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## ABSTRACT

This paper surveyed ecosystem services in coastal regions, seeking to build the concept of the economy of coastal ecosystem services in Brazil, especially the contribution of the function of the sea to the regional economy. The interest in the economic dynamics of coastal regions has attracted worldwide attention. In Brazil, the coastal zone covers 8,500 km in 17 federative units, counting more than 400 municipalities distributed from the North (Oiapoque/AP) to the extreme South (Santa Vitória do Palmar/RS). Such regions have abundant natural resources and biodiversity with a great capacity to generate economic gains. In this sense, coastal services were divided into six economic dimensions: energy; ports and logistics; fisheries and aquaculture; sociocultural dimension; Sports; and tourism. Finally, it is suggested the need for studies that quantify the relationship between the economic dynamics of coastal regions and environmental sustainability.

**Keywords:** Ecosystem Services; Coastal Economy; Economic Dimension

## RESUMO

Este artigo pesquisou os serviços ecossistêmicos nas regiões costeiras, procurando construir o conceito de economia dos serviços ecossistêmicos costeiros no Brasil, especialmente a contribuição da função do mar para a economia regional. O interesse pela dinâmica econômica das regiões costeiras tem atraído a atenção mundial. No Brasil, a zona costeira cobre 8.500 km em 17 unidades federativas, contando mais de 400 municípios que se distribuem do Norte (Oiapoque/AP) para o extremo Sul (Santa Vitória do Palmar/RS). Tais regiões têm uma abundância de recursos naturais e biodiversidade com uma grande capacidade de gerar ganhos econômicos. Neste sentido, os serviços costeiros foram divididos em seis dimensões econômicas: energia; portos e logística; pesca e aquicultura; dimensão sociocultural; desporto; e turismo. Finalmente, sugere-se a necessidade de estudos que quantifiquem a relação entre a dinâmica econômica das regiões costeiras e a sustentabilidade ambiental.

**Palavras-chave:** Serviços do Ecossistema; Economia Costeira; Dimensão Econômica

**Código JEL:** Q57, R10, Q58

## INTRODUCTION

The interest in the economy of coastal regions has attracted the attention of several researchers on a global scale. In Brazil, according to the Ministry of the Environment (Brasil, 2021a), the coastal zone covers 8,500 km in 17 federative units, counting more than 400 municipalities that are distributed from the North (Oiapoque/AP) to the extreme South (Santa Vitória do Palmar/RS). These regions have abundant natural resources and biodiversity with a great capacity to generate economic gains. Among these riches, we chose to study ecosystem services (ES).

According to the ME (Brasil, 2020), ecosystems integrate biological diversity and are composed of one or more groups of living organisms that interact with physical and chemical environments: water, air, temperature, sunlight, and other nutrients. It is, therefore, the interaction between energy and matter, given the physical and biotic components.

Ecosystem services, according to Andrade and Romeiro (2009), aim to promote well-being to man based on activities and other benefits provided by nature. These services include obtaining food and water, climate systematics, tourism, leisure activities, and primary production from agriculture and livestock. That is, the services made possible by the interaction of man with the ecosystem.

What, then, would be the main ecosystem services present in the Brazilian coastal region? This article aims to survey the economy of ecosystem services in coastal regions, seeking to build the concept of the economy of coastal ecosystem services, especially a contribution of the function of the sea to the regional economy. This research was conducted based on international and national literature, involving reference works that link the themes.

We sought to conceptualize the coastal ecosystem services of the sea through a study about the economic potential made possible by sensible and legal exploitation of ecosystem services provided in the coastal zone. It was observed that Brazil has great potential for tourism throughout its coast and is among the 25 largest food producers in inland waters, besides having a large territorial dimension, which allows new investments and greater growth in international trade.

To better list and study coastal ecosystem services, as well as facilitate their analysis, the theme was divided into six topics: energy; ports and logistics; fisheries and aquaculture; sociocultural dimension; sports; and tourism. In each of these, the objective was to describe the environmental services already explored or with great potential for exploration, besides showing challenges and pointing out solutions that are widely studied in the literature.

This paper is divided into four sections. After this introduction, a literature review on ecosystem services and studies on coastal regions is carried out. In the third section, the definition of coastal ecosystem services in Brazil is presented in six topics (energy; ports and logistics; fishing and aquaculture; sociocultural dimension; sports; and tourism), and final considerations are made.

## LITERATURE REVIEW

The economy, as a system, relates to the environment, extracting from its natural resources and delivering elements, mainly materials, in the form of waste. This interaction impacts due to the size and size of these exchanges and is determined by the way the economic system expands.

Andrade and Romeiro (2009) point out some characteristics of ecosystems, such as variability, which has to do with natural stock and other flows over time, and resilience, which can be interpreted as the characteristic of the environment in returning to its initial state even after undergoing some change.

Although considered a natural characteristic, resilience is a sensitive point in Nature, and nature's action is limited by a breaking point, which happens when a major change in the original characteristic is reached, that is, when irreversible losses occur, and it becomes impossible to return to the initial state.

### **The recent discussion on the economy and the environment**

The first thinkers who decided to articulate the field of economics with an environmental agenda were the authors of the physiocratic economic school, still in the early years of the industrialization process. But the main discussions, including marking the entry of government agents – that is, who makes the decisions – took place long after. It was only from World War II (1938-1945), more specifically in the 1970s, that the first debates began to emerge about the need to unite the economy and environment, and not separate them.

An important study, considered a milestone in the study of ecosystem services (ES), was the Millennium Ecosystem Assessment (MEA, 2003). This study was requested by the Secretary-General of the United Nations (UN) in 2000 and brought together representatives from 96 countries. The objective was to plan actions to support the decision-making of government agents of the private sector and civil society.

