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Introduction

Marine ecosystems are a vital resource for many people and make a significant economic contribution as they represent the main livelihood for many populations. It is estimated that approximately 61% of the total global gross domestic product comes from the ocean and coastal areas located within 100 km of the shore, and that fishing provides more than 15% of the animal protein consumed by 4.2 billion people (Nunes & Ghermandi, 2013). In monetary terms, the value of marine ecosystems is around 12 trillion dollars worldwide (Pendleton et al., 2016), and the ocean economy generates about 2.3 trillion dollars per year in goods and services (market-based), equivalent to the size of the German economy, the fifth largest in the world (UNDP, 2022). Per hectare, the value of coral reefs amounts to $87,211/ha/year, that of mangroves to $77,928/ha/year, and that of inland wetlands to $34,018/ha/year (Brander et al., 2024).

Despite this, over the past 50 years, these ecosystems have been under more human pressure than at any other time in history. These pressures have considerably affected the resilience and productivity of the marine environment. The collapse of fisheries, tourism infrastructure, habitat loss, and global pollution threaten the goods and services provided by marine ecosystems that humanity depends on for future generations. WWF (2015) reports that marine vertebrate populations declined by 49% between 1970 and 2012, and populations of fish species used by humans halved during that period, with some of the most important species experiencing even greater declines.

This combination of high economic value and a declining asset base makes it essential to have a solid understanding of ecosystem service values to determine what can be done to stop the losses and overuse of the ecosystems we currently observe. A key part of the debate on Marine Ecosystem Services (ESS) concerns the role they can play in expanding the value of services to develop new ones, thus contributing to sustainable development through the promotion of the "blue economy."

The "blue economy" proposes a model that seeks to balance economic growth, livelihood improvement, and the preservation of ocean ecosystems by sustainably using marine and aquatic resources. This idea, popularized by Gunter Pauli in his book "The Blue Economy: 10 years, 100 innovations, 100 million jobs" (2010), highlights the importance of an economy based on nature-inspired solutions that make use of what is naturally and locally available.

In this approach, blue ecosystems such as coral reefs, mangroves, seagrass meadows, marshes, and pelagic and benthic ecosystems play a crucial role. These ecosystems are vital for biodiversity, coastal protection, climate regulation, and resource provision for human communities. For example, mangroves are essential for protecting coasts against storms and erosion and are key habitats for many marine species (Barbier et al., 2011).

The concept of "blue carbon" focuses on carbon captured by marine and coastal ecosystems. Blue carbon ecosystems, such as mangroves, seagrass meadows, marshes, and seaweed forests, play an important role in combating climate change by capturing and storing atmospheric carbon. Mangroves are particularly recognized for their ability to retain large amounts of carbon both in their trees and in their soils rich in organic matter (McLeod et al., 2011).

For this interpretation of the "blue economy," it is essential to have information on the values of different methods of marine environment exploitation to do so sustainably and balanced. Environmental economics uses valuation techniques to provide society with information on the relative scarcity level of resources (Markandya & Richardson, 1993).

Economic valuation can therefore make it explicit to society and policymakers that environmental and natural resources are scarce and that their conservation brings benefits. If these benefits are not taken into account, policy will be wrong, and society will be harmed due to poor resource allocation. Thus, valuing (economically) natural resources and the environment (i.e., measuring the "economic values" of environmental and natural resources) can support decision-making that affects environmental and natural resources.

It is within this context that this study is framed. The 1,570 km of coastline in the Dominican Republic harbor much of the country's natural capital (116 km² of coral reefs, 224 km² of mangroves, and 813 km of beaches). This capital provides ecosystem services on which many populations depend and supports important economic activities, particularly tourism and fishing. For example, Dominican coral reefs are part of the Mesoamerican Reef system and are essential for protecting coastlines from storms and erosion.

Preliminary estimates have determined that the value of coastal ecosystem services in the country could range between $690 and $1.14 billion. However, these estimates suffer from several limitations, including the depth and scope of the analysis, as these are regional in nature.

This study has a broader and more detailed geographic scope to support coastal and marine ecosystem management policies in the country. It is also aligned with a previous coral reef valuation study of the Mesoamerican Reef system, which was funded by the Inter-American Development Bank in 2021, and which provided important inputs for the design of insurance instruments to protect the value of these coral reefs.

More specifically, the general objective of this study is to understand the economic value of coral reefs, mangroves, seagrasses, and salt marshes in the Dominican Republic. The selection of these ecosystems is based on their relevance for carbon capture, as well as their importance in preserving biodiversity, protecting coastlines, and supporting local communities. Additionally, these ecosystems provide economic opportunities within the framework of the ‘blue economy,’ promoting sustainable development that combats climate change.

To achieve this, an extensive literature review was conducted on the ecosystem services provided by these ecosystems within the scope of this evaluation. The available methods for estimating the value of the main ecosystem services provided by these four ecosystems were critically evaluated, and a clear justification was provided for the selected economic method and its alignment with those discussed in the context of the System of Environmental-Economic Accounting (SEEA) for ecosystem services accounts. From there, key primary and secondary data were collected for the subsequent estimation of the economic value of these goods and services.

One of the novel aspects of this study is that, in addition to calculating the use values associated with services such as tourism and recreational activities, fishing, coastal protection, or carbon sequestration, the non-use values of the four ecosystems were also estimated.

Methodology

The value of environmental and natural resources reflects what we, as a society, are willing to pay to conserve these natural resources (Pearce & Turner, 1990; Turner et al., 1994; Pearce, 2002; Hanley et al., 2007; Stavins, 2008; Atkinson, 2010). Assigning a monetary value to natural resources and the environment involves two steps. Step 1 consists of identifying the ecosystem services (ES) provided by the ecosystems under analysis. Step 2 consists of estimating their economic value in monetary units using valuation techniques based on economic theory.

1. Ecosystem Services

Natural habitats and biodiversity provide society with a wide range of ecosystem services understood as the benefits people obtain from ecosystems (MEA, 2003). The Millennium Ecosystem Assessment, developed within the United Nations, is the largest international effort to date to assess the state and trends of the planet's ecosystems and analyse the consequences of their changes on human well-being.

Ecosystem services consist of three categories that directly or indirectly affect human well-being: provisioning services (referring to the provision of materials and energy needs for the range of products we obtain from ecosystems), regulating services (regulate and maintain ecosystem processes), and cultural services (offer non-material benefits). They also provide supporting services (main ecosystem processes that support all other services).

The blue economy's ecosystems offer numerous critical services for population well-being. The blue economy's ecosystem services that have been most intensely and directly utilized globally have been provisioning services, including food provision (first through fishing and later through aquaculture as a technological solution to the fisheries crisis due to the overexploitation of commercial species) and freshwater production from desalination. Additionally, marine ecosystems play a fundamental role in climate regulation and contribute to carbon storage.

2. Economic Valuation

The underlying economic logic involves assuming that the market is a good mechanism for organizing economic activity where price is determined by the supply-demand interaction, resulting in an efficient allocation of resources that maximizes societal well-being. However, some goods and services do not have market prices, such as biodiversity conservation. Under this logic, these goods and services are automatically excluded from economic dynamics, and the costs, benefits, and effects of economic activity on them are not correctly calculated, leading to suboptimal management.

