

Ecosystem Services and Climate Change Policies in the Amazon

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Abstract: The Amazon is a region of great importance on the agenda of climate change. In this sense, the actions of local communities who value the use of “standing forest” are fundamental to the construction of models of autonomous development and adaptation to this phenomenon. Based on this consideration, this work aims to include the valuation of ecosystem services in the debate on climate change based on Brazilian Amazonian experiences, with a focus on the collection of açai in the state of Amapá. Methodologically, we start off with three conceptual procedures: we treat development as the freedom that people should have in order not to suffer substantial deprivation; we considered the territorial autonomy as fundamental for other manifestations of development to be introduced into environmental policies, such as the emergence of forest sustainability as an indicator; and finally, we treat the environment as a hybrid of nature and culture, which makes it possible to distance ourselves from the reductionist thinking that separates the social and the environmental. The results show the fragility of the chain in its local node; exposes the deficiency of public policies of incentives and recognition of non-timber forestry activity and, therefore, the emergence of new ways of thinking and phenomena such as climate change.

Key words: ecosystem services, climate change, Amazon, development as freedom

1. Introduction

Create climate change mitigation, adaptation, monitoring and control policies¹ should be a priority of States on a global scale through multilateral agreements. As the effects of greenhouse gas emissions do not have frontiers, that is, do not obey the agreements established between the States terrestrial linearity, this issue is treated as a common problem to all countries, although, as discussed in international

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¹ We treat the term as “climate change” to differentiate between changes that the population causes in the environment and the changes that occur in the atmosphere by the dynamics of nature. In fact, it is on this second issue that the skeptical theories are based on, in which they deny climatic changes provoked by the human actions.

negotiations, including the Paris Agreement, with differentiated responsibility, with transparency in monitoring the practices of all countries and with respect for human rights [21].

State leaders in actions to combat climate change, such as those reported and analyzed by Giddens (2010) [9], Great Britain, Sweden, Norway, Denmark, Iceland, among others, are creating mitigation policies for such changes through regulation of industrial activities, especially those focused on energy policy. Other countries, such as Costa Rica, which also features prominently in the emission control, have as strategy a good forest management policy and the reforestation of degraded spaces.

The 21st Conference of the Parties, held in Paris in December 2015, strengthened the debate around the commitments of countries that have policies to combat climate change, in part because of the proposal called

the Paris Agreement, presented during the Conference and placed at the disposal of the 195 countries who participated, for signature from April 2016. These trading spaces, besides being important because they provide the debate between countries, they also strengthen the interest in what each country needs to produce. Explaining otherwise, these events have a general value because, on the one hand, they are spaces where all converge to a common problem, and on the other hand, because each country is invited to dwell on their possibilities and limits in their own territory and analyze how to deal with the problem in question.

This statement puts us in front of two meanings: the first is that we won't be able to make progress on environmental issues such as climate change, without a global policy convergence for this purpose; and the second is that the fundamental subjects of this process are inserted locally, since environmental problems have a typification that only local specificities can respond, which puts this environmental issue as a multiscale problem. The "global thinking" of the international agreements only has meaning within a framework of local intervention with spatial planning measures, as well as mitigation, adaptation, management of cities, transport, production and consumption of energy, deforestation and agricultural production, coastal management, etc.

In this regard, environmental problems, widely discussed in the global negotiating arena, cannot serve as guarantors for a top-down policy where the interests of local populations are secondary to global interests. We need to think, from here, on the multidimensionality of the scales and the need for their convergence to the problem of climate change. Maybe that is the biggest challenge, as much or more than the political adjustment between the states.

Thus, as a policy of national states, their spaces are a way of thinking about this common problem on a global scale, which should be discussed on this broad scale, but whose greatest importance lies in national, regional and local scales of action. This is because,

even though many environmental problems, such as deforestation, systemically extrapolate the limits of their boundaries, it is locally that regulatory actions must be implemented. It is in this sense that global negotiating spaces cannot be a privilege of state leaders, because these are only the places of strategic thinking for policies to be implemented in other spaces and at greater scales.