The central issues of the MEA were: to study the conditions and trends of ecosystems, ecosystem services, and the well-being of men; examine changes in the future, as well as the possible consequences of them for well-being; seek to interpret the actions that can be taken for the conservation of the environment, highlighting strengths and weaknesses; observe the critical points for effective decision-making; consult tools and create methodologies that allow the assessment of the capacity and services of the environment, as well as to study these impacts.

As a result, the Millennium Ecosystem Assessment (MEA, 2003) also lists four main points. They are:

- There have been unprecedented changes in the world environment in the last 50 years, and these man-made changes have been accentuated. This ended up impacting the Earth's biodiversity strongly and irreversibly.
- These losses produced three problems considered crucial in the long run. The first is the deterioration of environmental services; followed by a higher probability of climate change, and collapse in fish production, among others; and, finally, the increase in poverty.
- Climate change and its respective impacts will be the main responsible for biodiversity loss by the end of this century.
- The agents were challenged: it is necessary to reverse the degradation of environmental means without prejudice to the supply of ecosystem services, which are increasingly demanded. As a form of preservation, it was suggested, among other points, investments in public goods and poverty reduction, cancellation of trade barriers and their subsidies, as well as investments in technologies and payments for environmental services.

## Ecosystem services

Hueting et al. (1998) describe ecosystem services as the benefits, whether direct or indirect, that people receive from the environment, such as energy, food, and other services obtained by a man from an exploration of this ecosystem, and which aims to promote the well-being of individuals, that is when it can be exploited for human purposes. They are divided, according to the MEA (2003), into four categories: provision/supply services; regulatory services; cultural services; and support services.

In **provision/supply services**, The MEA included products that can be obtained in the ecosystem itself, such as food, fibers, wood that can be transformed into fuel, materials that act as energy sources, biological and ornamental resources, water, and other products from the biochemical, medicinal, and pharmaceutical industries. It is emphasized that to measure sustainable development, it is necessary to analyze the quality and state of natural capital stock, and not just consider the terms of flows. One should pay attention to the physical, chemical, and biological limitations of this environment (MEA, 2003).

**Regulatory services** bring together services that relate to the regulatory particularities of the ecosystem, such as climate systematics, disease controls, floods, and other natural disasters, the issue of air and water purification, soil erosion control, waste treatment, and pollination. Unlike provision services, to evaluate regulatory services, it is necessary to analyze the environmental capacity of certain activities.

**Cultural services** include well-being activities, such as spirituality, leisure, inspiration, and education, in addition to tourism, that is, behaviors that are closely linked to human characteristics. Because it has a personal tone and deals with popular sensitivity, it is difficult to assess its provision. These services are closely linked to the collective characteristics of diversity and values, as well as to economic and social changes, such as urbanization, population growth, and leisure time availability. Tourism stands out in this category because it is an important instrument for the source of income and for the economic potential it represents.

On the other hand, **support services** bring together the primary processes, that are necessary to produce other ecosystem services. This is the case with natural processes, such as soil formation, oxygen production, agronomy, livestock, nutrient cycle, and other ecological resources. These services have been constantly impacted by pollution and global warming, and their cycling capacity has been compromised by these.

It is common to find works that use only two or three categories. Some scholars of the subject often unite some of these categories, such as provision and support, and leave the regulatory and cultural services separate.

## The Empirical literature on ES and Coastal Region

As part of the theoretical framework, and to base the discussion on ecosystem services, published works dealing with the subject of environmental services in coastal regions were sought in the international and national literature.

In the international literature, we found studies that integrate ecosystem services to coastal regions, but still incipiently. We chose to list the main analysis on the environmental theme. In the Brazilian literature, the result is even more scarce: although studies present different methodologies, it is rare to find scientific articles that analyze the economic importance of environmental services in coastal regions.

*International empirical literature*

The value of ecosystem services in China has been studied for two decades, as shown by the work of Zhongxin and Xinshi (2000). The authors, at that time, already drew attention to the need for the conservation of the environment and ecosystems. In the study, the type and area of terrestrial ecosystems, the total value of ES, and the isolated values of terrestrial, forest, humid, marine, and coastal ecosystems were quantitatively estimated. It was found, from this, that the value of ecosystem services in China was 1.73 times the gross domestic product (GDP) observed in that country in 1994 and that, overall, the Chinese ES contributed 2.71% to the planet.

A reference work in the valorization of ecosystem services is that of the Department for Environment Food and Rural Affairs (DEFRA, 2007). It includes approaches and evaluations of policies and the environment, as well as case studies. The part that lists the challenges and opportunities addresses the complexities of understanding how ecosystems interrelate to provide services that deal with the issue of irreversibility, in addition to the high levels of uncertainty. This article also observed that the ES provided by the marine environment is dependent on the species that live in the sea and that these depend on the maintenance of good-quality habitats.

Meiner (2010) researched the integration of marine policy into the European Union. To this end, it reviewed the coastal situation and marine systems and observed the political conjuncture. In conclusion, some topics are highlighted: it is necessary to monitor environmental changes through constant data collection; these data should be relevant in the socioeconomic context, and it is important to create spatial statistics; this data should be integrated; and, finally, produce an information system to support the implementation of marine control strategies.

A quantification of interdependence between economic systems and ES analyzed from an input-output model was published by Cordier et al. (2011). In the study, they opted for an input-output model to cover the interdependencies between environmental services. The results showed that the restoration of nurseries has a high cost and low impact on the macroeconomic scenario. The article collaborated with the literature by bringing the quantification of the trade-offs presented and having usefulness in providing subsidies for decision-making.

