

Cultural aspects for adaptation to the climate change impacts on the Ecosystem Services in a case study of Central Amazon

Aspectos culturais para adaptação aos impactos das mudanças climáticas nos Serviços Ecossistêmicos em um estudo de caso da Amazônia Central

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ABSTRACT

Climate adaptation tends to face resistance or produce adverse effects, if it is tested only on the generalist scientific models, ignoring its effects on the culture, values, and worldviews of local communities. This article investigates how climate change has threatened the livelihood and cultural dimensions of peri-urban communities in the Central Amazon. The analysis is based on the cultural theory of risk in climate adaptation and its relationships to local Ecosystem Services (ES). In this case study, semi-structured interviews were conducted with residents of three municipalities in the Metropolitan Area of Manaus – Brazil. Given that their diet used to be heavily based on native food, the results show how Amazonian communities are adapting their eating habits in response to climate and environmental changes to the ES decline in the category of food security (i.e., in the class of provisioning ES). In addition, these services have relevant cultural value (i.e., cultural services). The ES reduction influences adaptation strategies amid the dismantling of current environmental policies. As a result, these communities began to adopt industrialized means of production and consumption, such as adopting products derived from cattle, whose production is the main cause of greenhouse gas emissions in Brazil. Therefore, the studied case demonstrates how climate adaptation may pressure and erode local cultures, when these following the logic of globalized urbanization.

Keywords: Climate change. Ecosystem services. Cultural identities. Amazon communities. Adaptation strategies.

RESUMO

A adaptação climática tende a enfrentar resistências ou produzir efeitos adversos, se for testada apenas nos modelos científicos generalistas, ignorando seus efeitos na cultura, valores e visões de mundo das comunidades locais. Este artigo investiga como a mudança climática tem ameaçado a subsistência e as dimensões culturais das comunidades periurbanas na Amazônia Central. A análise é baseada na teoria cultural do risco na adaptação climática e suas relações com os serviços ecossistêmicos (SE) locais. Neste estudo de caso, foram realizadas entrevistas semiestruturadas com moradores de três cidades da Área Metropolitana de Manaus – Brasil. Devido à sua dieta ser fortemente baseada em alimentos nativos, os resultados mostram como as comunidades amazônicas estão adaptando seus hábitos alimentares em resposta às mudanças climáticas e ambientais ao declínio no SE na categoria de segurança alimentar (ou seja, na classe de abastecimento SE). Além disso, esses serviços têm valor cultural relevante (ou seja, serviços culturais). A redução do SE influencia as estratégias de adaptação em meio ao desmonte das atuais políticas ambientais. Com isso, essas comunidades passaram a adotar modos de produção e consumo industrializados, como a adoção de produtos derivados da pecuária, cuja produção é a principal causadora das emissões de gases de efeito estufa no Brasil. Portanto, o caso estudado demonstra como a adaptação climática pode pressionar e corroer as culturas locais, quando estas seguem a lógica da urbanização globalizada.

Palavras-chave: Mudanças climáticas. Serviços ecossistêmicos. Identidade cultural. Comunidades amazônicas. Estratégias adaptativas.

1 INTRODUCTION

Climate change models run to South America demonstrate that risk of heat stress exposure in the future scenarios was highest in Northern Brazil, where one of the most vulnerable populations is located on the continent. In a climate change perspective, the Intergovernmental Panel on Climate Change (IPCC) defines vulnerability as “the propensity or predisposition to be adversely affected.” Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and to adapt (IPCC, 2014). Therefore, adaptation represents the process of adjustment to current or expected climate change and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected climate changes and its effects

(IPCC, 2014). However, the social dimensions of climate change go beyond biophysical impacts and concern the social and structural factors fundamental to vulnerability (OTTO *et al.*, 2017), especially regarding populations with economic and cultural activities that are well tied to the ecosystem, as is the case of the Amazonian peoples.

Regarding these concepts, the increase in research on cultural dimensions of climate change reflects the understanding that the success of adaptation initiatives depends as much on social, political, demographic, and cultural factors (NOLL *et al.*, 2020) as it does on applying technologies based on biophysical solutions, such as renewable energy (OTTO *et al.*, 2020). However, scientific data have neglected local cultural aspects by standardizing the perception and the socio-environmental impacts related to climate change in a Universalist approach (ADGER *et al.*, 2013).

