



The importance of studies on the mitigation of environmental impacts in the Santos Basin region: focus on pre-salt oil and natural gas activities

  10.56238/homeinternationalanais-046

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Keywords: Sustainability, Environmental Impact, Pre-salt, Oil and Natural Gas.

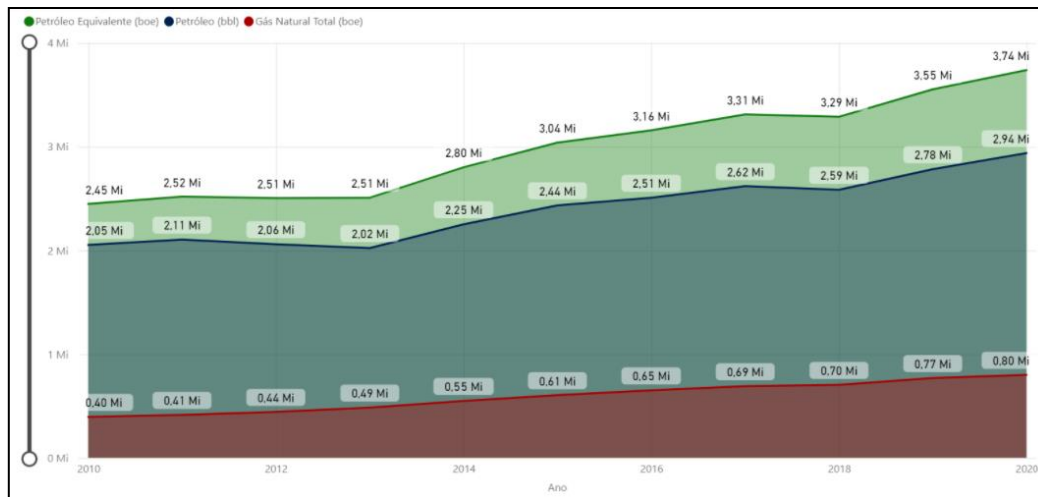
1 INTRODUCTION

After the discovery of pre-salt and the beginning of oil extraction in the coastal region of Brazil, many studies are being developed on this subject, mainly focusing on the exploration and production activities of oil and natural gas. However, in addition to studies on the technology used to extract oil from the pre-salt region, studies are also being conducted on the impacts that this activity will have. This project aims to show the importance of studies on the reduction of environmental impacts. These impacts occur in the entire coastal region covered by the pre-salt, however the work focuses on the Santos Basin region and the environmental impacts resulting from the exploration and production activities of oil and natural gas in that region. It is necessary to analyze the impacts on environmental sustainability, as well as the social and economic impacts. Through this study, an action plan can be created and implemented and implemented through public policies and by private companies.

Oil accounts for much of global energy production. Featuring many utilities and applications, this fossil fuel is a constituent raw material for various products such as plastics, footwear and cosmetics. A flammable and oily substance that has been used by mankind for thousands of years since embalming dead, paving roads, waterproofing houses and lighting. Oil production and extraction cause significant environmental impacts. The production phase is the most aggravating (MARTINS et al., 2015).

Within the energy market in Latin America, pre-salt discoveries are among the most relevant today. Even with the economy weakened by the damage caused by the Pandemic of the New Coronavirus, we can see an increase in the productivity of the withdrawal of barrels of oil in the national scenario in the last 10 (ten) years and even in the year 2020, in which the pandemic worsens.

Figure 1 – Evolution of Brazilian oil and natural gas production in the last decade (2010-2020). Source: ANP (2022).