Barbier et al. (2011) studied the value of the coastal ecosystem and mangrove services. The analysis was made from a variety of coastal ecosystem services, such as swamps, mangroves, coral reefs, beaches, dunes, etc. The authors draw attention to the fact that services vary depending on location and time, which ultimately impacts the evaluation of ecological functions and basic services of underlying ecosystems, such as coastal protection, erosion control, and habitat-fishing links. It was suggested to implement an action plan to protect the environment and to increase the immediate and long-term value of coastal ecosystem services.

Spatial models of coastal ecosystem services, given the options of preservation and development, are analyzed by Barbier (2012). Among the findings, the analysis shows that, in the case of a seafront valued about environmental services, and given the condition of constant marginal returns, landscape transformation should occur more inland. These valued coastal areas will determine what the transformation scenario will be and where this conversion should be located. In the study, it was also proposed to tax economic returns as a way of compensating for potential environmental risk.

The analysis by Liqueste et al. (2013) looked for 476 indicators in 145 studies that evaluated coastal ES and marine indicators – most of them highlighted the mangroves and coastal wetlands of Europe and North America. A review of scientific literature was performed and found that, among these studies, the most widely analyzed subject is the provision of food, especially fishing, while regulation and maintenance services were concentrated in the water purification process. Other issues, such as tourism, were also relevant. As an objective, information capable of giving subsidies for decision-making of biodiversity conservation policies was sought.

Presenting a spatial and economic analysis of coastal protection at the global level, Rao et al. (2015) researched ecosystem services. A specific variable was identified to present a multivariate global regression function that identified important agents in the assessment of coastal SE. They analyzed the characteristics of the sites, the type and size of the systems, forming variables for development measures, popular pressures, population density, and biodiversity. In conclusion, it was observed that these variants affect environmental services significantly.

The ocean economy part was studied by Koundouri and Giannouli (2015), who observed that 70% of the earth's surface is covered by oceans and seas and that these aquatic sources can contribute to humanity from the supply of food, energy, and other bio-based products. Despite this importance, this marine ecosystem is in the process of over-exploitation of resources, which impacts the supply expected of it. The work was based on the Marine Strategy Guideline and the European Marine Space Planning and presented a Total Economic Value Framework of ecosystem services, given the marine biosystem.

Another important international article provoked: have the values of global and coastal services changed? The analysis was made by Pendleton et al. (2016) and the scholars show that some marine and coastal services may have declined in the last thirty years, warning of the effects of scarcity associated with a steady increase in the population and in the use of environmental services. The study exposes the increase in public awareness about the need for preservation and calls for an update of the important analysis made by Constanza et al. (1997), a world reference work on the subject.

In line with the so-called "blue growth", which would be economic development, considering the coastal and maritime system, Mulazzani and Malorgio (2017) sought to resignify this concept. They used the United Nations Environmental-Economic Accounting System, which aims to link economic development with the SE, considers environmental degradation, and tries to value the benefits offered by the biosystem. The article estimated net added value and the conclusion was that this concept of blue development is not so defined, as it does not correspond to a strong vision of sustainability, besides drawing attention to the need for collaboration among academics to continue the study of benefits and riches.

Also, about blue development, Lillebø et al. (2017) analyzed how marine ecosystems can support this agenda. The authors showed that multi-sectoral economic activities, such as the extraction of marine mineral resources and cruise tourism, for example, are dependent on healthy ecosystems. For this, it is important to preserve the environment, because it is also considered that marine ES is responsible for promoting biomass from plants and animals living in the ocean space. In conclusion, they found that the so-called blue growth presents a trade-off between economic, social and environmental aspects and that they are supported in marine ecosystem services.

There was room to study community resilience to risk events in the Dvaskas inspection (2018). The publication brings research that addresses, in coastal and maritime areas, the contribution of human capital in the conversion of the flow of the ecosystem into a benefit obtained by people, having developed a methodology that aimed to evaluate essentially this contribution. A site analysis was used based on the classification system of North America and observed the supply chain of the ES in the United States region of Long Island, located southwest of the state of New York. The paper draws attention to the need for further studies and concludes with an assessment of how this supply chain helps in the resilience of coastal communities.

Rodrigues et al. (2018) sought to operationalize marine and coastal ecosystem services. The authors studied the Intergovernmental Platform for Scientific Policy on Biodiversity and Ecosystem Services, dated 2012, and established by governments such as Belize, Latvia, Portugal, and Spain, among others, to generate an interface to bring together scientists and decision-makers. The methodology used was the study of six articles published on the subject and the conclusions draw attention to the need to comply with environmental resolutions, such as climate agreements between nations.

Mehvar et al. (2018) reviewed the quantification of coastal ecosystem services (CES) in various parts of the world. The study showed that areas of coral reefs and mangroves are usually more valued while seagrass beds have lower economic value. The authors identified tourism and other recreations as factors of appreciation of the CES. In a second moment, an analysis of local and regional studies was presented, and attention was drawn to the incomplete terms of these studies that do not usually quantify coastal ecosystem services.

Another regional study was conducted by Seidel, Sourte and Diamond (2019). The authors researched the coastal ecosystems of the Gulf of Mexico, considering data mapping and applying three different approaches. At first, they attributed economic values to coastal ecosystem services aiming to calculate the benefits transferred. The second approach used the InVEST model, which provides relative values, but obliges the scholar to apply his estimates. In the third, data were used from a program called CHNEP, which synthesized the economic values for mangrove ES but without influencing changes in the economy.

