the relevance of meso-institutions in this process, as they are the organizations that will provide the connection between the general rules governing the institutional environment and influencing socio-economic activities (in this case, common resources use and management), and the actors that operate under said rules (Ménard, 2018).

Meso-institutions, therefore, work as an intermediary layer, a bridge of the sorts between macro- and micro-institutions, and they have as duties translating rules, implementing them, monitoring them, and fostering their propagation among the actors who are affected in this context (Ménard, 2014, 2018). Placed like this, they represent an important piece in the “institutional puzzle” that shapes the value chain governance, particularly within a socio-ecological environment that involves community-nature embeddedness. Moreover, there is empirical research showing that meso-institutions can positively impact actors' performance,

as well as explain heterogeneous results of public policy application (de Mello Brandão Vinholis et al., 2021; Ménard, 2014; Ménard et al., 2022). That is the reason for which we sustain that it is important to add meso-institutions' role into IAD framework and SES proposed by Ostrom and her followers.

3 Pirarucu Value Chain in the Amazon

Pirarucu (*Aparaima gigas*) is one of the biggest freshwater fish in the world, reaching up to 200 kg and over 2 meters length. The species is an important source of food in the Brazilian Amazon region, and its consumption is considered a local tradition (Alvarenga, 2018; Mesquita, 2017).

Pirarucu value chain is formed by several processes and arrangements and, specifically in Amazonas State, mostly includes people living on floodplain along with Solimões River, working on artisanal fishery, involved in the community mobilization for the species Management. The artisanal chain generates financial resources for local communities and contributes to the land-use planning (Tomasi, 2016).

This is reiterated when observing the whole fishery chain in the region. According to Hora (2020), fishery value chain in Amazon has developed onto two major models: (1) Technocrat Model, based on scientific Management, concentrated in the State Government, who conducts research on the resource at hand, establishes rules, controls and monitors consonant to a given sustainability criterion; and (2) Co-Management Model, which presents some de-centralization, involving local communities or fishermen groups alongside government, scientists, and non-governmental organizations, integrating local/traditional knowledge to scientific knowledge in the natural resources sustainable management. The latter may be seen as a polycentric governance system and includes the pirarucu chain portrayed in this paper.

In general, pirarucu fishery value chain in Amazon State is mostly formed by small producers, fishermen living alongside the Solimões River. Therefore, the adopted model is the co-Management. This model was fostered by the intensification of fishery activity as the “local fishery agreements” were recognized as a legitimate in legal reserve areas. From that point, floodplain communities started to control lakes adjacent to large rivers through a sustainable Management process involving the following stages: organize, establish zones, protect, count, fish, sell, and evaluate (Hora, 2020; Tomasi, 2016).

In the process of co-Management, the community collectively sets up rules concerning fishery quotas, users' participation in the Management, monitoring, and inspection activities, as well as the proceeds sharing and applicable sanctions to inhibit opportunistic behavior. The State Government is responsible for strengthening rules application inspections and approving requests for fishery quotas submitted by communities according to the yearly plan, always considering the closed season (pirarucu reproductive period, in which fishermen are forbidden to work, and gets financial compensation: the closure insurance⁵) established in 2004 by Normative Instruction no. 34 (Hora, 2020). Analysis and authorization are performed by the responsible environmental agency, the Brazilian Institute for the Environment and Renewable Natural Resources (IBAMA, in the Portuguese acronym)⁶.

Prices throughout the chain are arbitrated by the market, as a result of demand-supply equilibrium. As the demand for pirarucu is low compared to other chains – like açaí and Brazil nuts – there is a latent difficulty in finding buyers, and each harvest period requires intensive work in the search for potential customers (Tomasi, 2016). This chain presents, therefore, an important idiosyncrasy: the middleman. Given the difficulties in logistics and commercialization, particularly within Amazonas State, some of the producers opt for selling their harvest to middlemen at much lower prices compared to what associations or meatpackers in the region would pay, harming communities' income (Silva et al., 2021).

According to Tomasi (2016), there is a series of limitations in the pirarucu chain when it comes to search for buyers. Among them, the most important are the organization for collective selling (scale gain that raises the selling price), processing structure (value adding), lack of product awareness by the general public (advertising and marketing), low price compared to other chains (like Brazil nuts and açaí). Thus, understanding the pirarucu value chain dynamics under the light of its mentioned frailties and/or hinderances is key to identify and propose alternatives that contribute to the collective action' robustness and consequently the strengthening of the chain.

