The Economics of Ecosystems and Biodiversity, Aruba

January 2018

Updated version

WOLFS COMPANY
NATURE BY NUMBERS

IVM VU
Institute for Environmental Studies

YABI CONSULTANCY

Wolfs Company
Sarphatistraat 370
1018 GW, Amsterdam
The Netherlands
T: +31 20 520 6993
E: info@wolfscompany.com

IVM
Institute for Environmental Studies
VU University Amsterdam
De Boelelaan 1087
1081 HV, Amsterdam
The Netherlands
T: +31 20 598 9555
F: +31 20 598 9553
E: info.ivm@vu.nl

YABI
Boroncana 223A
Noord
Aruba
T: +297 560 2700
E: francielle@yabiconsultancy.com

ACKNOWLEDGEMENTS

Thanks are extended to all those whom participated in the workshop on the 28/29 April 2016, many of whom have contributed through expert interviews and sharing invaluable knowledge (see annex for a stakeholders list). Also to the principle funders of this project SETAR N.V. Corporate Social Responsibility Fund, without whom the research would not have been carried out. Additionally, a special thanks to the University of Aruba, whose students participated in data collection.

Lead authors:

Timothy Polaszek,
Consultant,
Wolfs Company,
Sarphatistraat 370, Amsterdam.

Francielle Lacle,
Consultant,
YABI Consultancy, Aruba.

Prof. Pieter van Beukering,
Associate Professor,
Institute for Environmental Studies,
Vrije Universiteit, Amsterdam.

Esther Wolfs,
Partner,
Wolfs Company,
Sarphatistraat 370, Amsterdam.

This report was commissioned by the Department of Nature and the Environment of the Aruban Government and SETAR N.V.

Table of Contents

List of acronyms & abbreviations

CE - Choice Experiment
CVM - Contingent Valuation Method
CES - Cultural Ecosystem Services
EEZ - Exclusive Economic Zone
GDP - Gross Domestic Product
IBA - Important Bird Area
IVM - Institute for Environmental Studies
MEA - Millennium Ecosystem Assessment
SDG - Sustainable Development Goals
SIDS - Small Island Developing States
TEEB - The Economics of Ecosystems and Biodiversity
TEV - Total Economic Valuation
WTP - Willingness-To-Pay
WTTC - World Travel and Tourism Council

List of figures

List of tables

Executive summary

Aruba's natural capital value for tourism, culture, fishing and carbon exceeds **US$ 287.3 million** per year.

ARUBA, an island of 115,000 human inhabitants and a myriad more animals, plants, bacteria and other fantastic organisms, is a gem in the Caribbean Sea. Located in the Lesser Antilles, outside of the hurricane belt, it enjoys a great, calm, warm climate. In combination with beautiful, white beaches, natural mangroves, forests and saliñas, this has turned Aruba into a very popular tourist destination.

Aruba depends on tourism

Direct contributions of tourism account for 28.6% of total GDP. When combined with indirect, this reaches 88.1%, expected to reach **97.4%** by 2027.

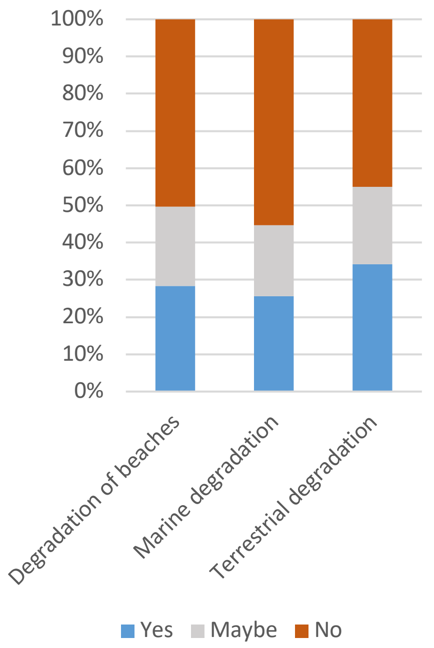
Tourism depends on natural capital

A natural capital assessment of tourist expenditures derived **US$ 269 million** in value. The growth, employment benefits and economic rewards of the tourism industry are related to Aruba's environmental attributes.

Environmental degradation could lose **50%** of visitors

This report estimates the value of several ecosystem services to residents and tourist on Aruba by answering various research questions about the role of natural capital on the island.

Aruba's **welfare could halve** if its marine environment degraded



A tourist exit poll of 584 surveys showed that between 45% and 55% of visitors would not return if there would be terrestrial, marine, or beach degradation.