However, ecosystems provide services that are essential not only to foster a country's or a specific area's economic growth but also to improve the quality of life and well-being of its inhabitants. This means that even if some of them do not have a market price, they have value to society, so capturing that value is important. Economic valuation allows for this.

The way to determine this value is through individual preferences that reflect individuals' needs and perceptions. These preferences are measured in terms of what users or society are willing to pay to use a particular good or service (e.g., a fish or a day of diving) or to preserve a particular good or service (e.g., biodiversity). When there is an efficient market, which is the basic premise of economic analysis, prices and value (i.e., Willingness to Pay (WTP)) coincide. However, in the case of goods and services without market prices, this is not the case. Nevertheless, economics has developed a set of techniques designed to estimate values for which there is no market.

Traditionally, conventional economic approaches tended to view value only in terms of WTP for raw materials and physical products generated for human production and consumption (such as fish, mining materials, pharmaceuticals, etc.) and focused exclusively on market activities and commercial benefits, i.e., goods and services with market prices. However, as the consequences of environmental alteration and species extinction became apparent, traditional concepts of value became a central topic of debate, and economists began to understand that people might also be willing to pay for other reasons beyond the current use of the service, such as protecting coral reefs from degradation or knowing that mangroves will remain intact in the future, meaning part of the value would be lost. This persistent undervaluation of environmental goods and services had led, in many cases, to decisions with economically suboptimal outcomes. Therefore, in the 1980s, after two decades of debate, the concept of Total Economic Value (TEV) emerged, becoming the most widely used and commonly accepted framework for classifying the economic benefits of ecosystems and attempting to integrate them into decision-making.

TEV distinguishes between use values and non-use values. Use values refer, for example, to fishing for food, tourism, or diving activities (direct values) or to the functional benefits of, for instance, oxygen from coral reefs (indirect values). Non-use values, on the other hand, refer to the value people assign to ecosystem services regardless of whether they use them currently (option value) and do not intend to use them in the future. These include the money people are willing to pay to ensure the existence of corals in the future (existence values), WTP to know that future generations will be able to enjoy these ecosystems (legacy values), or WTP to know that others can enjoy ecosystem services (altruistic values). Traditionally, non-use values refer to biodiversity conservation, the intrinsic value of cultural traditions associated with corals, or an experience in nature.

To assign economic values to the ecosystem services provided by a particular habitat (e.g., an ocean), various economic valuation methods are used. Valuation should consider all the values provided by the ecosystem in question (e.g., if a habitat provides recreational non-use values and also generates a good that is bought and sold in the market, such as fish, all these values should be considered).

Services that are bought and sold in markets, generally associated with provisioning services, are usually easier to value due to their associated prices. They are typically valued using market-based methods. Ecosystem services that are not traded in markets and, therefore, do not have associated market prices are more difficult to value. Cultural services (recreation and tourism, cultural and aesthetic) are usually estimated using the hedonic pricing method, the travel cost method, the contingent valuation method, or choice models. In the context of biodiversity, the contingent valuation approach has been widely used.

In this study, based on an extensive literature review[1], the main ecosystem services of the ecosystems studied in this document have been identified. From there, the economic valuation methods used to estimate their value were selected (Table 1).

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[1]The methodology used for identifying relevant information sources and recent published works was the Rapid Evidence Review: a total of 87 scientific articles and reports were reviewed. Of these, the 50 most relevant ones were selected and analyzed in depth because they provided information on the ecosystem services provided by the ecosystems of interest, their economic value, and the valuation method used for the analysis.

Table 1. Ecosystem Services and Valuation Methods

Ecosystem Service	Valuation Method
Coral Reefs	
Tourism and Recreational Activities	Market Prices
Fishing Activities	Market Prices
Coastal Protection	Benefit Transfer
Non-use Values	Contingent Valuation
Mangroves	
Fishing Activities	Market Prices
Coastal Protection	Benefit Transfer
Carbon Sequestration	Market Prices
Non-use Values	Contingent Valuation
Seagrass Meadows	
Carbon Sequestration	Market Prices
Non-use Values	Contingent Valuation
Marshes	
Coastal Protection	Benefit Transfer
Carbon Sequestration	Market Prices
Non-use Values	Contingent Valuation

Source: Own elaboration

1. Tourism and Recreational Activities

The contribution of coral reefs to the tourism in the Dominican Republic has been estimated using market prices. The guidelines and tools presented in the Coastal Capital Project: Economic Valuation of Coastal Ecosystems in the Caribbean developed by the World Resources Institute (WRI) have been followed and applied, which were used for case studies in Belize, Jamaica, Tobago, Saint Lucia, the Dominican Republic, and the Mesoamerican region (Burke & Maidens, 2004; Cooper et al., 2009; Waite et al., 2011; Kushner et al., 2011; Ruiz-Gauna et al., 2021).

The components and information needed to calculate the use value of tourism and recreation in coral reefs are presented below. The components are divided into eight categories:

1. Profiles of tourist sites and visitor profiles.
2. Direct travel expenses.
3. Income from protected marine areas.
4. Recreational activities outside protected marine areas: snorkelling, diving, etc.
5. Local tourism: direct expenses and visits.
6. Indirect economic impacts on other sectors or activities, such as transportation.
7. Estimation of consumer surplus.

The first step is to define the percentage of people visiting the Dominican Republic attracted at least partially by its coral reefs. Although there are no official data providing this percentage[2], several studies provide sufficient information to make estimates, forming the basis for the valuation of this ecosystem service.

Generally, tourism linked to reefs tends to be associated with what is known as "reef-adjacent tourism."

[2] The “Encuesta de Opinión, Actitud y Motivación a extranjeros no residentes” does not provide this information, and it could not be found in the National Statistics Office or the Ministry of Tourism either.

Reef-adjacent tourism refers to the recreational and tourism values derived from reefs but not linked to activities taking place directly on the reefs (i.e., the component of tourism that depends on the reefs without directly using them for in-water activities like diving and snorkelling). It includes, for example, values associated with beaches (white sand, views of bright-coloured waters near the shore, activities such as swimming or small non-motorized boat activities requiring calm waters) and local seafood linked to reefs (Spalding et al., 2017, 2018).

The study by Spalding et al. (2017) is a first approach to the value of reef-adjacent tourism: specifically, it provides the total number of tourist arrivals (international and national) to the country and the proportion of these associated with reefs. This information is available for all countries and territories with more than 50 km² of reef and total reef-related expenditures exceeding 10 million USD annually, as is the case in the Dominican Republic. This study also estimates the total expenditure of visitors (international and national) and the sum of expenditures associated with reefs.