⁵ Closure insurance is a benefit paid to the artisanal fishermen as means to guarantee income during the *piracema* (spawning) period, in which they cannot work. The monthly amount paid is the equivalent to a minimum wage R\$ 1.045,00 (around US\$ 202.13). The closure period in Amazonas is December to March.

⁶ Ibama is the institution that grants environmental licenses, assesses environmental quality control, authorizes natural resources use, and performs environmental inspections, monitoring and control.

4 Study area and Methodology

4.1 Study Area

The study focuses on Amazonas State, a Federation unit that, despite counting on huge biodiversity, abundant natural resources, and a Human Development Index (HDI) that is considered high (at 0.733), sits on the second position in household per capita income inequality when compared to Legal Amazon States⁷, displaying a Gini coefficient at 0.568, behind only Roraima.

Amazonas State is an example of successful pirarucu Management implementation in Brazil, despite the series of hinderances for the proper chain function in the State. In 2020⁸, the State has produced around 2.426.729 kg of processed pirarucu, coming from 50,749 individual capturings (Conab, 2022).

We have chosen to work on a section of the study area to delimit the analysis. To this aim, we have selected the region of Mamirauá Sustainable Development Reserve (RDSM, in the Portuguese acronym), the first one to implement pirarucu Management in the State. The Reserve is bordered by Solimões, Japurá, and Auati-Paraná rivers, and occupies a 1.124.000 ha area. Its major environmental characteristic is the great water level variation throughout the year: the level can go ten to twelve meters up during flood season, which grants it the floodplain classification (Amaral et al., 2011).

We visited some places during field work. The itinerary included State Capital Manaus, Tefé and Fonte Boa municipalities, on top of the São Francisco da Mangueira community, in the Macopani sector of RDSM. Figure 2 brings RDSM location and borders.

⁷ Legal Amazon is a land area covering 59% of Brazilian territory and completely encompassing eight states (Acre, Amapá, Amazonas, Mato Grosso, Pará, Rondônia, Roraima, and Tocantins) and partially encompassing Maranhão (IPEA, 2008).

⁸ Most recente information offered by IBAMA.

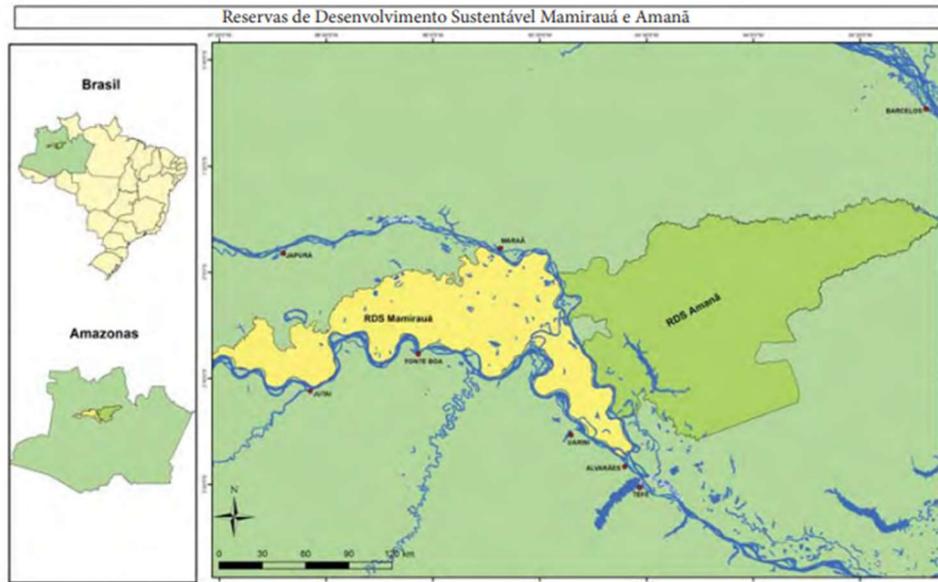


Figure 2: Study Area – Mamirauá Sustainable Development Reserve
 Source: Mamirauá Sustainable Development Institute - IDSM, 2011.