Half of all 1.6 million visitors also indicated that they were prepared to pay additional fees for improved nature protection on the island.

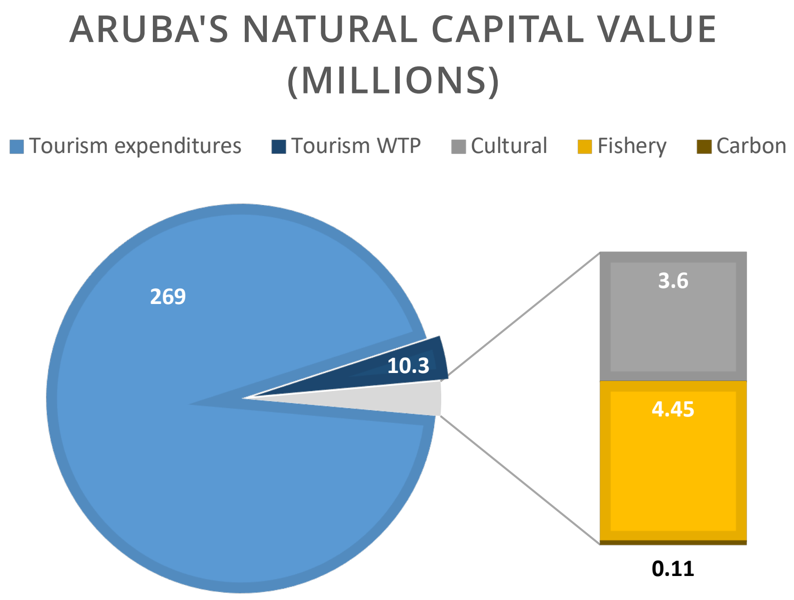
Tourists are willing to pay **US$ 10.3 million** per year

Aruba's small population relies and depends upon many different services provided by its ecosystems. The small fishing industry on Aruba provides its related natural capital with a value of **US$ 4.45 million**.

Aruba's local population values highly its natural surroundings: residents are willing to pay for an increased sized marine protected area. Also, increased fish catch, and natural areas, were indicated as priority services.

Residents willing to pay **US$ 3.6 million** for protection

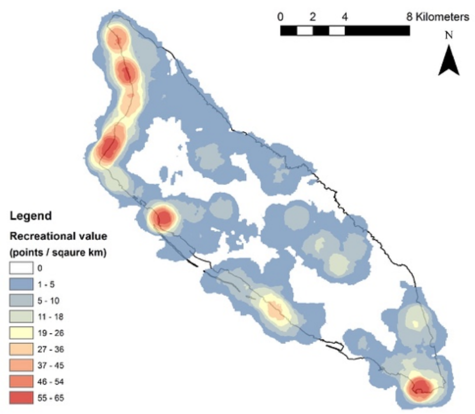
Whilst the majority of Aruba's residents are not bothered by the increase in visitors, over 80% of want natural history and cultural heritage to be taught in schools. They want to see a larger share of **government budget** going towards nature protection.



Carbon sequestration value on the island is estimated to be worth nearly **US$ 109,000** per year. This is largely due to the tropical dry forests in the northwest of the island.

illegal fishing derives over **US$ 2.1 million** in natural capital value

Recreational fishing activity on Aruba derives 36% of the value of fishing-related natural capital. However, the largest beneficiary is the illegal industrial fishing industry. Nearly **50% of the value** is attributable to foreign industrial fishing in Aruba's waters.
When considering the size of the tourism sector relative to Aruba's GDP alongside the sector's dependency on the environment, it is clear that any development plan must seriously consider the role of natural capital.



Value maps were also created for several services. As seen above, points of recreational interest for local residents are spatially analysed. These can provide input for spatial development plans and conservation programmes.

1. Introduction

General background

Many services that we are provided by the natural world are free. Rather, they are not paid for in dollars and euros. The bill is paid in human welfare and by our environment. Economics helps us to understand that certain behaviours can fit certain laws. To improve these models, in science and in practice, it is necessary to measure and incorporate influential externalities. Environmental economics provides the tools to steer sustainable development for an equitable future.

There is a strong and dependent link between nature and wellbeing.

The Economics of Ecosystems and Biodiversity (TEEB) is an international initiative focused on drawing attention to the economic benefits of biodiversity conservation and the growing costs of biodiversity loss and ecosystem[1] degradation. An economic, and thus anthropocentric, perspective is provided whereby our dependencies are captured and quantified.