To remain this logic, the separation between a space of thinking and another space of doing is maintained. In this sense, it is also necessary to promote the space of doing as an actor in the scale of thinking the global environmental problem. Regarding a document formulation, the Paris Agreement has advanced in this sense, since for the first time there is room for other actors, besides the representatives of the National States, such as Sciences Professionals and Non-Governmental Organizations, to be inserted as protagonists in the discussion and treatment of this problem. The exit of the United States from this Agreement, although regrettable, does not negate its importance.

Concerning mitigation, prevention and adaptation actions in face of climate change, we highlight two fronts to be considered in the Amazon. The first front corresponds to the regulation of activities that emit greenhouse gases, which attempts to ease the problem by controlling the causing activities and proposing new technological mechanisms. The cities are one of the main problems. They are large energy consumers and emitters of greenhouse gases. The energy production, industry and transportation are also responsible for atmospheric, water and noise pollution phenomena, which today have a strong impact on the health of populations. Contributing to the resolution of these problems is also a way of contributing to the mitigation of climate change. In this regard, we identify two points to be highlighted in this first front: the investment in promoting new technologies to adapt to climate change and encouraging proactive actions by

the productive sectors in the search for innovation: crisis as a promoter of creativity in problem solving [8].

The second front corresponds to the valorization of actions that maintain environmental services, such as those that contribute to the conservation of natural forests, mainly the extraction and valorization of non-timber forest products, and which are also part of the promotion of new creative processes, since we understand that the creativity is dominated by man in its entirety and not a technological privilege restricted to privileged human beings [8]. In the case of the treatment given to the Amazon by the Brazilian State, investments in this second front correspond to the path indicated by researchers such as Becker (2009) [4] and this is where we insert the importance of the Amazon region in this debate on climate change.

The issue surrounding the development of the Amazon has established itself as the main political and economic intervention speech with more intensity from the second half of the 20th century. With each project installed, new expectations were and still are created, when it comes to the possibilities of local transformations. This situation left the Amazon hostage to an economy of large projects, especially mining and logging extractivism — as well as livestock — and other possibilities of land use were not promoted or encouraged, given the potential for exploitation of non-timber resources from the forest, for example. These policies caused an intense deforestation in the region; according to Ab'Saber (2005, p. 77) [1], twenty years before the year 2000, about 12% of the old vegetation cover was eliminated, which, together with previous devastation, allows for a total of about 400,000 km² of forest suppression.

It is in this aspect that the development and new conceptions of nature appear as an alternative to the current development model, since they propose other indicators of development, such as the indicator of forest sustainability from the uses historically inserted by the Amazonian peoples, which can be made through the valorization of the interests of their communities

that have, as production base, means and productive techniques of low density and of low negative environmental impact. In this context, promote forms of use of the territory and alternative strategies to mining and agribusiness microprojects, focusing on household production or in other scales of social organization, cooperatives or not, is an important factor that generates income for the local population and, at the same time, also values other models of society-nature relationship. One way to achieve this is by promoting local and regional initiatives.

And how can these alternatives be embedded in climate change mitigation policies? First, we recall Anthony Giddens' concerns about the emergence of thinking and creating new development indicators so that the relationship with climate change occurs also for the promotion of activities that accompany the temporality of nature, using environmental dynamics and create income. One of these indicators would be sustainability [9], which, preserving the semantic imprecision of the concept, can be defined as the relationship between the culture of a nation and the use of nature's material substratum, without compromising the existence of both.

Sustainability, in this sense, is above all a matter of knowledge and environmental value. As this can be transformed into monetary values, capable of sustaining itself economically in the current market system, it is still a path to be constructed. Thereunto, it is necessary to overcome the logic that communities which have built an environmental knowledge capable of producing and maintaining local environmental dynamics can survive isolated from current social and economic dynamics; it is necessary to go beyond "market phobia" because, instead of isolation, this issue goes through the study of the forms of insertion. However, we understand that this is not possible without there being new development indicators introduced into the market system. One of the reasons is because the market, through the so-called "Green Economy", has already appropriated significant

environmental businesses produced by these communities, where there is an importance of dialoguing on the issue; another point is the very need to generate wealth from the material substratum of nature by these means discussed here.

