SPSAS SUSTAINABLE AND INCLUSIVE AMAZONIA

Local governance, climate change and natural resource management in the Amazon

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ABSTRACT

Strengthening community-based natural resource management initiatives is critical in dealing with the effects of climate change and pressures from predatory exploitation on ecosystems and fostering the adaptive capacities of communities. Adaptive capacity directly depends on the adopted governance system. The Amazon is home to a great diversity of ecosystems and traditional peoples (for example, indigenous peoples, extractivists, quilombolas), and plays a fundamental role in regulating the global climate. One of the current major challenges is to control and mitigate the impacts of climate change and the predatory exploitation of natural resources on both natural and human systems. These impacts compromise families' income and quality of life, the guarantee of their basic rights and the effectiveness of public policies for the region. To consider traditional, indigenous and quilombola peoples in jointly creating solutions to these problems is crucial to achieve effective results. We argue that strengthening and valuing local governance should be the starting point and guideline for natural resource management projects to ensure that challenges are overcome and enable the development of an effective socio-biodiversity economy.

Keywords: climate change, governance, natural resource management, traditional peoples.

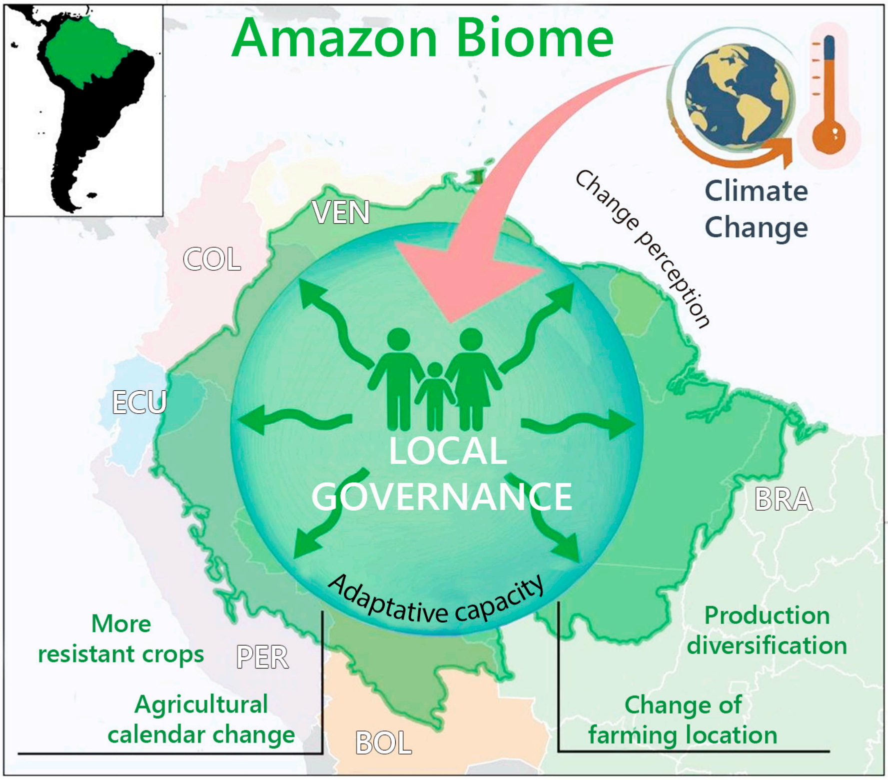

Figure summary: Local communities are constantly under internal and external pressure from various factors: social, economic, political and climatic. Governance can strengthen communities' capacities to cope with these external pressures. Thus, the effects of climate pressures on projects for the sustainable management of natural resources in the region can be mitigated due to changes in governance.

Introduction

The Amazon Biome is a vast and complex socio-ecological system, sheltering the greatest biological diversity on the planet, playing a key role in global climate regulation and in providing essential ecosystem services to human society (Antonelli *et al.* 2018). The region shelters a diverse range of peoples, including indigenous communities, quilombolas, small farmers, extractivists and artisanal fishermen, each one with its own culture and practices for managing nature (Lima & Pozzobon 2005).