The results of this report propose a socio-economic valuation of the ecosystem goods and services of Aruba.

This report provides a detailed view of the importance and value of the ecosystem services of this tropical, Caribbean island, which in turn can be used by policy makers to develop clearly driven measures for nature conservation, support the development of a green island economy and encourage social cohesion for the future well-being of Aruba's citizens and environment.

---

[1] An ecosystem is a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit. Ecosystem services describe the benefits that ecosystems provide to people (Source: Millennium Ecosystem Assessment)

Aruba has set a goal to move towards sustainable economic development, which aims to balance out three interconnected spheres: social equity, economic resilience and ecological responsibility. One of the dimensions of transformation set by Aruba's economic policy focuses on the environment: "Sustainable development by conservation, preservation and innovation of natural habitats, cultural expressions, and (land/marine) ecological systems" (The green gateway policy, 2011-2013). During the Wild Aruba conference – a multi-stakeholder platform in 2008 – the community expressed the desire for more coherence in environmental policy and less fragmentation. In addition to this, International conventions and treaties[2] commit countries of the Kingdom of the Netherlands to protect its rich and unique biodiversity.

Principally due to tourism, small island economies such as those in the Caribbean depend heavily on their marine and terrestrial ecosystem services. The biodiversity of these islands is rich[3] and often unique and should be considered as an important natural asset[4]. Ecosystem services are important to consider in countries and states such as these because the economies of these nations depend heavily on them. These services can include, among others, tourism, fisheries, and coastal protection (Waite et al., 2015). In spite of their importance, ecosystems have been significantly degraded over the past years due to local pressures such as coastal development, overfishing, physical destruction and disturbance caused by recreational activities and tourism. Additionally, water eutrophication that negatively affects the marine environment and its ecosystems is also considered a problem in this region (Waite et al., 2015).

Nearly two-thirds of the Caribbean's coral reefs are threatened by human activities[5], reducing the attractiveness and beauty of the islands for tourists,

---

[2] More information on international conventions and treaties is described in appendix 1 in paragraph Nature Conservation.

[3] The Dutch Caribbean is home to rich biodiversity with over 10.000 species of which 200 are unique in the world. More than 100 species are on the CITES list of endangered species.

4 The small Caribbean islands have limited means of generating foreign exchange with small domestic markets. They possess narrow production base with limited potential for economic diversification, and diseconomies of scale in production, leading to import dependency.

[5] In February 2008, according to UNEP, Caribbean coral reefs have been reduced by 80% in three decades. As a direct result, revenues from dive tourism have declined and are predicted to lose up to USD 300 million per year. That is more than twice as much as losses in the heavily impacted fisheries sector.

hampering fishery production, and undermining the protection from hurricanes. All of these impacts on the ecosystem services represent losses or costs to society that lead to a reduction on the national income.

Table 1 General overview of Aruba (CIA, 2017; Trading economics, 2016; WTTC, 2017; CBS, 2015)

Aruba			
Aruba is a country of the Kingdom of the Netherlands. The following facts and figures provide a general overview of this Caribbean island:			
Land area:	180 km2	Total population (2017): Urban density:	115,120 inhabitants 41.1%
Main Ecosystems:	Saliña Woodland Bare rock	GDP (total) (2016):	US$2.76 billion
	Coral reefs and sea grass bed	GDP (per capita):	US$23,974
	Beaches	Unemployment rate: (15-24)	28.9%
Households:	34,845		

Welfare on Aruba is, currently, principally created by its travel and tourism industry, which provides the majority of employment and income to the citizens of Aruba. The direct contribution of these activities to the gross domestic product (GDP) and the labour market is calculated by the output of tourism sectors such as hotels, airlines, travel agents, and leisure and recreation services that deal directly with tourists (Turner, 2015). Although the direct contribution of tourism to GDP was 28.6% in 2016, there seems to be a heavier underlying dependence. The indirect contribution of travel and tourism, which takes into account public and private investment in the sector and spending of industry employees, brings the figure up to 88.1%. Aruba is the second most dependent country on tourism as a share of its GDP in the world (WTTC, 2017). This shocking figure illustrates well how a change in the supply of natural capital could affect the welfare of a whole island and its economy.