4.2 Methodology

This study is classified as an exploratory-descriptive research, with a qualitative approach (Creswell & Creswell, 2018). The selected method is case study (Yin, 2018), and the analysis unit is the Amazonas State pirarucu value chain.

For the data collection, we started by exploring scientific literature, grey literature, and documental research, complemented by the field research carried out in Amazonas State. The field pillar aimed at primary data obtention, and a deeper understanding of the local reality experienced by actors involved in pirarucu Management in RDSM region. Collection techniques were individuals and group interviews with a semi-structured script (Cohen et al., 2007; Neuman, 2014) with fishermen and associates of Macopani Sector, in São Francisco da Mangueira community, Juruá, AM. Moreover, we took part in the Pirarucu Management Fishermen and Fisherwomen Federation of Mamirauá (FEMAMPAM) meeting, where we interviewed other fishermen, and local associations and community leaders. A total of thirty people were interviewed.

Additionally, we conducted in-depth interviews (Creswell & Creswell, 2018) with representatives of Mamirauá Sustainable Development Institute (IDSM, in the Portuguese acronym), Sustainable Amazon Foundation (FAS), and the Association of Residents and Users of RDSM Antônio Martins (AMURMAM): we have classified those three institutions as meso-institutions working in the region.

Occasionally we explore quotes by interviewees, which are hereby included with minimum editing, except when necessary for clarification or confidentiality, like names removal. Interviewees were identified according to the codes presented in Table 1.

Table 1. Interviewees' codes

| Identification | Code | Institution |
|-----------------------|-------------|--|
| Interviewee 1 | E1 | Mamirauá Sustainable Development Institute - IDSM |
| Interviewee 2 | E2 | Sustainable Amazon Foundation - FAS |
| Interviewee 3 | E3 | Sustainable Amazon Foundation – FAZ |
| Interviewee 4 | E4 | Association of Residents and Users of RDSM Antônio Martins – AMURMAM |
| Interviewee 5 | E5 | Macopani Sector Producers Association |
| Group interview | GI | Macopani Sector Producers Association |

Source: Research data.

Based on the information collected during the interviews, we have performed an analysis focused on the identification of the aspects proposed in the IAD framework. This includes but is not limited to the biophysical conditions of fishery resource, community attributes through historic-cultural artifacts, rules-in-use that are set by resource users, action situation description, and involved actors identification, as well as interactions and results. In addition to this analysis, we seek to understand meso-institutions' role within pirarucu chain in the region. Therefore, the acquired information set has enabled us to understand how collective action are articulated in the pirarucu value chain in Amazon, on top of contributing to the literature on collective action and polycentric governance.

5 Results

This section presents the outcome of the data collection and analysis methods previously described. We start by depicting the case study and later classifying our findings from the interviews. We dedicate a sub-section to detail collective action articulation and finally we approach the relevance of meso-institutions in this value chain.

5.1 Case Study

As presented in the methodology section, this case study has as its analysis unit the pirarucu chain in Amazonas State, specifically in the Mamirauá Sustainable Development Reserve – RDSM – region. The reserve is divided in 28 sectors, out of which twenty have the potential for pirarucu Management, and twelve (60%) actually are inserted in the activity (E1; E2, 2022). Figure 3 shows the organizational structure of pirarucu Management areas in RDSM.

