Is exploration in the Brazilian Amazon the best energy solution? Case study in the Cajuhiri indigenous land crossed

A exploração na Amazônia Brasileira é a melhor solução energética? Estudo de caso na terra indígena Cajuhiri atravessado

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Abstract
The Amazon is one of the last frontiers of untapped natural resources, with enormous cultural and biological diversity. In Brazil, policies for occupying the Amazon followed the developmental model of exploiting natural resources. Oil resources in the Brazilian Amazon, mainly in the Solimões sedimentary basin, converge with the interests of a market centered on fossil fuel, which puts the lives of indigenous peoples and their territories at risk. The present work analyzes the impacts on the socio-ecological systems of the implantation of a gas pipeline in indigenous territories. A case study of the Cajuhiri Atravessado Indigenous Land was carried out, supported by the socio-ecological system approach (SSE) proposed by Ostrom to analyze the impacts on the ecosystem. The study allows concluding that the process of capitalist development in the region has been causing decisive effects in the loss of identity, territory and indigenous culture.

Keywords: Brazilian Amazon. Pipeline. Indigenous Lands. Socioecological Impacts.

Resumo
A Amazônia é uma das últimas fronteiras de recursos naturais inexplorados, com enorme diversidade cultural e biológica. No Brasil, as políticas de ocupação da Amazônia seguiram o modelo desenvolvimentista de exploração dos recursos naturais. Os recursos petrolíferos na
Amazônia brasileira, principalmente na bacia sedimentar do Solimões, convergem para interesses de um mercado centrado em combustível fóssil, o que coloca em risco à vida dos povos indígenas e seus territórios. O presente trabalho analisa os impactos sobre os Sistemas socioecológicos da implantação de um gasoduto em territórios indígenas. Realizou-se um estudo de caso da Terra Indígena Cajuhiri Atravessado, suportados pela abordagem de sistema socioecológico (SSE) proposto por Ostrom para análise dos impactos no ecossistema. O estudo permite concluir que o processo de desenvolvimento capitalista na região vem causando efeitos decisivos na perda de identidade, território e cultura indígena.


**Introduction**

The Amazon is considered one of the last frontiers with vast and rich areas that are commercially unexplored or underexploited. It has an immensity of telluric resources, water, mineral wealth, fauna and flora, peoples and traditional communities. It comprises a unique set of landscapes and interdependent socio-ecological dynamics, configured by a diversity of actors, ecosystems, land uses and natural resource management practices (ATHAYDE et al., 2016). However, if on the one hand the Amazon presents this unique dimension of grandeur, on the other hand it continues to be a socially deprived region, with low quality of life, lack of opportunities for the population, the scene of socio-environmental conflicts and serious processes of degradation environmental (PEREIRA, 2014).

In addition to being a region of global superlatives that hosts enormous cultural and biological diversity, the Amazon is also a relatively untapped source of energy for Latin American countries (ATHAYDE; MATHEWS; BOHLMAN, 2019). The Amazonian countries concentrate vast oil reserves; which, due to the nature of the exploration, pressure and threaten the ecological balance and the communities that live in the region (JACOMINI, 2020).

In Brazil, the policies for occupying the Amazon implemented over the last few decades and most of the government programs to develop the region were and are designed according to developmental models of exploitation of natural resources. The Brazilian Amazon region is home to the largest hydrographic basin, the largest biodiversity reserve on
the planet, and the largest proven terrestrial reserve of oil and natural gas\(^2\) of the country (OLIVEIRA, 2016). Petroleum resources in the Brazilian Amazon, mainly in the sedimentary basins of the Amazonas and Solimões, converge with government interests, making it possible to establish a market centered on the production of natural gas. The prospecting and exploitation of such resources, however, is not a consensus with local actors, such as civil society organizations, indigenous, quilombola and riverside communities, who dispute their very existence in the region (AMAZÔNIA, 2020).

