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Marine Governance in Brazil's Southeast: SDG 14, GHG Emissions, and Coastal Protection

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Abstract

The health of marine and coastal ecosystems is fundamental to global climate regulation, biodiversity preservation, and sustainable economic development. In Brazil, the vast maritime territory known as the "Blue Amazon" holds immense ecological and strategic value, yet remains under increasing pressure from industrial expansion, pollution, and the impacts of climate change. Understanding the legal and institutional frameworks governing these areas is therefore essential to ensuring that economic activities align with international sustainability commitments. This article addresses the legal and supra-legal framework for achieving Goal 14 in the São Paulo state region and the prohibition of the release of substances resulting from GHG (greenhouse gas) emissions mitigation processes into the marine and/or oceanic environment. Thus, it presents the Brazilian justification for compliance with the SDG 14 target and its foundations according to the 2030 Agenda established within the United Nations and UN, and the existing regulatory framework for compliance with the goal in the region related to this type of activity, in addition to related international regulations. To this end, the article uses an analytical, deductive method, with documentary and theoretical research techniques.

Keywords: SDG 14; Sustainable Development Goals (SDG); Legal Frameworks; Supralegal Frameworks; Brazil; São Paulo; Marine Environment.

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1. Introduction

The engagement of countries and regions with the Sustainable Development Goals is a globally consensual resource for economic growth, social inclusion, and environmental protection (UN, 2020). The expectation is that the incorporation of these goals by public authorities and civil society will be carried out from the bottom up, reflecting a sense of responsibility regarding the right to sustainability (FERREIRA, 2015).

Thus, in 2015, 193 Member States gathered under the United Nations documented national efforts to meet the challenges set during the 2015 United Nations General Assembly Sustainable Development Summit, approving the document "Transforming Our World: the 2030 Agenda for Sustainable Development."In Brazil, to coordinate the implementation of the 2030 Agenda, the National Commission for the Sustainable Development Goals was created under the Government Secretariat of the Presidency of the Republic (Segov/PR), which assigned to the IPEA provides permanent technical advisory support for its work (IPEA, 2019). Several SDG 14 targets originally set for 2020 have already passed, and the United Nations and UNEP now treat them as "continuing or unmet goals" under the 2030 Agenda.

However, in the concrete reality of Global South countries, and particularly in Brazil, this statement of principle clashes with a historical trajectory marked by institutional practices that, rather than valuing and protecting communities and territories, accelerate their material, symbolic, and normative expropriation (LAMPIS, 2025).

However, the cooperative decentralization of environmental policies in Brazil – formally envisaged – faces in practice strong asymmetries in administrative capacity, technical and financial resources, which make the ability of the various subnational levels to implement effective environmental policies unequal. The result is a

fragmented and often inconsistent mosaic of environmental regulations, institutions, and policies, which contributes to the creation of unequal environmental territories (LAMPIS, 2025).

According to Viana (2019), as they cover more than two-thirds of the Earth's surface, provide a huge variety of resources, and host rich biodiversity, the relationship of men and women with seas and oceans accompanies and will continue to accompany their history, especially as it provides an important source of food. The first industrial revolution in the 18th century triggered a problem that affected the entire planet: ocean acidification. With a vast coast to protect, it is incumbent upon Brazil to adapt in order to systematically control the salinity (pH) along the Atlantic Ocean (IPEA, 2019). Brazil has almost 8,000 km of coastline, and the country's coastal strip has 42 million inhabitants and highly sectorized regulation, which presents spatial and normative overlaps. Strictly marine sectors represented 2.6% of Brazil's national GDP.

According to Patrizzi et al. (2025), Brazilian marine protected areas (MPAs) are predominantly small, partially protected, and concentrated along the coast, with uneven distribution among ecoregions. Many also lack formal management instruments. While the expansion of MPA coverage may indicate increased regulation of marine resources, this does not necessarily ensure effective biodiversity conservation. Therefore, Patrizzi et al. (2025) emphasize that improving conservation outcomes requires moving beyond area-based targets.

When the broader coastal economy is included — that is, all economic activities of the coastal municipalities — the total contribution rises to 19% of GDP (HADDAD and ARAÚJO, 2025). However, these aggregated numbers have limited usefulness for regional policies, as they do not capture the local economic differences among the various coastal areas of the country. For an effective blue economy strategy, it is essential to understand regional specificities and plan targeted interventions (HADDAD and ARAÚJO, 2025).

Table 1. Current Regulations on the Management of Seas and Oceans in Brazil

Regulation	Scope	Main Objective
Law No. 9,537/1997 (LESTA)	Waters under national jurisdiction (maritime and inland)	Establishes safety rules for waterway traffic and defines the Brazilian Navy's authority over inspection and enforcement.
Law No. 9,966/2000	Maritime zones, ports, and terminals	Provides for the prevention, control, and inspection of pollution by oil and harmful substances in national waters.
Law No. 9,985/2000 (SNUC)	National territory, including marine áreas	Establishes the National System of Conservation Units, applicable to both terrestrial and marine protected areas.
Decree No. 12,481/2025 (National Maritime Policy)	Brazilian maritime and coastal space	Establishes guidelines for integrated, sustainable, and secure management of the sea, covering economic, environmental, technological, and defense aspects.
NORMAM (Maritime Authority Standards)	Brazilian jurisdictional waters	Set of technical standards issued by the Navy regarding navigation, vessels, pollution control, and maritime safety.

The central regulation is Law No. 9,966/2000, which deals with the prevention, control, and supervision of pollution caused by oil and other harmful or hazardous substances in waters under national jurisdiction. Its Article 3 explicitly prohibits the discharge into the sea of any substance that causes or may cause pollution, except in cases where there is express authorization and within the regulated technical and environmental limits. This law was inspired by the International MARPOL 73/78 Convention of the International Maritime Organization (IMO), which Brazil ratified and incorporated into its legal system. In addition to Law No. 9,966/2000, there are complementary regulations, such as CONAMA Resolutions (particularly Nos. 001/1986, 237/1997, and 454/2012), which address licensing and control of effluent disposal.

In Brazil, national policies for the seas and marine resources reflect commitments made by the country in international conventions and treaties, such as the United Nations Convention on the Law of the Sea (UNCLOS), enacted in Brazil through DECREE No. 99.165, OF MARCH 12, 1990. It is combined with the Convention on Biological Diversity and the United Nations Framework Convention on Climate Change. Also included is the 2017 Oceans Conference. The event, held at the UN building in New York, has the theme "Our Oceans, Our Future: Partnerships for the Implementation of Sustainable Development Goal 14."

As Brazil seeks to achieve UN SDG 14 ("Life Below Water") by 2030, it is essential to consider local specificities when developing economic policies for coastal areas. Policymakers need to tailor actions to regional needs and leverage the strengths of each area.

Natural resources—oil, gas, fisheries, climate—and man-made resources—human capital, cultural heritage, infrastructure—are unevenly distributed along the coast, generating distinct locational advantages that influence the opportunities and challenges of the Brazilian blue economy (HADDAD, 2025).