However, in this study, a conservative approach is adopted. Spalding et al. (2018) went a step further by considering activities known as "on-reef" activities, which involve snorkelling, scuba diving, and fishing, and which, as previously explained, were excluded from the concept of reef-adjacent tourism. This allows for estimating a broader indicator called "reef-associated tourism," where:

Reef-associated tourism = reef-adjacent tourism + on-reef tourism

The sum of these values is expressed as a percentage of all values. In the Dominican Republic, the following was obtained:

Coral reefs account for 23.00% of all tourist expenditures[3]. Within this 23.00%, 86.47% corresponds to reef-adjacent values, and 13.53% corresponds to on-reef values.

Ultimately, 19.89% of total tourist expenditure is related to activities associated with reef-adjacent values, while 3.11% of total tourist expenditure is related to on-reef values (diving, snorkelling).

Regarding direct travel expenses, spending flows associated with tourism activity in the region are analysed to identify changes in sales, tax revenues, incomes, and jobs. Net tourism and leisure revenues are calculated by subtracting operating costs from gross revenues.

The approach to estimating income from protected marine areas involves subtracting the total revenues from fees charged to visitors to the area, fees charged to marine boat operators, other fees, and taxes collected from users from the costs of collecting revenue (including only the costs of fee collection and administration, not the costs of park management).

Recreation on reefs includes visits for diving, snorkelling, kayaking, hiking, and/or sport fishing on reefs within or outside a protected area. Estimating revenues from this activity required information such as the number of tourists per activity, the number of trips, or the price of the activity.

Local populations often play an important role. This component estimates the benefits of local use of coral reefs and coral beaches. The benefits of coral beaches are calculated by multiplying the population of the study area by the percentage of the local population

[3]The reef-adjacent values have been combined with the reef values to estimate the total values.

visiting coral beaches for pleasure, the number of visits per year per person, the average duration of the visit, and the prevailing average hourly wage. The benefits of reef recreation are similarly calculated by multiplying the population of the study area by the percentage of the local population engaged in reef recreation outside organized tours, the number of visits per year per person, the average duration of the visit, and the prevailing average hourly wage.

To calculate the secondary or indirect effects of tourism activity, multipliers are used to represent the economic interdependencies between the economic sectors of a country. A multiplier of 1.7461[4] for the tourism sector in the Dominican Republic was used (Central Bank of the Dominican Republic 2020), meaning that for every dollar spent on tourism and recreation, an additional twenty-two cents impact the economy.

Finally, consumer surplus is defined as the difference between the price consumers pay and the price they are willing to pay. The WRI tool provides typical lower-end estimates for the region.

Revenues from lodging and revenues from protected areas with reef presence fall under reef-adjacent values, while recreational activities on the reef (diving and snorkelling) would be related to on-reef values. The use of local resources would be an additional complement.

Various data sources have been used: statistics from the Ministry of Tourism of the Dominican Republic, the National Statistics Office, the Opinion, Attitude, and Motivation Survey of non-resident foreigners (2022), official data from the Ministry of Environment and Natural Resources, data from the Central Bank of the Dominican Republic, and academic literature.

2. Fishing Activities

The contribution to fishing was estimated using market prices of the country's catches (gross revenues from commercial fishing) and revenues generated by fish processing activities. As with tourism and recreational activities, the guide and tools presented in the Coastal Capital Project: Economic Valuation of Coastal Ecosystems in the Caribbean were followed and applied.

In this case, the component is divided into five categories:

1. Fishing profile.
2. Information on commercial fishing, including processing and cleaning value.
3. Local non-commercial fishing.
4. Indirect economic impacts.
5. Estimation of consumer surplus.

The value of commercial fishing is calculated as the difference between the revenues from commercial fishing associated with coral reefs and mangroves and the sector's costs (salaries plus annual operating costs of the fishing vessel owner) associated with reef- and mangrove-related fishing.

[4] The value of the multiplier of the total supply – intermediate inputs – has been taken for the sector "Hotels, bars and restaurants" because it is the most similar to the country's tourism sector (page 27 of document https://cdn.bancentral.gov.do/documents/estadisticas/sector-real/documents/Matriz_Insumo-Producto.pdf?v=1703100313938). The multiplier is for the year 2020, but the same value is assumed for the years 2019 and 2022, given that the economic structure of the country is practically the same from one year to the next.

Commercial fishing revenues are calculated from gross revenue data for the fishing sector and information on catches of reef- and mangrove-associated species and their prices. The first step was, therefore, to identify species associated with Dominican reefs and mangroves. The next step involved multiplying the revenue from fish catches by the average annual price of reef- and mangrove-associated species.

Sector costs, i.e., salaries plus annual operating costs, were estimated using ratios of 25.00% and 10.00% of gross revenue, respectively (WRI Tool 2009).

In the case of fish processing, there is no information on the weight and price of processed fish sold for each species, so its value could not be estimated.

The value of fish cleaning[5] was estimated by multiplying the total cleaned fish by its added value generated (estimated in Burke et al. 2008).

The value of local fishing consists of three components that must be estimated separately: fishing for sale, fishing for consumption, and fishing for enjoyment. Due to a lack of information, the value of local fishing could not be estimated.

Finally, a revenue multiplier of 1.1312 was used for net income from commercial fishing (Banco Central República Dominicana, 2020).

Several data sources have been used: CODOPESCA, FAO, National Fishing Census, data from the Central Bank of the Dominican Republic and academic literature.

3. Coastal Protection

One of the most commonly used methods for estimating the value of coastal protection is the avoided damage cost method (highly information-intensive). However, it is also common to see studies that use benefit transfer. In this study, the benefit transfer method was chosen, although the base studies applied the avoided damage cost method.

It is common to refer to the environmental policy being evaluated as the "policy site" and the source of the values being used as the "study site." In principle, the values at the policy site may differ from those at the study site for two sets of reasons: differences in the characteristics and between the populations valuing the resource change (e.g., differences in income, tastes, and preferences, and other relevant socioeconomic characteristics). In the transfer process, values should be adjusted to reflect these two types of differences.

The application of this method involved the following steps:

1. Identification of similar existing studies or values through an exhaustive literature review.
2. Analysis of similarities to determine if they can be transferred to the study in question, as the values found cannot be automatically transferred. This involved assessing:
    - Whether the good or service is comparable to the one valued in the existing study (site characteristics, quality, or availability of substitutes);
    - Parameters about the relevant population (whether the relevant population's characteristics are comparable).
    3. Evaluation of the quality and relevance of the studies to be transferred.

[5] It is calculated by multiplying the total weight of commercial catches associated with reefs and mangroves by the percentage of clean fish estimated in Burke et al. (2008).

4. Adjustment of available values to better reflect the values of the site (or ecosystem) in question (income differences, time, population, and site characteristics).
5. Estimation of total value by multiplying transferred values by the number of affected people.

4. Carbon Sequestration

The economic valuation of carbon sequestration required determining, on the one hand, the amount of carbon sequestered by ecosystems and, on the other hand, the Social Cost of Carbon (CSD) and the market price in the voluntary carbon market.

When discussing carbon sequestration, it is essential to differentiate between the ecosystem's sequestration rate and its carbon stocks. For this purpose, academic literature has been used.