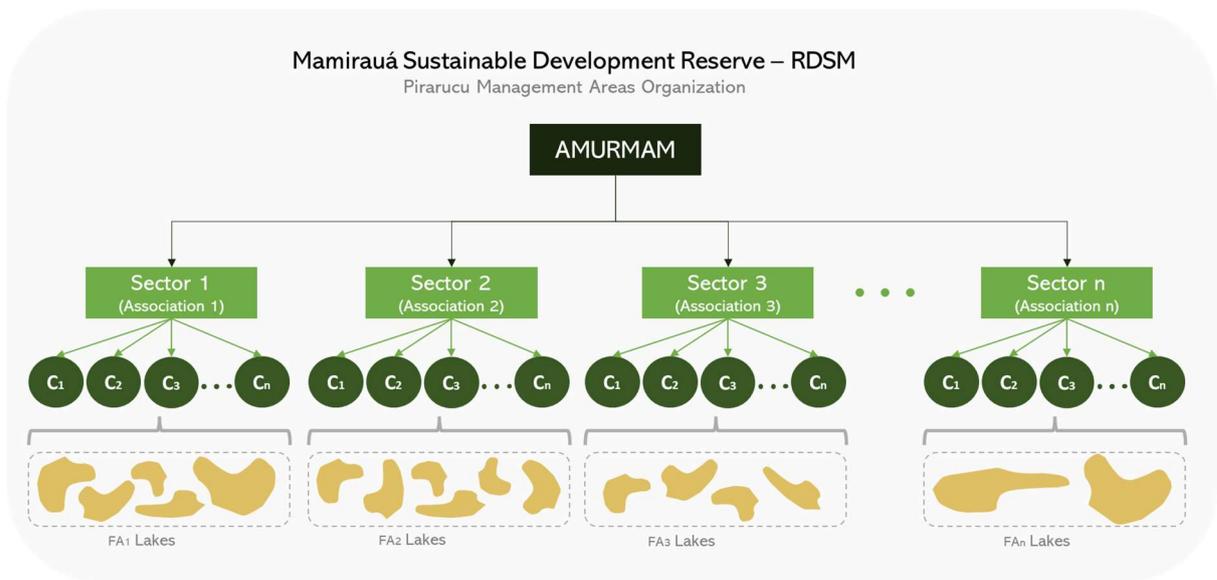


Figure 3. Pirarucu management areas organization within RDSM

Source: Authors, based on interviews (E1; E2, 2022).

*FA = Fishery Agreement

As shown in Figure 3, pirarucu management chain organization in RDSM central element is AMURMAM, which is the “mother” association, responsible for the social, environmental, and economic rights of the reserve residents (E4, 2022). Residents are organized in communities ($C_1, C_2, C_3 \dots C_n$), formed by “n” families, and grouped in sectors of “n” communities (average between five and six).

Communities sit on floodplain areas, close to lakes (varying in quantity and extension) where pirarucu and other fish species – like tambaqui, surubim, pacu, etc. – reproduce throughout the year. Therefore, fishery activity is intense and constant. Moreover, we observe that there is a cultural matter involved, as the activity is taught from generation to generation. Nonetheless, in some areas fishery only aims at subsistence, as they do not pertain to authorized management zones (E5; GI, 2022).

To become part of the pirarucu management zone, each community must manifest interest, actually wanting to do through all the stages for the process effectiveness: this is the first step. By accepting to take part in pirarucu Management, the sector creates an association to make a Fishery Agreement (AP) official. This agreement, on top of setting a series of requirements for fishery – like which gear is allowed or prohibited (gill nets, which mesh sizes, harpoons, etc.) –, also defines in which lakes those communities can fish. Lakes are then assigned to the sector, considering geographic criteria like closeness to the adhering communities, that is, those pertaining to the Fishery Agreement and share those lakes (E1, 2022).

As an example of this structure, we bring Macopani Sector case, which is the most recent adherent to pirarucu Management in RDSM. This sector is formed by ten communities⁹, or 84 families. To integrate legal pirarucu fishery into those communities, the Macopani Sector Producers Association was created in 2016. According to information from the interview, at first eighty members entered the association. Although the Management started in 2016, it takes around three years to the first fishing activity to be authorized by IBAMA, due to the need to increase pirarucu population in regions already practicing the Management, on top of the whole training and implementation process (E1, 2022). Thus, the first handled pirarucu fishery in Macopani sector happened in 2019. In the following year, 2020, number of members jumped to 140, and in 2022 they are 220 members (E5, 2022). It is worthy mentioning that the Fishery Agreement of Macopani Sector Hydric Complex was made official in 2021, by Normative Instruction no. 01 of State Secretariat for the Environment (SEMA), on July, 7¹⁰. The agreement encompasses 91 lakes, in nine communities: São Francisco da Mangueira, Itaboca, Nossa Senhora Aparecida, União do Amazonas, Vale da Bênção, Jussara, Bom Jardim, Bom Sucesso, and Barreirinha do Peixe. Lakes are separated for Management, maintenance, and preservation. Additionally, the agreement authorizes pirarucu fishing in the August-November period each year.