In this article, we seek to present some indicators to critically support the results obtained by the tool, in accordance with the targets defined for Brazil and the current SDG14 reports for the State of São Paulo, which prohibit the release of substances resulting from GHG (greenhouse gas) emissions mitigation processes into marine and/or oceanic environments.

The analytical, deductive method is used, with documentary and theoretical research techniques. The legal framework is considered to be the national and regional regulatory framework, specifically for the São Paulo Region. The term "region" encompasses the federalist aspect of a state and the specific grouping of municipalities, when relevant. The supralegal framework is considered to be the international regulations related before and after the establishment of the Sustainable Development Goals.

Brazil emerges as a crucial observatory for understanding how the rhetoric of sustainability can be co-opted and transformed into a regressive force, capable of deepening rather than resolving the ecological crisis (LAMPIS, 2025).

Carbon capture and storage activities are gaining relevance as instruments for mitigating anthropogenic greenhouse gas emissions, specifically carbon dioxide, within the context of international agreements on climate change, such as the Paris Agreement (MUSARRA et al, 2022). In this context, it is now understood that anthropogenic sources of carbon emissions need to be monitored to reverse their impacts, and capture, which consists of directing carbon dioxide to a specific structure that contains it, prevents its dispersion into the atmosphere through storage, which is usually geological (COSTA and MUSARRA, 2018).

This type of CO2 storage can be implemented in various geological units across Brazil and depends on economic, technological, and logistical factors. Some projects aim to overcome this logistical challenge by establishing structurally stable sites where water injection wells can be installed to dissolve part of the salt structure, artificially forming salt caverns. The subsequent process uses gas injection to maintain the stress conditions prior to dissolution, a necessary condition to prevent the collapse of the newly constructed structure. However, improperly performed activities can compromise the structure and result in fluid leakage into overlying layers or even into the atmosphere (COSTA and MUSARRA, 2018).

These activities, therefore, can be understood as likely to cause harm to the environment, which requires, under Article 225, Section IV of the 1988 Federal Constitution, a prior environmental impact study. In this regard, to adapt these activities to environmental regulations, it is important to note that they fall under the aegis of the instruments defined in the National Environmental Policy Law, namely, environmental impact assessment and licensing (COSTA and MUSARRA, 2018).

1.1 Conservation and sustainable use of the oceans, seas, and marine resources for sustainable development

Brazil, a country rich in natural resources and with a vast biodiversity, faces the challenge of ending marine pollution caused by untreated waste and improper solid waste disposal. In this regard, it is important to relate to target 14.1 of SDG 14, "Conserve and sustainably use the oceans, seas and marine resources for sustainable development."

Thus, the global target applies to the country. However, it is worth noting that the two variables considered in the target 14.1 indicator (eutrophication level and density of floating plastic debris) are not systematically monitored by Brazil along its entire coast. Consequently, it will be necessary to implement a monitoring system that collects the data necessary to measure the original indicator. To achieve this goal within the agreed timeframe, it is necessary to consider, among other technical aspects:

> i) the measurement, in a standardized unit, of plastic material from all sources present in the sea (based on fixed parameter collection stations along the coast); ii) the level of suspended organic matter in the marine environment (focusing, for example, on areas with pollution resulting from the discharge of urban and industrial sewage, and activities such as aquaculture); iii) the biochemical oxygen demand (UN, 2020).

The process of marine life pollution is called eutrophication, which causes changes in water color, making it

turbid and/or greenish and foul-smelling, a process that can be lethal to marine life due to the alteration in water oxygenation, which causes asphyxiation in living organisms (IBUSP, 2020).

BOD, or biochemical oxygen demand, is the amount of oxygen, expressed in milligrams of oxygen per liter, equivalent to the consumption of microorganisms in a given effluent sample, such as domestic and industrial sewage. These microorganisms are responsible for the decomposition of organic matter in the aquatic environment. It is through this gas that the level of pollution in the water is measured (CONAMA RESOLUTION No. 430, MAY 13, 2011).

A different process occurs in nutrient pollution, which is caused by chemical compounds containing large amounts of phosphorus or nitrogen. The main source is untreated sewage from urban properties and agricultural activities. Regarding agricultural activities, pollution occurs through the excessive use of fertilizers combined with the runoff of waste from captive-raised animals, or through processing in livestock farming (FINEP, 2009).

The corresponding goal in SDG 14 would be 14.1.1 - Eutrophication index of coastal waters and floating plastic debris density index. By 2020, manage sustainably and protect marine and coastal ecosystems to prevent significant adverse impacts, including by enhancing their resilience, and take measures for their restoration in order to ensure healthy and productive oceans (UN, 2020).

The Brazilian coast exceeds 8,500 km in length, which is both a privilege and a great responsibility (IBGE, 2011). Considering the second point, it is necessary to note that managing this heritage sustainably is a major challenge, especially regarding ecosystems. However, it should be noted that although Brazil considers ecosystem-based approaches in environmental management, the country does not systematically measure the percentage of the national exclusive economic zone managed in such a way (ENAP, 2021).

It is important to mention that environmental management needs to be carried out in an integrated and inclusive manner, since its nature is complex, without excluding elements such as the diversity of social components and economic interests at play, conservation needs, and the resources being exploited. For example, the pillars of the PNAP (National Strategic Plan for Protected Areas) established by Decree No. 5.758/2006 can be cited. The FAO (Food and Agriculture Organization of the United Nations) recommends that the same approach be adopted in fisheries management. However, the application of these approaches is complex, which hinders their implementation (FAO, 2019). Thus:

> Non-living resources primarily correspond to mineral resources of economic interest, which occur on the seabed or, like oil, below the seabed, in the sedimentary layers adjacent to continental margins. They also correspond to deposits in regions distant from continental margins, in ocean basins, mid-ocean ridges, and seamounts and chains of seamounts. Even ocean water is itself a mineral resource (IPEA, 2018).

The Brazilian Coastal Zone is a territorial unit encompassing 17 states and over four hundred municipalities, located between the North and the temperate equatorial South. There is also a maritime strip that contains the territorial sea (12 nautical miles wide from the coastline) (MPF, 2022).

The Marine Zone begins in the coastal region, encompasses the continental marine shelf, and extends to the EEZ (Exclusive Economic Zone) up to 200 miles offshore (DECREE No. 99,165, OF MARCH 12, 1990/United Nations Convention on the Law of the Sea).

Which brings us to target 14.2.1, Proportion of national Exclusive Economic Zone (EEZ) managed using ecosystem approaches. Which aims to "Minimize and address the impacts of ocean acidification, including through strengthened scientific cooperation at all levels." (UN, 2020).