Thus, it tends to replay the current hegemonic model of production and consumption, where humans and nature are dualistic elements of a market, which ignores cultural identities and local and traditional knowledge. In the context of climate crisis, these manifests as a preference for scientific praxis focused on quantitative data and on provision and regulation Ecosystem Services (ES), harming Cultural Ecosystem Services (CES), which encompass the multiple dimensions of how people identify, signify and value the environment (DOUGLAS; WILDAVSKY, 1982).

Extreme weather events are examples of the connection between climate and culture since those events affect spaces that shelter cultural identities, histories, and traditions. The damage to cultural and natural heritage is sometimes irrecoverable, and the cost to human lives and to the physical and mental health of the populations affected is immeasurable (SEIXAS; NUNES, 2017). The cumulative effects include problems in water supply, outbreaks of diseases, changes in cropping systems and consequent changes in eating habits, besides population migration (BRONDÍZIO *et al.*, 2016).

Another relevant aspect is the pressure on dietary patterns caused by climate change, especially in isolated populations, who are the most affected by food insecurity and water scarcity and take refuge in urban areas (ADGER, 2013). This tendency erodes the transmission of local cultural expressions (stories, myths, songs, language, and images) due to the interruption of the process of socialization for young people who leave the countryside searching for work in urban areas. The depletion of natural products reflects on social, economic, and cultural interactions, as human well-being relies on the benefits from the natural environment, such as the provision of wild food, water, and air (KADYKALO *et al.*, 2019). Thus, generally, all these aspects represent serious risks to the socio-ecological and biocultural system.

Therefore, the general objective of this study is to understand the relationship between impacts of climate change on Ecosystem Services (ES) and their effects on the cultural aspects of the way of life of local populations. From that understanding, the specific objective was to analyse what are the adaptation strategies employed by communities due to these impacts in a case study of a peri-urban region from Brazil. The results should contribute to the resumption of sociocultural aspects in the ES management.

2 ENVIRONMENTAL RISKS, CULTURE, AND CAPACITY BUILDING

In a more technical conceptual view, risks refer to the potential for adverse consequences for human or ecological systems, recognising the diversity of values and objectives associated with such systems. In the context of climate change, risks can arise from potential impacts of climate change as well as human responses to climate change. Relevant adverse consequences include those on lives, livelihoods, health and well-being, economic, social and cultural assets and investments, infrastructure, services (including ecosystem services), ecosystems, and species (IPCC, 2021).

Therefore, considering one of the fundamental elements for well-being – food security –, climate change can affect the provisioning of ecosystem services, for example, directly, with food supply losses from varied systems and crop failures, or indirectly, with increased food prices caused by decreased supply (OTTO *et al.*, 2017). Furthermore, the logical expansion of land use on a large scale causes environmental degradation due to the expansion of means of production displacing or compromising the livelihoods of local communities and traditional peoples based on ecosystems, who are pushed to join the global community or perish (SEIXAS *et al.*, 2014). About 30 years ago, Giddens (1991) dealt with the fact that globalization distances society as a system and focuses on ordering social life in time and space. As a result, three consequences can be observed: the disintegration of national identities with cultural homogenization; the reinforcement of nationalism as resistance to globalization; and the emergence of new identity configurations.

According to Douglas (1992), the ways in which environmental risks are perceived correspond to different types of worldviews that order values, beliefs, impressions, feelings, and conceptions of a group in two dimensions: affiliation (collective) or grid (social rules). Thus, the Cultural Theory of Risk allows us to understand how different adaptive strategies guided by the cultural context in which the agents are inserted and established (DOUGLAS, 1992). Therefore, the Cultural Ecosystem Services (CES) is an abstraction and can be symbolized by people’s wishes and desires, by which culture uses elements of nature to provide vital needs such as food and to support particular lifestyles, even though the activities could degrade the very products on which people depend to live (DAILY, 2013).

The concept of CES derives from the ES, which emerged in the 1970s to fill the gaps in valuing the natural system on the political agenda (DAILY, 2013). The ES are categorized as provisioning (food, freshwater, and wood) and regulating (climate, disease control, and air quality; productive soils and nutrient cycling) (BURKHARD *et al.*, 2014; MEA, 2005). The CES also describes non-material, non-monetary, and non-tangible benefits, obtained via spirituality, reflection, knowledge, recreation, and aesthetic experiences that influence human well-being (CICES, 2018; REID *et al.*, 2005) and is classified into two categories: those related to physical and intellectual interactions with ecosystems and those related to spiritual or symbolic interactions (Table 1).