In 2020, the Energy Research Company (EPE) carried out a Strategic Environmental Assessment in order to subsidize future concessions in the Solimões Sedimentary Basin. The study highlights the high risks of oil activity in the region, which, for example, identified 164 indigenous lands in its area of strategic influence, of which 101 are still not regularized with Funai (EPE, 2019).

A survey carried out by the Instituto Socioambiental (ISA, 2018) points out the threats to the lives of indigenous peoples and their territories. Infrastructure works planned for the coming years directly affect areas where there are records of the presence of these populations. There are 123 projects, including hydroelectric, thermoelectric, railways, waterways and highways, which will impact protected areas where 58 different isolated peoples live (ISA, 2018). Many of these works do not carry out consultations and consent with the affected indigenous peoples, or do the least, not providing the necessary clarification to these peoples and other traditional populations to give their opinion or prepare for the impacts and opportunities that may be generated by these undertakings.

According to the PNE 2030, in Brazil, the supply of hydraulic energy will continue to account for around 70%, while conventional thermoelectric generation (nuclear, natural gas and mineral coal) expands its share from 7% to around 15% (EPE, 2020). Indicating that the Thermoelectric Power Plants have a great trend in growth. This trend is partly justified by the so-called Isolated System, which is concentrated mainly in the Amazon region, which due to its geographical characteristics composed of dense and heterogeneous forest, in addition to large and extensive rivers, made it difficult to build transmission lines of great length that would allow connection to the National Interconnected System (ANEEL, 2008).

In order to exploit the potential of the oil equivalent basin, especially natural gas, the Urucu-Coari-Manaus Gas Pipeline was built, which crosses seven municipalities in the interior to the capital, covering an area of approximately 700 km (Figure 1). The gas pipeline

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\(^2\) Natural gas falls into the category of fossil fuel that is available in nature, usually in deep reservoirs located underground, associated or not with oil (EPE, 2021).
is a network of pipes, transporting natural gas from the Solimões Basin, province of the Urucu River, from the city of Coari to the city of Manaus, that is, from the producing sources to the consumer centers. Along the implanted pipeline, branches were made to supply the thermoelectric plants in the municipalities of Anamã, Anori, Caapiranga, Codajás and Coari (EPE, 2019).

Figure 1 – Urucu-Coari-Manaus Gas Pipeline and its area of influence.

The gas pipeline represents a significant change in the energy matrix of the State of Amazonas, allowing the replacement of diesel oil and fuel oil by natural gas for the generation of electricity, mainly. The implementation and activities of the gas pipeline require the development of an entire infrastructure composed of natural gas producing wells, surge lines, transmission lines, thermoelectric plants, effluent outfall pipes, pressure regulation stations, waterway terminals, roads, substations, with the objective of using natural gas. However, the environmental impacts of these pipeline implementation and operation activities include deforestation, contamination of soil, water and air, loss of biodiversity, changes in species distribution, conflicts between indigenous peoples and traditional peoples (Jacomini 2020). In addition, one of the risks of gas pipeline projects is oil spills, a type of incident that

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3Here we understand the whole set of actions aimed at the production, storage, transport and use of natural gas, as well as the flow of people, goods and services.
happened with some frequency in the Amazon Rainforest areas of Peru and Ecuador (Fearnside, 2020).

Among the social impacts are the processes of social decomposition, migration and the establishment of new community settlements, which, in turn, facilitate access to natural resources through the construction of road infrastructure, resulting in additional environmental impacts. The Environmental Impact Studies (EIA) of the Urucu-Coari-Manaus gas pipeline considered the areas real or potentially threatened by the direct and indirect impacts of the implementation and operation of the enterprise, as well as the associated activities, area of direct and indirect influence, only 10 km for each side of the undertaking's right of way, an area contained between the Juruá and Tefé rivers (Petrobras, 2008). However, the study carried out by the Instituto Socioambiental (ISA) shows that the installation of the 19 thermoelectric plants planned for the Amazon could impact 17 territories with records of isolated indigenous peoples (ISA, 2018). Demonstrating that the environmental impact study prepared, when installing the gas pipelines, presents flaws in the analysis of the impacts and the territorial limits established by the licensing body.