Chakraborty and Gaspartatos (2019) investigated the management of coastal ecosystem services on the island of Himeshima, Japan. Combining primary and secondary data to highlight the use of resources and the ongoing changes in the Japanese ecological-coastal system, the authors concluded that several important supply services have degraded over time, and this was due to demographic and economic factors, in addition to technological changes that have impacted the fishing industry. These technological changes would have created trade-offs that would substantially affect the local community, as this fishing ecosystem provides multiple benefits to locals.

Additionally, the comparison of offset values for coastal ecosystems between Brazil and Australia reveals disparities in monetary valuations, indicating the need for improved policy design and valuation methods to ensure the sustainable management of coastal resources in Brazil (Costa et al., 2022).

### *National empirical literature*

The economy of services provided by coastal ecosystems in Brazil is a crucial aspect that intertwines with societal well-being and environmental sustainability. Research highlights the economic value of ecosystem services in the coastal zone, emphasizing the benefits generated by these ecosystems for human populations, such as tourism revenue and recreational

activities (Islam et al., 2022). Coastal ecosystems in Brazil, including mangroves, seagrass beds, and coral reefs, play a vital role in providing services like biodiversity conservation, oxygen production, and carbon sequestration, contributing to the region's socio-environmental vulnerability and emphasizing the need for conservation and management strategies (Silva e Scherer, 2021). Furthermore, the identification, classification, and spatialization of ecosystem services provided by wetlands in Brazil underscore the importance of these habitats in providing various services, urging for detailed research and conservation efforts to preserve their ecological, socioeconomic, and cultural significance (Horta et al., 2020).

A national reference is the work of Andrade and Romeiro (2009), much mentioned in articles that seek to study ES. The authors make a theoretical opinion on ecosystems and record the need to create a value system because they understand the relationship between services provided by natural goods and the Economy. In addition, they examined the relationship between SE and human well-being, showing the importance of these natural services for people's satisfaction. The main contribution, however, was to warn about the importance of the valorization of ecosystem services as an ecological part and participant in the economic system of a given region.

Andrade and Fasiaben (2009) examined the Payments for Ecosystem Services (PES) from the use of environmental policy instruments to preserve the environment. The authors point out that THE PES is not the resolution of all environmental problems, and that these are applied when the threat to ES comes from the inadequate use of the soil. They also emphasize the importance of state participation as an incentive for preservation to generate ecosystem services favorable to the well-being of citizens, in addition to considering the economic character.

Soil use dynamics and the value of ecosystem services were the subjects of the analysis by Andrade et al. (2012). The authors applied the assessment of ES for land use in the Mogi Guaçu and Pardo River basins in the state of São Paulo and concluded that, between 1988 and 2002, the dynamics of land use negatively impacted the supply of generated services. Thus, they realized that forested areas have a higher value of ecosystem services compared to areas that have sugarcane or pasture exploitation, maintaining the unit. In conclusion, they suggest stimulating the transformation of explored areas into forests to generate greater social value.

Some studies show the application of the theory of economic evaluation of ecosystem services. Among these, we highlight the study by Santos and Silva (2012), who sought a qualitative value of the ES available in the coastal zone of the Bahian municipality of Camaçari, in the metropolitan region of Salvador. The conclusion is that some beaches have the offer of SE compromised because the use of its structure is above its load capacity, and this happens mainly on beaches where there are higher levels of urbanization.

An important area to stand out is Payments for Ecosystem Services (PES). The analysis of Simões and Andrade (2013) sought to study the effects of the green scholarship program in the state of Minas Gerais, innovative in Brazil, in this area. This program was regulated by the state of Minas Gerais in 2009 and aims to remunerate landowners and squat holders for the conservation of areas of native vegetation. For this payment, the offer of SE of water regulation and biodiversity sheltered in the areas is observed. The conclusion found positive facts, such as the identification that Bolsa Verde is effective as a policy that aims to preserve the environment but criticizes the low participation of environmental institutions.

Another study based on the PES is that of Godecke, Hupffer and Chaves (2014), which talks about the future of payments for environmental services in Brazil from the new forest code –



this entered into force in 2012 and institutionalized payments for ecosystem services in the country. The authors concluded that the future of payments for environmental services in Brazil needs to be legislated, and the conservation of these services is part of the sustainability of the country's development. It is imperative, however, that the State be present, through environmental policies, stimulating environmental education and acting through legal procedures and economic incentives.

Vezzani (2015) studied the relationship between soils and ecosystem services, showing that there is increasing evidence that ES is dependent on biodiversity. The conclusion reached in the study is that soil is of fundamental importance because it is the basis of the self-regulation of the planet and all ecological processes essential to life depend on it.

How geodiversity contributes to the ecosystem services of the mangrove was the subject of the article by Rabelo et al. (2016). In the study, the authors realized that the diversity of the abiotic characteristics of a landscape as a form of conservation is a recent theme, but that has been increasingly discussed. In addition, it is explained the mangrove, is an ecosystem that has great ecological relevance, and which is also important to enable intense biological and geochemical processes. Mangroves, according to the authors, are responsible for providing food and income for the riverside peoples, and there must be ecosystem maintenance so that this wetland provides all the services expected in its fullness.

Lima and Paula (2017) conducted a similar study on the urban coast of Fortaleza, Ceará, in a city recognized for its tourist potential and which has, on the coast, a great economic center. The evaluation was based on a qualitative analysis of the SE, with field visits to 12 beaches of the municipality. The methodology applied was to associate values with ecosystem services offered on the waterfront, dividing them into three categories: regulatory and/or support services, provision and information and culture. They concluded that much of the SE supply is impaired due to municipal urban density and suggested the application of measures to conserve ecosystems.