Biodiversity and ecosystem services represent the basis of Amazonian cultural maintenance and are connected with traditional activities such as fishing, hunting and the extraction of forest products (Sunderlin *et al.* 2005). Governance over the Amazon territory and its natural resources is complex and needs to conciliate sustainable paths for biodiversity conservation, poverty reduction, social security for communities and economic growth. This governance is essential to communities, as it provides their resilience in the face of disturbances, such as global climate change and environmental degradation caused by deforestation and other predatory forms of natural resources (de Andrade *et al*. 2022).

Estimates from the Sixth Intergovernmental Panel on Climate Change (IPCC) indicate that the Amazon region will be strongly affected by ongoing climate change, especially regarding the increase in temperature and decrease in soil moisture (IPCC 2023). These impacts have a high potential to bring significant consequences for Amazonian production chains (Evangelista-Vale *et al.* 2021). Even if mitigation and adaptation policies are implemented, the greenhouse effect should cause a cascade of climate consequences for a long time, with major impacts on ecosystems and traditional Amazonian communities (Pörtner *et al.* 2022). Such impacts can be exacerbated by forest degradation (e.g., forest fires and timber extraction), which will make the forests more vulnerable (Matricadi *et al.* 2020).

Climate impacts may vary in intensity over the different regions of the Amazon (Estevo *et al.* 2022), affecting agricultural practices, timber forest management and non-timber extraction (Bergamo *et al.* 2022). Many of these practices, besides representing the ways of life of local communities, are forms of income generation and contribute to the conservation of large portions of native forests (Silva *et al.* 2021), playing an important role as carbon sinks (Smith *et al.* 2023). For this reason, several community-based strategies for the management of natural resources have been adopted in order to promote sustainable forms of production and territorial sovereignty (Bergamo *et al.* 2022; Medina *et al.* 2022).

The strengthening of governance at the local level, led by grassroots organizations, is essential to overcome the challenges posed by climate change and to make projects for the sustainable management of natural resources in the Amazon viable (de Andrade *et al.* 2022). Several studies have shown that strengthening local governance about the use of natural resources is effective for the conservation of biodiversity and for the economy of communities that inhabit forests (Ostrom 2005; Brondizio *et al.* 2019; Campos-Silva *et al.* 2020; Athayde *et al.* 2021). Community management of natural resources has been particularly successful in the Amazon, promoting important ecological benefits, such as the conservation of a large set of taxonomic groups and the population recovery of overexploited species (Castello *et al.* 2009; Campos-Silva *et al.* 2018). This level of governance should also be aligned with other administrative, institutional and jurisprudence levels, in regional, national and international scales (Cordeiro-Beduschi *et al.* 2022).

Forms of community governance manifest themselves through formal institutions, such as associations, cooperatives and unions, duly regulated by statutes and rules, or even informal ones, such as kinship and affinity networks, which mediate exchange relationships within a group (Ostrom, 1990; 2005; Meinzen-Dick & Mwangui 2008). These forms of governance operate instances of representation to seek rights and public policies, they are spaces that create rules for relationships with the state (for example, legislation, taxes, among others) and with the market, that is, they represent training spaces for the management of collective goods and negotiation of products (Campos-Silva *et al.* 2020).

In this proposal, we bring together some elements about the importance of strengthening local governance in Amazonian communities as a way of overcoming challenges during the implementation of projects for the sustainable management of natural resources. In addition, we assess how local governance can be used to deal with the effects of climate change on the agro-extractive activities of Amazonian communities. Finally, we provide recommendations on the importance of this issue, highlighting the main challenges and potential solutions for decision makers, such as State agents, private entities, non-governmental organizations (NGOs), etc.