The social cost of carbon (or social carbon price) is defined as the total damage that an additional ton of CO2 has on production, converted into dollars. This provides the key information that societies need to determine how much to sacrifice to combat climate change, as it represents the benefit – that is, the avoided damage – of reducing CO2 emissions. This makes it a key guide for policymakers: by indicating how much society benefits from reducing CO2 emissions, it shows that climate policies will be cost-effective as long as the economic sacrifices involved do not exceed the social cost of carbon. Therefore, the SCC is used as a way to quantify and compare the costs and benefits of specific policies. This cost varies depending on the source used:

- The Directorate General of Public Investment of the Ministry of Economy, Planning, and Development requested technical assistance from the Sustainable Development and Human Settlements Division of ECLAC to estimate the social cost of carbon. The results are reflected in the study " Estimación del precio social del carbono para la evaluación de la inversión pública en República Dominicana”. The study also carries out a modelling exercise to calculate the social cost of carbon in the country by applying 2 commonly used models (DIGE and PAGE) and assuming a declining discount rate[6]. Based on these results, the study recommends using a social carbon cost of 26 USD/tCO2e (2021 value).
- The High-Level Commission on Carbon Prices estimated in 2017 that carbon prices consistent with the goal set in the Paris Agreement (to keep the temperature below 2ºC) should be between USD 40 and USD 80 per metric ton of carbon dioxide (tCO2) by 2020 (with an average of 60 USD/tCO2e).
- Another way to monetize externalities is based on a recent report (Rennert, 2022) that attributes a higher cost to CO2 emissions. It includes improved probabilistic socioeconomic projections, climate models, damage functions, and discounting methods, collectively reflecting a theoretically coherent risk assessment (185 USD/tCO2e).
- The voluntary carbon market offers companies, non-profit organizations, governments, and individuals the opportunity to buy and sell carbon offset credits. A carbon offset is an instrument that represents the reduction of one metric ton of carbon dioxide or GHG emissions. The 2021 State of Voluntary Carbon Markets data state that the weighted average price per ton of credits from forestry and land-use projects

[6] In line with the Dominican Republic's Project Evaluation Guide, the decreasing discount rate is compatible with the national reality, as the country is expected to increase its per capita income and better incorporate elements of intergenerational justice in relation to the impacts of climate change.

that reduce emissions or remove carbon from the atmosphere has followed a steadily upward trajectory, from USD 4.43 per credit in 2019 to USD 4.73 per credit in 2021.

Given that there are various sources of information (26 USD/CO2e, 60 USD/CO2e, 185 USD/CO2e, and 4.73 USD/CO2e), this study presents a range of values.

5. Non-use Values

To estimate non-use values, the contingent valuation method was used to obtain the WTP that would be paid for the protection of the four ecosystems. Contingent valuation is a technically sound method that has been widely used to estimate the economic value of multiple ecosystem services and has even been accepted in courts to estimate economic compensation for damages, as occurred with the Exxon Valdez oil spill in the Gulf of Mexico or the Prestige shipwreck in Spain.

The approach was directed at the resident population and potential tourists. On one hand, residents of the Dominican Republic are an important agent in working towards their maintenance and good conservation. Knowing the opinion of this population segment is essential to working towards the sustainability of ecosystems. The sample size consisted of 1,000 surveys (sampling error: Emax = ±3.16%)[7]. On the other hand, the study also considered knowing the opinion of potential tourists from the United States, Canada, France, and Argentina and their possible predisposition to pay since they also play a key role in the sustainability of these ecosystems. These countries were chosen because they are among the main tourism source markets for the region. The sample size consisted of 500 surveys in each of the four mentioned countries (sampling error: Emax = ±4.47%), and the sample design was proportional to the distribution of the general population universe over 18 years in each country. The surveys were conducted online[8] in October 2023, and a soft launch of 50 surveys was conducted.

The valuation question was asked in a double-bounded format, where the first question asks respondents if they would be willing to pay a certain amount of money to implement a project that protects Dominican coral reefs, mangroves, seagrass meadows, and marshes. If the answer is yes, they are offered the possibility to pay a higher amount. If the answer is no, they are offered the possibility to pay a lower amount. Then, an open-ended question asks them to indicate the maximum amount of money they would be willing to pay.

After collecting and thoroughly analysing the data, an econometric analysis (binary discrete choice format) was conducted, applying Hanemann's proposal (Hanemann, 1984, 1991). Version 4.0 of NLOGIT was used to estimate the parameters by maximum likelihood for the double-bounded logit function.

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[7] Individuals have been selected by sex and age quotas. The sample design is proportional to the distribution of the universe of the general population over 18 years of age in the country (175 surveys of people between 18 and 24 years of age; 225 surveys of people between 25 and 34 years of age; 185 surveys of people between 35 and 44 years of age; 152 surveys of people between 45 and 54 years of age and 263 surveys of people over 55 years of age). By sex, 474 surveys will be carried out on men and 526 surveys on women. A pre-test of 50 surveys has been carried out.

[8] Internet penetration is over 80% in all cases, so using an online approach does not present a bias in the opinion collected (compared to the total population). The survey has been reviewed by external experts prior to its conduct by Ipsos Public Affairs, the world's third-largest market research and public opinion polling company. The sample was selected using Ipsos' own access panel (Ipsos Interactive Services – ISS –), and the methodology applied was Device Agnostic Surveys (this method implies that participants can take in-browser surveys on any device they choose).

Economic Valuation Results

1. Coral Reefs

Tourism and Recreational Activities

The total use value of the tourism and recreational sector associated with coral reefs was USD 1,186 million in 2019 and USD 1,404 million in 2022 (Table 2). This gives an annual average contribution of around USD 1,295 million.

Table 2. Total Use Value of the Tourism and Recreational Sector Associated with Coral Reefs in the Dominican Republic (million USD, 2019, 2022)

	2019	2022
Accommodation	565.82	678.24
Protected Areas	0.300	0.354
Recreational Activities	88.01	95.59
Local Use	--	--
Direct Economic Impacts	654.13	774.18
Indirect Economic Impacts	531,84	629,62
Total Use Value (million USD)	**1,185.97**	**1,403.80**

Source: Own elaboration

Fishing Activities

In 2019, the total use value of the fishing sector associated with reefs was USD 21 million. In 2021, the value was USD 20 million (Table 3). The contribution of this activity is an average of around USD 20.44 million per year.

Table 3. Total Use Value of the Fishing Sector Associated with Coral Reefs in the Dominican Republic (million USD, 2019, 2021)

	2019	2021
Commercial Fishing	17.63	17.33
Fish Processing	--	--
Fish Cleaning	1.31	1.31
Local Fishing	--	--
Direct Economic Impacts	18.94	18.64
Indirect Economic Impacts	1.67	1.64
Total Use Value (million USD)	**20.61**	**20.28**

Source: Own elaboration

Coastal Protection

Beck et al., (2018) quantifies spatially and economically the benefits of reefs in terms of flood risk reduction for people and properties (or built capital) using the avoided expected damage cost approach. The authors conclude that the annual damage avoided (i.e., the benefit) from coastal protection provided by reefs is particularly relevant in the Philippines, Malaysia, Cuba, and the Dominican Republic. In the Dominican Republic, it is estimated at USD 96 million, equivalent to 0.11% of the country's Gross Domestic Product (GDP) (see Table 4).