Tourism, in turn, depends on coastal, marine and terrestrial ecosystems to be sustained, which often suffer from degradation. Drivers of ecosystem degradation

include inadequate waste disposal, the loss of coral reefs due to ocean acidification, nitrogen, sulphur and phosphorous waste; and the loss of both land use and biodiversity due to urbanization and habitat degradation. These factors may increasingly affect Aruba's capacity of providing its ecosystem services. For example, tourists will not be able to enjoy clean and beautiful beaches due to inadequate waste disposal observed today, and they will also be less inclined to take part in recreational activities such as scuba diving due to loss of coral reefs and marine biodiversity.

Natural capital provides the basis for the creation of human welfare, both directly and indirectly, and is responsible for part of the total economic value of the planet (Costanza et al., 1997). The incorporation of ecosystem services into economic assessments will support Aruba's decision-makers and enable them to move towards a sustainable island economy (Waite et al., 2015; Zanten et al., 2016). Nature has an influence on the wellbeing of Aruban residents, as shown in more detail in the associated report 'Cultural ecosystem services for the local community of Aruba'. Most residents visit the environmental attributes of the island to relax and many also use them to connect with family and friends. The environment is an essential component of Aruban life and culture.

Furthermore, having a better understanding of the relevance of ecosystem services contributes to more informed decision making regarding conversion of land. Bateman et al. (2013) indicated that "policies that recognize the diversity and complexity of the natural environment can target changes to different areas so as to radically improve land use in terms of agriculture and greenhouse gas emissions, recreation, and wild species habitat and diversity". Given that the coastal and marine ecosystems of Aruba have been significantly degraded over the past years, having a better understanding of ecosystem services can also contribute to better decisions regarding the management of the coastal and marine ecosystems in order to support the sustainable provision of these services in the long term.

This report provides a comprehensive economic valuation of ecosystem services on Aruba. The total economic valuation (TEV) framework was used to develop

methodologies of valuation for each type of ecosystem service using available data and those collected on site through surveys

Aruba's dependency on its nature and environment for the creation of its residents' welfare, and that of its visitors, is clear. Tourists are drawn to the island's beautiful beaches, natural wonders and fantastic climate, all of which require healthy ecosystems to function properly. With the TEEB Aruba study, decisions regarding sustainable development can be made more accurately, using previously unavailable knowledge about the economic contribution of Aruba's ecosystem services.

Research Area

Aruba is an island located in the southern part of the Caribbean Sea (see figure 1) with its jurisdiction under the Kingdom of The Netherlands. The island has a surface area of about 180 km2, with a length of 32 kilometres and a breadth of 10 kilometres at its widest point. The island is generally flat with its highest point, Mount Jamanota, rising to 189 meters above sea level (Hoetink, 2016). On December 31, 2015, the island had 118,696 residents of which 69% were born on the island (CBS, 2016). Aruba's population is ethnically mixed and the official languages are Dutch and Papiamentu.

The island experiences daily average temperature of around 28 ℃ and receives North-easterly trade winds providing a relatively temperate climate. According to Koeppen's climate system, Aruba is characterized by the tropical steppe, semi-arid hot climate.

The island receives little rain, on average about 471 mm per year (Departamento Meteorological Aruba, 2016). The combination of natural beauty and a warm and sunny climate makes Aruba a popular tourist destination with almost 1.5 million tourists every year and especially with Americans, who comprise nearly 60% of the total (US Department of State, 2016). Consequently, tourism is heavily relied upon by Aruba's economy and has an established tourism industry for over 50 years. In

2014, travel and tourism contributed 88.4% to the GDP, generated 32.5% of the direct employment and 91.2% of total employment when including indirect impacts (Turner, 2015).

Figure 1 Map of the study area (source: Google Maps)

The majority of tourists visiting Aruba are attracted to the coastline and the white beaches. Beaches like Palm beach (figure 2) and Eagle beach are the closest to the hotels and are often visited by tourists, who enjoy different types of marine recreational activities like swimming and sailing. Aruba also offers good snorkelling and diving spots from where coral reefs can be explored. In addition, the leeward side ensures calm and clear waters suitable for snorkelling.

Figure 2 Palm beach (left) and sand dunes (right) (Aruba Tourism Authority, 2017a.)

Another of the main attractions on the coast is the sand dunes (figure 2) which consists of lime sand and finely eroded coral debris. The sand dunes create a beautiful landscape based on subtle textures and gentle shades of greens and browns that compose Aruba's desert.