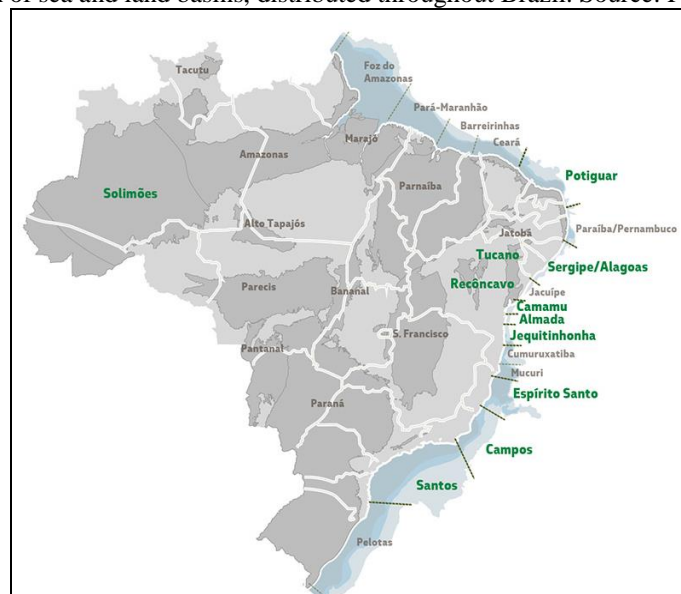


According to the National Agency for Oil, Natural Gas and Biofuels (ANP) "in 2020, Brazil had a record in oil and natural gas production, totaling 3.74 million barrels of oil equivalent per day (boe/d). 2.94 million barrels of oil per day (bbl/d) and 127.4 million cubic meters of natural gas per day (m³/d) were produced. This is an increase of 52.71% compared to 2010 (2.45 boe/d). "

It is the demonstration of the growth and development of the Brazilian energy sector, specifically the oil and natural gas industry, which shows a great opportunity for foreign business and investments in the oil and natural gas sector in the national scenario and specifically in the area selected for this study, the Santos Basin region. And within this area we can highlight one of the main regions for our study, the Metropolitan Region of Baixada Santista. (GASPAR, 2018).

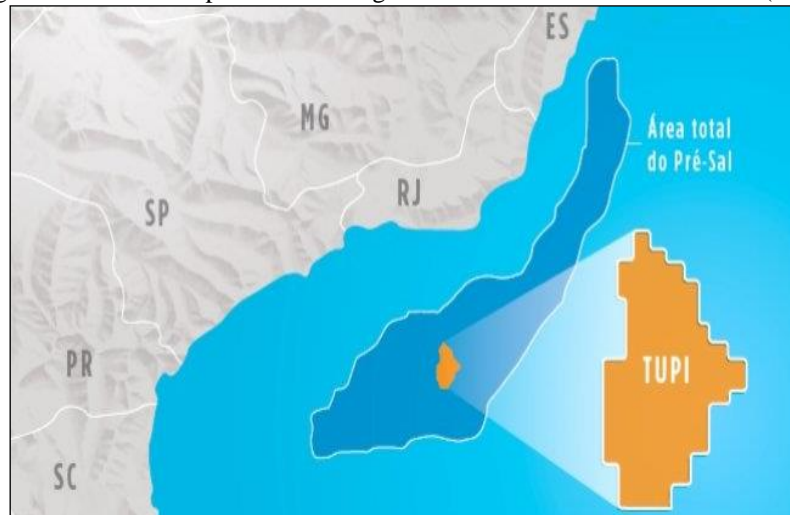
The Santos Basin is the largest offshore sedimentary basin in the country, with a total area of more than 350,000 square kilometers, extending from Cabo Frio (state of Rio de Janeiro) to Florianópolis (state of Santa Catarina). It is in this region that the Pre-Salt Pole of the Santos Basin is located, which brings together the largest producing fields in the country, such as Tupi and Búzios (PETROBRAS, 2022).

Figure 2 - Location of sea and land basins, distributed throughout Brazil. Source: PETROBRAS (2022).



The increase in oil production is also due to the discoveries made in relation to the pre-salt that according to the National Agency of Petroleum, Natural Gas and Biofuels (ANP) covers the coastal layer from the state of Espírito Santo to the state of Santa Catarina. In Figure 3, the highlighted area is the Tupi Field in the Santos Basin, whose reserves of 5 to 8 billion barrels of quality (light) oil, representing approximately 50% of Brazil's current reserves, with a total estimate of 15 billion barrels (PETROBRAS, 2021).

Figure 3: Location of pre-salt oil and gas reserves. Source: IG Economics (2021).