For Barth (2000) the borders on which we should focus our attention are evidently social borders, even though they may have a territorial counterpart. In this sense, from a social point of view, the problems are not minor. Among them, the impacts on traditional peoples and communities stand out, in particular, on the indigenous component. In this context, this research aims to analyze the impacts on Indigenous Land Cauhiri Atravessado resulting from the implementation of the Urucu-Coari-Manaus Gas Pipeline in the Amazon region from the point of view of socio-ecological systems. The approach used was the impacts to the Socioecological System (SSE) established by McGinnis and Ostrom (2014).

1.1 Socioecological Systems

Socioecological systems (SSEs) are complex and integrated systems in which human beings are part of nature and where there is interaction between cultural, political, social, ethnic, economic and ecological factors. They can be conceptualized as systems composed of nested hierarchical elements: units of (natural) resources and (human) users, resource systems (linked human-natural systems), governance systems, and wider social, economic, and political configurations at different scales (Athayde; Mathews; Bohlman, 2019).

The notion of socioecological system can contribute to the understanding of a region where geographic and temporal scales, social actors, economic factors and environmental...
conditions interact in a chain (ATHAYDE et al., 2016). In this sense, the Amazon region over the decades presents a reality in constant transformation, where multiple interest groups interact in pursuit of multiple objectives; where biophysical factors affect and are affected by these social and economic activities; and where multiple factors, internal and external, coming from local, national and international scales influence its dynamics (BUSCHBACHER, 2014).

Compared to traditional methods, the evaluation based on socioecological systems differs because it is a structure that makes it possible to analyze a common set of potentially relevant variables and their subcomponents in order to identify alternatives to expand sustainable policies according to the specificities of a given system (OSTROM, 2009). McGinnis and Ostrom (2014) present an SES approach based on a broad framework in determining socioecological system interactions and outcomes, to explain the necessary conditions for user cooperation in natural resource management. This approach can be useful to understand the environmental problems of a given system and especially in conflict management.

In the revised SSE framework there are top-tier components: Resource Systems, Resource Units, Governance Systems, and Actors are the higher-level variables that contain other lower-level variables. Action Situations are where all the action takes place as inputs are transformed by the actions of various actors into outcomes. It also considers the exogenous influences that may arise from the dynamic operation of processes on larger or smaller scales than the focal SES (MCGINNIS; OSTROM, 2014).

The fundamental question of the structure is to identify which variables of these multiple levels influence the behavior of actors and the socioecological results that are generated over time, in specific ecological and social domains (OSTROM, 2007).

Methodology

2.1 Case Study

The study area of this research is the Cajuhiri Atravessado Indigenous Land (figure 3) with emphasis on the effects caused by the implementation of the Urucu-Coari-Manaus gas pipeline. The TI Cajuhiri Atravessado is located (Figure 2) in the municipality of Coari, in the state of Amazonas. To the North it borders the Solimões River, to the South with Lake Coari, to the East with the property recognized as Emílio Nunes Seco and to the West it borders the town called Apaurá and, still to the east, it follows the natural limit of the Amanuí stream (TÁPIES, 2009).
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Amanuhi). In the East-West direction, the indigenous land is cut by the Urucu-TESOL Polyduct, owned by Petrobras.

The TI Cajuhiri Atravessado, with 12,455 hectares of territory, was demarcated by Decree s/n of 12/17/2015 (DOU 12/18/2015). In all, the indigenous group that lives today in the Cajuhiri Atravessado Indigenous Land totals fifty-one people, who belong to three ethnic groups: the Miranhas, the Kambebas and the Ticunas (EPE, 2019). This indigenous group has in its territory the traditional use of fishing, hunting, plant extractivism, swidden sites, extractivism sites, sacred places, and a rich hydrography in the region, as shown in the mapping shown in figure 2 (EPE, 2019).