Impacts of climate change in the Amazon: *lato sensu*

Climate change is one of the main ecological and social challenges today (Dietz *et al.* 2020). Understanding this challenge is essential to guide policies to reduce environmental risks, in addition to combating food insecurity and its impacts on the economy on global, regional and local scales (Ericksen *et al.* 2011; Mondal *et al.* 2023). The food security of the global population can be directly compromised by climate change, considering the losses in agricultural and extractive productivity associated with extreme variations in precipitation and temperatures (Asseng *et al.* 2015; Hasegawa *et al.* 2018).

In the Amazon, this situation is no different. The region hosts half of the planet's remaining rainforests, which are under intense pressure from deforestation, mineral extraction, livestock and agricultural cultivation. These intense changes include a significant reduction in precipitation, an increase in temperature and in the frequency of intense drought and flood events (Erfanian *et al.* 2017; Matricardi *et al.* 2020; Assis *et al.* 2022; Marengo *et al.* 2022; Smith *et al.* 2023), directly affecting the productivity of small-scale agriculture and extractivism and the composition and diversity of species in these ecosystems. Recent studies indicate that both the structure and composition of the tree flora in the Amazon have undergone adaptations to a drier and hotter climate (Brienen *et al.* 2015; Esquivel-Muelbert *et al*. 2019).

However, the adaptations of biological communities are not able to keep up with the rapid pace of climate change, which is leading to large-scale tree species mortality events (Esquivel-Muelbert *et al.* 2020) and consequent reduction in forest productivity (Brienen *et al.* 2015). These effects vary between Amazonian regions, being more intense in the southern and eastern portions of the biome (Marengo *et al.* 2022). These regions have a more seasonal climate when compared to the western and central portions, and exhibit the highest mortality rates in the biome, where the effects of climate change have already conditioned a regional 'tipping point' (Lovejoy & Nobre 2019). Degradation and deforestation associated with climate change have changed the status of these forests from being carbon sinks to becoming carbon sources (Reis *et al.* 2022).

Furthermore, local human communities that depend on forest and water resources are seriously threatened by these climate changes. For example, the expected increase in severe droughts and the consequent reduction in the volume of water in the Amazonian rivers could render fishing activities economically unviable, due to the precariousness of transportation and difficulties in exporting production from remote or isolated communities. These changes can lead to a degradation of living conditions and the exodus of these communities to urban centers (Silva *et al.* 2021).

Challenges for the sustainable management of natural resources in the Amazon in the face of global climate changes

Currently, the impacts associated with climate change and the predatory exploitation of the Amazon biome are changing the dynamics of ecosystems and directly impacting the production chains of traditional communities. This trend may spatially reduce the climate suitability of plant populations and affect the production of basic crops such as cassava, maize and banana (Beltrán-Tolosa *et al.* 2020). Crops such as wheat, for example, are very sensitive to the effects of climate change: a 1°C increase in temperature can lead to a decrease of up to 6% in the global production of this commodity (Asseng *et al.* 2015). These effects can also be extrapolated to non-timber forest products, which are the main source of income for traditional Amazonian communities (Igawa *et al.* 2022).

Future estimates show that communities in the 56 extractive reserves (RESEXs) located in the Brazilian Amazon will be affected by climate change by 2050 (Evangelista-Vale *et al.* 2021). Eleven out of the eighteen evaluated commercial species may present a reduction in their environmental suitable areas (area suitable for the occurrence of the species according to its tolerance to environmental conditions) and nine of them may disappear from some of these reserves. For example, species such as Brazil nut tree (*Bertholletia excelsa*), rubber tree (*Hevea brasiliensis*), buriti palm(*Mauritia flexuosa*), açaí (*Euterpe oleracea*), single-stemmed açaí (*Euterpe precatoria*) and copaiba tree (*Copaifera multijuga*) have shown a decrease in environmental suitability areas within the RESEXs where they are extracted. *B. excelsa*, extracted in 50 reserves, may no longer occur in nine of these areas, which would affect 996 extractive families. Both açaí species (*E. precatoria* and *E. oleracea*), extracted in 45 reserves, could be locally extinct in two RESEXs, which would affect 288 extractive families (Evangelista-Vale *et al.* 2021).