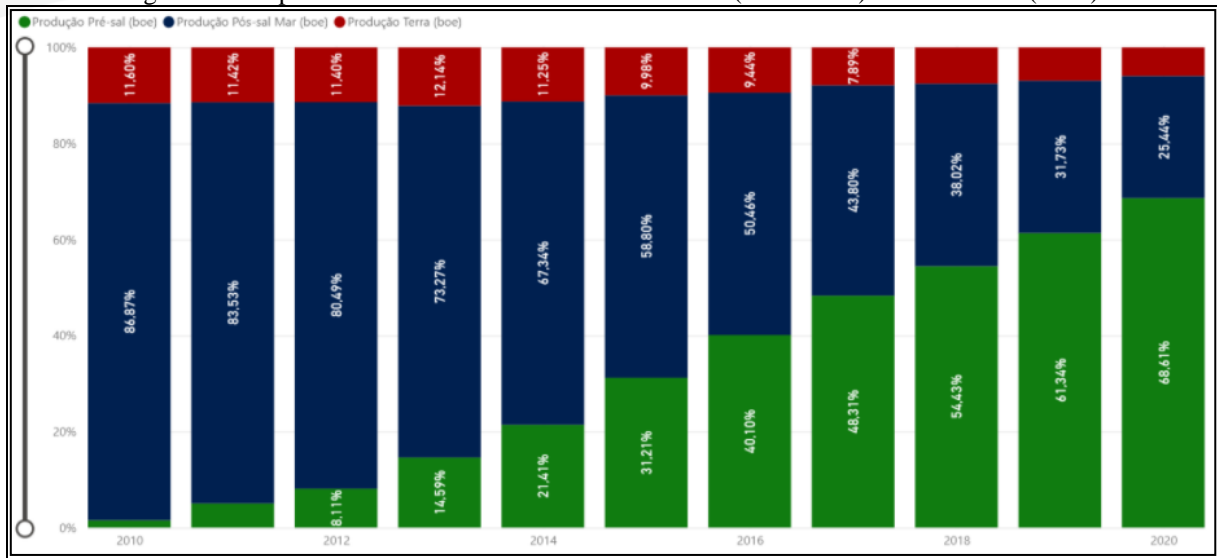


The light oil found at this site is 28 degrees API (American Petroleum Institute). According to this classification, the closer to 50 degrees, the better the quality of the oil, and is also considered to be of better quality than the average commercial oil found in Brazil, as it is easier to refine. According to Adriano Pires, director of the Brazilian Infrastructure Center (CBIE) - as light oil (less dense) has the best quality, is the most sought after. This oil produces more noble products, such as naphtha used in petrochemicals, gas and oil. Another advantage, for light oil, is the fact that for the denser oil the refining operation costs much more and requires more expensive technology to companies in the sector (ANP, 2022).

In addition to the good market quality of the oil, according to data taken from the Petrobras website, we see the great potential of the Santos Basin and the Tupi field (PETROBRAS, 2021). Data from the ANP and as shown in Figure 4 below show that by 2020 national oil production reached a record 3,740,612.09 barrels of oil equivalent per day. Another finding of the agency is that this is an increase of 5.22% compared to 2019 (3,554,976.06 boe/d) and 52.71% compared to 2010 (2,449,563.04 boe/d). That is, the last decade has had a constant increase in production, with the exception of only the years 2012 and 2018.

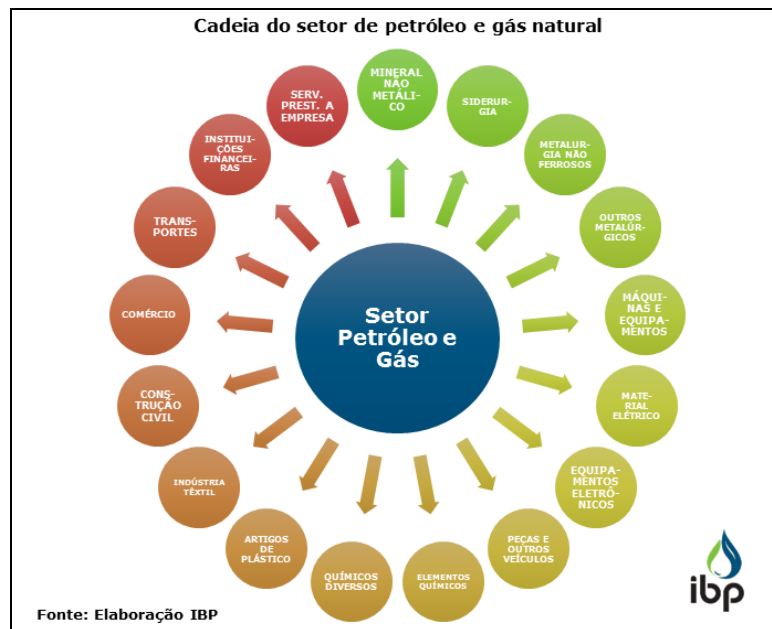


Figure 4 – Oil production environment in the last decade (2010-2020). Source: ANP (2022).