![Figure 2 – Location of Indigenous Land Cajuhiri Atravessado and Areas of Traditional Use of TI Cajuhiri Atravessado. Source: EPE, 2019.]

2.2 Methodological Procedures

The research used the theoretical approach (framework) of the Socioecological System (SSE) proposed by Ostrom (2009) to analyze the impacts on the SSE Terra Indígena Cajuhiri Atravessado (figure 3). The local socio-ecological system affected by the project was defined as the one related to the area of direct influence of energy generation. Although we recognize that the areas of influence are in the Cajubiri indigenous land, we can expect significant impacts on the ecosystem.
The characterization of the system was carried out for two different moments: (1) before the beginning of the installation of the enterprise and (2) after the beginning of the operation of the enterprise. For both, the scope of the local socio-ecological system is the same. The components of figure 3 are the most cited in the literature review on consequences in oil development sites.

The information necessary to carry out the description and analysis of the SSE elements was obtained through a documental and bibliographical review on the topics relevant to the study. The document analysis, the largest source of data for this essay, comprised two stages. Preliminary analysis, with a critical evaluation of the documents regarding the theme, authors, authenticity and reliability and later an analysis in which the interpretation applicable to the case study is carried out (CELLARD, 2008).

<table>
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<tr>
<th>Evaluated Elements</th>
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<tr>
<td><strong>Resource Systems</strong></td>
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<tr>
<td><em>Indigenous Territory</em></td>
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<tr>
<td><em>Indigenous Culture</em></td>
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<tr>
<td>restricted areas</td>
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<tr>
<td>ethnic identity</td>
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<td><strong>Governance Systems</strong></td>
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<tr>
<td>Environmental Licensing</td>
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Results and Discussion

3.1 Impacts on the Indigenous Component

In the document Environmental Study of the Sedimentary Area in the Solimões Terrestrial Basin (EAAS Solimões), the Energy Research Company (EPE), based on data from the National Indian Foundation (FUNAI) presents a total of 738 Indigenous Lands in all existing denominations in Brazil (indigenous lands, prohibited areas, lands under study, indigenous reserves and domain areas), with 163 located in the state of Amazonas and, of these, 35 in the study area of the Solimões Sedimentary Basin. It also points out that there are about 28 groups of indigenous people living in isolation, but the CIMI (2017), states that there

|----------------|---------------------|-----------------------|-------------------------------------|------|-----------------|--------|-------------|-------|---------|---------|
are more than 213 in the Amazon, most of which comprise the Javari valley, upper Solimões, interfluves between Juruá and Purus in the Amazonas (EPE, 2019).

EAAS Solimões is in line with the concept of Strategic Environmental Assessment (SEA). The SEA has a more comprehensive territorial analysis, which seeks to reflect on public policy strategies for regional development and aims to contribute to the decision-making process and conflict reduction during environmental licensing (FEARNSIDE, 2020).

In the Report on the Environmental Impacts of the Urucu-Coari-Manaus Gas Pipeline, the survey of aspects related to indigenous issues presented some of the existing ethnic groups in the area of direct influence of the Gas Pipeline route, only the indigenous localities of the municipalities of Coari, Anamã were considered in the study and Manacapuru that are in different situations, that is, demarcated indigenous lands, and in the process of demarcation and identification (PETROBRAS, 2014). Petrobras' own report identifies that in the municipality of Manacapuru three indigenous areas were identified: Jatuarana, São Francisco and Fortaleza do Patauá. In the municipality of Anamã, an indigenous area called Ilha do Camaleão was identified. In the municipality of Coari, an indigenous area called Cajuhiri Atravessado was identified, and eight other indigenous lands in the preliminary identification process.

The increase in anthropic activities, especially those related to the gas pipeline and adjacent infrastructure, negatively impacts areas of traditional use, compromising their ability to sustain the activities carried out by indigenous peoples. They bring additional pressure on the possibility of conflicts of use between indigenous and non-indigenous throughout the region.