5.2 Articulation of collective action in pirarucu value chain: a product that represents the Amazon socio-biodiversity

We analyze the pirarucu chain in RDSM region using as a reference the Macopani Sector, under the IAD framework (Ostrom, 2010). We highlight a few interviews' excerpts,

⁹ Data referring to first half of 2022.

¹⁰ Available on: https://legisla.imprensaoficial.am.gov.br/diario_am/completo/347

outlining a correspondence between observed characteristics and the broader categories of external variables affecting the action situation. This parallel is presented in Table 2.

Table 2. IAD framework external variables classification for pirarucu value chain

| Categories | Observed Characteristics |
|------------------------|--|
| Biophysical conditions | Pirarucu value chain extensively involves common resources use. Users' access to these resources is hard to restrict, bringing opportunity to overuse, that is, fishery is conducted in a disorderly manner, with the possibility of reaching scarcity. Pirarucu fishery happens in lakes shared by the communities residents and, in many cases, outsiders. |
| Community Attributes | Region background shows that indiscriminate resources use, that is, fishery over-exploitation, led to pirarucu species scarcity and endangerment. Macopani Sector Management implementation was motivated by the observation of a population decline in the region lakes, to the point that <i>"because there was no control, we were almost out of fish, out of food"</i> (E5). Moreover, Other vicinity areas had already started the Management work and experienced positive results, so this process has influenced the decision to join the collective Management. |
| Rules-in-use | Pirarucu fishery is prohibited in Amazonas State (Normative Instruction IBAMA no. 4/2004 and no.1/2005), being only allowed in pisciculture and Management licensed areas. To implement pirarucu Management, communities are subjected to rules other than the general ones set by IBAMA. According to E1, when a Sector decides to join the Management process, it will need to commit to a period of three years with no fishery activity, to build up the pirarucu population. Additionally, residents go through a training process to become capable of performing Management, which encompasses counting, area monitoring, and decision-making about the fishery activity per se. The association created to stand for the sector also prepares bylaws, almost a code of conduct, with rules defined by all the Management participants. Each community also sets its own rules, which must consider the general rules. The key Management rules are summarized in the Fishery Agreement, which grants fishermen the right to closure insurance. |

Source: Authors, based on research data.

Every category of external variables described in Table 2 affects the action situation, that is, the way in which Management participants will act during each interaction. In the Management case, there are some activities that shall be performed only in specific months – like the fishing per se, that shall be performed only between August and November (with more intense activity in October and November). Additionally, communities depend on the quota setting done by IBAMA, as well as on the lakes' conditions, which must be at the right level to enable fishing. Some communities face challenges to carry out the fishing, depending on the quota announcement date: this is due to the natural flow of rivers – when there is a draught, lakes become inaccessible by available vessels. This, despite IBAMA ruling being general, specifying that fishery in Management areas can be performed between August and November, not all actors are impacted in the same way by this ruling (E4, 2022).

Other activities are performed throughout the entire year, as lakes monitoring. The absence of State performed inspections cause the communities to keep teams to prevent lake

invasions by non-authorized users intending to perform illegal fishing. The surveillance goes on 24/7 and requires investment in supplies like fuel, food, batteries for flashlights, etc., generating costs for the communities (E1; E2; E5, 2022). This kind of work brings positive externalities for the lakes environment, like the preservation of species other than pirarucu, as well as of the forests around them. Nonetheless, fishermen are not compensated for the costs involved in the task.

The period prior to fishing season is filled with process planning, and handlers training and organizing. All residents of the community take part in the activities, including youth and women, who have a key role and are currently compensated according to the performed job, equal to men (GI, 2022). Communities blend pirarucu to other species fishing and subsistence agriculture, growing produce like yuca, banana, and corn. Pirarucu commercialization is collectively performed throughout the fishery period, in open fairs conducted in partnership with supporting institutions. Fairs happen mostly in the State capital city, Manaus, plus Tefé and Fonte Boa. Additionally, a key commercialization channel is made of the meatpackers in the region. Production that is not absorbed by them is negotiated with middlemen. Average price in fairs sits around R\$11/kg, while meatpackers pay around R\$7/kg. Middlemen, on their turn, pay an average R\$4.5/kg. Before the Management started, most of the production was sold to middlemen. Thus, current market prices are an improvement that traces to the developed activities, although not yet enough to cover all operational costs (E1; E2; E3; E4; E5, 2022).