Three factors can cause stress on the environment and marine life: rising ocean temperatures, acidification, and pollution. Among the best-known consequences is that which affects species that depend on the calcium present in seawater, a constituent of their skeletons, shells, and carapaces. This is the case for corals, mollusks, and crustaceans (COPPE/UFRJ, 2020). Ocean acidification is the continuous decrease in water pH as a result of the absorption of carbon dioxide (CO2) from the atmosphere. Seawater pH tends to be slightly basic (above 8), and ocean acidification causes a shift toward neutral pH conditions (pH = 7). The increase in CO2 concentration in the atmosphere is caused by anthropogenic activities such as emissions from deforestation, industrial activities, and the operation of engines that use fossil fuels (INEP, 2020).

Target 14.4 focuses on regulating harvesting and eradicating illegal, unreported, and unregulated overfishing, as well as destructive fishing practices. In Brazil, fishing is of paramount importance to the economy, providing income for countless self-employed and informal workers. To balance sustainability and fishing, the country needs to adopt a global target. It is worth noting, however, that the last official fisheries statistics bulletin was

published in 2011 (ICMBIO, 2011). According to IPEA (2020), the country conducts surveys of fisheries production in some states and scientific research covering certain species and areas. The Special Secretariat for Aquaculture and Fisheries of the Presidency of the Republic (SEAP/PR) has structured a fisheries monitoring system.

Biologically sustainable levels refer to the limits that can be used without harming the ecosystem, in this case, fish. This analysis is based on scientific parameters that determine how much each stock can support. Biologically, this means estimating a value that allows the environment to recover, returning to what in law is called the status quo ante, or previous state (IO/USP, 2021). Target 14.5—Proportion of fish stocks within biologically sustainable levels—is related to this.

Biologically sustainable levels are those that correspond to the limits within which resources can be used without causing harm to the ecosystem, in this case, to fish populations. This assessment is based on scientific parameters that determine how much each stock can withstand without compromising its ability to regenerate. From a biological standpoint, it requires estimating a value that allows the environment to recover, returning to what, in legal terms, is called the *status quo ante*, or the prior state (IO/USP, 2021). This principle is directly related to **Target 14.5** — *the proportion of fish stocks within biologically sustainable levels*. "By 2020, the goal was to conserve at least 10% of coastal and marine areas, in accordance with national and international law and based on the best available scientific information" (UN, 2020).

Goal 14.6 aims to prohibit certain forms of subsidies for illegal, unreported, and unregulated fishing, and to refrain from introducing new subsidies of this kind, recognizing that appropriate and effective special and differential treatment for developing countries and least developed countries should be an integral part of negotiations on fishing subsidies under the World Trade Organization (UN, 2020). To this end, Brazil committed to, by 2020, consider eliminating subsidies that contribute to these types of fishing, refraining from introducing new subsidies of this kind.

The development of research and technology transfer was allocated in target 14.a, which, according to the UN (2020), must include criteria and guidelines on Marine Technology Transfer from the Intergovernmental Oceanographic Commission, "in order to improve ocean health and increase the contribution of marine biodiversity to the development of developing countries, in particular small island developing States and least developed countries".

Small-scale artisanal fishing was covered by target 14.b, which aims to provide fishers of this type with access to marine resources and markets. Target 14.c, in turn, ensures conservation through the implementation of international law, in accordance with UNCLOS (United Nations Convention on the Law of the Sea), which provides the legal framework for the conservation and sustainable use of the oceans and their resources, as stated in paragraph 158 of "The Future We Want." Both targets were maintained by Brazil without changes.

The reference to the document "The Future We Want" (RIO+20, 2012) is justified by the fact that it establishes the recognition of the legal framework for the conservation and sustainable use of the oceans and their resources:

> We recognize that the oceans, seas, and coastal areas constitute an integral and essential component of the Earth's ecosystem and are fundamental to its survival. International law, as reflected in the United Nations Convention on the Law of the Sea (UNCLOS), establishes the legal framework for the conservation and sustainable use of the oceans and their resources. We emphasize the importance of the conservation and sustainable use of the oceans, seas, and their resources for sustainable development, notably through contributions to poverty eradication, sustainable economic growth, food security, the creation of sustainable livelihoods, and decent work, while protecting biodiversity and the marine environment and mitigating the impacts of climate change (...).

Given the current state of fisheries resources and considering the Doha and Hong Kong Ministerial Declarations on fisheries subsidies and the need to conclude these negotiations, states were encouraged to eliminate subsidies responsible for overfishing and to refrain from introducing new ones, in addition to improving existing ones (ENAP, 2021).

It was also agreed on the need to guarantee access to fisheries and the importance of ensuring that the population has access to subsistence fishing, in this case small-scale and artisanal fishers, as well as women, indigenous peoples, and their communities, especially in developing countries and especially in small island developing states, have access to markets.

An international cooperation agreement was established, aiming to conserve coral reefs and mangrove ecosystems and realize their social, economic, and environmental benefits, without compromising the facilitation of technical collaboration and voluntary information sharing.

The importance of measures based on conservation areas, including marine protected areas, was agreed upon, in accordance with international law and based on the best available scientific information, as a tool for the conservation of biological diversity and the sustainable use of its components.

There was a commitment to protect and restore the health, productivity, and resilience of oceans and marine ecosystems, ensuring the maintenance of their biodiversity and conservation and sustainable use for present and future generations. This text also aligns with the environmental policy enshrined in the 1988 Federal Constitution. Reference was also made to the regular process of Global Reporting and Assessment of the State of the Marine Environment, taking into account socioeconomic aspects, as established by the UN General Assembly.

Goal 14.6 aims to prohibit certain forms of subsidies for illegal, unreported, and unregulated fishing, and to refrain from introducing new subsidies of this kind, recognizing that appropriate and effective special and differential treatment for developing countries and least developed countries should be an integral part of negotiations on fishing subsidies under the World Trade Organization (UN, 2020). To this end, Brazil committed to, by 2020, consider eliminating subsidies that contribute to these types of fishing, refraining from introducing new subsidies of this kind:

- Harmonization with other national policies and with the Pluriannual Plan;
- Definition of priorities for programs and actions, as provided for in the Pluriannual Plan, and based on their contribution to the defense of national interests and sustainable development;
- Decentralized and participatory implementation, encouraging partnerships among the federal government, states, municipalities, the private sector, and civil society;
- Adoption of the precautionary principle in the exploration and sustainable use of marine resources;
- Protection of biodiversity and genetic heritage within marine areas under national jurisdiction and adjacent ; coastal zones; and
- Observance of international commitments undertaken by the Brazilian government. The PNRM is guided by the following instruments: The 1988 Federal Constitution and related national legislation; The National Maritime Policy; And by international acts to which Brazil is a signatory, particularly: The United Nations Convention on the Law of the Sea (UNCLOS); The United Nations Convention on Biological Diversity; The United Nations Conference on Environment and Development (Agenda 21); The International Maritime Organization (IMO) Conventions on the Prevention of Marine Pollution; and The FAO Code of Conduct for Responsible Fisheries.