Table 4. Annual Avoided Damages (Net Benefits) of Coastal Protection in the Dominican Republic

Net Annual Benefits	
Annual Avoided Damages (million USD)	96
Annual Avoided Damages/GDP	0.11

Source: Beck et al. (2018)

Non-use Values

As previously explained, to estimate non-use values, an econometric analysis was carried out, applying the binary discrete choice format, which consists of asking respondents if they would be willing to pay a certain amount (BID) for an environmental quality improvement of the resource or to maintain it. If the answer is yes, they are offered the possibility to pay a higher amount (BIDU). If the answer is no, they are offered the possibility to pay a lower amount (BIDL).

In this case, a BID of 400 Dominican pesos (USD 7), a BIDU of 600 Dominican pesos (USD 10.5), and a BIDL of 230 Dominican pesos (USD 4) were used. The results are per person and would be a one-time payment. The WTP obtained was USD 11.85[9]. To obtain the total non-use value, the WTP was multiplied by the reference group. In this case, the survey was conducted online, so the reference group could only consist of people with an internet connection. According to official data provided by the National Statistics Office, in the Dominican Republic, 8,849,678 people (out of the 10,760,028 inhabitants of the country) have internet access through various means. The number of people with an internet connection would include all household members. However, it is unlikely that all of them would have the same WTP. This stated WTP can more reasonably be taken as the household's WTP. The average household size is estimated at 3.1. Therefore, the group to which the average WTP should be applied is 2,854,735 people.

Table 5. Non-use Values for Coral Reefs in the Dominican Republic

	Pesos per person	**Target Population**	**Total Non-use Value (million Dominican Pesos)**
Total Non-use Value	204	2,854,735	582.36
	USD per person[10]	**Target Population**	**Total Non-use Value (million Dominican Pesos)**
	11.85	**2,854,735**	**33.83**

Source: Own elaboration.

Table 5 shows the total non-use values. These amount to USD 34 million.

2. Mangroves

Fishing Activities

The total use value of the fishing sector associated with mangroves in 2019 was estimated at USD 23 million. In 2021, the value was USD 27 million (Table 6). The average annual contribution during the period is estimated at USD 24.88 million.

Table 6. Total Use Value of the Fishing Sector Associated with Mangroves in the Dominican Republic (million USD, 2019, 2021)

	2019	**2021**
Commercial Fishing	18.46	21.84
Fish Processing	Nd	Nd
Fish Cleaning	2.64	3.00
Local Fishing	Nd	Nd
Direct Economic Impacts	21.10	24.84
Indirect Economic Impacts	1.75	2.07
Total Use Value (million USD)	**22.85**	**26.91**

Source: Own elaboration.

[9] Range [11.839-11.861].
[10] The official exchange rate of November 29, 2023 has been applied. This is valid for the rest of the estimates of the non-use values in the case of the remaining ecosystems.

Coastal Protection

The benefit transfer for the total value estimation of the coastal protection service associated with mangroves was based on the CEPAL (2018) study Its choice is due to three reasons: (i) it allows estimating the value per hectare protected; (ii) it offers results for a country with similar climate-coastal characteristics to those of the Dominican Republic, such as Cuba; and (iii) it provides information that combines values for regular climate conditions and for sporadic extreme conditions (tropical cyclones) with different return periods.

In the CEPAL (2018), the value of the coastal protection service against floods is estimated using a methodology recommended in the World Bank guidelines for valuing the natural protection of coasts (Losada et al., 2017)[11]. Although many hectares along the coast receive protection from mangroves, not all these areas contain exposed assets that increase the value of these ecosystems. Nevertheless, aggregate country-level results can be used to approximate the value of nature's services.

On this basis, the annual avoided damages (or benefits) of mangroves for coastal protection are estimated at USD 154 million. This is equivalent to USD 377 per hectare[12].

In Cuba, there are 5,321 km² of mangroves (532,100 hectares), of which 77.00% (409,090 hectares) contain exposed assets. Meanwhile, in the Dominican Republic, there are 293.16 km² of coastal mangroves (29,316 hectares). In the absence of official information, it is assumed that, as in Cuba, 77.00% of the area with mangroves would have exposed assets (equivalent to 22,573 hectares). The per-hectare values are thus extrapolated. For income adjustment, the per capita GDP is used, measured in terms of purchasing power parity (PPP). In total, the expected avoided damages (benefits) of the coastal protection ecosystem service associated with Dominican mangroves would amount to USD 8.51 million annually.

Carbon Sequestration

The economic valuation of carbon sequestration is estimated by multiplying the amount of carbon sequestered by mangroves by the Social Cost of Carbon (SCC) and the market price in the voluntary market.

First, it is important to differentiate between the carbon sequestration rate and the carbon stocks of mangroves, i.e., the amount of carbon they can store over their lifetime.

The average annual carbon sequestration rate of mangrove ecosystems ranges between 6 and 8 Mg CO2 eq/ha (tons of CO2 equivalent per hectare) (Murray et al., 2011). These figures are consistent with others obtained from various studies: for example, Alongi (2012) estimates that there is a high rate of carbon storage in mangrove sediment, with an average of 174 gC/m²/year (equivalent to 1.74 MgC/ha/year or 6.38 Mg CO2 eq/ha/year) globally. Chatting et al. (2022) also point out that the median soil sequestration rate is 1,725 gC/m²/year (equivalent to 1.72 MgC/ha/year or 6.31 Mg CO2 eq/ha/year). In this study, the average is taken as a reference (7 Mg CO2 e/ha).

[11] It consists of 5 stages: (1) Characterization of the offshore maritime climate for both regular climatic conditions and sporadic extreme conditions (tropical cyclones); (2) Reduction of the scale of the offshore dynamics to the near-shore location of the ecosystem (without crossing it), taking into account the relevant wave transformation processes; (3) Modelling the effect of ecosystems on marine dynamics; (4) Calculation of the flood height and the resulting impact on the coast, i.e. the land area covered by this water level; and (5) Calculation of the consequences of floods in social and economic terms using an expected damage function approach for events with different return periods, and annualization of these consequences. Consequently, it is an accepted and widely applied methodology.

[12] The IUCN (2017) study obtains a similar value: 392.5 USD per hectare per year.

Meanwhile, the average total carbon stocks of mangroves vary depending on the type of mangrove and their location. The study by Kauffman et al. (2014) provides specific information on the total carbon stocks of mangroves in the Dominican Republic and disaggregates this information according to mangrove height (low, medium, and high).

The Dominican Republic has 264.35 km² (or 26,435 hectares) of mangroves, so the distribution of hectares for each type of mangrove is shown in Table 7.

Table 7. Total Carbon Stocks of Mangroves in the Dominican Republic by Height and Distribution in the Country

	Total Carbon Stock (MgC/ha)	Total Carbon Stock (Mg C02 e/ha)	Total Hectares Occupied
Low	733	2,690	7,137
Medium	1,131	4,151	3,172
High	707	2,595	9,781

Source: Own elaboration based on Kauffman et al. (2014)

The total use value associated with the carbon sequestration service is shown in Tables 8 and 9.