From this point of view, it is argued that, particularly in the Amazon, ecosystem services can make an important contribution to climate change policies, generate income for local populations and conserve the environment. Perhaps the main thing is that these modes of production under the rhythm of the local environmental dynamics do not interfere in the emission of greenhouse gases, leaving little or nothing to contribute to the increase of these emissions. More than that, they work in favor of a conservation dynamic of forest ecosystems able to combat elevated climate change by putting themselves as alternatives to environmentally impacting economies, such as monocultures of soy, more recently the eucalyptus and the livestock activities.

Another important point is that populations carrying out activities with environmental reciprocity are often unfamiliar with the issue of climate change but are aware of local environmental manifestations. And while we know that the manifestation of environmental phenomena, especially climate change, does not occur homogeneously on the globe, the population's perception of this phenomenon should be the object of our concerns. Dialogue with the local population should be expanded, because it is on this local scale that the phenomenon of these changes manifests in its peculiarities and, in this case, it is where we can conceive this phenomenon as a multiple scale. Finally, dialogue between countries alone does not seem to be enough to fully understand them, much less to devise strategies for mitigation, control, adaptation and prevention.

In this aspect, this article raises some points about the social re-appropriation of nature from the appropriation and commercialization of non-timber forest products, based on the collection of açai fruit in

the state of Amapá. To think alternatives concerning the model of appropriation of the society-nature relationship in the Amazon means to study and encourage these strategies of appropriation to generate wealth and local development, in addition to indicators of economic growth and income, and including the way of life itself as an element of environmental value, without making it a model to be imputed to others. Regarding the discussion surrounding climate change, we conceive that these activities go beyond the boundaries of the locality because they contribute with concernment and global challenges. The actions of these local agents in the Amazon must be searched with the purpose of strengthening these populations in the ability to provide their own development and contribute to the creation and strengthening of productive activities in the region, which will give positive responses, although on a small scale, to the contemporary environmental challenges.

2. Climate Change Policy

A policy of mitigation and adaptation of the consequences of climate change is fundamental for a political action project. It must contemplate global to local actions, and especially considering the assumptions present in the Paris Agreement document, which may favor inclusion processes of actors and subjects from bottom to top and top to bottom. For this, we incorporate to this discussion the concepts proposed by Giddens (2010) [9]:

(1) A climate change policy needs a state that is safe. “The present state has to be a facilitator: its primary role is to help trigger a diversity of groups so that they come up with solutions to common problems, and many of these groups will act from bottom to top” (p. 95). In addition to acting as a facilitator of the actions of social subjects involved in environmental policies, with emphasis on climate change policies, the state needs to be a surety because this guarantees that it will not only be a stock manager, but also a fundamental actor since results must be presented. This concept

expresses that “the state is responsible for monitoring public objectives and seeks to make sure they materialize in a visible and acceptable manner” (p. 96). Actions that are aimed to control and adapt to climate change, as well as environmental issues in general, are public objectives, since they are a common need, as well as a human right: it is about how we can respond to the environmental challenges we face, and which future societies will also face.

(2) Political Convergence. “This idea refers to the degree to which the relevant policy measures to mitigate climate change overlap in a positive way to other areas of public policy, so that each can be used to make the other move forward” (p. 96). This means that a well-formulated but disconnected policy on climate change policy in relation to other policies promoted by the State and to the actions of social agents may not have an effect, since some can override the others. For example, supposing that Brazil and France make agreements for a shared management of the Amazonian forest in the space between Amapá and French Guiana to control these changes and, at the same time, continue with an energy plan based on fossil fuels. The second policy tends to nullify the effects that the former might cause. Another example comes from the Brazilian proposals within the framework of the national policy determined for the Paris agreement. Brazil, in addition to elaborating a general policy, elaborates sectoral plans for strategic areas in the country, such as the sectorial plan for the forest area. Although we recognize the importance of these policies for this sector, if they do not dialogue with the other policies, they will tend to suffer limitations or be overridden by others, such as mining policy. Policy convergence is a necessity for any environmental policy to move forward effectively.