Between June 5 and 9, 2017, another important global event on oceans took place at the United Nations Headquarters in New York: the United Nations Ocean Conference. The conference brought together heads of state and government as well as representatives of organizations from around the world engaged in marine and oceanic issues (ECODEBATE, 2017).

Governments, civil society organizations, and private sector entities participating in the event were encouraged to present voluntary commitments related to Sustainable Development Goal 14 (Life Below Water).

The document was prepared by 193 Member States of the United Nations at the UN Headquarters in New York, with the participation of leading heads of state and government, as well as representatives of organizations from around the world. The outcome was the adoption of the document “Our Ocean, Our Future: Call for Action”, issued to support the implementation of Sustainable Development Goal (SDG) 14 of the 2030 Agenda, with the full participation of civil society and other stakeholders. The declaration states:

> We call upon the Secretary-General of the United Nations to continue his efforts to support the implementation of Goal 14, within the context of the implementation of the 2030 Agenda, particularly by strengthening coherence and coordination among United Nations system agencies on ocean-related issues, taking into account the work of UN-Oceans.(Translation by Camila Martins, ECODEBATE, 2017).

Brazil, in turn, highlighted at the conference two key initiatives—the Blue Fund (Fundo Azul) and the Whale

Sanctuary (Santuário das Baleias)—presented by the Brazilian Government as solutions for marine conservation.

The country was represented at the event by the Ministry of the Environment (MMA) and ICMBio (Chico Mendes Institute for Biodiversity Conservation), alongside the Ministry of Foreign Affairs, the Ministry of Science, Technology, Innovations, and Communications, and several civil society organizations, including Conservation International and WWF-Brazil, among others.

Brazil reaffirmed its commitment to SDG 14 through measures such as the Blue Fund of Brazil, the South Atlantic Whale Sanctuary, and marine spatial planning initiatives, with special focus on the Abrolhos Region, the Vitória–Trindade Chain, and the Northern Coast of Brazil.

The Blue Fund is Brazil's main project for conserving biodiversity within its coastal and marine jurisdictional areas. It is estimated to mobilize USD 140 million by 2022 to restore endangered species, rebuild fish stocks, and promote sustainable development and tourism practices, thereby contributing to the integration of climate change mitigation strategies.

The Blue Fund is to be established by the Ministry of the Environment and the Chico Mendes Institute for Biodiversity Conservation (ICMBio), aiming to expand and strengthen the management of protected areas to achieve the 10% effective conservation target within Brazil's coastal and marine jurisdictions (FUNDO AZUL, 2020).

According to Rodrigo Medeiros, Vice President of Conservation International Brazil (SANTUÁRIO DE BALEIAS, 2020): *"The strategy will also help integrate terrestrial and marine areas, promoting the sustainable use of biodiversity by local and traditional communities, encouraging volunteer actions, among other initiatives"*.

In addition to the measures mentioned earlier, ensuring the protection of marine life in Brazilian waters requires further conservation initiatives, such as the Procosta – National Program for the Conservation of the Brazilian Coastline. It is estimated that by 2020, all endangered species should be protected by at least one conservation instrument. Procosta aims to conserve Brazil's coastal regions by minimizing environmental damage and preserving coastal ecosystems, through adaptive strategies in response to ongoing climate change.

The National Strategy will identify and propose improvements in conservation instruments needed to prevent, mitigate, and reduce current and potential threats to these species. Such instruments include conservation action plans, guidelines for environmental licensing, and monitoring programs (PROCOSTA, 2020).

In Brazil, the National Coastal Management Plan II (PNGC II) was developed by the Coordination Group established under Decree No. 1,540 of June 27, 1995. However, it requires adjustments to align with the targets of SDG 14.

In 2009, Brazilian civil society submitted a request to the Ministry of the Environment to revise the National Coastal Management Plan (PNGC). The Commission on Environment and Sustainable Development of the Chamber of Deputies (CMADS), supported by the Parliamentary Environmental Front and the SOS Mata Atlântica Foundation, during the seminar "25 Years of the Federal Constitution and the Protection of Coastal and Marine Ecosystems" held on April 11, 2013, raised discussions concerning the need to revise the protective regulations for marine and coastal ecosystems. This movement provided Brazil with the opportunity to adopt a modern policy for the management and protection of its marine and coastal ecosystems.

There is also an ongoing Bill that seeks to establish the National Policy for the Conservation and Sustainable Use of the Brazilian Marine Biome (PNCMar) and related provisions (Bill No. 6969 of 2013). Among its justifications is the following:

The National Policy for Marine Resources, established by Decree No. 5,377 of 2005, includes among its strategies the recommendation to "propose updates to Brazilian legislation to ensure its application in all matters concerning marine resources, the integrated management of coastal and oceanic zones, and national maritime interests."

The enactment of this bill is listed among the objectives of the Fourth Federal Coastal Zone Action Plan (2017–2019, BRASIL, 2017b). It seeks to establish a regulatory framework for marine and coastal areas capable of integrating productive activities with conservation efforts, creating a marine biome, and instituting the mechanism of Marine Spatial Planning (MSP).

The proposal, approved by the Chamber of Deputies in May 2025, aims to create guidelines and rules for the integrated management and protection of Brazil's marine and coastal ecosystems, serving as a regulatory milestone to address the existing gaps in national legislation.

Brazil possesses approximately 5.7 million km² of maritime territory, known as the Blue Amazon, and about 8,500 km of coastline, where ecosystems of high environmental and economic significance are concentrated. Marine Protected Areas (MPAs) play essential roles, including the protection of coral reefs, mangroves, seagrass beds, oceanic islands, and species breeding zones, as well as acting as natural barriers against extreme climatic events.

In recent years, the country has expanded its network of protected areas, reaching approximately 26.5% of its territorial sea under some form of protection—encompassing Environmental Protection Areas (APA), National Marine Parks (PARNAMAR), and Marine Extractive Reserves (RESEX).

The Southeast region, which hosts one of the most densely populated and industrialized coastal zones in the country, has recently achieved significant progress in consolidating marine protected areas at both federal and state levels.

Over the past few years, Brazil has considerably strengthened the creation and management of marine conservation units, with the goals of protecting coastal and oceanic ecosystems, ensuring the sustainable use of natural resources, and fulfilling international biodiversity conservation commitments. This process has intensified since 2018 and gained renewed momentum from 2024 onward, when the federal government and state administrations, particularly in the Southeast region, began to integrate environmental policies aimed at ocean governance, aligned with the 2030 Agenda and the National Maritime Policy (Decree No. 12,481/2025).

Brazil encompasses an extensive maritime area—known as the Blue Amazon—covering about 5.7 million km² and a coastline of approximately 8,500 km. This area hosts remarkable ecological diversity, including coral reefs, mangroves, seagrass meadows, oceanic islands, coastal dunes (restingas), and upwelling zones. Marine conservation units play a crucial role in safeguarding these ecosystems, which serve as breeding grounds for species, climate regulators, and natural shields against extreme events, while also supporting fishing communities and tourism activities. Currently, about 26.5% of Brazil's marine territory is under some form of legal protection, although gaps remain in the management and monitoring of many of these areas.