Moreover, analysing CES is a complex task since different people construct culture in different ways, depending on their ancestries, experiences, cultural heritage, age, and gender, as well as their local environment (PLIENINGER *et al.*, 2013). However, such services are fundamental to well-being in tangible and intangible way as described by Russell *et al.* (2013) in ten typologies: i) physical health; ii) mental health; iii) spirituality; iv) sense of control and security; v) learning and capacity building; vi) inspiration/accomplishment; vii) sense of place; viii) identity and autonomy; ix) sense of connection and belonging; and x) subjective sense of general well-being.

Table 1 | International Classification of Ecosystem Services

Category	Division	Group
Provisioning	Nutrition	- Crops, fish, livestock, wild food - Freshwater
	Biomass and water	- Fibres, Timber - Water (ex. domestic and industrial use)
	Energy	- Energy source based on biomass (ex. wood fuel) - Energy source based on ecosystem properties (ex. wind and geothermal energy)

Category	Division	Group
Regulating & Maintenance	Regulation of waste, toxics and nuisances	- Mediation by biota - Mediation by ecosystem
	Regulation of flows	- Mass flows (ex. erosion control) - Liquid flows (ex. surface runoff control) - Gaseous flows (ex. regulation of pollution)
	Regulation of physical, chemical, biological conditions	- Lifecycle maintenance, habitat and gene pool protection - Pest and disease control - Nutrient regulation - Air quality and climate regulation
Cultural	Intellectual and representative interactions with abiotic components of the natural environment	- Recreation and Tourism - Aesthetic and inspiration experiences
	Spiritual, symbolic and other interactions with the abiotic components of the natural environment	- Spiritual and religious values - Cultural and natural heritage

Source: Elaborated by the authors based on Burkhard et al. (2014) and Cices (2013).

A case of the relationship between nature-culture in the Amazon Forest is about how cultural beliefs and folkloric symbology drive interactions with the ecosystem. For example, myths and legends of the indigenous peoples of the Amazon that present forest guardians such as the Curupira. In addition, the Mother Nature concept, which is a Sumaúma tree, “who” is able to protect the animals, the soil, and the watershed that, together with the other trees in the forest, reduces air pollution, regulates the climate, and maintains biodiversity. “Many values emerge from cultural processes and influence assessments that support environmental behaviours and policies, which in turn influence cultural processes” (COMBERTI et al., 2015).

In this sense, the capacity building is also flourishing, from the cultural organisation of adaptation strategies to climate change. Among the adaptation types, autonomous adaptation entails the spontaneous or ongoing implementation of existing knowledge and techniques, whereas planned adaptation involves intentional efforts to engage information about present and future change considering the suitability of current and planned practices and policies often with direct government assistance (FISCHER, 2019; FÜSSEL, 2007; SZLAFSZTEIN; ARAÚJO, 2021).

3 METHODOLOGICAL PROCEDURES

The descriptive method of this study is based on precepts of the Cultural Theory of Risk model (DOUGLAS, 1992) and applied in a case study in a peri-urban region of Brazil in the cities of Itacoatiara and Silves, in the Metropolitan Area of Manaus (MAM), state of Amazonas. These cities were chosen due to their peripheral location on the urban-rural border of the Global South. The MAM underwent rapid development since the second half of the 20th century and is intensely influenced by globalization, until today. From those particular regional characteristics, we sought to highlight the mediating effect of local culture in perceiving and reacting to the impacts of global climate change that are a tendency in developing countries. Thus, the investigation was guided by three questions:

- I. How do the effects of climate change pressure ES related to the local way of life and culture?
- II. How ways of life and culture are determinant for adaptation strategies to climatic events at the local level?
- III. Which adaptive strategies were developed by these populations to maintain the food supply?

3.1 CHARACTERIZATION OF STUDY AREA

3.1.1 METROPOLITAN AREA OF MANAUS, AMAZON, BRAZIL

The Amazon is one of the few broad areas of tropical rainforest on the planet contemplating the ES supply on a local, regional, and global scale (DAVIDSON *et al.*, 2012). The case study was carried out in the MAM in the Central Brazilian Amazonia, which is representative of the study, since it still preserves traditional communities and economic and cultural identity based on the ecosystem.

The region has peri-urban characteristics resulting from the accelerated economic growth and globalization process, which began in the rubber period at the end of the 19th century (BARHAM; COOMES, 1994). This process also intensified in the 20th century, when the federal government approved the establishment of a Free Trade Zone (Zona Franca de Manaus) facilitating investments and industrialization but generating disorderly urban occupation and predatory exploitation of nature (KANAI, 2014).