Because it is an economically attractive market, the flow of people will cause the region's economic activity to grow. There will be a lot of national and international investment in this region, both in the oil and natural gas industry and in the areas of hospitality, events, construction and the entire sector that involves the urban structure. Mobilizing a series of activities in various sectors of the economy, the oil and gas industry generates income and jobs directly and indirectly, affecting many other economic and social aspects of the country and especially the region.

Figure 5 - Oil and natural gas chain. Source: Brazilian Institute of Oil and Gas - IBP (2022).



With all this economic development, considering the increase in business in the region and industrial and urban growth, there will be influence on the national and international migration of people in search of new opportunities. Thus, the trend is the seriousness in the social and environmental impacts generated by



this flow in coastal regions located in the vicinity of regions with activities related to oil and natural gas. The cities of the region have a strong tourism as a whole, because geographically all municipalities are coastal, which attracts many tourists behind their natural beauties. They also attract business tourism, due to their intense economic activities in various areas, but mainly oil and gas activities throughout this region that is within the pre-salt region (GASPAR, 2018).

Even though it is a non-renewable natural resource, oil is the main source of energy used in society today. Its exploitation generates irreparable impacts on nature and the environment and therefore government agencies have demanded an environmental licensing process by companies involved in the oil and gas chain. In order for these impacts to be minimized in the best possible way (FERREIRA, 2019).

Throughout history, the human being shows himself as the great enemy of his own environment. But in a way, it's also your great ally. And it is not today that the struggle for environmental preservation conflicts with the economic interests of our current society.

Research should be done on the environmental impacts caused by the oil and gas industry in the Santos Basin region and consequently alternatives to mitigate these impacts. As society's needs have been growing, along with economic development and increased industrialization, the likelihood of accidents occurring during the exploration, extraction, transportation or refining of the oil and gas industry is higher, as activities are becoming increasingly intense. Accidents followed by contamination can occur through oil spillage of oil tankers, platform accidents and specific pipeline leaks (RIOS, 2014 apud ALMEIDA, 2018).

According to Almeida (2018, p. 13) "If there is an accident, the environment will suffer consequences that can last many years and, generally, accidents that occur in the marine environment cause greater impacts since oil can travel long distances." The author also addresses that if this oil reaches the coastal zone, it will contaminate mammals, molluscs, algae, fish and seabirds, as well as causing damage to human health.

The Department of Infrastructure and Environment of the State of São Paulo (SIMA/SP) defines mitigation as actions that reduce or remedy the harmful impacts on the fauna and flora of the region, as well as the anthropic environment (SÃO PAULO. SIMA, 2022). Environmental compensation can be an option for areas already impacted such as the Metropolitan Region of Baixada Santista.

In addition to the study, it is necessary to address the first environmental struggles. The beginning of the preservation of large natural areas from National Parks begins in the 21st century in the USA, with the creation of Yellowstone Park. Since 1894, Latin America began to establish its parks, countries such as Mexico and Brazil establish Forest Reserves. They are created for the initial purpose of maintaining natural areas were for the enjoyment of visitors, both for parks and for reserves. In Europe, national parks were created to study local fauna and flora. It is observed that there was no consensus on the objective of a National Park, so only from the twentieth century, several congresses are called for its definition (DIEGUES, 1994).



With so many industrial advances that emerge in the 20th century around the world, accompanied by pollution, deforestation, and with the use of excess natural resources, it is increasingly necessary to create laws for the preservation of biodiversity. Overall, this struggle began strongly from the 1970s with the Stockholm Conference, several nations met in Sweden where the relationship between environment and development was discussed. Brazil was within this global framework, in 1992 the United Nations Conference on Environment and Development (UNCED) was held in Rio de Janeiro, better known as Rio 92 or Eco 92. At this Conference were present several important representatives of the nations involved, and Agenda 21 was the most important signed document (BRAZIL). MINISTRY OF TOURISM, 2022).

The knowledge of history between society and Brazilian nature becomes necessary for understanding the beginning of environmental conservation. At the "beginning" of national history, the very name - Brazil - arises from the exploration of the brazilwood that was practically extinct. The settlers not satisfied with everything they had already explored began to plant sugarcane and then coffee producing them on a large scale, thus being the main devastating forests in Brazil.