Considering the agricultural scenario, even though the Amazon has 17% of areas with suitable soils for cocoa cultivation (*Theobroma cacao*), the increase in temperature and reduction in precipitation can make this productive potential unfeasible, especially in areas with consolidated economic activities (Igawa *et* *al.* 2022). This reduction in production areas could cause a 4.2% decrease in national cocoa production and affect the income of almost 9,000 families. Likewise, Pastana *et al.* (2021), evaluating the effect of the 2015/2016 El Niño on the annual production of Brazil nuts (*B. excelsa*) in the Rio Cajari Extractive Reserve (Amapá), found a strong relationship between the reduction in precipitation and the increase in temperature with the decrease in Brazil nut production. The authors report that the reduction in production and the consequent low supply of Amazonian nuts in a strong market with rising prices led to invasions and conflicts in extractive units. Thus, the negative consequences of climate change on socioecological systems become evident, pointing to the need for the creation of adaptive strategies to these changes in order to promote the resilience development of these systems (Scarano 2017).

Solutions to mitigate the effects of climate change: local governance and sustainable management of natural resources

Climate-related changes occurring in the Amazon substantially impact socio-ecological systems, affecting the livelihoods of communities heavily dependent on natural resources (Estevo *et al.* 2022). The forms of local governance carried out by traditional communities, indigenous peoples, quilombolas and family farmers can play a fundamental role in the sustainable management of natural resources and in adapting to climate change. These forms of governance promote and can expand i) awareness of climate change and, ii) conservation practices and sustainable use of natural resources.

Through local governance, it is possible, for example, to establish monitoring and control systems for extractive activities, ensuring that they are carried out in a responsible and sustainable way, without harming biodiversity and local ecosystems. Forms of local governance can also act as mediators between communities, government and private entities, advocating for community rights and the pursuit of public policies that promote sustainability and environmental conservation. Thus, it is important that these organizations have an active voice in the decisions that affect their members and that they work in partnership with other institutions to adapt production methods to the conditions imposed by climate change, seeking sustainable development.

Communities perceive the effects of climate change and the impacts of deforestation and large extractive projects. This perception is important for defining joint strategies to mitigate these effects. A recent study indicated that the majority (72% of respondents) of traditional Amazonian populations are noticing climate changes, especially reduced rainfall (62% of respondents). In addition, a significant part of the respondents (30.8%) associate these changes with deforestation, dam construction and soil and environmental degradation (eg pollution, silting) (Funatsu *et al.* 2019). This is worrying, as alterations caused by global warming do not have the same level of reversibility as the changes caused by land use, which impact precipitation and temperature in a given location.

Adaptations in the production system to better deal with problematic exposures and sensitivities (social, environmental, climatic) are manifestations of the adaptive capacity of community-based organizations. These adaptations can occur at different levels. For an agricultural system under drought, for instance, a simple adaptation could be the use of cultivars that are more resistant to water scarcity, while a more substantial adaptation would be to transitioning from agriculture to livestock grazing. An even more substantial adaptation would be to abandon agriculture altogether (Smit & Wandel 2006).

Other adaptations involve the need to align agricultural practices to the climate calendar, although in some places crop planning is more associated with market price, change of crop, change in sowing date, installation of greenhouses and use of irrigation, which has become more frequent in the Amazon (Funatsu *et al.* 2019). However, the high cost of irrigation systems in relation to land prices should be considered (Costa *et al.* 2019), as well as the impacts on water reserves. To minimize climate risk, an adaptive measure would be to select crops based on the start date of the rainy season, although a forecast system that is not yet available would be necessary (Costa *et al.* 2019). The study by Igawa *et al.* (2022), on the inadequacy of cocoa production in areas in the Amazon in scenarios of climate change, shows that it will be necessary to implement, in a large area, the process of transition and diversification with the planting of another crop that is more resistant to drought and heat.