Manaus is the most populous city in the North of Brazil, with an estimated 2,255,903 inhabitants and a Human Development Index (MHDI) of 0.737 (IBGE, 2021; UNDP, 2010). The city occupies an area of 11,400 km², at the confluence of Negro and Solimões Rivers, forming the Amazon River (IBGE, 2022). Located in the “heart” of the Amazon Forest, it is considered an important centre for regional development and ecological tourism. The municipality has the most thriving economy in the region, given the Industrial Pole of Manaus (Free Trade Zone), one of the largest industrial parks in Latin America, concentrating 80% of the Amazonas’s Gross Domestic Product (RIBEIRO, 2012). Currently, Manaus is the seventh-largest Brazilian city (IBGE, 2019). However, despite its position, half of the population lives in poverty (KANAI, 2014).

Cities such as Itacoatiara and Silves were selected in the sample due to exerting great economic influence within the metropolitan area. Itacoatiara is the third-largest city in Amazonas State with an estimated 104,046 inhabitants, considered medium-size, intermediate to Manaus, and has easy access to large international vessels through the Amazon River (SCHOR; MARINHO, 2013).

On the other hand, the municipality of Silves has around 9,000 inhabitants, an island city with rich aquatic diversity; thereby the local communities have fishing as their main source of subsistence. Concerning the local economy, small-scaled livestock, agriculture, extractive fishing, poultry, and plant extractives are the main activities (IBGE, 2010; UNDP, 2010), which make it an important supplier to neighbouring urban areas.

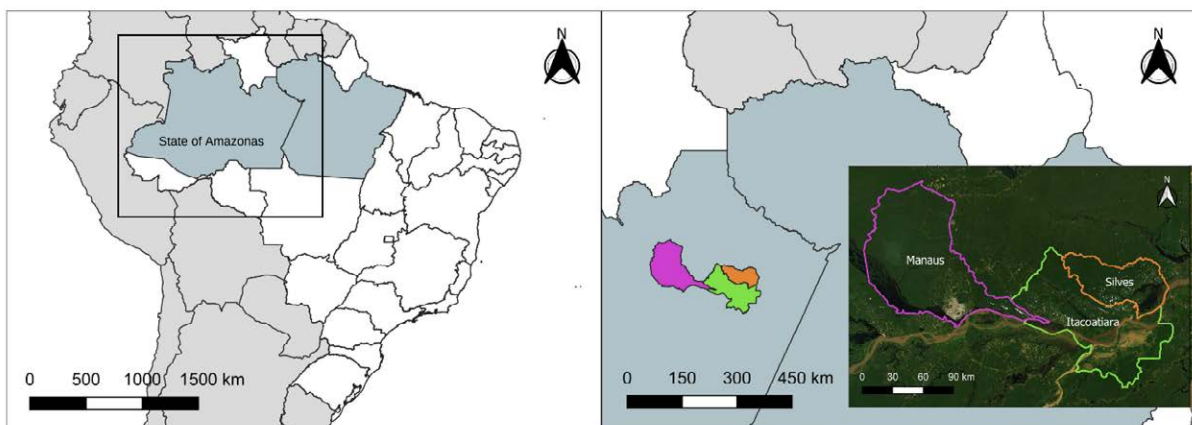


Figure 1 | Study area. Municipalities of Manaus, Silves, and Itacoatiara in the southeast of the state of Amazonas, representing the Metropolitan Area of Manaus

Source: Elaborated by the authors.

3.1.2 COLLECTION AND ANALYSIS OF DATA OF THE METROPOLITAN AREA OF MANAUS

The data was analysed with an approach of perception. Research based on perception has been employed in diverse knowledge fields (RODRIGUES *et al.*, 2012). It understands that the perception term comes from the act or effect of having a notion or consciousness of reality that surrounds people in the present or past moments and of future projections. People’s perceptions of objective reality relate to research conducted “through somebody else’s eyes” as in surveys, interviews, or many laboratory experiments. Thus, an assessment of people’s perceptions may yield significant insights into the underlying explanation of the phenomenon (MEREDITH *et al.*, 1989).