Royal Letters of the Portuguese Crown in 1797 was one of the first measures to contain forest devastation, which was more concerned with the lack of wood for shipbuilding than with nature conservation. In 1937, the first national park was created in Itatiaia, with the purpose of encouraging scientific research and offering leisure to urban populations. Environmental preservation has its emergence through economic interests, with scientific research and visitation being its main factors. Since the 1960s, with the rapid deforestation, mainly of the Amazon, and the expansion of agricultural frontiers, several conservation units were created. The Amazon National Park was then created in 1974, which in the following year provided for the creation of new conservation units in the region by the II National Development Plan (DIEGUES, 1994).

In 1967 a decree created the Brazilian Institute of Forest Development (IBDF), which has the purpose of managing conservation units. With this in 1979 the IBDF elaborated the System Plan of Conservation Units in Brazil, with the recommendation of the creation of new types of Conservation Units, which was not done (DIEGUES, 1994).

In 1989, the Brazilian Institute of Environment and Renewable Natural Resources (IBAMA) was created and the conservation units were established and administrated. However, in 1992, a new proposal was sent to Congress with the plan of the National System of Conservation Units (SNUC), promulgated in 2000 in the Constitution. In Brazil the emergence of environmental laws is crucial for the preservation of its vast area. Therefore, the SNUC defines a conservation unit in its Art. 2nd paragraph I (BRAZIL. LAW 9,985 OF JULY 18, 2000).

Conservation Units are areas specially created in order to preserve and/or conserve a certain good, whether it is an element of the fauna, flora or landscape. There are several types of Conservation Units, some of which have greater potential for environmental preservation. And other types for the tourist use of



their space, since, through a management plan and a plan of public use, allow controlled visitation within their area (MENEZES, 2022).

Law 9,985 of July 18, 2000 establishes the SNUC, which establishes criteria and standards for the creation, implementation and management of conservation units. Taking into account Article 7 of this law (The conservation units that are part of the SNUC) established in the constitution, two types of conservation units with specific characteristics are placed: Integral Protection Units and Sustainable Use Units (SILVA, 2019).

There are several types of conservation units and among these, stand out the National Parks and their derived models, State and Municipal Parks. These areas usually have great potential for the development of tourism activity and for this reason, they are in a delicate management situation, as they must reconcile preservation/conservation with public use.

The best known conservation unit today is the National Park, and the State Park is within a category of this unit. By the constitution, the National Park is established as an Integral Protection Unit that aims to preserve the resources of nature, assuming only the indirect use of its resources. As mentioned in the law: "The units of this category, when created by the State or Municipality, will be named, respectively, State Park and Municipal Natural Park". Being the Park of public possession and domain, its norms and restrictions are established by the Management Plan made by the responsible body. In Art. 2nd paragraph VIII, also in the law of the SNUC, management is "any procedure that aims to ensure the conservation of biological diversity and ecosystems".

In order to strengthen conservation units administratively and economically without losing their main focus (environmental protection), the present work seeks to strengthen the mandatory ties of oil and gas exploration companies and environmental preservation institutions. It becomes fundamental for the survival of an institution in the current market, the need for adequate strategic planning and financial resources, as well as an analysis of its environment. For conservation units, which are involved in the economic environment and depend on their administration to stay active is no different, even if they are units that do not aim for profit.

Thus, the management of the Conservation Unit, through an effective strategy that uses its public use correctly, can have an administration that brings financial sustainability to Unidade. Since the resources coming from the government are not sufficient for the protection of the area. Combining projects and financial resources with the oil and gas industry can be a way to mitigate environmental impacts (GODOY, 2019).

It is intended to contribute as a form of study to the actions that will be carried out in public policies, by the local community and also by the private sector in every sector involved. The general plan is to show the importance of studies to mitigate the environmental impacts caused by the activities of exploration and production of oil and natural gas in the Santos Basin region, and that from this study, an action plan can be



developed. In addition to this general objective, the present work has as specific objectives to also show the importance of other relevant studies that focus on:

- Map current and future areas environmentally impacted by oil and natural gas exploration and production activities in the region.
- Identify the development of companies in the areas of oil and natural gas.
- Characterize all areas impacted economically and socially by this activity in the region.
- Discuss how to manage the environmental, social and economic impacts in a sustainable way that will occur in the coming years.
- Assess the positive and negative points of environmental, social and environmental impacts in the region.
- Measure the increase in the flow of people in the region and the impacts caused by oil activity.
- Map current and possible future environmental conservation areas in the region.
- Analyze the projects and programs carried out by the oil industry and their effectiveness.
- Discuss environmental licensing laws and their relationship with conservation units.