At the end of the process, after the fishery per se, a results assessment is performed, seeking to identify satisfactory aspects, as well as those that need improvement in the next season. ARMURAM actively takes part in this process, along with other associations (E4, 2022). By following this procedure, rules are periodically reviewed and updated as needed. A few sanctions are provided by the bylaws for rule-breakers, like pay cuts for missed days or “dragging their feet” during activities. Also, although there is an assigned monitoring agent, responsible for inspecting the processes, everyone in the community inspects, observes whether rules are being followed. Besides formal sanctions set in the association bylaws, fishermen are concerned about their reputation among peers. Another relevant matter in this process relates to conflict resolution mechanisms: dialogue clearly is the most frequent one. Usually when there is a demand, the community gets together to reach a democratic solution. Last, there is trust in the leader and amongst the group, represented by the sense of community collectivity and unity (GI, 2022).

5.3 The importance of meso-institutions in the robustness of collective action in pirarucu chain

Amazon pirarucu chain governance involves multiple analysis layers and several decision-making centers, therefore representing a polycentric governance structure. At first, we see the general game rules that affect all the chain actors from top to bottom (regulations, laws, and norms set to shape the activity functioning in that State). On the second level, Fishery Agreements regulate the sector activities, followed by the third layer represented by the association bylaws, and finally the fourth level is defined by the rules established by each community for the development of collective action. Each of these levels considers those immediately above them. Nonetheless, such rules translation and implementation from the highest level into the fourth layer, that is, the process in which the community internalizes and comply with those rules, is not trivial.

That said, IAD institutional analysis framework brings valuable insights to assess factors pertaining to this context and influencing collective action developed at community level, as previously reported. However, we have identified a critical link between the action situation (the arena where actors interact) and variables in the broader context. We understand that pirarucu chain is immersed in an ampler socio-ecological environment and we believe this link is missing in the Ostrom proposed model. Therefore, we added to that structure the meso-institutions as a moderating variable of collective action robustness.