Therefore, the collected data from interviews took place from December 2019 to June 2021. The individual semi-structured interviews and participant observation were conducted with 119 local residents from Manaus (n=40), Silves (n=38), and Itacoatiara (n=41), selected by convenience sampling . A convenience sampling is a nonprobability sampling strategy where participants are selected based on their accessibility and/or proximity to the research (JAGER; PUTNICK; BORNSTEIN, 2017), as well as, having high representation in the local scale (ANDRADE, 2021). The sample was composed of individuals aged over 18 years for each municipality, and at least five years of residence in the place, including different socioeconomic profiles such as gender, education level, living place, labour situation, etc (Table 2). The participant observation aimed to establish trust relationships by enabling the collection of personal and specific information to complete all data analysis based on perception. Four questions served as a guide for the interview:

- I. What do you understand by functions, benefits, and/or services of nature for your well-being?
- II. Has there been any change in the environment and/or climate that has affected or is affecting your life and income generation?
- III. Do any of these environmental benefits no longer exist or have diminished?
- IV. If yes, what do you do to replace this natural provision to maintain your income and maintain or improve your quality of life?

The qualitative data of interviews were transcribed to spreadsheets, and codes were assigned to each response, to generate discrete or binary categorical variables, as well as continuous variables (BARDIN, 2011). The goal was to compose a dataset for ex-posterior multivariate statistical analysis of discrete and/or non-metric variables (HAIR *et al.*, 2010) by canonical correspondence analysis. The justification for using this statistical method is the graphic exploration of the collected data, which allows the recognition of trends in differences or similarities between perceptions.

Table 2 | Framework of interviewee’s socioeconomic profile

	Manaus (n=40)	Itacoatiara (n=41)	Silves (n=38)	Total (n=119)
Gender (%)				
Female	58	73	29	54
Male	43	27	71	46
Total				100
Education level (%)				
Elementary school	30	20	29	26
High school	40	40	63	48
Undergraduate degree	20	40	5	22

	Manaus (n=40)	Itacoatiara (n=41)	Silves (n=38)	Total (n=119)
Graduate degree	0	0	0	0
No access	10	0	3	4
Total				100
Living place (%)				
Rural	55	5	47	50
Urban	43	90	53	48
Urban/Rural	2	5	0	2
Total				100
Labour situation (%)				
Formal income	35	36	35	35
Informal income	65	46	60	57
No occupation	0	18	5	8
Total				100

Source: Elaborated by the authors.

4 RESULTS AND DISCUSSION

4.1 THE METROPOLITAN AREA OF MANAUS – BRAZIL PERSPECTIVE

In the Metropolitan Area of Manaus, the environment and climatic variables with the highest perception of change are related to the temperature rise (32%), unbalanced seasons (15%), precipitation rise (11%), and deforestation (10%). Secondly, extreme events (6.5%), wildfires occurrence rise (6.5%), waste quantity increase (4.5%), drought increase (3.5%), accelerating urbanisation (2.5%), precipitation reduction (2%), biodiversity loss (1.5%), and erosion (less 1%), and 4.5% did not perceive changes (Table 3). The local perception about temperature corroborates the temperature data based on the literature, which point to a trend of increasing temperature over the Amazon region, with the MAM reaching about 0.6°C increase, being higher during the dry period, in the last 40 years. The Amazon is also one of the terrestrial environments that registered the greatest rate in the process of global warming from 1980 (IPCC, 2021) due to vegetation losses, wildfires, and urbanisation expansion.

Besides, the beginning of 21st century has had marked episodes of climate extremes to droughts in the Amazon (2000, 2005, 2010, 2015), associated to warming in the tropical North Atlantic and El Niño-Southern Oscillation (Enso) (MARENGO *et al.*, 2011; MARENGO; ESPINOZA, 2016). The climate extreme impacts have resulted in losses of agriculture and extractive production; the drought has disturbed the fishing system and health has been compromised due to a lack of freshwater (MARENGO; ESPINOZA, 2016; MARENGO *et al.*, 2013; PINHO, 2016; PINHO *et al.*, 2015; TOMASELLA *et al.*, 2011).

Considering the effects of climate and environmental changes associated with well-being observed in this research (see Figure 2), outside the context of income generation, the variables of wildfires and precipitation rise perceptions showed a high connection to health issues, i.e., increase in diseases and pests (22%), and deforestation perception to thermal discomfort (20%) and effects on tourism activities (1.5%).

The answers indicated greater association to the direct effects on food culture from impacts of unbalanced seasons, drought, and deforestation on agriculture productivity and reduction of fishing

(33%) and supplies (4%) of these products, whereas perception of temperature and extremes events was associated with mobility (8.5%) and infrastructures (11%) (Table 3). As the most common means of transport in the Amazon region is the waterway, residents pointed out that prolonged drought or floods, as extreme events, hinders the access of boats with food and medical supplies to their communities (Figure 2).

