



The Economics
of Ecosystems
and Biodiversity
on Bonaire

What's Bonaire's Nature Worth?



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This study is part of the "Economics of Ecosystems and Biodiversity Netherlands" (TEEB NL) study. It is being conducted for the Caribbean Netherlands on behalf of the Dutch Ministry of Economic Affairs.

The Challenge

Healthy ecosystems such as coral reefs and mangroves are critical to Bonairean society. In the last decades, various local and global developments have resulted in serious threats to these fragile ecosystems of Bonaire, thereby jeopardizing the foundations of the island's economy. Therefore, it is crucial to understand how nature contributes to Bonaire's economy and its wellbeing in order to make well-founded decisions when managing the economy and nature of this beautiful tropical island. This research aims to determine the economic value of the main ecosystem services that are provided by the natural resources of Bonaire and their overall importance to society. The challenge of this project is to deliver sound scientific insights that will guide decision-making regarding the protection of Bonaire's ecosystems and the management of the island's economy.

The Approach

By assigning economic values to the main ecosystem services of Bonaire, this research draws attention to the economic benefits of biodiversity and highlights the growing costs of biodiversity loss and ecosystem degradation. The study addresses the most relevant ecosystems and ecosystem services for Bonaire and applies a range of economic valuation and evaluation tools. By surveying over 1,500 persons, including tourists, fishermen, local residents, and citizens of the Netherlands, this study estimated the willingness of individuals to pay for the protection of Bonairean nature, as well as mechanisms (e.g. user fees) through which such payments would be transferred. Furthermore, a scenario analysis is conducted to inform decision makers about the most effective strategies to protect the ecosystems of Bonaire. This study intensively involved stakeholders from the start to finish, which facilitated data collection while simultaneously building capacity in applying the concept of ecosystem services among the target audience.



Country Overview.

Bonaire is a Caribbean island of approximately 288 km², with about 16,000 permanent inhabitants. Bonaire is a public entity of the Netherlands. The entire coastline of the island is designated as a marine sanctuary in an effort to protect what are considered to be some of the most pristine coral reefs in the Caribbean. Tourism accounts for the majority of economic activity on the islands and fisheries hold significant economic and cultural influence. Much of Bonaire's economy and many of its residents rely on the quality of the island's ecosystems. Bonaire currently has two protected natural areas: the Bonaire National Marine Park (BNMP) set up in 1979 and the Washington-Slagbaai National Park (WSNP) set up in 1969. The national marine protected areas include five Ramsar sites- Lac, Gotomeer, Pekelmeer, Slagbaai and Klein Bonaire.

The Results

In total, more than 10 different ecosystem services have been valued in monetary terms. The total economic value (TEV) of the ecosystem services provided by the marine and terrestrial ecosystems of Bonaire is \$105 million per year. This TEV and its underlying components can be used to build a strategy for effective conservation measures on Bonaire. After extensively analyzing different scenarios for future ecosystem services values one result becomes very clear: an ounce of prevention is worth a pound of cure. In other words, it is more efficient to prevent extensive environmental damage than trying to revitalize the environment while there are still threats at hand. With the current threats unmanaged, the TEV of Bonairean nature will decrease from \$105 million today to around \$60 million in ten years time and to less than \$40 million in 30 years. The project is well documented and provides several extensive online reports, five easily accessible policy briefs and a beautiful film documentary that translates the scientific results into real life situations on Bonaire.



Introduction

In the current era of financial insecurity and environmental degradation it becomes clear that conventional investments in the economy do not always contribute to a healthy environment. In response, a growing community is working to show that the economy and environment are strongly interlinked, and that in fact a healthy environment is critical to financial as well as human wellbeing. To make well-founded decisions when managing the economy and natural environment of a country, it is necessary to determine all benefits that are derived from ecosystems and their importance to society. The challenge is to find methods to accurately measure and value these ecosystem services.