Selection of ecosystem services

The services provided by ecosystems and their respective biotic and abiotic constituents are essential for the wellbeing of communities and the global population. To assess the contribution of Aruba's ecosystems in economic terms a wide variety of tools and methodologies are available. To decide which are the most appropriate for this particular study, an analysis of data availability, context, time constraints and purpose was undertaken. A workshop was held with local stakeholders and the research team to deduce a subset of ecosystem services that could be relevant in the local context.

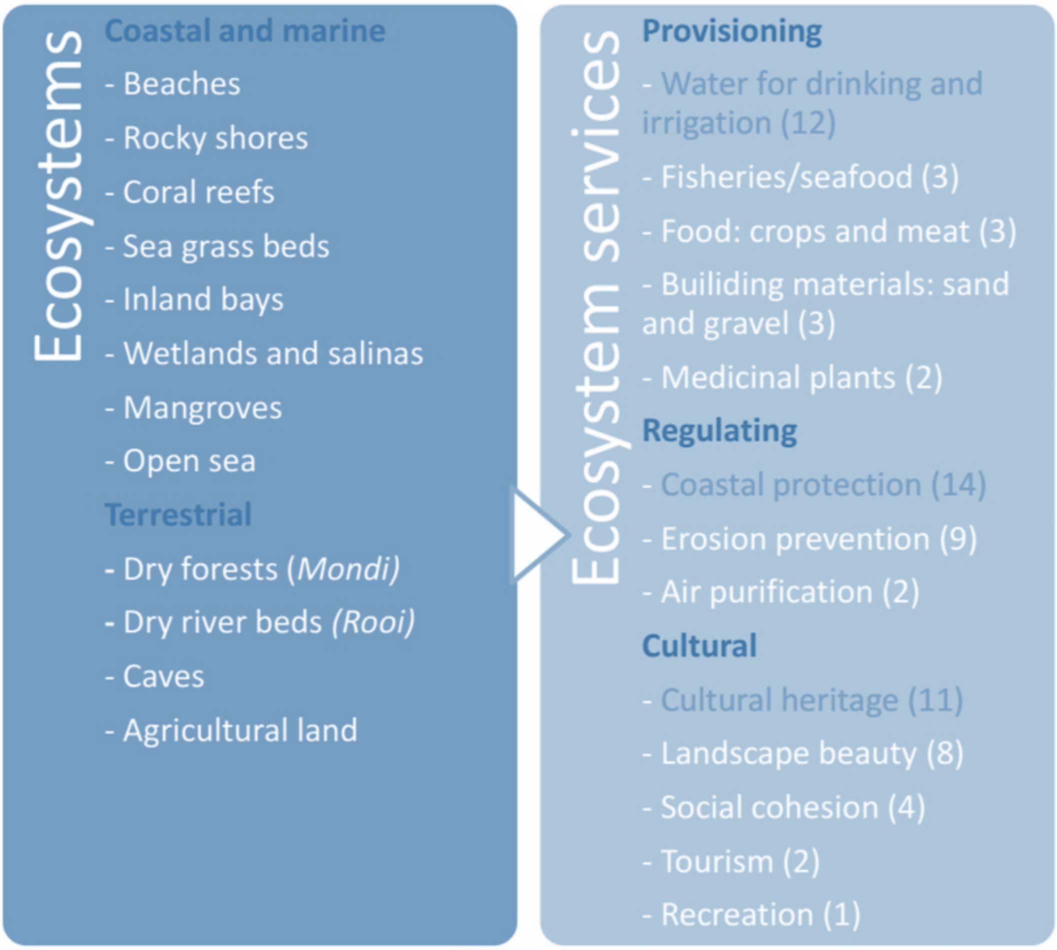


Figure 3 Outcome of the stakeholder meeting on 28/29 April, 2016, day 1, 32 participants.

The socio-economic value of the ecosystem services of Aruba had not yet been quantified. The main objective of this research is to carry out a TEV assessment of the environmental goods and services in Aruba. The economic valuation of ecosystems and biodiversity is defined as "the sum of the values of all service flows that natural capital generates both now and in the future". It is a representation of what society is willing to trade off to preserve these services that nature provides (Pascual et al, 2010). In addition to the mathematical valuation of these services, value maps, which are a geographical visualization of economic values, have also been provided for certain services.