Table 8. Total Use Value of the Carbon Sequestration Service of Mangroves in the Dominican Republic (Annual Value)

	Sequestration Rate (Mg CO2 eq/ha)	Market Price (USD/tCO2e)	Area (ha)	Total Economic Value (USD 2021)
Low mangrove			7,137	0.24
Medium mangrove	7,00	4.73	3,172	0.11
High mangrove			9,781	0.32
TOTAL			**20,090**	**0.67**
	Sequestration Rate (Mg CO2 eq/ha)	**Social Cost of Carbon (USD/tCO2e)**	**Area (ha)**	**Total Economic Value (USD 2021)**
Low mangrove			7,137	1.30
Medium mangrove	7,00	26	3,172	0.58
High mangrove			9,781	1.78
TOTAL			**20,090**	**3.66**
Low mangrove			7,137	3.00
Medium mangrove	7,00	60	3,172	1.33
High mangrove			9,781	4.11
TOTAL			**20,090**	**8.44**
Low mangrove			7,137	9.24
Medium mangrove	7,00	185	3,172	4.11
High mangrove			9,781	12.67
TOTAL			**20,090**	**26.02**

Source: Own elaboration

Table 9. Total Use Value of Mangrove Carbon Stocks in the Dominican Republic

	Total Carbon Stock (MgC/ha)	Total Carbon Stock (Mg C02 e/ha)	Market Price (USD/tCO2e)	Area (ha)	Total Economic Value (USD 2021)
Low mangrove	733	2,690	4.73	7,137	90.81
Medium mangrove	1,131	4,151		3,172	62.28
High mangrove	707	2,595		9,781	120.06
TOTAL				**20,090**	**273.14**
	Total Carbon Stock (MgC/ha)	**Total Carbon Stock (Mg C02 e/ha)**	**Market Price (USD/tCO2e)**	**Area (ha)**	**Total Economic Value (USD 2021)**
Low mangrove	733	2,690	26	7,137	499.16
Medium mangrove	1,131	4,151		3,172	342.34
High mangrove	707	2,595		9,781	659.92
TOTAL				**20,090**	**1,501.42**
Low mangrove	733	2,690	60	7,137	1,151.91
Medium mangrove	1,131	4,151		3,172	790.02
High mangrove	707	2,595		9,781	1,522.90
TOTAL				**20,090**	**3,464.83**
Low mangrove	733	2,690	185	7,137	3,551.73
Medium mangrove	1,131	4,151		3,172	2,435.89
High mangrove	707	2,595		9,781	4,695.61
TOTAL				**20,090**	**10,683.23**

Source: Own elaboration

Non-use Values

A BID of 314 Dominican pesos (USD 5.5), a BIDU of 513 Dominican pesos (USD 9), and a BIDL of 143 Dominican pesos (USD 2.5) were used. The results are per person and would be a one-time payment.

The WTP obtained was USD 12.56[13]. As with coral reefs, the reference group would be 2,854,735 people.

Table 10 shows the total non-use values amounting to USD 36 million.

Table 10. Non-use Values for Mangroves in the Dominican Republic

	Pesos per person	Target Population	Total Non-use Value (million Dominican Pesos)
Total Non-use Value	216.23	2,854,735	617.28
	USD per person	**Target Population**	**Total Non-use Value (million USD)**
	12.56	**2,854,735**	**35.86**

Source: Own elaboration

[13]Range [12.551-12.569].

3. Seagrass Meadows

Carbon Sequestration

Although they occupy less than 0.20% of the ocean surface, it is estimated that they absorb between 27 and 44 Tg of organic carbon (Corg) per year[14], representing between 10.00% and 18.00% of the annual ocean Corg uptake, and they have soil Corg stocks comparable to those of temperate and tropical forests, mangroves, and marshes (Bedulli et al., 2020).

There are several estimates of the Corg uptake rate by these ecosystems per year and per hectare, as well as the total carbon stocks of seagrass meadows[15]. However, this study assumes an annual uptake rate of 0.83 MgC/ha (equivalent to 3.05 Mg CO2 e/ha), that the total stocks are those estimated by the IPCC[16], and that the social cost of carbon is, as with mangroves, USD 26/tCO2e (2021 values).

According to the World Atlas of Seagrasses, the main species of seagrasses in the Dominican Republic are *Halodule wrightii*, *Halophila decipiens*, *Syringodium filiforme*, *Syringodium isoetifolium*, and *Thalassia testudinum*. The country has approximately 186 km² (18,600 hectares) of seagrass meadows (Moya & Díaz, 2004).

The total use value associated with the carbon sequestration service of seagrass meadows is shown in Table 11.

Table 11. Total Use Value of the Carbon Sequestration Service of Seagrass Meadows in the Dominican Republic (million USD)

	Sequestration Rate (Mg C02 e/ha)	Total Carbon Stock (Mg C02 e/ha)	Market Price (USD/tCO2e)	Area (ha)	Total Economic Value (million USD)
Annual Value	3.05		4.73	18,600	**0.27**
Carbon Stock		513.90			**45.21**
	Sequestration Rate (Mg C02 e/ha)	**Total Carbon Stock (Mg C02 e/ha)**	**Social Cost of Carbon (USD/tCO2e)**	**Area (ha)**	**Total Economic Value (million USD)**
Annual Value	3.05		26	18,600	**1.47**
Carbon Stock		513.90			**248.52**
Annual Value	3.05		60	18,600	**3.40**
Carbon Stock		513.90			**573.51**
Annual Value	3.05		185	18,600	**10.50**
Carbon Stock		513.90			**1,768.33**

Source: Own elaboration

Non-use Values

A BID of 285 Dominican pesos (USD 4.5), a BIDU of 455 Dominican pesos (USD 8), and a BIDL of 85.5 Dominican pesos (USD 1.5) were used. The results are per person and would be a one-time payment.

[14] Fourqurean et al. (2012) estimate the value in 27.4 Tg C per year and Ramírez-García et al. (2019) between 48 and 112 Tg C.
[15] Not all species sequester the same amount of carbon, but this information is unknown by species.
[16] The reports prepared by the IPCC are characterized by their rigor, their transparency in the drafting process and the consensus on the part of scientists in the approval of the reports.

The WTP obtained was USD 10.55[17]. As with the previous cases, the reference group would be 2,854,735 people.

Table 12 shows the total non-use values amounting to USD 30 million.

Table 12. Non-use Values for Seagrass Meadows in the Dominican Republic

	Pesos per person	Target Population	Total Non-use Value (million Dominican Pesos)
Total Non-use Values	181.63	2,854,735	518.50
	USD per person	**Target Population**	**Total Non-use Value (million USD)**
	10.55	**2,854,735**	**30.12**

Source: Own elaboration

4. Marshes

Coastal Protection

Costanza et al. (2008) estimated that coastal wetlands provide USD 8,240 per hectare per year (median of USD 3,230/ha/year) in storm protection services in the United States (2007 prices). Considering the wetland area in the country, they estimated that they provide USD 23.2 billion annually.