Bonaire's unique environment and biodiversity are part of the Netherlands. The coastal waters contain coral reefs, mangroves and sea grass systems, and on land the island is characterized by dry forest and farmland (Kunukus). Historically, Bonaire's inhabitants lived in balance with this natural environment. However, many pressures including the fast economic development of the island have led to environmental degradation and a loss of the ecosystem services of which the people of Bonaire take benefit. Therefore, it is crucial to understand how nature contributes to Bonaire's economy and human wellbeing.

'Ecosystem services' is a fairly new concept and represents the benefits supplied to human societies by natural ecosystems. Ecosystem services include the coastal protection provided by marine and coastal ecosystems, the habitat and nursery support for commercial fisheries, recreation, cultural significance, or simply aesthetic pleasure. Most ecosystems are either public or quasi-public goods: there are no specific property rights assigned and people cannot be excluded from using them. Such situations are often labeled 'a tragedy of the commons' because overuse and degradation often occurs.

By recognizing and assessing the economic value of ecosystem services, environmental economists hope to highlight the willingness of individuals to pay for their protection, as well as mechanisms (e.g. user fees) to do so. One way to define the value of ecosystem services is by figuring out a communities' "Willingness-to-Pay" (WTP) to maintain their public natural spaces in a healthy state. For example, how much would a resident, as an individual, be willing to pay to preserve nature near their home? How much would a tourist be willing to pay to improve the coral reefs on an island they visit, even if they don't fish or swim there?

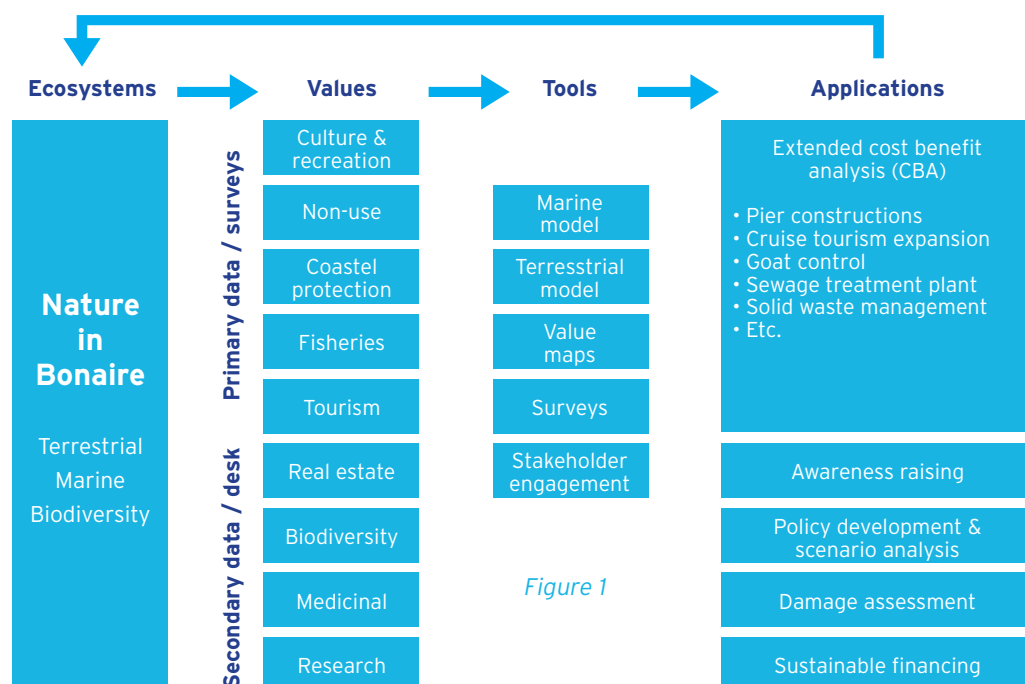


Figure 1:
Overall analytic
framework

This research project draws attention to the economic benefits of ecosystems and biodiversity and highlights the costs of biodiversity loss and ecosystem degradation. Insight into the value of ecosystems and biodiversity can support decision makers to make wise and inclusive decisions for long-term sustainable economic development. To inform decision makers about the most effective strategies to preserve nature as an important economic source a full-scale valuation of all ecosystem services on the island of Bonaire has been undertaken by WKICS¹ and the VU University Amsterdam. The study addresses all relevant ecosystems and ecosystem services for Bonaire and applies a range of economic valuation and evaluation tools. The overall analytical framework followed in the study is depicted in Figure 1.