Another evaluation of ecosystem services in coastal areas was made by Silva and Paula (2017), this time in the municipality of Caucaia, located in the metropolitan region of Fortaleza. The authors identified seven main beaches along almost 30 kilometers of coastline in the city and applied an evaluation grouped in three areas (regulation/support, provision and information/culture), using a quality-quantitative methodology, which determined values from 1 to 3 for each service. They concluded that urbanization rates have a direct interference with the supply of SE to the local population.

A good study on the importance of ecosystem services in cities was conducted by Muñoz and Freitas (2017). The authors reviewed the publications between 2013 and 2015, and the contribution to the literature was made through studies of biodiversity characterization, and urban sustainability planning, among others. From the data found, they noticed a considerable increase in the percentage of publications on ES in urban areas in the period surveyed, from 1.4% in 2003 to 15.5% in 2015, a constant evolution.

Similarly, the study "Brazil's Value of the Sea: An Integrated View of Brazil's Ocean Resources" by Beirão, Marques, and Ruschel (2018) thoroughly analyses Brazilian marine resources and highlights their strategic importance for sustainable development. The authors aim to raise awareness among society and decision-makers, encouraging sustainable policies, practices, and collaboration between academia, the private sector, and civil society. They advocate for sustainable exploitation of marine resources through continuous research and technology investment. The study emphasizes a holistic approach to maximize the economic, social, and

environmental benefits of ocean resources, promoting their conservation and responsible use. It also evaluates tourism data and the historical evolution of maritime exploration, underscoring the need for a sustainable and integrated view of the oceans and their industries in Brazil.

Gonçalves, Oliveira, and Johnston (2019) conducted an innovative study on the economic profile of the South Coast of Rio Grande do Sul and estimated an input regional product matrix seeking to know the productive structure of the region from the analysis indicators. The results of income and employment multipliers indicated that the sectors with the greatest impact were forest production, fishing and aquaculture; storage and mail; construction; trade; agriculture and forestry and road freight transport.

In addition, key sectors of the region were considered based on the link indexes: construction; other services; wood products - exclusive furniture; water, sewage, and waste management; manufacture of chemicals, resins, elastomers, and other transport equipment. Finally, Gonçalves, Oliveira and Johnston (2019) reported that, in the region, activities related to forest production, port activity and agribusiness have great economic representativeness.

Costa et al. (2022) sought to identify, classify and spatialize the level of relevance of ecosystem services provided by wetlands in the Galinhos-Guamaré Estuarine System, on the semi-arid coast of Brazil. To achieve this goal, the researchers used GIS (Geographic Information Systems) mapping of ecosystem services. The main results indicated that ecosystem service capacities varied between the macrohabitats of the region studied, with estuaries, mangrove forests, and tidal flats standing out as the most relevant service providers, while shrimp ponds showed the lowest performance.

Magalhães, Gonçalves and Oliveira (2023) estimated an input-output matrix for the northeastern coastal region for the year 2017, the matrix comprised 216 municipalities in all 9 states, to quantify the economic participation of the region and its sectoral profile. The results indicated that the region specializes in activities related to the oil chain (extraction, refining, and shipbuilding); food, cellulose, rubber, paint, and iron processing industry; and transportation, energy, scientific activities, and tourism services. Furthermore, the authors highlighted the need to formulate socioeconomic sustainability policies to maintain the potential of the region's ecosystem services.

The literature review conducted for this study indicated that the countries and/or regions that are more advanced in the theme are Europe, the United States, and Asia and that the approach to the subject in Latin America is still incipient. It also pointed out the need for increased efforts as a way to improve the understanding of the dynamics of urban ecosystems and these services, so that more effective planning strategies are sought, taking into account sustainability criteria. In this sense, it is noteworthy that the literature presents a gap in studies that associate the economic profile of coastal regions and ES, and the present work intends to contribute by conceptualizing and presenting the state of the art.

## COASTAL ECOSYSTEM SERVICES

It is important to note that some authors mention the conceptual difference between coastline and coast, calling the coast the area where land and sea meet, while the coastal, is called the widest strip that enters the terrestrial part. But in this study, the definition of the Ministry of the Environment (Brasil, 2021b, s./p.) will be used, which says: "the Brazilian coastal zone corresponds to the geographical space of interaction of air, sea, and land, including its

renewable resources or not, covering a maritime strip and a land strip". The limits would be divided into tracks, such as:

- **Maritime range:** space that extends for twelve nautical miles, proportional from the baselines (average of the lowest water of the tide), thus comprising the entire territorial sea.
- **Land strip:** space covered by the limits of municipalities that are directly influenced by the phenomena that occur in the coastal zone.
- **Strip contained in the coastal zone:** variable extension space, also comprising a maritime and another land part, defined as the seafront.

It's not possible to study the coastal economy without understanding the economic possibilities offered by the seas. We chose to reference this chapter of the study by Beirão, Marques and Ruschel (2018). The authors conducted a broad study of the maritime economy and found that, in the period from 2005 to 2016, Asia led the rates of fishing, aquaculture, port movement, and shipbuilding worldwide, and found great potential to be developed in South America and Africa.

Brazil has great potential for development through the coastal and marine economy since it has one of the largest exclusive economic zones in the world, about 3.6 million km<sup>2</sup> (Beirão; Marques; Ruschel, 2018, p. 20). In addition, the study details the possibilities of fossil or renewable energies, the increasing importance of placing shipbuilding orders, scientific production organized in universities, the development of seaports (imports and exports), and food production, among other factors of potentiating the economic progress of the region.

The example of Portugal in the planning and exploration of the sea economy stands out. The authors see an advantage in what they call blue thinking: the sustainable approach promotes economic growth and generates jobs, boosts innovation, and encourages new ideas in established sectors such as fishing.