2 METHODOLOGY

Given the commitment to quality scientific research, this work uses scientific methods based on data collection, through people and or books, documents and *papers specific to* the environmental sector and oil and gas. The bibliographic research seeks to identify some conceptual references on the environment, conservation unit, tourism, environmental, social and economic sustainability important to create a conceptual and technical basis for the development of work.

With documentary and bibliographic character, for the realization of this study was selected the qualitative research methodology, in which are used several sources of research, such as: books, articles, environmental impact studies (EIA), environmental impact reports (RIMA), physical library of the Faculty of Engineering of Guaratinguetá (FEG), among others. A portion of the sources were acquired through the Internet, through the feg library website, academic "google", Petrobras website and companies in the sector. We also used digital platforms that provide reliable journals such as "SciELO", the portal of the Coordination for the Improvement of Higher Education Personnel (CAPES) and digital libraries of renowned universities where you can find scientific journals, articles, theses and dissertations for the contribution of the study.

The object of study proposed here is the region of the Santos Basin, this coastal region extends from the city of Cabo Frio in the state of Rio de Janeiro to Florianópolis in the state of Santa Catarina. In addition to covering a significant economic area of the Santos Basin, the Metropolitan Region of Baixada Santista, this area has 9 (nine) municipalities ranging from Peruíbe to Bertioga. As the main municipality and headquarters, we have the city of Santos, where is located one of the most important port complexes in



Brazil, in addition, the Industrial Park of Cubatão is also a region that is economically of great importance to the region (PITTERI, 2012).

For the survey of the desired information, analyses can be made through observations in cities and places, which are and possibly will be affected environmentally, socially and economically by the activity of oil exploration and production. Observation is a technique of data collection to obtain information, it also examines facts or phenomena that one wishes to study, being a basic element of scientific research used in field research (MARCONI; LAKATOS, 2005). Because it is a very extensive area, only the industries and Conservation Units most relevant to the study can be visited.

It is also important to note that the controlling company of oil and natural gas activities in Brazil is PETROBRAS (Petróleo Brasileiro S/A), a publicly traded state-owned company whose majority shareholder is the Brazilian government. The company operates in the energy area in the exploration and production, refining, commercialization and transportation of oil and natural gas, petrochemicals and other energy sectors. And it also carries out studies in the environmental and socioeconomic area, so its database and all the information provided were taken into account in this project.

The method approached for the work is the case study, which DALMAZO (2013, p. 49) defines a case study as the "in-depth study of a unit in its own complexity and dynamism, providing relevant information for decision making". With this can be created a history of the activities of exploration and production of oil and natural gas and its environmental impacts in the Santos Basin, describing it from its creation to the present day, containing critical analyses. Interviews were conducted with managers, entrepreneurs, technicians and several others involved. Among the bodies taken into consideration for carrying out all the research we can mention:

- Secretary of the Environment of the State of São Paulo (SM).
- Department of Tourism of Santos and São Vicente.
- Prefectures of the cities of the Santos Basin.
- Universities in the region and especially the UNESP São Vicente campus.
- Environmental Company of the State of São Paulo (CETESB).
- Brazilian Institute of Environment and Renewable Natural Resources (IBAMA).

3 CONCLUSION

For the implementation and operation of an oil exploration or production project, the responsible company must analyze in detail the environmental impacts related to the enterprise. The environmental licensing process is a legal obligation, which must follow the guidelines and standards for its implementation such as Federal Law 6.938/81, Complementary Law No. 140/2011 and CONAMA Resolutions No. 001/86 and No. 237/97. (LIMMER, 2018).

In the licensing process, environmental studies are prepared by the company in charge and delivered to the environmental agency for analysis and approval. For each stage of licensing there are specific studies



to be prepared (IBAMA, 2022). "To support the previous license stage, being the undertaking with significant environmental impact, the entrepreneur forwards to Ibama the Environmental Impact Study (EIA) and its Environmental Impact Report (RIMA). For other ventures, more simplified studies are required. " (PETROBRAS, 2022).