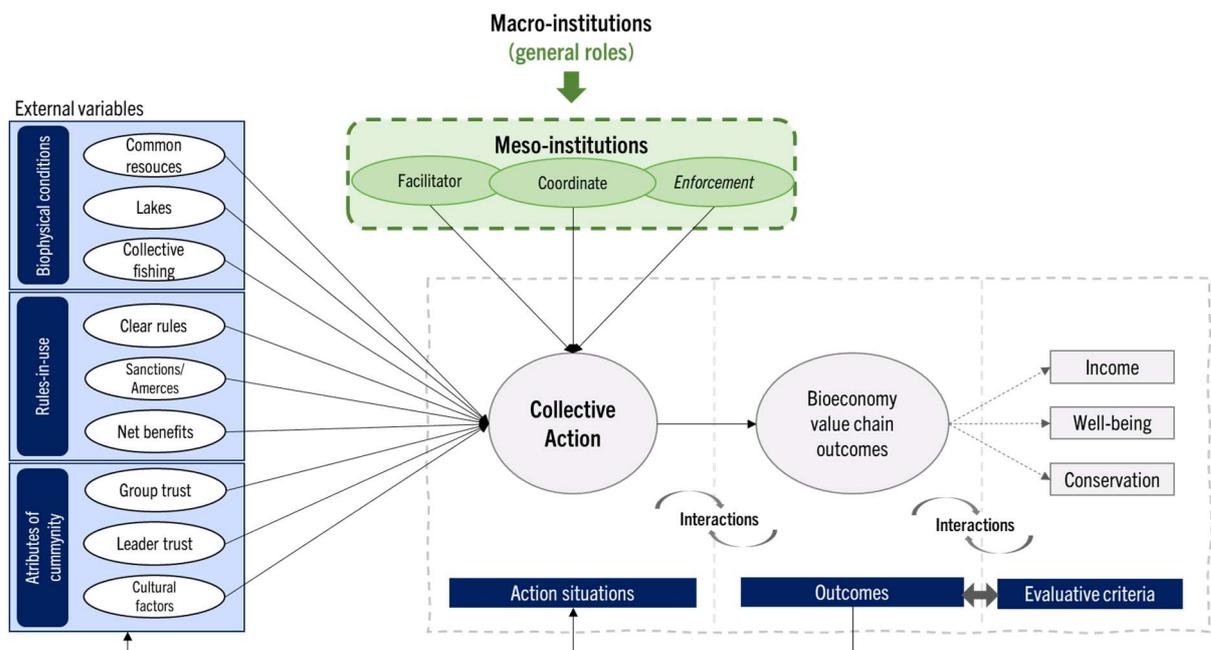


Figure 4. IAD Framework Affected by meso-institutions and the bioeconomy value chain outcomes
Source: The authors (Adapted from Ménard, 2014, 2018; Ostrom, 2010).

Worthy reminding that meso-institutions do not create rules. These are shaped in the macro-institutional layer domain (North, 1990), as shown in Figure 4. Specifically, we want to show that meso-institutions' presence and agency play a critical role in the manifestation of the collective action, as they perform as facilitators, aligning actors' expectations and interests through interaction in the action situation.

In the case in hand, of the pirarucu chain in RDSM region, we have identified three meso-institutions, whose agency within the chain is described below.

The first meso-institution, IDSM in Tefé-AM, was founded in 1999. The institute was gestated from the Mamirauá Civil Society, which develops studies in the region since the early 1980s, focusing on solutions for the social and environmental problems generated by the disorderly natural resources extraction, particularly performed by people from outside the communities, like large timber companies, and fishermen from Manaus, Manacapuru (a strong fishing region in the State periphery), Santarém, and Belém (these in the Pará State). IDSM is engaged in the pirarucu management and Management project since its beginnings and has gathered experience and know-how to replicate and broaden the Management areas. The institute supports communities in the Management process implementation, guiding the group constitution course, training fishermen on the Management process stages, and aiding with the terms of Fishery Agreements and rules definition. The organization also acts as coordinator of negotiations among fishermen, counseling during discussions and implementation of agreed upon actions. In addition, as the institute realized the importance of the Mamirauá product recognition, undertook the process along other local institutions and associations to the attainment of the denomination of origin "*pirarucu de Mamirauá*" [pirarucu from Mamirauá]. Each pirarucu fish that is captured in the region is marked with a unique insignia containing information that enable traceability, like the lake in which the fish was caught, the fisherman, community, time of slaughtering, date, among others. Thus, throughout the years, IDSM progressively reshaped its own way of working, moving towards the chain coordination, implementing initiatives that help to add value to the handled pirarucu, broaden commercialization, and invite more communities to take part in the Management, as the system has been generating significant results for RDSM when it comes to preservation of protected areas. For the institute, the population is part of the solution of the social and land use conflicts (E1, 2022).

The second meso-institution, FAS, was created in 2008 to act on projects focused on Amazon sustainable development, implementing agendas related to the following strategic

thematic pillars: health, education and citizenship, empowerment, income generation, community infrastructure, environment conservation, management and transparency, research, development, and innovation. The institution is a strong partner to handlers in the RDSM region pirarucu chain. FAS agents promote fishermen assemblies to decide on actions to be implemented and destination of funds gathered by the foundation for projects execution. It is a successful process built in partnership with the community. A few concrete examples are the fairs organized by the foundation in Manaus and the acquisition of a salting tub and a cold chamber for fish processing in Fonte Boa region, all of them results of a collective effort. FAS also develops training and incentive actions to give communities autonomy. The foundation supports the idea that communities should be able to conduct their own strategic processes and should be increasingly robust in acting within the chain. To that aim, FAS seeks to identify potential leaders in the communities, specifically looking at youth, to give them opportunities and confidence that communities have the requirements to make things happen. The continuous pursuit of improvements to the processing and value-adding infrastructure, along with the development and diversification of trade strategies, have brought effective gains, not only in terms of income, but also in the way collective action are developed by the communities (E2; E3, 2022).