The intensification and expansion of activities in the oil industry can make indigenous peoples more vulnerable, especially in the SSE of the Cajuhiri Atravessado Indigenous Land, which can be described according to the items in the SES framework below.

### 3.1.1 Focal action situation, interactions and results

Using data and information present in the environmental licensing (PETROBRAS, 2008), as well as documents from indigenous associations (COIAB, 2012), it was found that for the case under analysis the focal action situation is the conflict over the territory and its resources due to the impacts resulting from the implementation of the Urucu-Coari-Manaus gas pipeline (EPE, 2019).
In the documentary review, it was also verified the little (how much?) expressive participation of indigenous peoples in the licensing process. Petrobras carried out insufficient mitigation measures regarding the socioeconomic and cultural reality of the indigenous peoples affected by the project, according to the COIAB opinion with the following words:

“The Environmental Impact Study is, therefore, inadequate in terms of understanding the current dynamics of the indigenous peoples of that region, as it did not have the capacity to measure the actual impacts that the project could cause them. Nor did it deepen the understanding in relation to the conception of traditional forms of territorial occupation, not only within the limits of the territory, but beyond this specific occupation of legally recognized lands. It is necessary to know the way in which indigenous peoples guarantee their social organization, determine social, political and cultural relations between territories and communities. In addition, the planned protection measures are surprising due to their weakness and inconsistency in relation to the size of the impacts indicated in the EIA/RIMA, even more so in relation to other impacts not identified in the document” (COIAB, 2012).

According to our case study and in other studies carried out (BRAGA, 2018; COIAB, 2012; EPE, 2019), several harmful situations were identified for indigenous populations in the area of influence of the Coari-Manaus Gas Pipeline project, which are listed below: 

i. attracting indigenous people to the construction site and the cities of Coari, Anamã and Manacapuru, contributing to a process of “caboclarização” and loss of the ethnic identity of these indigenous groups;  
ii. increased pressure on the natural resources of indigenous lands and adjacent areas, such as wood, hunting and fishing, with a view to opening “roads” for the implementation of gas pipeline pipes, which may become passageways for outsiders;  
iii. establishment of undesirable interethnic relations between indigenous and non-indigenous people, considering that the mobility of indigenous people in the Amazon is a fact, as they are capable of covering long distances in the forest and on rivers;  
iv. threat to the physical and cultural integrity of indigenous peoples with little or no contact with other ethnic groups in the region and with non-indigenous people; 

v. change in the cultural patterns of the indigenous populations, who periodically go to the city to sell their products, such as manioc flour and chestnuts, in the face of new habits, such as the consumption of industrialized goods, including superfluous ones;  
vii. presence of Petrobras workers or people working for that company in the indigenous land; 

viii. changing demographic flows, which can lead to conflicts between indigenous peoples of different ethnicities and customs;  

ix. risks of accidents in the pipes and keys of the gas pipeline, with the total impossibility of providing immediate assistance to indigenous populations;
ix. also risks of environmental accidents, with irreversible damage to the Solimões Hydrographic Basin, lakes, streams and Paraná;

x. weakening of the indigenous movement of Coari and Médio Solimões, which was in the process of expansion, as a result of the direct impacts of the project on the different villages;

xi. reduction of hunting territories, due to the construction of “roads” through the gas pipeline, as the fauna is chased away with the cutting down of the forest;

xii. deceleration trend in the demarcation of Indigenous Territories due to the commercial exploitation of the region;

xiii. aggravation of animosities of the indigenous populations, who inhabited the area of influence of the project, against Petrobras, since there was a lack of interest on the part of the company in indemnifying the Miranha, from the indigenous land Cajuhiri Atravessado, impacted by the construction and operation of the Polyduct, that crossed the land of the Miranha;

xiv. resurgence of a negative image of the Indian fostered by the population of the cities, when viewing the Indian as an enclave for development or “backward”.