(3) Economic Convergence. Ecological modernization, while necessary to tackle pressing problems, cannot run against the political convergence, where new forms of economy are needed. Thus, in addition to “ecological modernization”, the main thing

is to think the limits and be aware of the ecological principles of modernity. The very notion of reflexive modernization, introduced by Giddens (2012) [10] and Beck (2011) [5] helps us understand this proposal. Of the effects produced by the modernity are the environmental problems, such as the climatic changes, among other effects.

In this context of new perceptions about society and the environment, it becomes a *sine qua non* to think of new development indicators. The sustainability indicator, understood as complex of nature and culture, whose environmental values begin to direct development, is an indispensable construction. It is in this sense that, in addition to the factors highlighted by Giddens, we add socioecological practices as elements to combat climate change.

3. Climate Change and Ecosystem Uses in the Amazon Rainforest

In this environmental crisis context, the debate around the need to think about new economic uses of forests has intensified over and in the Amazon. The region appears as an object of concern at the scale of globalization because it is directly and constantly related to the problems that have gained the most evidence in the last three decades: climate change, deforestation and biodiversity loss. We believe that the problems cited above cannot be treated separately, mainly because the last two cause great impact on climate change. Thinking about the climate and how its changes affect life on Earth requires understanding the problem as complex and global — yet diversified spatially.

It is possible to identify an evidence of the Amazon on an international scale, which makes the region a constant target for discourses of foreign rulers, non-governmental organizations, multilateral organizations (such as the UN) and the Brazilian government itself. On the other hand, the development of the region has never been the focus of these policies [7] when analyzing and evaluating the various policies

already implemented in this territory by development plans, from military governments to the current government. In this aspect, it can be inferred that public policies for the Amazon use it as a strategic territory for the interests of the State and large companies, without directing the objective to the internal problems that the Amazonian population experiences. Based on this statement, we argue that when it comes to the Amazon as a strategic region in the fight against climate change, its inhabitants should be called to work on environmental issues as new opportunities for development, focusing on the insertion of the sustainability indicator as a differential value in the market.

The forest is the source of income for many Amazonian families, whether organized into larger scale chains or circumscribed to the scale of the place. Nonetheless, public policies do not address small-scale activities of forest products, since they favor large-scale projects such as eucalyptus, for example, an activity that has been expanded in the Amazon over the past decade, including in Amapá. Thus, the macropolitics are implemented in the Amazon in counterpoint to the macropolitics of local agents who historically sought the development of the region as a synonym for sustainable production of nature and its resources, a necessary condition for regional sustainability, which meets the interests of the Brazilian environmental policy within the framework of the Paris Agreement.

We believe that combining regional development and environmental sustainability requires encouraging and investing in local actions to transform the non-timber forest products and the knowledge and use that local populations make of them into a new development vector — the “socioecological vector” — considered here as the arrangement between the traditional knowledge produced about the region applied to the processing of these natural resources into income, using techniques and forms of management in symmetry with the dynamics of the nature in the

Amazon. There are many challenges in building a configuration of indicators of development based on the values of the forests and the people who inhabit them. To achieve this, it is necessary, for example, to build other conceptions and perceptions of the relationship between society and nature, which may even meet the ideas of sustainability and sustainable development that are successful today, if we consider that these are mainly of a discursive nature aimed at the green marketing.

It is a fact that the environmental issue, especially through the notion of sustainable development, managed to impose itself as an important conditioner of the action of political-economic actors, just as it has become important in the social aspect. Since the United Nations Conference on the Human Environment in 1972, also known as the Stockholm Conference, some events within the framework of the United Nations (UN) have been working to bring environmental issues into politics and economics spheres on a global scale, hence conferences, conventions, protocols, etc., with the aim of making this environmental issue an important concept of the policies of the states and, at smaller scales, the order of the territories [6, 21, 22]. For Leff (2006) [12] and Porto-Gonçalves (2004) [16], the manifestation of the environmental crisis as it has occurred has become a strategy of the actors who control the globalization process (developed countries, large companies, international organizations), transforming the environmental issue in a discourse of exclusively economical legitimacy on the globalization scale.