The third meso-institution, AMURMAM, was created in 2008 with the purpose of giving voice to RDSM residents' interests and currently, besides concentrating other associations that represent each sector, works on projects that aim income growth and living standards improvement for the communities, and articulate actions to develop infrastructure, health services, sewage disposal, education, and technical and academic training for youth. However, the association also has worked in meeting the requirements for institutional markets access, extending pirarucu offer to the Food Acquisition Program (PAA, in the Portuguese acronym), and actively took part in negotiations with meatpackers and fair promoters. Thus, AMURMAM acts on reducing middlemen activity and creating the necessary conditions so that handlers can autonomously make the sale. In the fairs case, for example, AMURMAM organizes everything in partnership with FAS, but the sale to consumers per se is carried out by the fishermen themselves. Other initiatives undertaken by the association aiming at implementing infrastructure for fish processing and value-adding, like the Salting Industry and the Meatpacking Plant in Fonte Boa, both in progress through a partnership with FAS. Such actions focus in taking prices to a level that is more consistent with costs and expanding the sharing of benefits with communities engaged in pirarucu Management in the region (E4, 2022).

In addition to the aforementioned meso-institutions, there is a series of organizations supporting the pirarucu chain in Amazonas. Among them SEMA, IBAMA, and IPAAM, which have an inspection related role, ensuring rules of the game are being followed. Here, though, we focus on meso-institutions that intervene towards generating concrete results, which actually get to the end of the chain, helping communities.

Our model identifies three meso-institutions' roles, according to recent contributions by NIE (New Institutional Economy) (Kunneke et al., 2021; Ménard, 2014, 2017). The first role is “Facilitator” (interpreter): here, meso-institutions aim to translate formal and informal rules into practical guidelines towards the objectives, evaluating and listing alternative modes of implementation, with the goal of “generating a dialogue and trust between regulators and targets, and creating experienced and compliant communities among the targets”, and providing feedback to regulators. Inside the pirarucu chain, facilitators organize meetings, provide training and opportunities for discussion of the internal rules (fish counting, payment modes/profit sharing). The second role is “Enforcement”, where the State power lays, that is, the power of making sure rules are followed. Although none of the organizations actually hold that power, a relevant way to exert it – mentioned by the group interview – is ostracism: those who do not follow the rules cannot participate in the associations' meetings, or even in the fishery per se, in addition to become *persona non grata* in the community (GI, 2022). The third role is “Coordinate”: given the State deficiency (institutional void), particularly in terms of infrastructure (for commercialization, credit, etc.), organizations took over the chain coordination.

Table 3 presents our attempt to classify the meso-institutions' roles identified in the pirarucu chain.

Table 3. Meso-institutions' roles in pirarucu chain

| Meso-institution | Roles | | |
|------------------|------------------------------|-------------|------------|
| | Facilitator (interpreter) | Enforcement | Coordinate |
| AMURMAM | X | x | x |
| FAS | x | | x |
| IDSMS | x | | x |

Source: The authors.

6 Conclusions

We have developed our research with focus on understanding how collective action are articulated in value chains of products originated in the Amazon socio-biodiversity, because of

the common resources extensive use and sharing in that Brazilian region. To that aim, we have investigated the Amazon pirarucu chain, specifically in the RDS Mamirauá region. We applied polycentric governance and collective action theory developed by Ostrom (Ostrom, 2010), and added to that the meso-institutions, as proposed by Ménard (Ménard, 2018).

We verified that the theory developed by Ostrom and the presented frameworks are valuable for our analysis. Nonetheless, as suggested by the author, rules need to be adapted to each specific socio-ecological environment, so that expected results can be reached in an effective manner. We then have identified meso-institutions, as proposed by Ménard (2014, 2018), as crucial elements of these structures to ensure collective action are implemented and thrive over time, and we suggest this element to be added to the institutional analysis and development framework (IAD).

Moreover, we have identified that collective action is effective in promoting environment preservation and increasing production, but is not as effective in improving income distribution throughout the production chain. Therefore, meso-institutions, in addition to undertake the role of filling State institutional voids, have decided to also act onto the production process, particularly commercialization and search for new distribution channels. This has been reshaping the relationships among the chain agents.

Our findings suggest that the presence and the *modus operandi* of meso-institutions in the pirarucu chain are relevant for the collective action to work in a robust manner, particularly when it comes to the process of consistent income generation and boosting benefits sharing. Additionally, rules adjustments effectiveness depends on the presence and action of meso-institutions in this context. We suggest that future research compare cases of value chains with strong meso-institutions' activity to those with frail action.

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