These studies are indispensable to support the definition of mitigating and compensatory measures necessary during the implementation, operation and deactivation of projects that impact the environment. Rima, currently developed by Petrobras, specifically from the Santos Basin can be used as a bibliographic source for the study.

As a form of study, one can smooth out the results and also the effectiveness of the projects currently underway in the Santos Basin, PETROBRAS' RIMA Stage 3, for example, provides as a mitigation measure required by the federal environmental licensing process monitored by IBAMA (Brazilian Institute of the Environment and Renewable Natural Resources) the program and projects below:

- Pollution Control Project (PCP);
- Invasive Alien Species Prevention and Control Project - Petrobras (PPCEX-PETROBRAS);
- Workers' Environmental Education Project (PEAT);
- Marine Biota Monitoring Project for Seismic Activity;
- Environmental Education Program (PEA);
- Santos Basin Regional Communication Program (PCSR-BR);
- Project to monitor impacts of platforms and vessels on the Avifauna of the Santos basin (PMAVE).

In addition to mitigation measures, Petrobras also carries out programs and projects in the environmental area of characterization, emergency, compensation and monitoring in the Santos Basin.

The Federal Government and the Brazilian states are administratively weakened, unable to formulate, implement and evaluate, in an orderly and effective manner, their public policies. This is not only due to the new global economic reality caused by the pandemic that began in 2020, but also because of the history that imposes on developing countries a series of limitations, thus not allowing the State to perform its functions satisfactorily. In addition, we can mention that these functions are poorly performed by the involvement of corruption and technical incapacity of public managers (SILVA, 2019).

With regard to environmental preservation, there is a movement that seeks to democratize environmentally preserved spaces, seeking solutions so that conservation units can contribute to the social development of a given region (SILVA, 2019). To this end, governments, together with organized civil society, should discuss participatory management mechanisms in the Units, thus decentralizing the administration of these spaces.

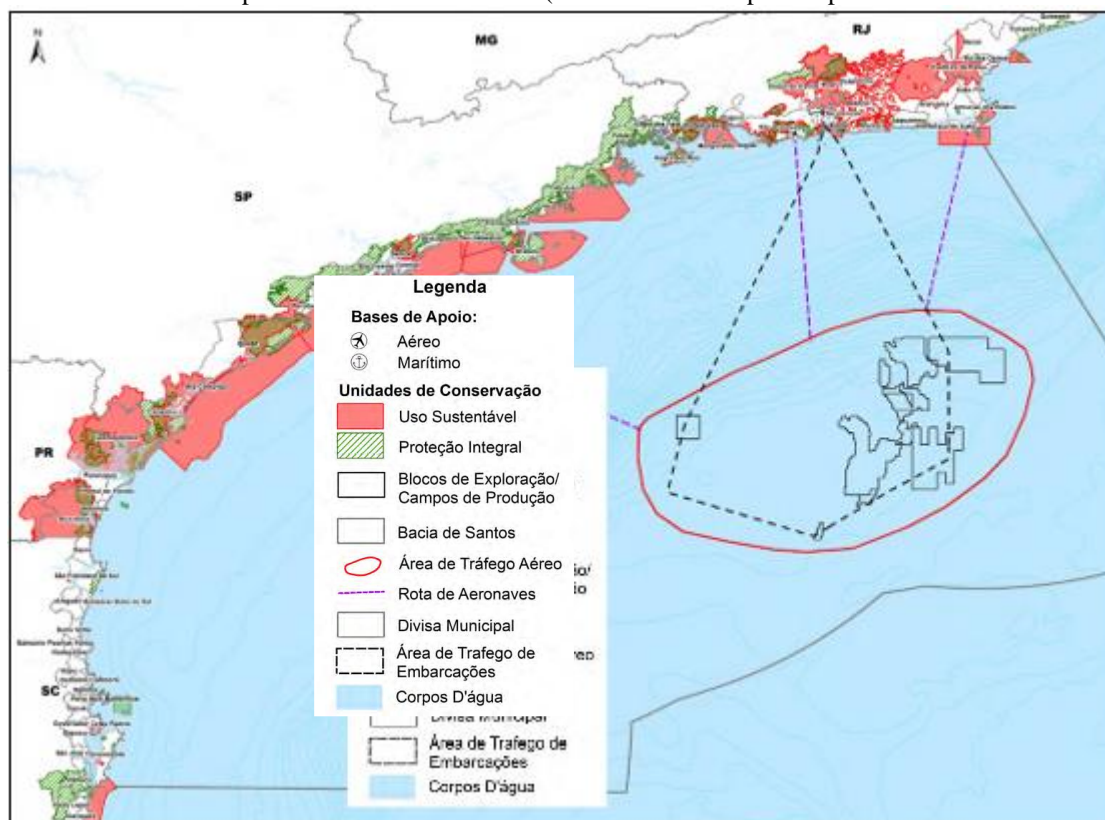
Another aspect involved in a major enterprise such as pre-salt oil production is the "sense of inexorability" of such an enterprise, which ends up imposing indigenous (local) communities that should