Results

This extensive study has resulted in a showcase example for socio-economic valuation studies in the Caribbean. The main outcome of the study is the Total Economic Value (TEV) of Bonaire's nature. This TEV and its underlying components are used to build a strategy for effective conservation measures on Bonaire. The TEV is the sum of the ecosystem services

provided by the marine and terrestrial ecosystems of Bonaire. In total, more than 10 different services have been valued in monetary terms. The most relevant services that were assessed in extensive sub-studies are summarized in the following Sections. Moreover, the results have been translated into easily accessible policy briefs and a beautiful film documentary, which places the scientific results into real life situations.

Local cultural and recreational values

The importance of the natural environment to the residents of Bonaire has been assessed through a public survey. Almost 400 households in Bonaire participated in this household survey, addressing a wide range of issues such as ecosystem threats, benefits, and preferred environmental management options. The Willingness-To-Pay (WTP) by all Bonairean households to improve the overall marine and terrestrial environment is estimated at almost \$4 million per year. Residents identified waste and coastal development as the main threats facing nature on the island. A crucial next step is raising awareness among the residents of Bonaire about the vital role of nature on the island, which will result in stronger support for additional environmental measures and more responsible behaviour by the local community.

¹⁾ WKICS BV is a Bonaire based consultancy firm, specialized in the link between economy and nature and contractor of this research.



Tourism value

Bonairean ecosystems support touristic activities that mostly depend on the quality of the natural environment, such as diving and snorkeling. Although the tourism sector is a substantial component of the economy of Bonaire, the economic value of the contribution of nature to Bonaire's tourism industry has never been quantified. To determine the tourism value of Bonairean ecosystems a survey of tourists visiting Bonaire has been conducted, recording visitors' expenditures as well as their Willingness-To-Pay (WTP) for protection of Bonairean nature. The expenditure by tourists on Bonaire is found to be around \$125 million annually. The estimated value of Bonaire's natural environment for tourism is around \$50 million. Stay-over tourists are found to contribute more to the tourism industry than cruise tourists, and marine ecosystems prove to be more economically important than terrestrial ecosystems on the island. The high WTP of tourists for additional nature protection in Bonaire suggests that the current user fees for visitors to Bonaire could be increased without having an effect on the number of tourists visiting the Island.

Fisheries values

Fishing provides an important source of income and recreational enjoyment for the residents of Bonaire. A substantial part of the catch is composed of reef-dependent species, which rely on the health and productivity of local coral reefs. The study estimates the economic importance of reef fisheries by accounting for both the recreational and commercial values and converts this aggregate value into a fisheries value map for the purpose of improved spatial decision making. The annual reef-related commercial fisheries are valued at \$400,000 while the recreational fishery value is almost twice as high at \$700,000 per annum. Surveys revealed that fishing is used as a way to reduce food expenses while at the same time providing a healthy protein intake for local residents. Furthermore the research revealed that local fishermen seem to have a genuine concern regarding the decline in fish stock in Bonaire's coastal waters.