Given the studies presented, we can identify two possible solutions for production chains to be less affected by climate change: use of crops and/or species that are more resistant to high temperatures and low precipitation, and diversification of production. In addition to more resistant species and genetic improvement (a procedure that can select a specimen that is more adapted to new climatic conditions), the selection of provenances and progenies (materials with greater genetic diversity from different matrices and locations) can provide a higher adaptive capacity of the cultivar to adverse conditions and ensure production. Agroforestry systems, which simultaneously combine trees and agricultural crops, could be an alternative for restoring degraded areas with economic returns in the short, medium and long term (Brandão *et al.* 2022). In the Amazon, this system has achieved greater productivity than monoculture. For example, agroforestry systems allow for a more shaded environment and protect cocoa from extreme climate conditions (Niether *et al.* 2018).

However, adaptive capacity depends on different types of capital, such as cultural capital (how people perceive and interact with their world), human capital (people's skills and knowledge to develop and multiply the benefits from their resources) and social capital (connections between individuals and organizations that allow them to collaborate or help each other) (Freduah *et al.* 2019). These capitals, together, enable better utilization of the skills and knowledge of local and external actors to address the impacts of climate change and to foster more partnerships and collaborations in order to respond to the impacts of climate change. Adaptive capacity can be influenced by governance, as in socio-ecological systems it is decisive and poor governance can be another stress factor, in addition to the effects of climate change itself (Freduah *et al.* 2019).

Local governance carried out by communities

Several authors and civil society organizations worldwide argue that it is necessary to pay attention to local governance carried out by communities in the context of implementing conservation and income generation projects, as well as promoting the inclusion of these organizations in the construction of projects and decision-making (Brondizio *et al.* 2021; Abramovay *et al.* 2021). Such authors and organizations rely on consolidated experiences, on a variety of theoretical and conceptual models to defend these arguments. Among these debates, we can highlight the development of the theory of common resources, carried out between the 1970s and 1990s, which brought significant contributions to the recognition of local governance of communities within academia and within global strategies for nature conservation (Ostrom 1990).

In general terms, this theory proposes that communities that sustainably manage the natural resources they depend on, typically exhibit specific governance characteristics, including cultural, ecological, and economic particularities, for example. Eight governance principles (Design Principles) were established, based on case studies with human groups around the world and with laboratory experiments on human behavior (Ostrom 1990, Ostrom 2005, Cox *et al.* 2015), and serve as criteria for evaluating the extent to which the principles of local governance of common resources are being met by grassroots organizations (Box 1). Studies using these principles show that the organization of communities and their ability to carry out collective actions are among the variables that influence the success of community-based initiatives for natural resource management around the world (Pagdee *et al.* 2016).

Box 1

Principles of governance (Ostrom 1990, 2005, 2009, modified by Cox *et al.*, 2010)

Principle 1: a) Are there clear boundaries between who can be a resource user and who cannot? b) Is it easy to separate the resource system from the surrounding systems?

Principle 2: a) Are the norms of appropriation and provision of resources adequate to the local conditions (spatial and temporal heterogeneity, local culture)? b) Is there congruence between the norms of appropriation and provision, in other words, is there proportionality between the costs that users have to bear to care for the resource and the benefits they receive when participating in collective action?

Principle 3: Can the individuals affected by the exploitation rules participate in the change of the same?

Principle 4: a) Are there people responsible for supervising the use of resources by users? Does the supervisor also benefit from the resources? b) Is there a control of the conditions of the resources (medium-environmental)?

Principle 5: Are graduated sanctions imposed on users who disobey the rules?

Principle 6: Is there a scope for resolving conflicts between users or between users and external agents that is fast, low cost and local?

Principle 7: Do government agencies allow local users to believe in their own institutions? Are local institutions recognized by government bodies?

Principle 8: Is the local governance system nested in other levels of governance? Do you have horizontal connections with other community systems?

More recently, when the topic of sustainability projects involving communities and income generation is analyzed in the Amazon, the principles remain intact. Medina *et al.* (2022), for example, identified more than 100 innovative and sustainable initiatives in communities across the Brazilian Amazon. The authors demonstrate the importance of scientists and policymakers involving local communities in decision-making, adopting *bottom-up* approaches.