On the 28th and 29th April 2016, a workshop was held on Aruba to primarily build on existing knowledge about natural capital and share experiences between different stakeholders from public, private and citizen's organisations. Stakeholder involvement has been key under the context of the TEEB Aruba project. In this 2-day workshop, which targeted high-level decision makers (public and private sector), one of the objectives of the workshop was "scoping on defining objectives and boundaries for the economic valuation study of ecosystem services". An exercise was carried out to prioritize the ecosystem services of Aruba (results of the votes by 32 participants seen in figure 3). The combination of the input from this workshop and the availability of secondary data for Aruba are the main factors that helped determine the scope of this project. Subsequently, seven specific ecosystem services were selected to be evaluated, four of which under a TEV assessment for the island.

Largely an awareness raising and engagement exercise, this workshop also acted as the interface between academia and industry. Ecosystem service concepts were incorporated into practical thinking for Aruba's specific context, essential for efficient scope building.

Although stakeholder input is invaluable when setting the scope of a project, it was found that there was a mismatch between stakeholder demand and availability of data. Subsequently, the list of ecosystem services to be assessed and mapped was filtered to the following list:

1) Economic Valuation:
    a. Cultural Ecosystem Services (CES) - Tourism
    b. CES - Local cultural values
    c. Fisheries
    d. Agriculture
    e. Carbon sequestration
    f. Medicinal plants
    g. Non-use values
2) Value maps:
    a. Tourism
    b. Local cultural values
    c. Carbon sequestration

The results of the research are split into three separate reports: 1) A general report which includes the evaluation of all the services, 2) A detailed report on the value of tourism in Aruba, and 3) A detailed report about local recreational and cultural values. The results concerning the natural capital valuation associated with agriculture, medicinal plants and non-use values will be provided in the relevant chapters. However, these were not taken into account for the overall natural capital value.

Outcomes of the report will provide a foundation for further development of a national sustainable development 'going green' policy for Aruba. Moreover, the results can serve as environmental baseline data for Aruba, next to social (e.g. health, social cohesion), financial, manufactured and human capital. This can be used to incorporate natural capital into progress towards the Sustainable Development Goals (SDGs), into spatial analysis and potential monitoring dashboards.

Research scope

The ecosystem services concept provides arguments for the preservation of natural capital based on utilitarian arguments regarding human well-being (Haines-Young et al. 2010). The ecosystems have the capacity or function of providing certain services to humanity that may be valued or seen as beneficial. For example, woodlands and wetlands in a catchment may have the capacity of slowing running surface water and this function can have the potential of reducing

the intensity of a flooding which may be considered a benefit to the people of the area (Haines-Young et al. 2010).

The value that is assigned to these services can vary depending on, among others, location, type of service, method of valuation and the nature of beneficiaries. In addition, to define key ecosystem service, there is a need for a deeper understanding of the location itself, the societal choices and values, etc. Estimating the value of ecosystem services needs to be built on scientific information but also on local knowledge, in order to understand and assess the impacts of biodiversity loss or changes in the ecosystem conditions on the provision of services on the islands.

The focus of this study is the integration of natural capital into economic thinking on Aruba. Carrying out ecosystem service assessments is beneficial for decision making and the results provide insights into the influence of externalities; those aspects that had not before been measured. The monetisation of the contribution of these services allows integration into the current economic accounting system. It does not aim to put a financial value on nature, the purpose is not to buy or sell but to assess the impact on human well-being in economic terms.

Research objectives

Research questions for each underlying topic are listed below:

Cultural ecosystem services:

a. *What is the perception of cultural ecosystem service (CES) value of Aruba's marine and terrestrial ecosystems to its local community?*
b. *What is the willingness-to-pay towards management of Aruba's marine and terrestrial ecosystems to its local community?*
c. *Where are the hotspots of cultural ecosystem services (CES) (aesthetic, recreational and cultural heritage) provision situated for Aruba's local community?*

Tourism ecosystem services:

d. *What are the most important natural features of Aruba to cruise and stay-over tourists and where are they located?*

e. *What is the willingness-to-pay of tourists on Aruba for enhanced nature protection?*

f. *What is the added value of tourism?*

What is the TEV economic value of tourism as an ecosystem service?