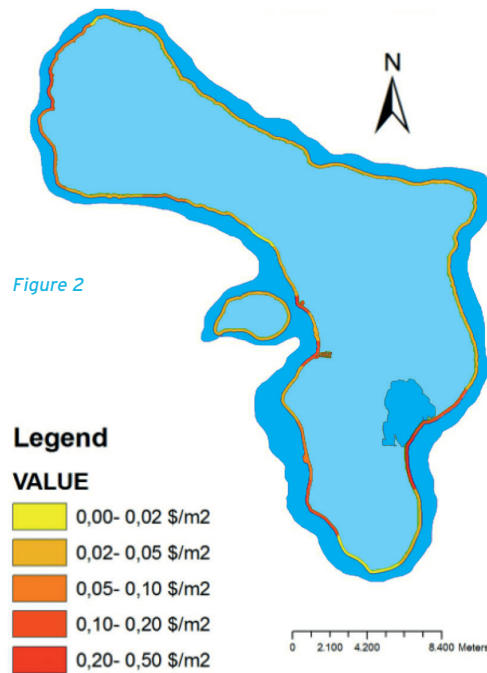


Figure 2:
Spatial allocation
of coral reef fishery
values

Value of nature in the Caribbean

Netherlands for citizens in the Netherlands

How do citizens of the Dutch mainland value the ecosystems in the Caribbean Netherlands, even if many will never visit these beautiful islands? This and other questions are addressed in an extensive case study. Over 800 face-to-face interviews of people living in the Netherlands were conducted, and an additional 500 respondents filled out an online questionnaire. The most notable result is that Dutch mainland citizens have a positive WTP for protecting nature on both sides of the ocean. Despite a negative perception of Dutch economic prospects, respondents placed significant emphasis on environmental protection. The aggregated monthly amount for the value of nature protection in the Caribbean Netherlands by residents of the Netherlands is estimated at €17 million (\$22 million). Raising awareness among Dutch citizens that the small population of 20,000 inhabitants of the Caribbean Netherlands is in no position to fundamentally support the level of nature conservation that is needed is an important first step to take.

Research value

Nature in Bonaire provides important services for research and education. The marine and terrestrial environment of Bonaire is subject for a large group of academics conducting and publishing innovative research based on these unique and easily accessible ecosystems. Without the presence of healthy ecosystems, Bonaire would not attract large numbers of researchers nor would Bonaire's nature be a source of inspiration for many educational activities on the island and beyond. This sub-study made an inventory of all ecosystem related research expenditures funded by governmental and non-governmental organizations for Bonaire. The annual research value was estimated at around \$1.3 million.

Coastal protection value

The coral reefs of Bonaire play a role in the protection of coastal properties during storms and hurricanes. The basic principle of coastal protection by coral reefs is the observation that reefs dissipate wave energy either by wave breaking or friction by reef structures. The question remains what the economic worth is of this ecosystem service. A spatial coastal protection valuation model has been designed for Bonaire based on the analysis of a wide range of relevant data. In this study, the coastal protection value (CPV) is estimated at a 30x30 m grid cell level, which gives a more spatially explicit estimation of the CPV of coral reefs.



The annual coastal protection values of the coral reefs of Bonaire for short-term (i.e. within 10 years) and long-term processes (i.e. beyond 10 years) are estimated at \$33,000 and \$70,000 respectively, based on avoided damage to private property. Adding public infrastructure to the valuation of coastal protection by the coral reefs is likely to increase the estimated value to considerably over \$0.1 million.

Art value

Artists are inspired by their surroundings. Such is also the case on Bonaire, where the natural scenery of the island stimulates artists to use components of nature in their work. Clearly, nature plays a crucial role in the production process of art on Bonaire. The demand for art consists of the thousands and thousands of tourists visiting the island, who are keen to bring home a piece of art to remember the beauty of the island upon their return. Moreover, the beautiful photographs and books produced on Bonaire are distributed to clients across the world. Given the explicit demand and supply of art on Bonaire and its strong dependence on nature, the art sector on Bonaire plays an important role in the overall economy and provides an additional reason to manage nature well on the island. The value of this ecosystem service of artistic inspiration is valued at \$460,000 annually.





Medical and pharmaceutical value

Medicinal plants play important roles in many traditional societies. The healing properties of herbal medicines have been recognized in cultures thousands of years ago. Besides these local benefits, biodiversity is important for the development of pharmaceutical treatments and drugs. The purpose of this sub-study is to economically value the benefits of species and ecosystem functions that are relevant for medicinal and pharmaceutical purposes. A large part of the population in Bonaire is found to regularly collect and use local herbs and other medicinal plants for medical treatment. Two-third of the inhabitants who were surveyed made use of local plants as an alternative to modern medicine or prescription drugs. The annual medicinal and pharmaceutical value of nature on Bonaire was estimated at \$0.7 million.