Obviously, the effects of the environmental impacts of a gas pipeline go beyond the “simple” limits presented in the EIA/RIMA. The indigenous populations reached by the area of influence of the gas pipeline remain uncertain about the real social and environmental costs of the undertaking (ISA, 2021).

### 3.1.2 Resource system

The resource system is delimited by the Cajuhiri Atravessado Indigenous Land, which is part of the Solimões Basin (Sedimentary and Hydrographic). The territory was cut by a Petrobras pipeline, impacting the potential of areas traditionally used by local indigenous peoples.

### 3.1.3 Natural resource units

The affected resource units are related to natural resources, however, the studies do not provide specific information for the Cajuhiri Atravessado Indigenous Land. In the EIA/RIMA there is no depth of specificities of the fauna and flora resources, and these present only an overview of these groups. In the EAAS Solimões (EPE, 2019), in the Indigenous
Land of Cajuhiri Atravessado, the existence of land conflicts and extractivism with non-indigenous local residents is highlighted; and with Petrobras, due to the gas pipeline that crossed a certain area of land, destroying the chestnut groves, an important area for the nutritional base and for the maintenance of indigenous cultural practices. In addition, there are immediate impacts related to natural resources, such as: the loss of biological diversity, the death of fish and fauna, reptiles, amphibians, birds and mammals, invaded territories, deforestation, logging, fishing without authorization by commercial fishermen, conflict by areas of common use such as fishing areas.

### 3.1.4 Actors

The main actors involved are Indigenous Peoples, Petrobras, FUNAI, IPAAM and COIAB, identified as the most relevant actors in the scenario, as shown in Table 2.

<table>
<thead>
<tr>
<th>Actor</th>
<th>Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indian people</td>
<td>Indigenous peoples holders of the use and rights of the territory</td>
</tr>
<tr>
<td>Petrobras</td>
<td>Company in the energy segment, which operates primarily in the areas of exploration, production, refining, marketing and transport of oil, natural gas and its derivatives</td>
</tr>
<tr>
<td>FUNAI</td>
<td>Guarantee the rights of indigenous peoples.</td>
</tr>
<tr>
<td>IPAAM</td>
<td>Supervise irregular fishing, hunting and deforestation activities, with a view to protecting the environment. Works in the area of licensing and environmental control.</td>
</tr>
<tr>
<td>COIAB</td>
<td>Defend the rights of indigenous peoples to land, health, education, culture and sustainability, considering the diversity of peoples, and aiming at their autonomy through political articulation and strengthening of indigenous organizations.</td>
</tr>
</tbody>
</table>

Table 2 – Actors and their performance.
Source: Prepared by the authors (2023).

In the EAAS Solimões (EPE, 2019), indigenous groups reported that their villages are located at a great distance from the municipal headquarters and do not have the participation or contact with public administration actors (FUNAI, IPAAM and Public Ministry). During the construction phase, Petrobras should involve an anthropologist, with the endorsement of FUNAI. Neither Petrobras nor FUNAI acted in this regard. COIAB proved to be the most active actor, issuing and forwarding an opinion on the consequences of the gas pipeline for indigenous peoples to the Federal Government and the Public Ministry (COIAB, 2012). Other actors were also present throughout the process, namely: Federal Public Ministry, Funasa, riverside people, indigenous associations, among others.
3.1.5 Governance system

Petroleum activities in the national territory are constituted by a set of norms that address aspects of safety and operational and environmental management. With special attention to Environmental Licensing, which manages governance among all actors. Governance in the region is exercised by governmental and non-governmental institutions that, depending on the activity, constitute governance networks of greater or lesser density. In the EIA/RIMA presented there is a lack of information and considerations regarding isolated Indians in the region, as well as information about the consultation process and free, prior and informed consent with the indigenous community. Despite four indigenous organizations found for the TI region, it was not possible to find information about the performance of these institutions (Petrobras, 2008).