Table 3 | Percentage data of perception categories of climate and environmental changes and of their effects

<i>Climate and environmental changes</i>	<i>Percentage of mentions</i>
Temperature rise	32.3
Unbalanced seasons	15.4
Precipitation rise	10.9
Deforestation	10.0
Extreme events	6.5
Wildfires rise	6.5
No changes	4.5
Waste increase	4.0
Drought increase	3.5
Accelerating urbanisation	2.5
Precipitation reduction	2.0
Biodiversity loss	1.5
Erosion	0.5
Total	100
<i>Effects of climate and environmental changes</i>	<i>Percentage of mentions</i>
Agriculture productivity and reduction of fishing	33
Increase in diseases and pests	22
Thermal discomfort	20
Infrastructure problems	11
Mobility problems	9
Supplies	4
Effects on tourism activities	1
Total	100

Source: Elaborated by the authors.

The negative effects mentioned by the Amazonian people, which are related to the climate and environmental change perception, were indirect but indicated damage to the ES, which reflected the magnitude of well-being hazards. Respondents also reported that climate change has impacted the ES supply, above all, sources of livelihood and income (source of wild, ornamental, and fishery food) (Figure 2), which influenced the search for self-adaptation strategies.



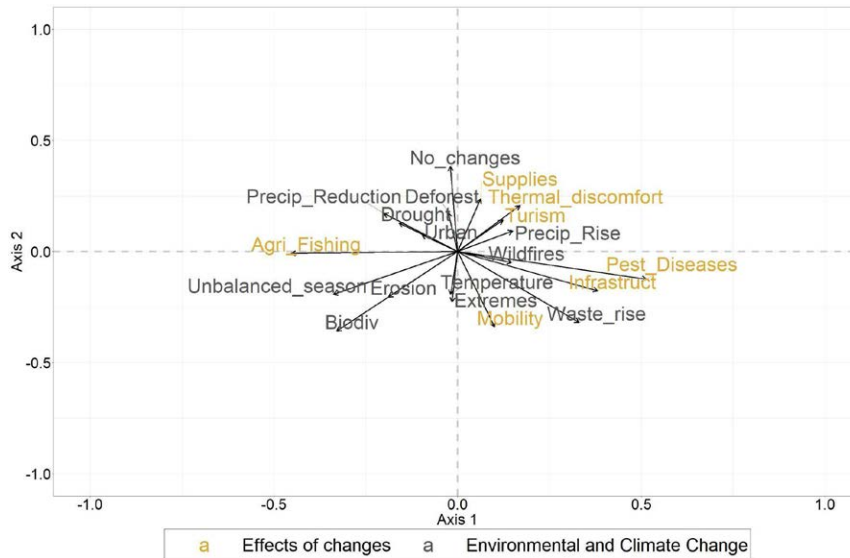


Figure 2 | Canonical correspondence analysis indicating the association of perception categories of climate and environmental change and of its effects

Source: Elaborated by the authors.

Autonomous adaptive measures are behaviours that a population adopts without explicit planning nor the assistance of either institutions (public or private), professionals, or both, all of which are focused on protecting themselves from risks. Thus, autonomous adaptation is related to perception and to the various forms of management processes before or after the occurrence of a disaster or estate change. This is because they arise from the decision-making of the community regarding their experiences (SZLAFSZTEIN; ARAÚJO, 2021).

Based on the interviews, 12 autonomous adaptation strategies (based and not based on ecosystem) applied by this population to minimize the effects of climate change could be classified (Figure 3).