Carbon sequestration

The ecosystem service of climate regulation deals with greenhouse gas emissions and how ecosystems can mitigate such effects. Bonaire has six ecosystems that provide carbon-sequestering properties: salinas, dry forest, coral reefs, sea-grass, mangroves and open ocean. This sub-study aims to value the climate regulation potential of Bonaire. This desk study has made a rough attempt to estimate the carbon sequestration value of the main ecosystems of Bonaire. Based on actual carbon market prices this value was estimated at \$1.6 million per year.

Pollination by bats

By supporting the growth of fruit trees and aesthetically valuable flora, bats play an important role in preserving high levels of biodiversity on Bonaire. Although no estimate is generated of the economic value of pollination, by describing the possible links between pollination and the economy, this sub-study provides comprehensive insights in the potential economic importance of bats on Bonaire. Both economic and cultural reasons have been identified to support the notion of conserving the bats of Bonaire and their natural habitat (i.e. caves).

The fact that many people prefer natural over manufactured environments is often reflected in house prices. Therefore various environmental conditions may have a significant impact on house prices. In Bonaire these include the view or proximity to water bodies, coral reefs and other healthy ecosystems. Despite the limited data available, this sub-study made an attempt to estimate this so-called amenity value of nature of Bonaire. No strong impact of environmental variables onto the house prices has been detected. Whether this is a genuine result or whether it is caused by the limited availability of house sales data remains to be studied.

Functional valuation of ecosystem services

Clearly, nature on Bonaire has a significant economic value at present. However, to say something about the production of these

services in the future, we need to understand more about the functional value of ecosystems, such as coral reefs. The functional value of coral reef ecosystems refers to the capacity of coral reefs to provide ecosystem services on the long term. The “functional group approach” was used as a measure of the importance of habitats based on the level of representation off island coral functional groups. The outcome of this sub-study is matrices presenting relationships between socio-economic services and ecological functions. The ecological function consists of the functional processes of the reef with the fish and benthic species. Moreover, maps are generated presenting the functional value of each location to support twelve ecosystem services. These maps are analyzed taking into account resource use on Bonaire and thereby highlight the ecosystem hotspots indicating which areas are of high importance for each ecosystem service

Conclusions & Recommendations

The analysis of the wide range of ecosystem services provided by the natural environment of Bonaire generates many opportunities for decision makers to improve economic and environmental policies on the island. To deliver information to decision makers the first step is to calculate the Total Economic Value (TEV) and to grasp the role of nature in the Bonairean economy. Next, an extended cost-benefit analysis of alternative future scenarios provides an objective means of deciding which interventions in the economy and environment generate the highest yield. Such an integral approach is intended to ensure the betterment of Bonaire's environment while at the same time warranting sustainable economic development.

Total Economic Value versus the Total Financial Value

By summing up the worth of the range of valued ecosystem services, the TEV of the natural environment of Bonaire is estimated

to be more than \$105 million annually. To get an idea of the importance of nature for Bonaire, it is useful to compare the TEV of nature to the Gross Domestic Product (GDP). The GDP of the Bonaire economy was around \$224 million in 2008, which means that welfare derived either directly or indirectly from ecosystems is almost half of Bonaire's economy. Compared to other island-based studies, this shows that the economy of Bonaire has an extremely high dependence on their natural environment.

Although the TEV of nature on Bonaire is very large, this aggregated value is composed of numerous latent welfare-related values that are not necessarily translated into actual monetary flows. For example, the value by Dutch mainland citizens is a genuine economic value, yet, at the same time, this ecosystem service is predominantly a non-financial value (i.e. its value is not [fully] transferred in money terms to the financial economy of Bonaire). Of the TEV of \$105 million, only one-third of this amount (i.e. \$37 million) is truly traceable in the financial accounts of the economy of Bonaire, see figure 3. The majority of this financial value is captured by the tourism sector.