In the Southeast region, progress in marine conservation has taken place through the creation of new protected areas and the restructuring of existing units, aiming to reconcile environmental protection with the economic and social development of coastal zones. In the state of São Paulo, notable examples include the Marine Environmental Protection Areas (APAs) of the Northern and Central Coasts, established by State Decree No. 53,525/2008. These APAs, which encompass municipalities such as Ubatuba, São Sebastião, Ilhabela, and Santos, seek to protect marine and insular ecosystems while regulating activities such as nautical tourism and artisanal fishing. Currently, studies conducted by the Forest Foundation and the Environmental Research Institute (IPA/SP) aim to create a coastal–marine mosaic of protected areas, connecting different units and promoting ecological corridors for migratory species.

In Espírito Santo, the federal government established two new conservation units in 2025, focusing on marine and insular ecosystems, thereby strengthening the protection of coastal and reef environments. Among them, the Marine Environmental Protection Area of the Trindade and Martim Vaz Islands stands out for its strategic ecological and geopolitical role in the South Atlantic, alongside the Rasas Islands National Marine Park, dedicated to the protection of reefs and endangered species. These initiatives form part of the national network expansion of protected areas and involve the participation of ICMBio (Chico Mendes Institute for Biodiversity Conservation), the Brazilian Navy, and various scientific institutions, which contribute to coral monitoring, biodiversity assessment, and regulated tourism management.

The state of Rio de Janeiro has also advanced in consolidating its marine protected areas, particularly through the Arraial do Cabo Marine Extractive Reserve, created in 1997 and currently undergoing a revision of its management plan. The update seeks to improve the regulation of artisanal fishing, enhance the protection of upwelling zones, and implement sustainable practices, serving as an example of participatory co-management that integrates traditional fishers' knowledge with environmental science.

Despite these advancements, the management of marine conservation units in the Southeast still faces structural challenges, such as urban and industrial pressure on coastal ecosystems, port expansion, conflicts between artisanal and industrial fisheries, and unregulated tourism. Moreover, the ongoing energy transition—marked by the growth of offshore wind energy projects and geological CO_2 storage—demands a robust environmental governance framework capable of harmonizing technological innovation with ecological preservation.

1.2. Programs in São Paulo Associated with SDG 14

SDG 14 focuses on the conservation and sustainable use of oceans, seas, and marine resources through the

prevention and significant reduction of marine pollution, the sustainable management and protection of marine and coastal ecosystems, the fight against destructive fishing practices, and the conservation of coastal and marine zones.

The first monitoring report of the SDGs in São Paulo's 2016–2019 Multi-Year Plan (PPA) identified the following institutions as being involved in achieving Goal 14 (with the most relevant highlighted): Secretariat for Sanitation and Water Resources; Environmental Sanitation in Watersheds of Regional Interest; Water Infrastructure, Flood Control, and Sanitation; Planning and Administration of Water Resources; Planning, Formulation, and Implementation of the State Sanitation Policy; Universalization of Water Supply and Wastewater Collection; Planning, Formulation, and Implementation of the Water Resources Policy under the Secretariat of Energy and Mining; Flood Control of the Pinheiros Canal; Promotion of Energy Development and the Mining Industry in São Paulo State; Secretariat of Government; Strengthening of Regulatory Competencies in Energy, Gas, and Sanitation.

The report selected two indicators for SDG 14—the beach water quality index (balneability) and the proportion of marine protected areas—and three indicators for SDG 15—the proportion of preserved forests, the proportion of municipalities with forest and biodiversity protection legislation, and the proportion of municipalities affected by erosion.

In the state of São Paulo, there are 228 conservation units under federal or state private management, distributed across terrestrial, marine, and coastal environments. Of particular relevance is the marine environment, where 45.3% of the territorial sea is protected by conservation units. The Forest Foundation and the Forest Institute together have created four additional conservation units since 2012, according to reports from the State Secretariat for the Environment (RPPN, 2020).

1.2. Strategic Environmental Assessment Action Plan for the São Paulo Coast

The Strategic Environmental Assessment (SEA) is a planning instrument regulated by the São Paulo State Climate Change Policy (Decree No. 65,881/2021). It seeks to strategically analyze cumulative and synergistic medium- and long-term impacts arising from policies, plans, programs, and structural projects. The SEA for the São Paulo coastal region focuses on port, naval, and offshore industrial activities and aims to support environmental planning and sectoral actions along the state's coastline in light of potential benefits and impacts from pre-salt oil exploration projects, which are expected to be integrated into upcoming Multi-Year Plans (PPAs).

The assessment is guided by the following premises:

In the oil and gas sector, an economic expansion cycle has already begun, including the expansion and modernization of port activities in São Sebastião and Santos, with projected investments of 23 billion USD. This cycle may sustain a continuous growth rate of 6% to 7% per year, thereby increasing employment and income levels throughout the São Paulo coastal region (PEMCSP, 2021).

With regard to protected areas, the objective is to address existing protection gaps concerning lowland forests, floodplains, mangroves, rocky shores, water bodies, and coastal sandy environments; to consolidate Integrated Risk Management, focusing on the new challenges posed by pre-salt oil exploration; and to anticipate the management of impacts on marine ecosystems (PEMCSP, 2021).

In the São Paulo region, the estimated outcomes, according to the tool, were at 2020, as follows:

Figure 1. São Paulo's State Overview for SDG 14 (UN,2020)

The chart provides a comparative overview of São Paulo's performance relative to the Brazilian national average in achieving the United Nations 2030 Agenda Sustainable Development Goals (SDGs). Each blue point represents the state's performance, while each yellow point indicates the national average; the outer circle marks the target value expected for 2030. This visual analysis clearly highlights the areas in which São Paulo is progressing more rapidly and those where it faces greater challenges.

Overall, the state of São Paulo demonstrates significant progress in socioeconomic and institutional goals, standing out in SDG 8 (Decent Work and Economic Growth), SDG 9 (Industry, Innovation, and Infrastructure), and SDG 16 (Peace, Justice, and Strong Institutions). This performance reflects the strength of its diversified economy, its high degree of industrialization, the dynamism of its service sector, and the robustness of its public and private institutions. The presence of universities, technology centers, and a more formalized labor market boosts competitiveness and innovation, making the state a national hub for development.

In the social sphere, São Paulo also performs well in education and health. Its results in SDG 4 (Quality Education) exceed the national average, largely due to a greater availability of higher and technical education and a well-established public education network. In SDG 3 (Good Health and Well-Being), the state maintains favorable indicators for infant mortality, life expectancy, and access to medical services, although territorial inequalities persist between metropolitan regions and inland municipalities.