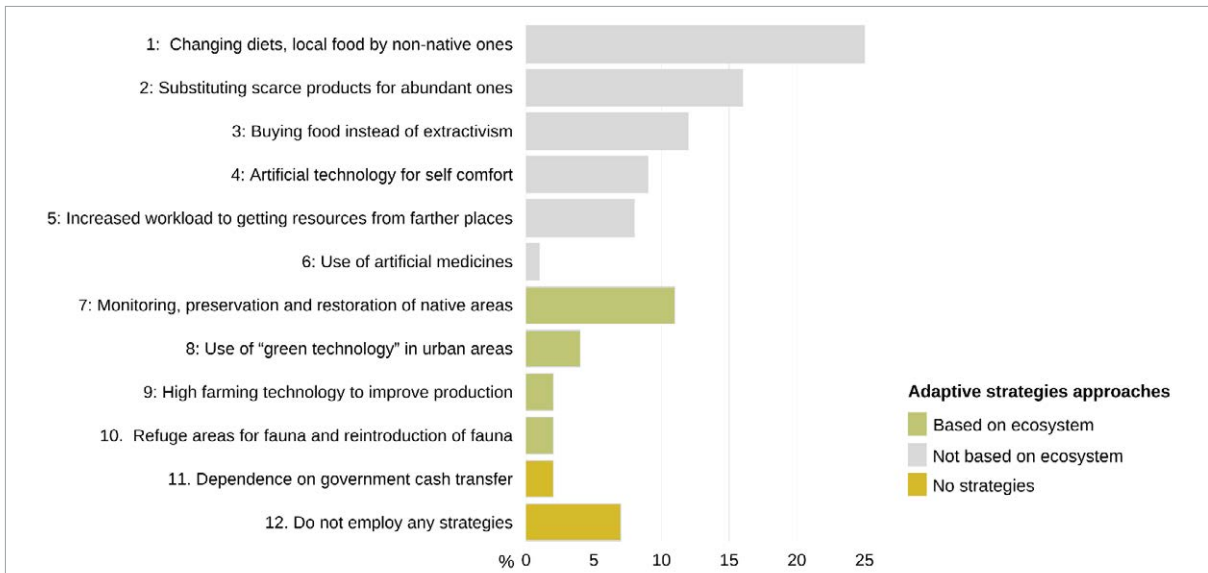


Figure 3 | Adaptation strategies employed by residents

Source: Elaborated by the authors.

The changing diet, with the substitution of local foods for non-native products (26%), is intrinsically related to the conversion or reduction of extractive activities, due to impacts on ES, to agricultural activities (cattle, chicken, pigs, oranges). Given this scenario, the respondents reported a greater

inclusion and consumption of processed foods instead of foods from extraction (12%). This is contrary to a diet historically based on the natural and cultural heritage of the local ecosystem, i.e., CES.

However, of those who still maintained their fishing habits and use of forest products as a source of income and subsistence, around 8% mentioned the increased workload in the search for resources, which are more distant and inaccessible. Thus, another strategy employed is replacing the product that is more difficult to access with more abundant ones (16%), for example exchanging Pirarucu and Tambaqui fish for Branquinha, but generating an increase in pressure on species previously less consumed.

Health consequences of diet changes were also addressed, for example, the increase in health problems related to malnutrition, such as obesity, hypertension, diabetes, and high cholesterol. This indicates that limitations in the supply of healthy foods at affordable prices increase the consumption of ultra-processed foods that are, generally, cheaper, high-sugar and -fat contents, and have low nutritional value, in addition to generating waste with packaging disposal.

The use of fans, air conditioning, and refrigerators was another measure that interviewees reported for reducing thermal discomfort and for food stock (9%). With the heat, the stock of more durable food, in substitution to local delicacies consumed fresh, generates greater use of electric energy and increased costs.

Although most adaptation strategies follow the globalization logic of commodity production and consumption, this research mentions other adaptation alternatives based on ecosystem, denoting community's interest in strengthening some cultural economic aspects of the Amazon region. Therefore, of the 12 mentioned adaptations, four have an approach based on ecosystem, which embed three macro strategies described in Table 4.

Table 4 | The three actions as autonomous adaptation strategies for climate impacts on Ecosystem Services in the Metropolitan Area of Manaus (state of Amazonas), using ecosystem-based approaches

<i>Surveillance strategy</i>	<i>Preservation strategy</i>	<i>Regulatory strategy</i>
Voluntary inspection in which the residents themselves monitor possible environmental and climatic threats, for example, stopping fishing activity during the reproductive period of fish species in the region "defeso" (closed season)	Respect for the closed season, reduced extraction of native trees and restoration of local vegetation in their own backyards or rural areas	To regulate the local climate in urban-rural areas - Planting trees (4%); - Reintroducing wild animals into their habitat (2%); - Intensive farming and use of technology in production (2%)
- Monitoring, preservation, and restoration of native areas (11%)		

Source: Elaborated by the authors.

Although many residents used their own ways, inconsistent with the characteristics of the ecosystem, for adapting to the ES decline, a relevant number of people showed engagement in environmental movements on a local scale. This demonstrates that the social dynamics of Amazonian communities is not passive to climate change, which reinforces the need for public policies to consider the ES management, preservation, and conservation valuing the cultural, and not only the material, dimension of the territory.



4.2 LESSONS LEARNED WITH THE CASE STUDY OF BRAZIL

Since collective goals driven by an individual's belief system are behind personal choices, managing food consumption is a crucial component of public policy planning with greater respect for local cultural diversity. This points to the need for adaptive solutions that reflect multiple worldviews and more collectivist adaptive strategies to overcome climate change challenges.