not fight for their rights. This is because this sensation inhibits attitudes of the affected local community, because the positive economic aspects involved are seen as more important than the environment and culture (GASPAR, 2018).

It is considered that the projects underway to mitigate the environmental impacts caused by the oil and gas industry in the Santos Basin region, carried out obcurrently under the Brazilian environmental licensing law, are running vaguely and disassociated. It is believed that the oil industry only put into practice its projects related to the environment and social, so that the licensing is approved, but such projects are not effective.

Pesquisas should also be made in order to analyze the connection between existing Conservation Units and mitigation projects already executed and implemented by mandatory environmental licensing. Analyzing its direct and indirect relations of financing, administration and operation between the Conservation Units and the oil and gas industry. It is observed below in Figure 06, that in all four member states of the Santos Basin there are Conservation Units, especially in the State of São Paulo.

Figure 6 - Conservation Units present in the Santos Basin. (Environmental Impact Report - RIMA PETROBRAS, 2022).



Environmental risks in the Santos Basin are imminent and a reality, as well as the impacts on populations affected by the process, such as fishermen and traditional communities, and also caused by tourism in the region. Economic impacts related to the prevention and repair of environmental damage deserve to be highlighted. (GASPAR, 2018). These future and current environmental, economic and social



impacts that may be caused in the pre-salt region and being the Santos Basin within the region affected by the pre-salt, prove the need to reduce these impacts.

In addition to the impacts caused by the oil and natural gas industry, the flow of people and urbanization will be major aggravating not only for the environment, but also for the local and native population of the region. At the moment, there is no definition on the part of the companies and political entities involved in any part that will be affected by the production and exploitation of oil and natural gas in the region, whether the affected offshore part (not continental or at sea), which is where the pre-salt wells are located, or where there is no exploration and production of oil (onshore or continental).

Still with the activities of oil exploration and the economic activities involved in the region, the economic benefits are also highlighted, but the environmental consequences will have to be diminished and the social ones will have to be controlled. Indigenous communities lose their cultural essence with the large influx of people.

The delay in the formulation and regulation of environmental laws in Brazil is a culture that needs to be changed. A historical fact that proves this was the incident that occurred on January 18, 2000 in Guanabara Bay in Rio de Janeiro with the rupture of a Petrobras pipeline. Plans to respond to emergencies in Brazil in relation to the oil spill are then being structured. Only after the incident that Law No. 9966 was enacted that same year, which provides for the prevention, control and supervision of pollution caused by the release of oil and other harmful or dangerous substances in waters under national jurisdiction (NORONHA; FERREIRA; PINTO, 2018).

This work is extremely important for private companies and public agencies in the region to know how to deal in advance with the new environmental, social and economic situation in which it will be subject to the Santos Basin. Also another important area, the Metropolitan Region of Baixada Santista. This is necessary to plan an action plan that reduces environmental impacts as much as possible. Consequently, a well-prepared study with all methodology and schedule will help private industry and public policy actions. This will also bring a better use of public resources destined to this area. It is expected with the studies, provide an analysis that can contribute to future sustainable environmental preservation plans in the region and stimulate international agencies and companies focused on the oil and gas chain that are interested in the effective implementation of environmental standards. And also bring financial resources for projects in the environmental area.

This work aims to clarify the local society about the importance of conservation units. So that this way, the local population can press public policy actions. In order to serve as a north and even a model for future projects to be carried out in the socio-environmental field, this research can be used in the future by Non-Governmental Organizations (NGOs), public and private agencies.

Sustainable development is the great challenge of modern society, so it is necessary to elaborate a study on the sustainability relationship between the pre-salt oil industry and the Conservation Units, together with the community of the Santos Basin.



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