Fisheries ecosystem services:

g. *What is the estimated gross value created by Aruba's marine ecosystems through fishing?*

h. *What proportions of value are associated with industrial, artisanal and recreational fishing?*

Agricultural ecosystem services:

i. *What is the estimated proportion of Aruba's output that is attributable to agriculture?*

j. *Considering farming and livestock production, what is the estimated yearly value of this service?*

Medicinal plants ecosystem services:

k. *What proportion of Aruba's citizens engage in use of medicinal plants?*

l. *What is the estimated value of subsequent reduced medical bills?*

Non-use ecosystem services:

m. *How can we estimate the non-use value of Aruba's marine and terrestrial ecosystems?*

Carbon sequestration ecosystem services:

n. *What are the vegetation types on Aruba and their respective carbon storage and capture rates?*

o. *What is the spatial distribution of Aruba's carbon sequestration capability?*

Project organization

Wolfs Company, the Institute for Environmental Studies (IVM) and YABI Consultancy were selected by the Government of Aruba to conduct this research in association with the Department of Nature and the Environment. The work, to carry out economic valuations of Aruba's ecosystem services following the TEEB approach, has been commissioned by SETAR N.V. SETAR is a telecommunications company based on the island and has commissioned research into the status and functioning of the ecosystem services of Aruba. This constitutes part of its corporate social responsibility program.

The project commenced in 2016 with Pieter van Beukering, Associate Professor of Environmental Economics at the Institute for Environmental Studies (IVM), Vrije Universiteit (VU) Amsterdam, students of the Environment and Resource Management master program, VU, Amsterdam, students of the University of Aruba, YABI Consultancy and Wolfs Company.

Report outline

This report is structured as follows. The next chapter has a general description of the basic concepts for the valuation of ecosystem services and the type of values. This is followed by a description of Aruba's key ecosystems, both marine and terrestrial, and the pressures affecting them. Chapters 3 to 8 have the descriptions of the economic valuations and value maps for the correspondent services that are valued under this project. For tourism and local cultural values, only a summary of findings is provided here as two separate and more detailed reports have been compiled for each topic. Finally, chapter 9 will give some general recommendations and governance implications of this TEEB study for Aruba.

References

Bateman, I. J., Harwood, A. R., Mace, G. M., Watson, R. T., Abson, D. J., Andrews, B., Binner A., Crowe A., Day B. H., Dugdale S., Fezzi C., Foden J., Hadley D., Haines-Young R., Hulme M., Kontoleon A., Lovett A. A., Munday P., Pascual U., Paterson J., Perino G., Sen A., Siriwardena G., Vaan Soest S., Termansen M. (2013). Bringing ecosystem services into economic decision-making: land use in the United Kingdom. Science, 341(6141), 45-50.

Costanza, R., d'Arge, R., De Groot, R., Farber, S., Grasso, M., Hannon, B., ... & Raskin, R. G. (1997). The value of the world's ecosystem services and natural capital. nature, 387(6630), 253-260.

CBS (2015). Housing. In Statistical Yearbook 2015 (p 100).

Haines-Young, R., & Potschin, M. (2010). The links between biodiversity, ecosystem services and human well-being. Ecosystem Ecology: a new synthesis, 110-139.

Hoetink, H. (2016, April 29). Aruba. Retrieved June 07, 2016, from Encyclopedia Britannica: http://www.britannica.com/place/Aruba

CBS. (2016). Personal contact during fieldwork period (Master Thesis Rosa Pols).

Departamento Meteorological Aruba. (2016). Climatological summary 2015.

Departamento Meteorologico Aruba. (n.d.). Climate Data Aruba. Retrieved June 07, 2016, from Meteo: http://www.meteo.aw/climate.php

Pascual, U., Muradian, R., Brander, L., Gómez-Baggethun, E., Martín-López, B., & Verma, M. (2010). The Economics of Ecosystems and Biodiversity: The Ecological and Economic Foundations. TEEB Documents.

The Green Gateway Policy 2011-2013 (2010). The Government of Aruba Ministry of Economic Affairs, Social Affairs and Culture.

Turner, Rochelle (2015). Travel and Tourism Economic Impact 2015 Aruba. Retrieve March 19, 2017, from: http://www.caribbeanhotelandtourism.com/wpcontent/uploads/data_center/destinations/Aruba-WTTC-EconomicImpact2015.pdf

US Department of State. (2016, October 31). U.S. Relations With Aruba. Retrieved August 01, 2017, from https://www.state.gov/r/pa/ei/bgn/22491.htm

Waite, R., Kushner, B., Jungwiwattanaporn, M., Gray, E., and Burke, L. (2015). Use of coastal economic valuation in decision making in the Caribbean: Enabling conditions and lessons learned. Ecosystem Services, 11 (201502), 45-55. doi:10.1016/j.ecoser.2014.07.010

Wolfs Company, a. Green Aruba Retrieve March 19, 2017, from: http://www.greenaruba.org/ga7/assets/presentations/day1/esther_wolfs.pdf