As pointed out by Niles *et al.* (2017), a survey of this type regarding people's cultural perception must be used by decision makers in the public policy sphere to influence adaptation and mitigating initiatives for climate change impacts. Especially if the adaptation strategies employed by residents reinforce a land use for agriculture and livestock, which is one of sectors that contribute the most to deforestation, consequently to Brazil's GHG emissions, mainly of the Amazon biome (SEEG, 2021).

Food security is evidently threatened in Brazil in regions where, historically, the population would have access to food in sufficient quantity and quality for a healthy life. In this case study, the perceptions indicate the impacts in the cultivation, hunting, and consumption in the variety of species and natural sources of food.

Notably, access to food depends on purchasing power and that a substantial portion of peri-urban populations is low-income in Brazil, for this reason it is essential to include the most vulnerable people in local environmental policies (HOFFMAN, 1995).

5 FINAL CONSIDERATIONS

Generally, the case study of one peri-urban community from a country of the Global South evinced the interrelationship between climate and environmental changes and cultural ecosystem services.

Therefore, the research tried to fill a gap in the literature on the approach of cultural ecosystem services at the intersection with other categories by integrating information about services related to provisioning and regulation services in the Amazon. The evaluating interface among the ES categories is rich in complementing the design of forest management and conservation strategies by analysing different values and trade-offs at the landscape scale based on local ecosystem services. Moreover, this article identified how local communities are adapting themselves to climate change by integrating disrupted aspects of cultural and natural heritage.

This study examines the diversity of adaptations to climate change and their effects as a cultural phenomenon. Note that the choice of an analysis on a micro scale, in which the range of actors, contexts, and interests is less diffuse, does not mean that it is not socially representative of the conditions that increase or restrict adaptive capacity (ADGER *et al.*, 2009). The perception of climate risks generated adaptive responses that triggered changes in that regional socioeconomic structure.

Thus, the intensification of regulations at the global level normalizes the rhetoric of the international community. Nevertheless, local communities continue to live in territories, which are disparate in terms of economic resources and political representation power when compared with the countries of the Global North, which are sovereign in the debate on climate change. These worldviews prevalent in politics and economics are broken down at regional, national, and local levels and adapted to multiple interests, not always suited to the realities and needs of their citizens.

Cultural processes of meaning-making remain marginalized. Although difficult to value, these intangible values may help to measure the costs and risks associated with environmental degradation as well as implement environmental policies that really attend to people's needs and expectations.

While the links between culture, values, nature, well-being, and politics are complex and the plural and fluid quality of their meanings is difficult to grasp, a more inclusive and deliberative approach to environmental policy requires a cultural change within institutions. This is because critical reflection on what shapes our individual and collective values is as essential as efforts to capture the value of ecosystems. The results indicate that these approaches are relevant elements to formulate more adequate public policies and better physical-spatial planning to manage environmental ecosystems and better manage forests and land use.

Finally, integrating Cultural Ecosystem Services in the assessment and governance of common resources, which may challenge the traditional market approaches aimed at the interests of a few, is needed.

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NOTES

1 | For culture, or a system of collective ideas, comprises notions and social norms of a group on what are acceptable, correct, and morally adjusted behaviours (PFAU-EFFINGER, 2005).

2 | Perceptions about environmental and climate change can also be analysed by individualistic or collectivist cultural positions that stimulate and shape the relationship between humans and risks (ADGER *et al.*, 2009).

3 | Curupira is a figure from Brazilian folklore, characterized as an entity of the woods that manifests itself in the form of a boy with long red hair whose main characteristic is having feet turned backwards.

4 | Peri-urban areas are zones of transition from rural to urban land uses located between the outer limits of urban and regional centres and the rural environment. The boundaries of peri-urban areas are porous and transitory as urban development extends into rural and industrial land. Source: Unesco. Available on: <https://en.unesco.org/events/peri-urban-landscapes-water-food-and-environmental-security>

5 | The Manaus Free Trade Zone (ZFM) was created by Decree-Law no. 288, of 1967, as free trade area, beneficiary of tax incentives, with the objective of occupying the Amazonian territory in 2013, the ZFM tax incentives were extended until 2073. That is, a tax incentive program has been in existence for more than half a century and is expected to last another half century. However, its effectiveness, costs, and benefits are still studied. Source: FGV Study. Zona Franca de Manaus: Impactos, Efetividade e Oportunidades. Available on: https://eesp.fgv.br/sites/eesp.fgv.br/files/estudos_fgv_zonafranca_manaus_abril_2019v2.pdf

6 | This research was conducted in accordance with the ethics commitments

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