However, the chart also reveals that São Paulo continues to face significant challenges in environmental and social equity goals. The state performs below the national average in SDG 10 (Reduced Inequalities), SDG 13 (Climate Action), SDG 14 (Life Below Water), and SDG 15 (Life on Land). Despite its economic strength, São Paulo struggles with deep socio-spatial disparities, where peripheral areas and municipalities in the Vale do Ribeira and Northern Coast remain particularly vulnerable. Furthermore, urban and industrial pressures on ecosystems, a deficit of green areas, and persistent water and air pollution problems hinder progress toward environmental sustainability goals.

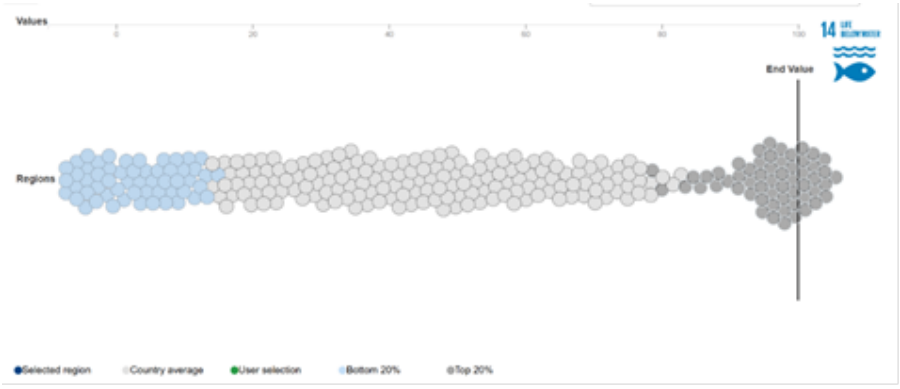

Figure 2. São Paulo's Performance chart for SDG 14

The figure shows a regional performance chart for SDG 14 – Life Below Water, developed using the OECD tool *"Measuring the Distance to the SDGs in Regions and Cities."* Each hexagon represents a region, and the horizontal axis indicates progress toward the goal, ranging from zero (far from the target) to one hundred (target achieved). Light blue hexagons represent regions in the bottom 20%, meaning they are the farthest from meeting SDG 14. Gray hexagons show intermediate performance, while dark gray ones represent the top 20%, or those closest to reaching the established target. The vertical line marked "End Value" represents the ideal benchmark, where the objective would be fully accomplished.

The selected region, highlighted in dark blue, falls within the lowest-performing group, indicating that the State of São Paulo is still far from achieving the expected outcomes of SDG 14. This result reveals limited progress in implementing effective measures for marine and coastal ecosystem protection, such as pollution control, expansion of marine protected areas, and monitoring of ocean acidification.

1.3. Discharge of Substances Resulting from Greenhouse Gas (GHG) Mitigation Processes

In principle, the discharge of substances originating from greenhouse gas capture and their subsequent release into marine or oceanic environments constitutes an activity without explicit legal authorization in Brazilian law.

The dispersion of saline compounds, minimization of temperature variations, and reduction in the use of chemical substances listed in IBAMA's Normative Instruction No. 01/2018, as well as avoidance of toxic substances or discharges exceeding the tolerance thresholds of affected ecosystems, require the implementation of an Emergency Control Plan. This plan must include explosion control measures and a Groundwater Monitoring Program.

The extinction of species, significant socio-environmental alterations, or irreversible consequences that hinder the subsequent rebalancing of the ecosystem may justify the suspension or interruption of such activities at any time.

Upstream activities—ranging from exploration to well drilling and the production of oil and natural gas (E&P)—are classified as "potentially polluting and environmentally resource-consuming activities", pursuant to Annex VIII of Law No. 6,938/1981 (National Environmental Policy) and Annex I of CONAMA Resolution No. 237/1997. Activities involving the disposal of substances in noncompliance with environmental standards must be subject to the same classification.

The National Environmental Policy and Decree No. 99,274/1990 define, in Article 3, key environmental concepts. They describe "environmental quality degradation" as any adverse alteration of environmental characteristics, and "pollution" as the degradation of environmental quality resulting from activities that, directly or indirectly: a) harm the health, safety, or well-being of the population; b) create adverse conditions for social and economic activities; c) negatively affect biota; d) impair the aesthetic or sanitary conditions of the environment; or e) release materials or energy in violation of established environmental standards.

As can be observed, these legal definitions were designed to encompass any actions or omissions that cause adverse alterations or degradation of environmental quality. Therefore, if brine disposal results in environmental alteration or degradation, it will be classified as a polluting activity.

Annex VIII of the aforementioned law, as amended by Law No. 10,165 of December 27, 2000, lists as potentially polluting and environmentally resource-consuming activities—with a high pollution potential (PP) and high environmental resource utilization degree (GU)—the following activities subject to inspection:

mineral extraction and processing, including mineral prospecting under a utilization permit, open-pit mining (including alluvial) with or without beneficiation, underground mining with or without beneficiation, artisanal mining, well drilling, and the production of oil and natural gas.

Thus, the legislation is generic regarding the term "minerals." Since brine is a by-product of well drilling, it follows by extensive interpretation that brine disposal within the salt cavern production process—intended for carbon dioxide storage—is subject to environmental inspection. In this regard, IBAMA also holds regulatory and licensing authority over brine management, given that offshore activities fall under its jurisdiction pursuant to Complementary Law No. 140/2011, as the Territorial Sea, Continental Shelf, and Exclusive Economic Zone are federally regulated areas.

The Canadian Water Quality Guidelines (CWQG) for the protection of marine life establish that salinity variation must not exceed 1.2 ppt above ambient levels within 50 meters of the discharge point and 0.8 ppt within 1,000 meters, while temperature variation must remain within 1% of ambient seawater temperature for any human activity (CCME, 2008).

The salinity of seawater is also critical due to its physical, chemical, and biological interactions with other stressors and toxic substances. Physical interactions include the effects of salinity on the solubility, adsorption, and bioavailability of certain compounds in aqueous media (Whitehouse, 1984; Nugegoda & Rainbow, 1989), while chemical interactions involve the modification of the chemical speciation of trace metals (Hong & Kester, 1985).

Furthermore, salinity influences a wide range of organismal responses—such as survival, reproduction, behavior, and other sublethal effects—to various substances (Sprague, 1985; De Lisle & Roberts, 1988).

Non-lethal effects have also been observed in connection with hypercapnia (elevated exposure to CO_2). Tamburri et al. (2014) reported narcotic effects of increased CO_2 concentrations in fish and noted that a higher partial pressure of carbon dioxide may have harmful impacts on marine organisms, such as slowed respiration. Consequently, passive marine animals may experience depressed metabolism when exposed to low and chronic levels of CO_2.

Several studies also indicate slower growth in mussels and corals, as well as developmental effects in certain marine larvae and eggs—including brittle stars and bivalves—due to acidified seawater exposure, which reduces

pH in body fluids. Barry et al. (2010) report that organisms with weaker control over internal fluid chemistry, relying on passive molecular diffusion for gas exchange (such as sponges and echinoderms), are more sensitive to ocean acidification.