Costs and benefits of environmental measures

Through the use of simulation models, scenario development, and cost-benefit analysis the efficiency of various interventions is determined. Out of the extensive analysis of the ecosystem services and the different scenarios one result becomes very clear: an ounce of prevention is worth a pound of cure. In other words, it is more efficient to prevent extensive environmental damage than trying to revitalize the environment while there are still threats at hand. With the current threats unmanaged, the TEV of Bonairean nature will decrease from \$105 million today to around \$60 million in ten years time and to less than \$40 million in 30 years. Therefore, addressing the main threats proves to be very cost effective, e.g. by removing the threat of goats and lionfish, the environment has the

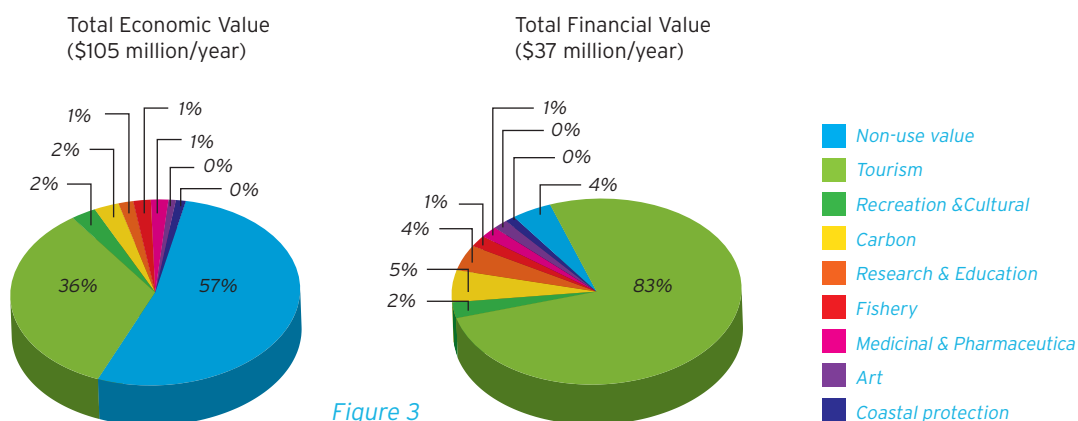


Figure 3

Figure 3:
the financial of the
economy of Bonaire

possibility to regenerate. Similar conclusions are drawn for the economic efficiency of improved sewage treatment. This demonstrates that interventions and policies need to aim at preventing damage to Bonaire's nature.

Stakeholder engagement

This project intensively involved stakeholders from the start. Therefore, the local government began the research with a public kick-off, followed by several workshops. Relevant stakeholders from various backgrounds participated in all sessions. These included local and national policy makers, nature conservation organisations, local industry (e.g. tourism industry), but also financial services and waste management companies. One of the objectives was building capacity with a select group of stakeholders educating them on socio-economic valuation and learning from them which ecosystems, ecosystem services and threats are most relevant on Bonaire. During the complete research cycle

these stakeholders provided continuous feedback and frequently reviewed research output. A final workshop took place in which stakeholders discussed the results and applied the monetary estimates in extended cost benefit analyses and explained the results from their own perspective in the documentary. This process restated the lesson that raising awareness locally as well as nationally is of crucial importance to generate the necessary support for preserving nature as an important economic source for Bonaire. Moreover, strong societal support is needed to convince local decision makers to apply the recommendations of the study. Examples of recommendations are for the improvement and further development of sustainable financing mechanisms, emergency plans or damage assessments protocols in response to increased hurricane events, and to improve policies that should guide Bonaire towards a sustainable green island economy.



Further Information

For further information about valuing Ecosystem Services on the island of Bonaire, contact Esther Wolfs (esther@wkics.com) or Pieter van Beukering at IVM VU, Amsterdam (pieter.van.beukering@vu.nl) and the webpage www.ivm.vu.nl/en/projects/Projects/economics/Bonaire

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