In this way, promoting and strengthening the local governance of communities helps in the fairer distribution of benefits among the actors involved in natural resource management projects. In addition, this strengthening provides security to communities and the possibility of changing paternalistic, integrationist and colonialist biases that occurred in the past and were unsuccessful, enabling the long term sustainability of projects (Campos-Silva *et al.* 2021).

Step-by-step guide to strengthening local community governance

We list some points that can help decision makers – agents of the State, NGOs and private institutions – to recognize, include and/or strengthen local governance of communities in contexts of natural resource management projects, given the impact of climate change:

- The communities involved in the projects must have, *a priori*, guaranteed rights to land and territories, among other fundamental rights and public policies. The lack of tenure security and the absence of demarcated territory for the reproduction of the way of life can threaten local governance in the long term (Pagdee *et al.* 2016; Barreto-Filho *et al.* 2021). Observing in which conditions of territorial rights the communities are inserted and working so that these conditions are guaranteed and improved is fundamental. The State, through public policies, is primarily responsible for addressing these issues. Territorial public policies should serve as catalysts for sociocultural processes that guarantee the autonomy of groups, their rights to control their own lands, resources, institutions, their social and cultural organization and their own ways of relating to the State. Life Plans and Territorial and Environmental Management Plans, developed by indigenous peoples and traditional communities, are examples of management instruments that promote territorial security based on the practices and knowledge of these peoples; the National Policy for Environmental and Territorial Management of Indigenous Lands (in Brazil, Decree No. 7,747, of June 5, 2012) is an example of public policy that contributes to the realization of territorial security and sustainable production practices (Barreto Filho *et al.* 2021).
- Differences between the assumptions and forms of knowledge production (ontologies and epistemologies) of external actors (project supporters) and communities must be recognized by the partners. Based on this

recognition, it is possible to establish more efficient dialogues between implementation knowledge and execution of the project, so that both technicians and communities improve their understanding of each other, in a more equitable way, with appreciation and respect (Bensusan 2019). This is important, as for technological innovation to occur, it's necessary to value marginalized local knowledge (Medina *et al.* 2022; Abramovay *et al.* 2021) and address power imbalances between different types of actors (Campos-Silva *et al.* 2020; Medina *et al.* 2022). "Community biocultural" protocols and consultation protocols, for example, are instruments developed by communities to communicate to external actors – commercial partners and others – how the community organizes itself, works and should be consulted.

- There are often more chances for project success when local governance bodies share values of the group's "sense of identity" and help to create and/or promote common values/goals in relation to the project. It is also necessary to strengthen, or create, spaces for the elaboration of rules within the project, which include pre-existing mechanisms in local governance - mainly rules for appropriation and provision of natural and financial resources that the project deals with - for decision-making and conflict resolution, in a way that promotes a distribution of benefits considered fair by the group. These spaces may include other actors, such as technical assistance agencies. In addition, it is necessary to prioritize pre-existing local governance mechanisms or create mechanisms capable of carrying out adaptive project management (Pagdee *et al.* 2016; Medina *et al.* 2022; Ostrom, 1990; 2005; 2010).
- Nesting local forms of organization with other initiatives within projects at different levels of governance (Pagdee *et al.* 2016; Ostrom 2010; Cordeiro-Beduschi *et al.* 2022). For example, establishing networks of institutional support and decentralized and continuous funding models for the project, well-coordinated with local governance. (Barreto Filho *et al.* 2021). Building and maintaining a long-term community-based natural resource management project requires collective effort (actor network) and available financial resources. Pre-existing forms of local community governance cannot and should not sustain investments in human and financial resources for innovative projects by themselves. Thus, an institutional arrangement that facilitates access to resources is important (Vidal *et al.* 2021).