The monitoring of the Portuguese maritime economy, according to Beirão, Marques and Ruschel (2018), began in 2010 and aims to quantify the economic evolution and the weight of blue thinking in the gross domestic product (GDP) and in the generation of jobs in that country. The study found a considerable increase in cargo movement in Portuguese ports, in addition to an increase in the export of products, and it was possible to observe, in addition, the Portuguese leadership, at the European level, in the international register of ships.

In the chapter dedicated to the strategic importance of the sea for the development of Brazil, attention was drawn to the strong tangible and intangible values that can be made possible through a conscious and sustainable exploration. Observing only fishing, the variety of species in the Brazilian coastal zone is evidenced and a comparison is made: "China has the highest production in the world (70 million tons per year), while Brazil remains in the modest production of 1.2 million, surpassed by countries with much smaller coastline, such as Vietnam, Peru and Egypt" (Beirão; Marques; Ruschel, 2018, p. 59).

In the perception of Beirão, Marques and Ruschel (2018), the 21st century brings a great challenge to Brazilians. According to the authors, it is necessary to have a study about the understanding and respective ordering of the use of the 7,367 km that form the Brazilian coastal zone. It is an area of 3.6 million km<sup>2</sup>, which corresponds to the oceanic stretch that is under the sovereignty of the country. In this range, however, there are economic challenges and possibilities to be explored: the improvement of port logistics, the construction of ports, considering the impact on the fishing and socio-environmental activities of the communities that live there, the issue of the oil and gas industry, ocean mining, tourism exploration, etc.

Here are some topics about the sea economy in Brazil, in a listing of LEME World, PwC Barometer of The Sea Economy (PWC LEME, 2017):

- Brazil is in the Top 25 of the Exclusive Economic Zones (EES).
- It has size, cargo of raw materials, and fleet in quantities that are sufficient to stimulate maritime transport, in addition to ports and port logistics. All this, even though it is located outside the navigation corridor that has the highest traffic (Asia - Europe - United States).
- It is among the 10 world leaders in fossil energy production (oil and gas) but has bet little on renewable energy.
- In terms of the world's navy, it is among the top 25.
- It is among the world's 25 largest producers of inland food.
- It stands out in the ranking of the best athletes in the world of water sports and has high potential in marinas and maritime tourism.

Of the 27 Brazilian federative units, 17 of them have a coastline. According to the Brazilian Institute of Geography and Statistics (IBGE, 2020), 13 of the 27 state capitals are located by the sea, where 26.6% of the population lives, or 50.7 million inhabitants. However, the economic and strategic importance of the Brazilian coastal zone is clear.

An important study on the number of employees in the maritime economy was carried out by Carvalho (2018). In the preparation, based on data from the Annual Social Information List (ASIL), for the year 2016, the author presented the number of 970,406 Brazilians employed in maritime services. Among the 17 coastal states, the one with the highest percentage of worker participation compared to the rest of the state is Rio de Janeiro, with 41.39%, while Pará was the one with the lowest participation: only 0.11%.

This work aims to study coastal ecosystems, and it was decided to divide them into six topics, such as energy (oil and gas extraction, mining, etc.); ports and logistics; fisheries and aquaculture; sociocultural dimension; sports; and tourism.

### **Energy (oil, gas, and mining)**

To Beirão, Marques and Ruschel (2018, p. 100) “[...] It is no exaggeration to say that, before the discovery of oil in deep waters, Brazil looked at the sea in a contemplative way” (The quote makes us reflect on the importance of extracting fossil fuels, such as oil, for the Brazilian economy. In 2010, according to the authors, the country produced 41,000 barrels a day in the pre-salt fields. At the end of 2017, exploration in deep waters accounted for more than 50% of national production, which allowed Brazil to enter the select group of the 10 largest oil producers in the world – 957 million barrels of oil and 40 billion m<sup>3</sup> of natural gas. All this represented 13% of the national GDP. In addition, almost R\$ 27 billion were raised with royalties for Union, State and municipal funds.

The economic capture provides technological development, having strengthened Petrobras, which is a state-owned mixed economy company, in the exploration of fossil fuels in deep waters. “In the 1970s, Petrobras did not have the technology for submerged exploration in waters in the 120 m range.” (Beirão; Marques; Ruschel, 2018, p. 103). According to the authors, in the following years, the company tried to seek technological partnerships with other companies and even universities. The result is that, at the end of the 1980s, the Brazilian oil company “became the first in the world to produce oil in waters below 500 m” (Beirão; Marques; Ruschel, 2018, p. 103).

This investment in research and development boosted Brazilian industrial growth and gave new directions to national maritime production. To the authors, applied technology has made Brazil a world reference in oil technology, but there are still, however, challenges to be overcome, such as the issue of refining: the country exports oil and imports fuel. In other words, it exports raw material and buys it back in the form of a value-added product.

The Brazilian coastal zone does not only produce oil, the main product among fossil fuels, of a finite nature. There is the so-called alternative energy, which comes from waves, tides and winds. There is already a wealth of research that highlights the relevance of the sea as a source of energy generation. “Brazil is among the few countries engaged in the development of technologies that will provide these new marine benefits.” (Beirão; Marques; Ruschel, 2018, p. 115).

There are several projects to produce alternative energy. According to the authors, there is already a pilot project to produce energy from the movement of sea waves in Rio de Janeiro, 14 km from Copacabana beach. There are also projects for onshore production (which has a structure over the breakwater, but is supported on the mainland), such as the port of Pecém, located in the municipality of São Gonçalo do Amarante/CE. The wind energy production plants – produced from the winds –, however, spread along the coast of the states and increasingly participate in the Brazilian energy matrix.