Thus, the proposal of an ecodesvelopment disseminated by Sachs (2007) [17] is displaced, where the effort was to seek new economic rationalities in the production for the discourse of sustainable development, where the model of use of natural resources does not change, being the only change focused on the technologies for the use and transformation of these resources, which, although recognized as important in environmental matters, will

not take account of preserving the nature. As pointed by Leff [12], this process of nature economization has generated the detachment between things, their place of reference and purpose, being deprived of the sense and use it has or could have for others, those who are not part of global market strategies. This discourse focuses on spatial structures, their organization and directly affects the populations of places that become an object of interest of external actor's strategies. It is a challenge to build solutions to environmental problems, such as the problems of deforestation, desertification and climate change, in addition to the current strategies of sustainable development.

Nonetheless, we infer that we do not rule out the State, large corporations and Non-Governmental Organizations as major actors in overcoming these challenges. On the contrary, we emphasize its fundamental role, just as we insist on the strategy of technological development in this process. Our point is regarding the concentration in these actors as the only architects of sustainability, and the fact that their actions, in the way they have been developed, did not present effective measures for the development and sustainability of the regions and the places.

The Amazon is a space marked by the execution of actions thought and commanded externally, in which the spatial interventions were and are still marked by large projects that served the purposes other than the local [1, 3, 14, 19] and social strategies that may be alternatives to large projects for the purpose of generating development conditions that address regional specificities, overcoming the logic of employment dependency coupled with the macroeconomics of space prostheses of these large enterprises. These, if the forms of implementation and their regional action are rethought they can bring contributions, but they should not remain as the only possibility to regional demands and expectations. Thus, the use of natural resources available to the local population is an alternative to income generation.

This initiative means supporting the local population

that depends on these forest products to live, helping to organize the production and, at the same time, thinking about the environment, since these activities constitute the true social use of nature. We consider this social use of nature as the relation that produces a re-appropriation of the second by the first, like other ways of being and seeing with nature and with the proper sense of development; to produce other commercial relations, even if this does not mean that there is no market (as already discussed), since non-timber forest products are part of an important productive chain that already far exceeds the local level.

It is a condition, starting from this principle, to think how Amazonian communities that live on forest resources can increase income, using forest products and providing ecosystem services with social valorization and return to the environment. Investing in this alternative implies new ways of thinking about development, moving from the restricted idea as exclusively economic growth, shifting the focus to guaranteeing human freedoms [18], where the local population can have to their disposal the means to achieve such development. It also means proposing new development indicators, such as the environmental sustainability indicator [9], considering that these actions contribute to overcoming environmental challenges, especially regarding climate change.

4. The Socio-Ecological Vector as Conservation of Nature and Prevention of Climate Change

Nature and the environment are knowledge. In the culture of the people, we find meaning in what is nature and the way in which it relates to the environment. We consider them knowledge because they are historically built and became the means in which people create their environmental values in a territory. This is the basis used by Enrique Leff for the idea of eco-communitarian society [12]. Even in the case of Amazonia, despite the fact that it is, generally,

presented as a natural, homogeneous and monotonous space [1], the innumerable interactions of the last decades involving urban and forest-related populations (gold miners, rubber tappers, farmers, manual workers) make this space a place with people and history.

Our question, then, is how the environmental knowledge of Amazonian communities can contribute in overcoming environmental problems such as climate change? In this work it is still not possible to offer answers to this question, but some paths for reflection are pointed out.

Some considerations about the complexity of climate change are drawn. Once assuming these do not reduce the issue of greenhouse gas emissions, which is normally attenuated by the insertion of “clean technologies” and alternative energy, then it is necessary to insert the knowledge they use and, at the same time, preserve nature in debates about this dilemma of our time. First, we analyze the issue of the forest while a carbon sink, supporting the idea that the deforestation itself is an important factor that contributes to climate change [11, 15], at least in tropical regions, even though authors such as Lomborg (2002) [13] do not value the importance of large forest areas in containing climate change. The defended position is that populations working with non-timber forest products, for example, create means to produce with low environmental impact, which results in environmental gains, because they follow the dynamics of the local forest ecosystem, keeping it in operation and providing undeniable ecosystem services.