To estimate the value relative to the Dominican Republic, the value provided by Costanza et al. (2008)[18] has been updated to 2022 and adjusted to the Dominican socioeconomic context using per capita GDP, measured in terms of purchasing power parity (PPP). Considering the income difference, the annual use value of the coastal protection service associated with seagrass meadows would be USD 95.86 million.

Carbon Sequestration

According to Murray et al. (2011), both marshes and mangroves capture an average of between 6 and 8 t CO2e/ha/year (equivalent to 1.63 – 2.18 MgC/ha). Alongi (2012) estimates that these ecosystems sequester carbon at an annual rate of 140 gC/m² (equivalent to 1.4 MgC/ha). Miller et al. (2022) provides a similar figure (167.7 gC/m² – or 1.67 MgC/ha).

Regarding carbon stocks, the IPCC states that near-surface carbon stocks (including only the top meter of sediment) are approximately 250 MgC/ha (equivalent to 917.5 Mg CO2 e/ha) for tidal marshes.

In this study, it is assumed that the annual absorption rate is 1.9 MgC/ha (equivalent to 7 Mg CO2 e/ha and is the average of the estimates by Murray et al. (2011)), and that total stocks are those estimated by the IPCC.

According to official data from the Ministry of Environment, in the Dominican Republic in 2022, wetlands occupied 1,550.6 km², estuaries 667.55 km², and lakes and lagoons 64.36 km². In total, these ecosystems occupy 2,282 km². There is no updated information on the km² of marshes in the country, so it is assumed to be equivalent to that of estuaries, i.e., 667.55 km² (equivalent to 66,755 hectares).

With all this, the total use value associated with the carbon sequestration service of marshes is shown in Table 13.

[17] Range [10.540-10.560].
[18] The value 3,230 USD/ha/year in 2007 is equivalent to 4,800 USD/ha/year in 2022.

Table 13. Total Use Value of the Carbon Sequestration Service of Marshes in the Dominican Republic (million USD)

	Sequestration Rate (Mg C02 e/ha)	Total Carbon Stock (Mg C02 e/ha)	Market Price (USD/tCO2e)	Area (ha)	Total Economic Value (million USD)
Annual Value **Carbon Stock**	7	917.5	4.73	66,755	**2.21** **289.70**
	Sequestration Rate (Mg C02 e/ha)	**Total Carbon Stock (Mg C02 e/ha)**	**Social Cost of Carbon (USD/tCO2e)**	**Area (ha)**	**Total Economic Value (million USD)**
Annual Value **Carbon Stock**	7	917.5	26	66,755	**12.15** **1,592**
Annual Value **Carbon Stock**	7	917.5	60	66,755	**28.04** **3,674.86**
Annual Value **Carbon Stock**	7	917.5	185	66,755	**86.45** **11,330.83**

Source: Own elaboration

Non-use Values

A BID of 285 Dominican pesos (USD 5), a BIDU of 485 Dominican pesos (USD 8.5), and a BIDL of 114 Dominican pesos (USD 2) were used. The results are per person and would be a one-time payment.

The WTP obtained was USD 10.99[19]. As with the previous cases, the reference group would be 2,854,735 people.

Table 14 shows the total non-use values amounting to USD 31 million.

Table 14. Non-use Values for Marshes in the Dominican Republic

	Dominican Pesos per person	Target Population	Total Non-use Value (million Dominican Pesos)
Total Non-use Values	189.20	2,854,735	540.12
	USD per person	**Target Population**	**Total Non-use Value (million USD)**
	10.99	**2,854,735**	**31.37**

Source: Own elaboration

5. Aggregated Results

Total Annual Values

Table 15 presents the aggregated annual results by ecosystem and ecosystem service, as well as the total value (including both use and non-use values).

[19] Range [10.981-10.998].

Table 15. Total Economic Value of Ecosystem Services Provided by Coral Reefs, Mangroves, Seagrasses, and Salt Marshes in the Dominican Republic (million USD per year)

	Corals	Mangroves	Seagrasses	Salt Marshes	TOTAL
Tourism and Recreational Activities	1,295				
Fishing Activities	20.44	24.88			
Coastal Protection	96	8.51		95.86	
Carbon Sequestration[20]		25.35	10.23	84.24	
Non-Use Values	33.83	35.86	30.12	31.37	
TOTAL					**1,791.69**

Source: Own elaboration

Discounted Total Values

In addition to knowing the annual benefits provided by the ecosystems, it is also important to determine the total value of these ecosystems, which involves estimating the present discounted value of anticipated future benefits.

One of the objectives for decision-makers in environmental policies should be to preserve these ecosystems in perpetuity, so estimating this discounted value is especially useful as it allows the consideration of ecosystem benefits over their lifetime. For example, it allows us to understand how much would have to be paid for the mangroves in the Dominican Republic if someone wanted to buy them, or at a sectoral level, how much would need to be paid to the tourism and recreation sector to take ownership of coral reefs.

In short, measuring natural capital is more appropriately done by discounting future yields. In fact, this is the central normative procedure of the System of National Accounts (SNA) and the System of Environmental-Economic Accounting (SEEA) (UN 1993; UN et al. 2013, 2014).

In this section, the present discounted value of the four ecosystems, namely coral reefs, mangroves, seagrasses, and salt marshes, is calculated.

To estimate the present discounted value of the blue economy in the Dominican Republic, the first step is to determine the discount rate to apply. There is a debate around this issue that has profound implications: a critical characteristic of the distant future is the uncertainty about what the appropriate rate of return on natural capital for discounting will be at that time. For this reason, Weitzman (1998) proposes using a discount rate that decreases over time, that is, the "lowest possible" discount rate for the evaluation of long-term environmental projects and assets (generations or centuries from the present).

Stern (2006) proposes a discount rate of 0.1%, which gives almost the same weight to the welfare of present generations as to future ones, considering that the costs of early action against climate change would be lower than the costs of inaction. The Office of Management and Budget (OMB) of the United States, in its guidelines for federal agencies on regulatory analysis development, suggests using a discount rate of 2% per year. Meanwhile, in its global natural capital assessments, the World Bank uses a discount rate of 4%. A recent analysis of the economic value of flood protection provided by reefs and mangroves in the Caribbean (including the Dominican Republic)

[20] In the case of carbon sequestration, by offering 4 possible values, the range (difference between the maximum and minimum value) is shown.

also uses a discount rate of 4% (Beck et al., 2022). However, some countries in the region, such as Colombia, Bolivia, Argentina, Uruguay, and Costa Rica, maintain rates of 12%.

In this study, we propose using the four types of discounts mentioned above, thus offering a range of values.

In the case of carbon sequestration, the study has estimated both the annual values (the amount each ecosystem sequesters per year) and the values of total reserves, that is, the carbon stock stored by the ecosystems throughout their life.