Another economic opportunity is mining. “The European Economic Community has estimated [...] that around 10% of world production of minerals could come from the oceans in 2030, generating resources of € 10 billion annually.” (Beirão; Marques; Ruschel, 2018, p. 119). And Brazil is part of the select group that studies ocean minerals, including copper, zinc, lead, barium, gold, silver, diamond, phosphorites, etc. Opportunities, however, collide with environmental risks.

## Ports and logistics

Although they are not directly ecosystem services, ports, and port logistics are responsible for the flow of production, resulting in attracting currency and monetary values to the national economy. “Approximately 80% of Brazilian foreign trade-in values and almost 96% of the gross weight of exported and imported goods transit through ports.” (Beirão; Marques; Ruschel, 2018, p. 140). Therefore, the importance of the geography of the place, the relief, the entrances to estuaries, and the rivers and bays are highlighted as physical characteristics that allow the viability of these ports and logistics.

It is possible, therefore, to understand that a large part of the Brazilian economy is moved along the coast, but, until it reaches the ports, a large part of the production is conducted through other logistical modes: such as rail and road, according to Beirão, Marques et al. Russell (2018). The authors report that 57.3% of goods transit by road and 31.5% by rail.

Carvalho (2018) made a list of Brazilian ports, dividing them into three sections: the north coast (ranging from Amapá to Pernambuco), the central coast (from Alagoas to Espírito Santo), and the south coast (from Rio de Janeiro to Rio Grande do Sul). Among the main Brazilian export hubs from maritime port centers are the ports of Itaqui, Ponta da Madeira, and Alumar (MA), Pecém (CE), Suape (PE), Vitória (ES), Itaguaí (RJ), Santos (SP), Paranaguá (PR), Itajaí (SC) and Rio Grande (RS). There is also a need for investment in cabotage navigation, which is navigation between national ports, to increase trade between regions.

## **Fishing and aquaculture**

Beirão, Marques and Ruschel (2018) report that international bodies, such as the Food and Agriculture Organization of the United Nations (FAO), have drawn attention to the need to increase food production given the population growth observed in the world. Reports from the Organization for Economic Co-operation and Development (OECD) note that the capacity of the oceans to enable food production is increasingly compromised due to overfishing and the depletion of reserves in many regions.

In Brazil, fishing activity employs around 1.5 million workers directly and the same amount indirectly: “[...] in 2017, Brazilian aquaculture produced 790 thousand tons of fish, mollusks and crustaceans [...]. In total, fish production [...] generated revenue of BRL 8.2 million” (Beirão; Marques; Ruschel, 2018, p. 161). As obstacles, the study pointed out the excess of bureaucracy, the slowness in obtaining environmental licensing in the states and a certain difficulty in obtaining the legal assignment of waters that belong to the Union.

To overcome these obstacles and promote economically and environmentally responsible exploitation, it is necessary to “[...] determine the number of fish that can be removed from the sea without compromising the natural replacement capacity of their populations” (Beirão; Marques; Ruschel, 2018, p 162). It is also observed that the increase in the supply of fish is a necessity shortly, given the studies by FAO and the OECD on the ineptitude of food production in meeting and accompanying the increase in demand for proteins caused by population growth.

Among the main fish supplied by the Brazilian coast are tuna, shrimp, lobster, sardines, snapper, and various fish, according to Beirão, Marques and Ruschel (2018). The authors also inform that Brazil is the fourth largest producer of tilapia in the world and that this productivity is made possible using genetics following international standards, balanced nutritional management and strict control of diseases. “The main marine crop in the country is shrimp, mainly in Rio Grande do Norte and Ceará. Together, the two states are responsible for approximately 97% of the national crustacean production.” (Beirão; Marques; Ruschel, 2018, p. 166).

## **Sociocultural dimension**

The coastal occupation of Brazil, according to Beirão, Marques and Ruschel (2018), comprises 395 cities of small, medium, and large sizes across 17 states, ranging from Amapá to Rio Grande do Sul. In these cities, the demographic density is high, which makes them considered intensely populated: in 293 of these coastal municipalities, the urban population is predominant, especially in the Northeast, Southeast and South regions.

This intense occupation is the result of socioeconomic relations formed during the “[...] historical process of occupation of the national territory, forging a trajectory characterized by environmental and cultural diversity, and by social and economic imbalances” (Beirão; Marques; Ruschel, 2018, p. 181). These processes can be divided geographically in two ways: the first, which runs from Rio Grande do Sul to the Metropolitan Region of Fortaleza, has an urban character and great value for land; and the second, which runs from the western part of the Metropolitan Region of Fortaleza to Amapá, which has a more rarefied character, with the presence of traditional extractivist and collector communities.

Such a large coastal extension is also important in the culture of millions of people, with the presence of myths and popular folklore, such as monsters, mermaids, strange fish, and

indigenous mythologies that were mixed with those of the Portuguese and the black slaves who were brought to Brazil. This mixture, from the perspective of Beirão, Marques and Ruschel (2018), made possible the cultural diversity of Brazilians: happy, religious, musical, and attractive.

Among the main maritime events in the country is the maritime procession of Nossa Senhora dos Navegantes, held in all Brazilian coastal states; the maritime procession of Bom Jesus dos Navegantes, held in some regions of Bahia; Festa de Iemanjá, in many parts of the coast and more focused on Afro-Brazilian religions; and the maritime procession of São Pedro, also held in various places, especially on the coast of Rio de Janeiro.