The potential adverse consequences include (GOSAC, 2004):

- Disturbance of nekton caused by collisions involving drill ships or support vessels in transit;
- Disturbance of nekton due to fuel spills in the sea;
- Introduction and/or spread of invasive exotic species within the coastal benthic community;
- Disturbance of marine biota through shipborne introduction of exotic species;
- Changes in seawater quality resulting from fuel leakage;
- Alteration of salinity levels;
- Disturbance of the planktonic community due to fuel spills;
- Disturbance of the benthic community due to fuel spills;
- Disturbance of ichthyofauna resulting from fuel spills;
- Disturbance of seabirds caused by fuel spills;
- General ecosystem disturbances;
- Deterioration of seawater quality from the discharge of sanitary effluents and food waste;
- Deterioration of air quality;
- Contribution to the greenhouse effect;
- Noise generation disturbance;
- Light generation disturbance affecting marine organisms (including Neptune and neon zones in ecological monitoring terminology);
- Disturbance from FPSO installations and associated collection and drainage systems;
- Seabird disturbance due to artificial light generation;
- Nekton disturbance caused by chemical spills in marine environments;
- Accidental chemical leaks into the sea;
- Planktonic community disturbance due to chemical contamination;
- Seabird disturbance from chemical exposure.

The constitutional principle of civil liberty, set forth in Article 5, Item II, of the Federal Constitution, ensures that "no one shall be required to do or refrain from doing anything except by virtue of law." This guarantee extends to the private sphere, allowing both individuals and legal entities to freely engage in economic and contractual activities. However, the Civil Code, in Articles 104, 187, and 421, establishes that such freedom must be harmonized with morality, public order, social function, and environmental protection. Thus, private autonomy finds its limits where the exercise of individual rights interferes with collective goods, such as the marine environment, whose protection is mandated by Article 225 of the Federal Constitution.

Within the framework of marine environmental governance, these limits become even more evident. The seas, seabed, and continental shelf form part of the Union's property and are classified as common goods for public use. Therefore, the economic exploitation of these areas—whether for transportation, fishing, resource extraction, or energy-related activities—requires state authorization and strict compliance with environmental regulations. Law No. 9,966/2000, for instance, explicitly prohibits the discharge of harmful or hazardous substances into waters under national jurisdiction, including industrial waste, effluents, and gases in liquid or dissolved form that may cause pollution. Consequently, the direct release of carbon dioxide (CO_2) into the sea is prohibited by law, as it poses a risk of ocean acidification and degradation of marine ecosystems.

Nevertheless, this prohibition does not preclude the development of technologies aimed at carbon capture and geological storage (CCS/CCUS) under environmentally safe conditions. In the Brazilian context, there is particular interest in storing CO_2 in deep pre-salt geological formations, especially within salt caverns and depleted rock reservoirs, where the gas can be injected and securely confined for thousands of years. This technique prevents carbon dioxide from being released into the atmosphere, thereby contributing to the achievement of national climate mitigation targets, as established under the National Policy on Climate Change (Law No. 12,187/2009) and the international commitments undertaken by Brazil under the Paris Agreement.

Studies based on literature reviews and geological data from the Santos Basin formations indicate that the geological storage of CO_2 in depleted oil and gas fields is geologically favorable (Ciotta, 2019). The selection of these formations occurs simultaneously with area mapping and production assessments to verify the structural integrity and storage potential of the reservoirs. However, the feasibility of this form of storage also depends on

an examination of the legal and regulatory frameworks governing the use of depleted fields for permanent CO_2 storage, as well as the alignment of Brazilian regulations with international standards of environmental safety and liability.

Depleted fields are oil and gas production areas that have undergone significant pressure depletion and hydrocarbon extraction yet still retain geological characteristics suitable for secure gas storage. The reuse of this infrastructure provides important economic and environmental advantages, including lower construction and licensing costs and reduced environmental impacts associated with well and platform decommissioning. It is estimated that, globally, well decommissioning costs may reach approximately US$ 85 billion between 2019 and 2028 (Townsend et al., 2020). Therefore, the conversion of oil wells into CO_2 injection wells represents a promising alternative, provided that technical integrity and safety requirements are duly met.

It is essential to highlight, however, that wells originally designed for oil and gas extraction have construction standards that differ from those required for CO_2 injection and confinement, thereby necessitating corrective actions and specific adaptations to ensure proper geological isolation. These adjustments entail additional costs and risk assessments, requiring a case-by-case feasibility analysis. International experiences, such as the Porthos Project in Rotterdam, have demonstrated the potential for repurposing existing wells, if such operations comply with robust technical and regulatory standards.

In the Brazilian context, by analogy with the standards applicable to the oil and natural gas industry, the storage of CO_2 in depleted fields must adhere to the existing safety and environmental control regulations, including ANP Resolution No. 37/2001, CONAMA Resolution No. 23/1994, Federal Decree No. 8,437/2015, and MMA Ordinance No. 422/2011. It is important to emphasize that, despite the technical feasibility of geological subsurface confinement, the direct discharge of CO_2 into the sea is expressly prohibited under Brazilian environmental law, particularly by Law No. 9,966/2000, which bans the release of harmful or hazardous substances into waters under national jurisdiction.

Thus, the use of pre-salt depleted fields for the geological storage of carbon dioxide (CO_2) emerges as a legally compatible and environmentally responsible alternative, if it is conducted under strict technical control and state supervision. This practice aligns with the National Policy on Climate Change (Law No. 12,187/2009) and contributes to the fulfillment of Brazil's decarbonization targets, ensuring that economic and technological freedom is exercised within the boundaries of environmental and climate protection.

However, it must be conducted under a precise political rationality, as Lampis (2025) suggests Brazilian environmental policies should be, since currently they rely on the historical marginalization of territories, the naturalization of environmental violence, and the selective co-optation of green agendas.

Accordingly, it becomes evident that the economic freedom to exploit subsoil and continental shelf resources must be reconciled with the legal duty of environmental and climate protection. The distinction between storing CO_2 in controlled geological structures and discharging CO_2 directly into the sea is fundamental: the former constitutes an approved and regulated mitigation instrument, while the latter represents a prohibited act under Brazilian law. Therefore, within the framework of the blue economy and the energy transition, Brazil must promote technologies that reduce emissions and prevent impacts on marine ecosystems, reaffirming that civil and entrepreneurial freedom ends where the constitutional duty to protect the sea—as a common good essential to planetary climate stability—begins.

Conclusions

Objective 14 seeks the conservation and sustainable use of the oceans, seas, and marine resources for sustainable development through a series of calls to action, such as the reduction of marine pollution, the elimination of overfishing and destructive fishing practices, and the economic benefit for small and less developed countries through the sustainable use of marine resources (sustainable management of fisheries, aquaculture, and tourism). These measures are still insufficient, as about 80% of marine pollution still originates from land-based activities. The remaining 20% of marine pollution comes from ocean-based activities such as maritime transport, fishing, and industrial exploitation (UN, 2017).