In this sense, the socioecological vector would gather the conditions to offer other possibilities of uses of nature and environmental conservation through ecosystem services. It is understood as ecosystem the action in which when using the material substrates of nature for human life, does not compromise the optimal performance of the system in which the source of resources, people and other living things are inserted. In this concept, an ecosystem service does not work in the opposite direction of the dynamics of a given

environment, but uses environmental properties as a material basis for the maintenance of all existing life forms. The product of ecosystem action is a hybrid of nature and culture, of the interests of human societies, and of the environmental quality indispensable to maintaining the system.

The concept of ecosystem services contrasts with the idea of untouched nature for already inhabited spaces, since it understands nature as being the base material of life, therefore people need to find ways of existing as a systemic element. From this point of view, it is necessary to discuss the limits of the logic of conservation of nature by excluding people and territories objects of protection by public policies of integral protection. This is only possible by valuing these ecosystem services, such as those that exploit and, at the same time, preserve non-timber forest products, as previously exemplified.

Perhaps the main challenge to these strategies is how to reconcile the environmental interests of local people, the interests of external actors and the insertion in the market in question. An already established experience, such as the Extractive Reserve of the rubber tappers of Xapuri, in Acre, shows that this issue of insertion in a given productive chain is one of the main problems to be managed, both regarding the internal issues of the cooperative planning, and the negotiation of products. The same happens with the açai collecting communities in the state of Amapá (Fig. 1). The main problem detected during the research done by the first author, and by Araújo (2016) [2] and Silva (2019) [18], is the work exploration of communities in the local and global product chain. Since the public policy of the Brazilian State and the Federation units does not contemplate the valorization of communities that work with these ecosystem services, they become a fragile point in the networks of extraction, processing and marketing of the product. Here we will focus a little more on the issue of açai collection.

Açai is a fruit that, whether in the form of natural juice or in derivatives, has had an increased demand on

the global scale. One of the leading companies in the marketing industry, the North American Sambazon (based in Amapá), already sells derivatives of the product to nine countries. The main Amazonian states where the company operates are Amapá, Acre, Pará and Amazonas, also having activities in the state of Maranhão. Although Amapá has been benefited by the environment with a large amount of açaí, and the culture of the communities has allowed its conservation, these local populations represent a link of

extreme fragility in the productive chain. The way the açaí collect is sold, for example, is still made through the figure of the “middleman” who buys the product to sell it to the processing centers and, also, to companies like Sambazon. The amount generated from the sale of the product is not enough to cover the basic expenses and is far from enough for plantation, for example, which could increase production and provide seeds for reforestation.