Table 1 The first column lists the governance principles (Ostrom, 1990 2005). The two columns below show the characteristics that we highlight, throughout the document, as important to strengthen local governance. The colors highlight the features in common with the governance principles. Characteristics that do not have colors are those that promote collective action. Caption: RUC = "Resources in common use".

<table>
<tr><th>Principles of institutional design (Ostrom 1990)</th><th colspan="3">Points evaluated in the bibliography</th></tr>
<tr><td>1) Clearly defined boundaries</td><td colspan="2">Group identity, values and goals aligned</td><td>Collective identity in the community</td></tr>
<tr><td>2) Coherence between the rules of appropriation and provision with the local conditions</td><td rowspan="3">Collective instances to elaborate rules, decision-making and conflict resolution</td><td>Appropriation and provision rules</td><td>Effective inter-institutional agreements</td></tr>
<tr><td>3) Collective election arrangements</td><td>Adaptive management</td><td>Common interests and incentives between actors</td></tr>
<tr><td>4) Supervision: actively monitor the conditions of the RUC</td><td>In the long run</td><td>Defined property rights</td></tr>
<tr><td>5) Graduated sanctions</td><td colspan="2">Biocultural community protocols: Management of the same languages</td><td>Context dependency</td></tr>
<tr><td>6) Conflict resolution mechanisms</td><td colspan="2">Exchange of experiences</td><td>Recognition of marginalized local knowledge</td></tr>
<tr><td>7) Minimum recognition of organizational rights</td><td colspan="2">Institutional support networks: Public authorities, own initiatives</td><td>Dialogue of knowledge (Science and traditional knowledge)</td></tr>
<tr><td>8) Nested entities</td><td colspan="2">Multilevel action</td><td></td></tr>
</table>

Conclusion and recommendations

Climate change poses major challenges for maintaining Amazon's indigenous, traditional and quilombola communities' natural resource management systems sustainability. The main challenges are: the reduction in the suitability of production areas, the reduction of areas of environmental suitability and the reduction in the production of usable and marketable resources by Amazonian communities. Once these effects on production systems are perceived, mainly by the communities involved, a series of technical solutions are suggested to promote mitigation or adaptation to these impacts, for example: the use of more resistant crops, production diversification, changing the agricultural calendar, shifting cultivation location, and adpting natural resource management practices (fish, wood, non-timber products).

We argue that these technical solutions require the strengthening of governance by the communities involved in the projects, in order to be implemented and sustained in the long term, and to ensure their success. We also present five strategic points for strengthening local governance: 1) promoting territorial security and other fundamental rights for the involved communities; 2) promoting shared values and objectives concerning the project; 3) having well-defined operating rules and agreements; 4) promoting actions and solutions based on knowledge sharing; 5) connecting local governance with other forms of multi-level and multi-scalar governance.

The strengthening of local governance, combined with technical solutions provided by scientists, public policies or private sector, provides greater adaptive capacity of communities – including their forms of governance – when facing challenges imposed by climate change on their production systems (Figure 1). This strengthening is the backbone of long-term community-based management and conservation initiatives. Large-scale projects that do not engage with the local level, which is directly involved in Amazonian socio-ecological systems, are bound to fail, whether due to a lack of social reach or economic and ecological unsustainability.

In this sense, attention to local, participatory actions, aligned with the perspectives of traditional, indigenous and quilombola communities, can provide the strengthening of projects and policies of broader scope, at the level of the Pan-Amazon region. Such measures must ensure the sustainability of production methods that keep the forest standing and the rivers abundant in life forms. Considering the current climate emergency scenario, as well as the future projections for the Amazon biome, this type of engagement with communities becomes a crucial solution for addressing this crisis. Traditional communities must necessarily be included in this process, so that these projects reach their potential for recovery and maintenance of community income, thereby contributing to the ongoing mitigation of climate change.