Another cultural aspect has to do with music and poetry, which, along the entire national coast, presents peculiar artistic characteristics. Further south, there is the presence of marujada, also known as fandango in some parts of Brazil, a party that is present from the extreme south of Rio Grande do Sul to parts of São Paulo. Another remarkable event is one of the symbols of the country: the samba, one of the most important portraits of popular culture, which was born in the port area of Rio de Janeiro.

Cuisine also plays an important role in the coastal region, especially in the north of the country, which is very rich in terms of ecosystems. But the richness extends from north to south: from the country's resident fish, such as whiting and grouper, to more sophisticated seafood, such as mollusks, mussels, and oysters present on the coast of Santa Catarina, passing through the already mentioned shrimp from Rio Grande do Sul, North and Ceará.

### **Sociocultural dimension**

Along its 8,500 km of coastline, Brazil offers great possibilities for lovers of water sports. Beirão, Marques and Ruschel (2018) listed some sports activities practiced in the Brazilian coastal zone: rowing, sailing, surfing, windsurfing, kitesurfing, water skiing, wakeboarding, kayaking, and canoeing. Other modalities, such as swimming and diving, although not considered water sports, are included among water sports. The most popular, according to the authors, are sports that require human strength and nature.

Sailing and canoeing depend on human strength, waves and winds. Canoeing is divided into modalities, such as ocean canoeing and kitesurfing, among others. Other sports, such as wakeboarding and surfing, are considered water skiing. Brazil is “[...] the biggest nation on the world [surfing] circuit. It is the country that also concentrates the largest surfing audience in the world, ahead of the United States and Australia” (Beirão; Marques; Ruschel, 2018, p. 207).

According to the authors, the country has more than 3 million surfers and lists relevant audience figures for sporting events: more than 1.5 million hours of live broadcasts, 2.5 million views, 647 thousand downloads of apps, and a local audience of 150k.

### **Tourism**

In addition to being a great sports center, Brazil also stands out in the tourism industry, which is one of the three most important activities in the world. “Brazil was the 11th tourism economy in the world, and direct tourism GDP represented 2.9% of the total Brazilian GDP, with a turnover of US\$ 59 billion in 2016” (Beirão; Marques; Ruschel, 2018, p. 212). According to the

authors, in 2017, tourism employed 2.3 million people, which represented 2.4% of formal jobs in the country, divided into 60 activities.

Beirão, Marques and Ruschel (2018) report that the country received, in 2016, the visit of more than 6.5 million foreigners, most of whom declared tourism as their main motivation. At that time, 19,485 tourism agencies, 7,117 inns, 393,970 housing units, and 837,169 beds were registered, in addition to 8,577 tourist transport companies and 1,023 car rental companies, which generated 472,113 jobs and moved R\$ 5.31 billion. It is important to highlight the context of the Olympic Games in Rio de Janeiro, in 2016, when the city received athletes from different countries.

The tourism industry already has great relevance in the national economic activity, but it has the potential to collaborate even more with employment and income for Brazilians. Given the country's biodiversity, one must consider the potential of swampy, forested, desert, river, maritime, pampas, as well as coastal regions. "The figures for the tourism economy still do not reflect the benefits that could be expected from a country with these characteristics." (Beirão; Marques; Ruschel, 2018, p. 214).

The highlight goes to the Northeast region, as "[...] it is the region that most resembles the Caribbean, the model destination for diving tourism, whether for the visibility of up to 30 m, water temperature or for the biological diversity and the patches and reefs" (Beirão; Marques; Ruschel, 2018, p. 215). There are many regional destinations described as having great tourist potential for diving: Salvador (BA), Maceió (AL), Fernando de Noronha (PE), Recife (PE) etc.

Another modality is tourism to follow whales, dolphins, and manatees, with emphasis on the southern coasts of Bahia, Espírito Santo, and Santa Catarina. For surfing, the cities of Santos (SP) and Rio de Janeiro (RJ) stand out. The type of tourism that generates more income is maritime cruises. Data from Beirão, Marques and Ruschel (2018) show that, in the 2011/2012 season, the public present on cruises was 805,189 people.

## CONCLUSION

The sea allows much more than contemplation. In the Brazilian coastal areas, there are many examples of economic exploitation, such as fossil fuels (mainly oil, but also mining), fish production and cultivation, industrial potential in port areas, festive, sports, and tourist events, which promote income generation for coastal populations and great exploration potential worldwide, including with a growing audience. It is necessary, however, to draw attention to the medium and long-term indirect effects of lack of preservation.

In the Portuguese example of monitoring the economy of the sea, there is a good lesson for Brazil: it is necessary to promote fair, legal, and environmentally safe exploitation since it is known that nature has limitations to replace the services it provides. One must consider the world's population growth and see an opportunity in this challenge. Brazil, for which it is inserted in international organizations, has great possibilities even of leading the supply and exploitation of some services that depend on the environment.

The coastal ecosystem services of the sea are still poorly studied, including at the international science level. In Brazil, therefore, studies, approaches, and analyses of ecosystem services are scarce. The objective of this article is to raise the importance of these environmental services for the country's economy as a way of producing income and promoting industrial, fishing, sports, and tourism potential.



As a way of contributing to national studies, it is suggested to deepen the analysis of ecosystem services, with the inclusion of some that, perhaps, have not been listed, and also to study the relationship between economic profile and sustainable development in coastal regions. It is also important to highlight the potential of these services in different regions of the country, as there was a strong presence of events, whether manufacturing or tourist, along the entire Brazilian coastal zone, which goes from Amapá to Rio Grande do Sul.

Finally, it should be noted that this paper directly contributes to the debate on topics related to the Sustainable Development Goals established by the United Nations, such as the generation of clean energy, sustainable fishing, sustainable tourism, balanced exploitation of sea resources, sustainable cities and communities and responsible consumption and production.

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