Total Economic Value of the Carbon Sequestration Service Provided by Blue Economy Ecosystems in the Dominican Republic (million USD)

	Corals	Mangroves	Seagrasses	Salt Marshes	TOTAL
Carbon sequestration		10,410	1,723	11,041	**23,174**

Source: Own elaboration

Thus, in the case of carbon sequestration, we have not discounted the annual benefits but instead taken the stock value to avoid double counting.

Tables 16, 17, 18, and 19 present the values for discount rates of 0.1%, 2%, 4%, and 12%, respectively.

Table 16. Total Economic Value of Ecosystem Services Provided by Coral Reefs, Mangroves, Seagrasses, and Salt Marshes in the Dominican Republic (million USD Present Discounted Value 0.1%)

	Corals	Mangroves	Seagrasses	Salt Marshes	TOTAL
Tourism and Recreational Activities	1,295,000				
Fishing Activities	20,440	24,880			
Coastal Protection	96,000	8,510		95,860	
Carbon Sequestration		10,410	1,723	11,041	
Non-Use Values	33,830	35,860	30,120	31,370	
TOTAL					**1,695,044**

Source: Own elaboration

Table 17. Total Economic Value of Ecosystem Services Provided by Coral Reefs, Mangroves, Seagrasses, and Salt Marshes in the Dominican Republic (million USD Present Discounted Value 2%)

	Corals	Mangroves	Seagrasses	Salt Marshes	TOTAL
Tourism and Recreational Activities	64,750				
Fishing Activities	1,022	1,244			
Coastal Protection	4,800	426		4,793	
Carbon Sequestration		10,410	1,723	11,041	
Non-Use Values	1,692	1,793	1,506	1,569	
TOTAL					**106,768**

Source: Own elaboration

Table 18. Total Economic Value of Ecosystem Services Provided by Coral Reefs, Mangroves, Seagrasses, and Salt Marshes in the Dominican Republic (million USD Present Discounted Value 4%)

	Corals	Mangroves	Seagrasses	Salt Marshes	TOTAL
Tourism and Recreational Activities	32,375				
Fishing Activities	511	622			
Coastal Protection	2,400	213		2,397	
Carbon Sequestration		10,410	1,723	11,041	
Non-Use Values	846	897	753	784	
TOTAL					**64,971**

Source: Own elaboration

Table 19. Total Economic Value of E. S. Provided by Coral Reefs, Mangroves, Seagrasses, and Salt Marshes in the D. R. (million USD Present Discounted Value 12%)

	Corals	Mangroves	Seagrasses	Salt Marshes	TOTAL
Tourism and Recreational Activities	10,792				
Fishing Activities	170	207			
Coastal Protection	800	71		799	
Carbon Sequestration		10,410	1,723	11,041	
Non-Use Values	282	299	251	261	
TOTAL					**37,107**

Source: Own elaboration

Public Policy Implications

The information on value can be used in various policy-making contexts, such as determining investment in ecosystem health, compensation for damages, and cost-benefit analysis of conservation measures. In this context, the results of this study provide insights to argue in favor of the Dominican Republic's government and other stakeholders increasing budgetary resources dedicated to the conservation and management of "blue economy" ecosystems. In the Dominican Republic, ecosystems need to be restored and expanded. Restoration is underway in some areas, but it should go a step further. This requires establishing specific criteria for selecting corals, mangroves, species, and salt marshes to be restored, adaptive scientific monitoring, and close collaboration with the local community to ensure the sustainability of these ecosystems.

Economic valuation can also be useful in raising local and global awareness of the economic importance of ecosystems as natural infrastructure, and in opening the door to discussions with the private sector (e.g., tourism, fishing) on how they can protect their business interests by investing in the health of the ecosystems their industries depend on.

Expanding the number of protected areas and fully protected fishery replenishment zones is also essential for safeguarding and maintaining fisheries. The adoption of size limits, closed seasons during spawning periods for key species, and stricter enforcement of fishing regulations would also be necessary to reverse the decline in fish populations and create sustainable fisheries based on better management and improvements in market supply chains to expand the benefits for fishermen. Monitoring the situation in these areas and implementing these measures can yield more promising results if there is regional coordination and oversight. It would also be highly beneficial to conduct consultation processes, work at the community level, and promote responsible consumption, as this would involve local and regional communities in the process of protecting and conserving coral reefs.

The most significant threats to ecosystems from tourism are the destruction of coastal habitats associated with the development of hotels, resorts, and related infrastructure, water pollution resulting from coastal development and cruises, coastal and marine habitat degradation associated with the concentrated impact of cruise visitors, and increased fishing pressure. Participatory processes can help implement sustainable tourism practices. Reef management in relation to tourism must adapt to the new world in which we live. Sustainable and eco-friendly tourism can help ensure that coral reefs are not damaged, benefit the economy, and maintain cultural diversity and pluralism. Best practices are not always known by tourists, even those with an eco-friendly mindset. Therefore, it is necessary to include certain guidelines, such as not touching or stepping on coral, not buying souvenirs made of coral or taking home shells and minimizing the use of sunscreens containing chemicals that have been proven to harm coral reefs, among others.

Finally, by identifying the beneficiaries of specific ecosystem services, it helps to design measures to recover maintenance costs against external damage. In general, economic valuation identifies and generates economic arguments to support policies that help ensure healthy coastal ecosystems and sustainable economies.

Caveats

This study is novel in incorporating, among other aspects, the non-use values into the total economic valuation of the ecosystems in the Dominican "blue" economy. However, it has several limitations, which are mentioned below and should be addressed in the future.

Firstly, the values obtained do not encompass all the ecosystem services provided by coral reefs, mangroves, seagrasses, and salt marshes, as this would require more availability of primary data and execution time. Therefore, the results would fall within the lower range of the Total Economic Value, implying that this value would be much higher if, for example, fishing activities and nutrient recycling associated with seagrasses were considered.

It has not been possible to find official information on certain aspects, such as the multipliers for the fishing sector to calculate the indirect impacts (spillover effects) of this sector on the overall structure of the Dominican economy. Another example is the costs associated with protected areas. The methodology explains that only the costs of collecting and administering fees should be included, not the costs of park administration. This specific information is not available.

Finally, it would be interesting to quantitatively analyse how the obtained values are allocated and distributed among the different stakeholders (public sector, private sector, etc.) and the willingness to pay for coral reef insurance. Additionally, there are financial tools for the conservation and restoration of marine ecosystems (such as insurance and funds) that could be explored. These instruments are relatively new but have great potential, especially in Caribbean countries, to support more sustainable management and efficient protection of ecosystems in the future. Along these lines, a case could be made for the protection and restoration of coral reefs, mangroves, seagrasses, and salt marshes.

Conclusions

There are very few studies on the economic valuation of marine ecosystems in the Dominican Republic. The objective of this study has been to estimate the total economic value of four Dominican ecosystems: coral reefs, mangroves, seagrass beds, and salt marshes, focusing on the main ecosystem services they provide.

The results show that coral reefs, mangroves, seagrass beds, and salt marshes can contribute up to 23.274 billion USD annually to the economy of the Dominican Republic. However, the total value of these ecosystems (applying the discounted present value of expected future benefits) would amount to between 37.107 billion and 1.695 trillion USD.

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