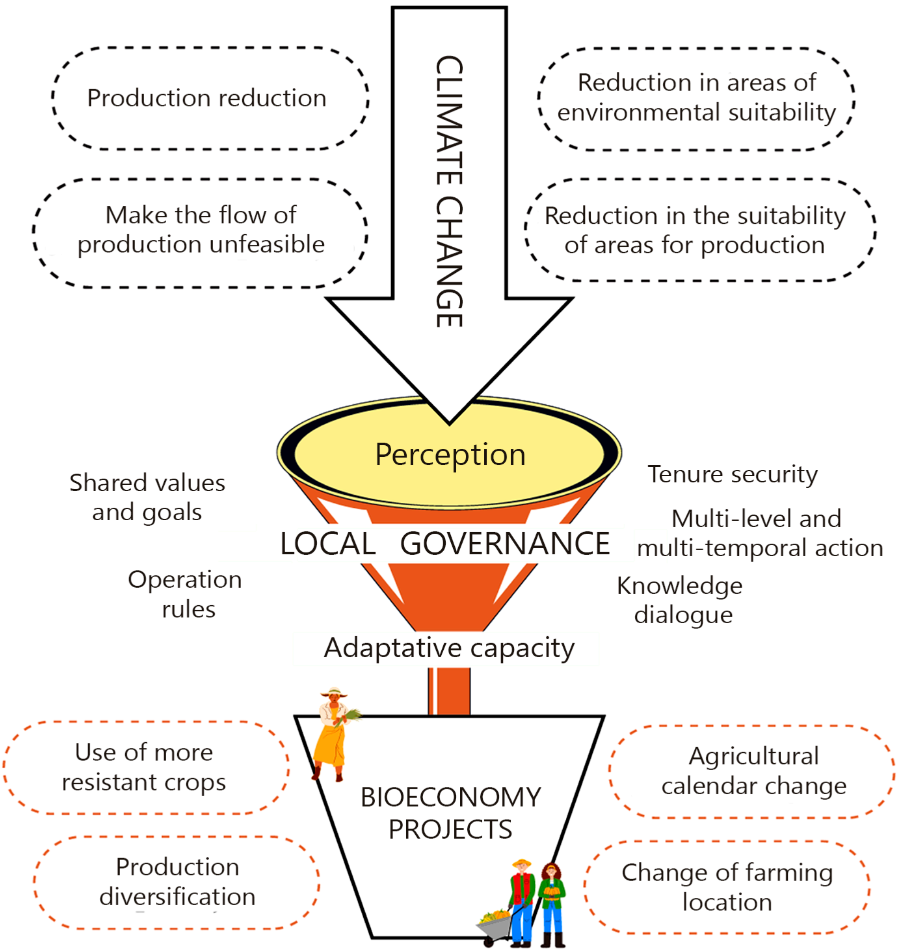

Figure 1 Illustrative summary of how local governance can overcome the challenges posed by climate change to sustainable natural resource management projects.

Acknowledgments – We would like to thank Fundação de Amparo à Pesquisa do Estado de São Paulo for encouraging the participation of São Paulo School of Advanced Science – Sustainable and Inclusive Amazonia's authors, enabling the gathering of different researchers, which culminated in the creation of this manuscript. To the speakers Marlúcia Martins (Museu Goeldi), Paulo Moutinho (IPAM), Lauro Barata (UFOPA), Helder Lima de Queiroz (Instituto Mamirauá) and Gustavo Silveira (OPAN), who shared their experiences during the elaboration of the initial idea of this proposal. The participation of Fernando Elias, one of the authors, received financial support from the BJT-FAPESPA Program (Process N° 2021/658588) at the Federal University of Pará. The authors would like to thank Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP) for supporting the project "São Paulo School of Advanced Science for a Sustainable and Inclusive AMAZONIA (Process 2022/06028-3)" and all professors and colleagues who participated in SPSAS Amazônia and contributed to the development of this work.

Author Contributions – All authors equally contributed to the conceptualization, methodology, and drafting of the initial and final versions of the text.

Conflict of Interest – The authors declare that they have no conflicts of interest related to the publication of this manuscript.

Ethics – This study does not involve human subjects and/or clinical trials that should be approved by the Institutional Ethics Committee.

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