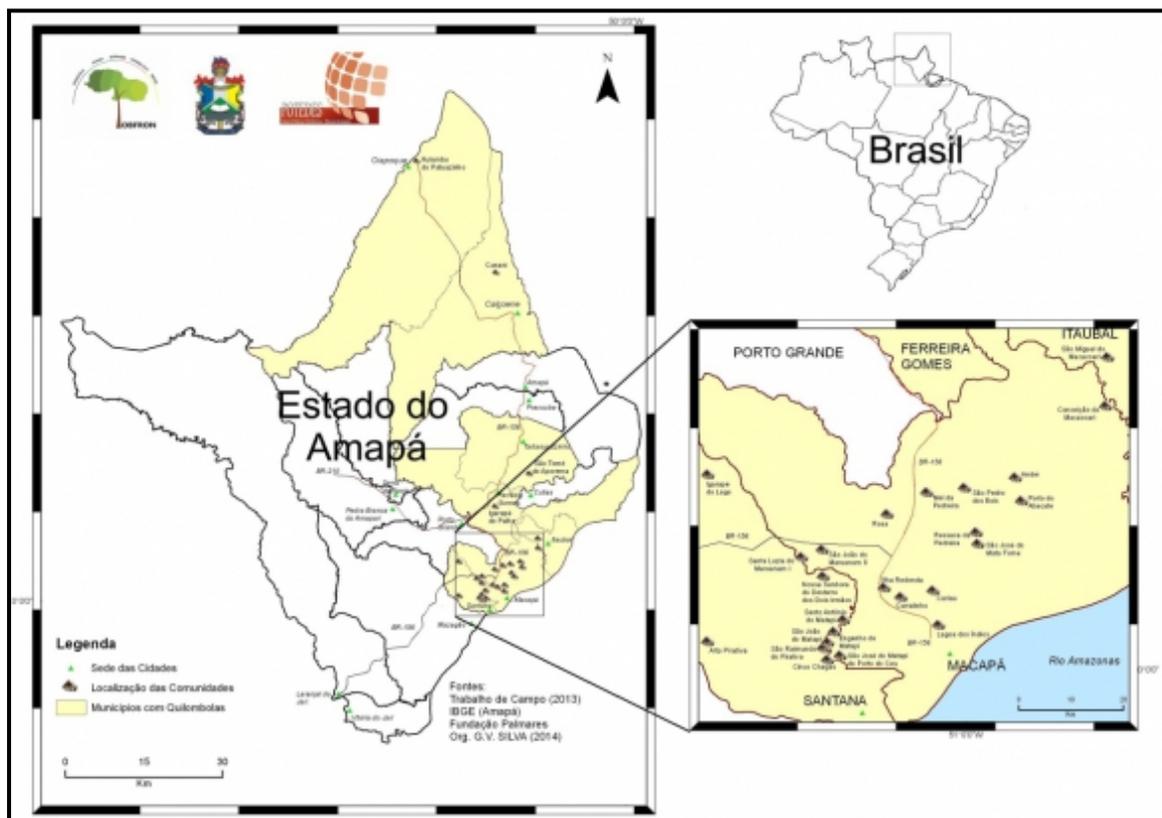


Fig. 1 Amapá: quilombola communities that produce açaí fruit [20].

This brief mention of the exploitation of the work of açaí collectors makes it possible to reflect in two directions. The first is that the ecosystem service provided by the community for the environment is not an element of added value to the product, precisely because the logic of the current market sustainability is displaced from the cultural values that produce forms of seeing and being in nature. The second is that the environmental policy of the Brazilian State also does not incorporate the knowledge of local communities as

a strategic element of environmental conservation, nor as valuable work capable of producing income for the communities.

These factors may reflect directly on climate change, when we consider the issue of complexity and political and economic convergence. The valuation of non-timber forest products has the potential to generate income from forest conservation and provide for its ecosystem maintenance, in which climate changes are included. To illustrate, if more income comes from the

forest without compromising its systemic quality, less deforestation is practiced. The same way that it contributes to the quality of the air, to the maintenance of rains, protection of water bodies, etc. And all this has adherence to the issue of climate change.

However, even in this case, the question of convergence arises. Although the collection of açai is an activity of great ecosystem importance, its circulation to the processing centers still occurs through means of transport that represent high potential of pollution: boats with risk of leakage, besides being highly polluting regarding the emission of atmospheric pollutants. This simple example serves to illustrate how environmental issues cannot be addressed in a single or isolated way.

5. Final Observations

A policy for climate change needs to be complex, in the sense that it needs to go beyond the specific and isolated interventions in the environment. Establishing a convergence policy for climate change is a condition for its combat and adaptation.

One of the policies that can converge to climate change is a public policy for ecosystem actions. They exist as a historical practice in the Amazon and need to be recognized and appreciated as services provided to combat environmental problems. Public policies to promote these services will act as autonomous territorial strengthening measures, since they will give economic empowerment and valorization of the activities developed. It also means enabling the development of substantive liberties [18] of individuals by eliminating economic vulnerabilities (deprivations) to which people are subjected to: health prevention and treatment of diseases, elimination of hunger, empowerment of women, etc.

The açai case, in which we highlight the collecting communities of Amapá State, manifests the Brazilian State's choice regarding environmental policy, still based on measures of combat and control that prevents access to services and maintains the Cartesian thinking

that separates society and nature. One consequence of the non-inclusion of ecosystem services in environmental policies to combat environmental problems is the undervaluation of work in the production chains of services provided, which expresses the very reductionist nature of these environmental policies and the idea of sustainability. Sustainability in the current environmental policy is reduced to the insertion of technologies and uses of materials with less environmental impact, lacking the insertion of environmental knowledge as a fundamental dimension of sustainability.

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