According to COIAB, environmental licensing, the main governance instrument, based on the EIA presented by Petrobras, had a series of criteria that were not respected, causing deficiencies in relation to the information addressed regarding the reality of indigenous peoples located in the area of influence of the enterprise. Furthermore, the information presented in the EIA/RIMA is insufficient to measure the impact that will be caused, thus threatening the integrity of indigenous peoples (COIAB, 2012).

3.1.6 External factors

The oil industry is one of the most influential and powerful in modernity (Lovelock, 2010). Large projects for the exploration of fossil resources generate political and economic variables that are exogenous to the SES and that exert pressure on different actors. This pressure from exogenous variables (political and economic) has historically been presented for energy issues in the Amazon region to the detriment of social and environmental issues, often being justified by their contributions to the “developmentalist” model employed in the Amazon region since the beginning of the 1990s. 70.

Political and economic pressures in the region accelerate potential issues of conflict and uncertainty among actors and influence governance systems. The political and economic influence surrounding the design of large enterprises in the Amazon is usually biased when choosing which scientific information to include in decision-making in governance systems, especially in environmental licensing rules and in the actors who represent the State. These external factors commonly overlap with preferences of local resource users. It is worth
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remembering that the gas pipeline will cross one of the most preserved regions of Amazonas (the Solimões river basin), and the political and economic pressures of actors with greater power and influence, in this case Petrobras, a state-owned company of the Federal Government, will have impacts on resource users, particularly indigenous peoples.

What is perceived is that the strategic decisions for the Amazon region regarding large infrastructure projects are influenced by exogenous variables and occur in an attempt to limit the power of populations and movements of local actors.

**Final Considerations**

The Amazon is not isolated from the impact of infrastructure megaprojects and extractive industries, such as the construction of roads and roads, the installation of hydroelectric plants and concessions for mining and oil extraction (JACOMINI, 2020). Historically, the big projects: hydroelectric plants, gas pipelines, highways, railroads, colonization, logging and prospecting under the aegis of capitalist development in the Amazon brought two premises to support their projects: completely ignoring the indigenous presence, or benefiting them with insufficient measures to mitigate the environmental and social impacts and make the project viable (KROEMER, 2002).

In the Brazilian Amazon, insufficient assessment and monitoring of socio-ecological transformations associated with natural gas exploration are aggravated by the limited and/or inadequate participation of various social actors and stakeholders during the planning, installation and operation phases of projects. The bibliographic deepening showed that it is of paramount importance to follow not only the initial moment of the work and its end, the beginning of the operation phase of the enterprise, but its entire process and the way in which local conditions are changed throughout it.

The SSE methodological approach proposed by McGinnis and Ostrom (2014) supported the identification of conditions to be observed in the dynamics of natural resources, social organization, economy and institutions, allowing a better analysis of the environmental impact. This is due to the fact that the studies are superficial, requiring specific research efforts to meet the demands for understanding the system. It is noteworthy that more detailed studies are needed for undertakings in the Amazon, which really bring the true social, environmental and economic impacts so that there can be more assertive discussions. With more details and transparency, the socioecological system will then be able to absorb such disturbances and reorganize itself in order to maintain the same identity (FOLKE et al., 2010). What we have,
for now, is that the impacts are generally undersized, or even not shown and debated more collectively, making it difficult for the system to prepare for such events.

From the social point of view, the problems are not minor. Among them, the impacts on health, problems with displacement of people, adverse effects on indigenous populations and little or no insertion of the enterprise in the local economic dynamics stand out. That is, the benefits occur in another part of the country while the costs are borne especially by the populations in the area of direct influence of the enterprise.

From examined discussions on the socio-environmental impacts on the living conditions of the actors involved in this process, we can consider not only the immediate implications of the capitalist development processes in the region, but, above all, evaluate how the unfavorable effects contribute decisively to the loss of identity, territory and indigenous culture, these people being a significant part of the populations in the Amazon.

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