Activities such as agricultural practices, coastal tourism, port activities, river damming, urban growth, mining, fishing, aquaculture, and industrialization are identified as causes of massive pollution that threatens marine and coastal ecosystems, as well as the health and well-being of those who live in coastal areas and depend on their natural resources (UN, 2017).

About 60% to 80% of marine litter is composed of plastics, and there is also the improper disposal of fishing gear, responsible for 10% of ocean waste, which harms marine life that may ingest or be injured by it (IO/USP,

2022). Oil spills, untreated sewage, and waste dumping from vessels into the sea must also be considered as marine pollution factors.

Thus, the distance to achieving Sustainable Development Goal 14, identified by the OECD tool, is rooted in practical actions. The intention was to present the general normative framework related to Sustainable Development Goal 14, which is sufficient in terms of supralegal and national standards for implementation. What remains is monitoring, personal commitment, and institutional resources to effectively and integratively implement the set of guidelines for the proper management of oceans, seas, and marine ecosystems.

Given the above, it is recommended to establish new marine conservation units and to review and improve Bill No. 6.969/2013 at the federal level, as well as to strengthen institutional actions in the State of São Paulo, especially concerning its strong industrial, mineral, and energy exploitation in the marine environment and its potential interactions with ocean acidification.

In addition, caution is recommended when using salt caverns for CO_2 storage, as well as the prohibition of any possibility of direct gas discharge into the seabed or ocean environment at any depth.

The seas, the seabed, and the continental shelf are part of the Union's assets and are public goods for common use. Therefore, the economic exploitation of these areas—whether for transport, fishing, resource extraction, or energy activities—requires state authorization and compliance with specific environmental regulations. Law No. 9.966/2000, for example, expressly prohibits the discharge of harmful or hazardous substances into waters under national jurisdiction, including industrial waste, effluents, and gases in liquid or dissolved states that may cause pollution. Thus, the direct discharge of carbon dioxide (CO_2) into the sea is prohibited by law, as it poses risks of water acidification and marine ecosystem degradation.

However, this prohibition does not prevent the development of technologies aimed at carbon capture and geological storage (CCS/CCUS) under environmentally safe conditions. In Brazil, there is particular interest in storing CO_2 in deep geological formations in the pre-salt layer, particularly in salt caverns and depleted rock reservoirs, where the gas can be injected and confined stably for thousands of years. This technique prevents carbon dioxide from being released into the atmosphere, contributing to the achievement of climate goals for reducing greenhouse gas emissions, as established in the National Policy on Climate Change (Law No. 12.187/2009) and in the international commitments assumed by Brazil under the Paris Agreement.

Studies based on bibliographic reviews and data from the rock formations of the Santos Basin indicate that geological storage of CO_2 in depleted oil and gas fields is geologically favorable (CIOTTA, 2019). The selection of these formations occurs simultaneously with area mapping and production status assessment to verify the structural integrity and confinement potential of the reservoirs. However, the feasibility of this form of storage also requires analysis of the legal and regulatory aspects related to the use of depleted fields for permanent CO_2 storage, as well as the adaptation of Brazilian regulations to international safety and environmental responsibility standards.

Depleted fields represent oil and gas production areas that have already undergone significant pressure and volume reduction but maintain geological characteristics suitable for safe gas storage. The reuse of this infrastructure offers relevant economic and environmental advantages, such as reduced construction and licensing costs for new structures and decreased environmental impact from well and platform decommissioning. It is estimated that, globally, well decommissioning costs may reach around US$85 billion between 2019 and 2028 (TOWNSEND et al., 2020). Thus, converting oil wells into CO_2 injection wells is a promising alternative, provided that technical integrity and safety requirements are met.

However, it is essential to note that wells originally designed for oil and gas extraction have construction standards different from those required for CO_2 injection and confinement, requiring corrective actions and specific adaptations to ensure proper isolation of geological formations.

In the Brazilian context, by analogy with the regulations applicable to the oil and natural gas industry, CO_2 storage in depleted fields must comply with existing safety and environmental control guidelines, such as ANP Resolution No. 37/2001, CONAMA Resolution No. 23/1994, Federal Decree No. 8.437/2015, and MMA Ordinance No. 422/2011. It is important to emphasize that although subsurface geological confinement is technically feasible, the direct discharge of CO_2 into the sea is expressly prohibited by Brazilian environmental law, particularly by Law No. 9.966/2000, which bans the dumping of harmful or hazardous substances into waters under national jurisdiction.

Thus, the use of depleted pre-salt fields for the geological storage of carbon dioxide emerges as a legally compatible and environmentally responsible alternative, provided it is conducted under strict technical control

and state supervision. This practice aligns with the National Policy on Climate Change (Law No. 12.187/2009) and contributes to Brazil's decarbonization goals, ensuring that economic and technological freedom is exercised within the limits of environmental and climate protection.

The consolidation of Sustainable Development Goal 14 ("Life Below Water") in Brazil depends on effective actions that address the causes and consequences of greenhouse gas (GHG) emissions and the discharge of substances into marine and oceanic environments. The expansion of the national energy frontier and the increasing adoption of carbon capture and storage (CCS/CCUS) technologies require the country to adopt a clear, preventive regulatory framework aligned with the precautionary principle, to prevent atmospheric mitigation measures from generating new environmental liabilities in the marine environment.

The Brazilian legal framework is unequivocal in prohibiting the discharge of harmful or hazardous substances into waters under national jurisdiction, as established by Law No. 9.966/2000, and in requiring prior environmental impact assessments for potentially polluting activities, according to Article 225 of the Federal Constitution and Law No. 6.938/1981. Thus, the direct discharge of CO_2 or effluents resulting from mitigation processes into seas and oceans is legally prohibited, as it can cause acidification, changes in salinity, disruption of marine life, and degradation of coastal ecosystems.

The distinction between safe geological CO_2 storage—in deep, confined, and monitored formations—and direct disposal in the marine environment must be treated as a central axis of Brazil's environmental and climate governance. The first represents a legitimate mitigation instrument; the second, a violation of the socio-environmental function and the constitutional duties to protect the Union's natural heritage.

Therefore, achieving SDG 14 requires not only expanding marine conservation units and updating the National Coastal Management Plan but also strengthening inspection and monitoring of emissions and discharges in the marine environment, with transparency, federative integration, and social participation. Brazil's marine sustainability will depend on the country's ability to keep its seas free from pollutants and to transform climate mitigation into a vector of ocean protection—rather than a new environmental risk.

Future studies should explore the integration of marine spatial planning (MSP) with carbon management policies to assess the cumulative impacts of offshore industrial activities on marine biodiversity. It would also be valuable to develop legal and technical indicators for monitoring CO_2 storage safety and ocean health under Brazil's Blue Economy strategy, promoting evidence-based policymaking for sustainable ocean governance.

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