Van Zanten, B. T., Verburg, P. H., Scholte, S., and Tieskens, K. (2016). Using choice modelling to map aesthetic values at a landscape scale: Lessons from a Dutch case study. Ecological Economics, 130 (October 2016): 221-231. doi:10.1016/j.ecolecon.2016.07.008

World Travel & Tourism Council. Economic Impact, Aruba. 2017. https://www.wttc.org/-/media/files/reports/economic-impact-research/countries-2017/aruba2017.pdf

2. Theoretical Background and valuation methods

The ecosystem services concept gained broader attention in 2005 when the UN published the Millennium Ecosystem Assessment (MEA). The MEA was a four-year, 1300 scientist, study for policymakers. The objective of the MEA was a global-assessment of the current state of ecosystems and the consequences of ecosystem changes for human well-being. Between 2007 and 2010, a second international initiative was undertaken by the UN Environment Programme, called The Economics of Ecosystems and Biodiversity (TEEB). The TEEB report brought ecosystem services to a broader audience (MEA, 2005; Potschin and Haines-Young, 2011; Daniel et al., 2012; Potschin et al., 2016).

The main theoretical foundation of this research lies in the ecosystem services framework which aims to clarify the multiple interdependencies between human well-being, ecosystems, and biodiversity (Daily, 1997). Figure 4 illustrates how these services arise from biophysical structures or functions, which directly or indirectly contribute towards meeting a human need or want (De Groot et al., 2010; Daniel et al., 2012).

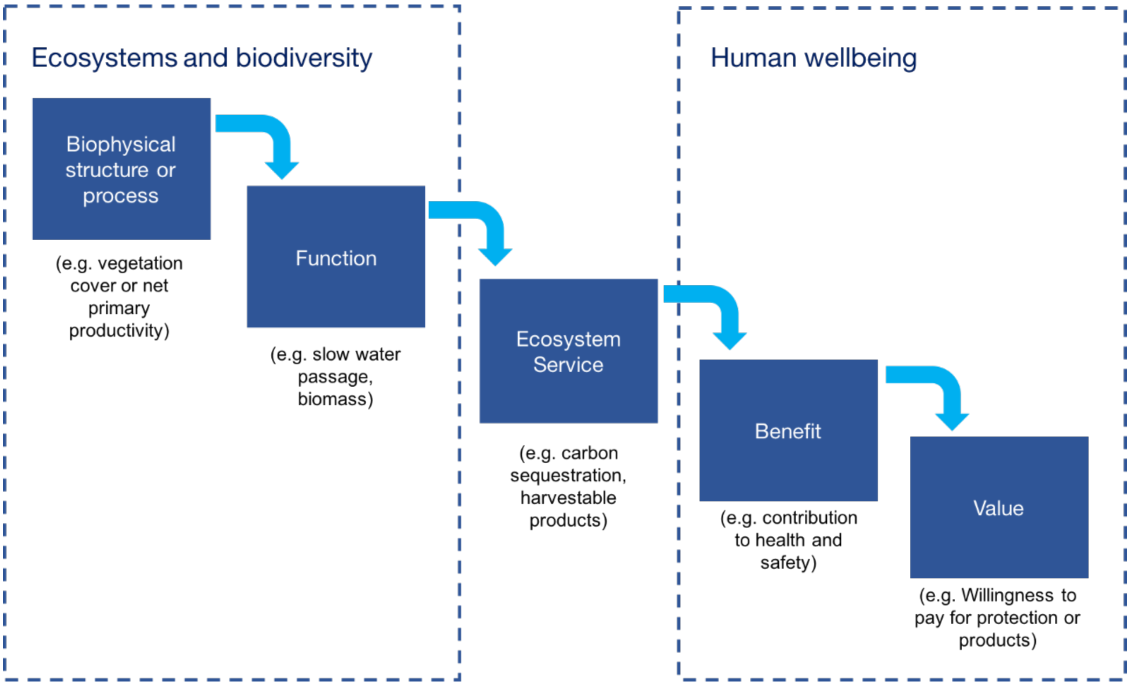


Figure 4 The ecosystem service cascade that depicts the pathway from ecosystem structure and processes to human well-being. Adapted from de Groot et al. (2010) and Haines-Young and Potschin (2011)

The classification of the ecosystem services that will be used in this research is the classification from TEEB as defined in the 2008 interim report derived from the MEA (MEA, 2005). The ecosystem services are classified into four groups: provisioning, regulating, cultural and supporting (Figure 5):

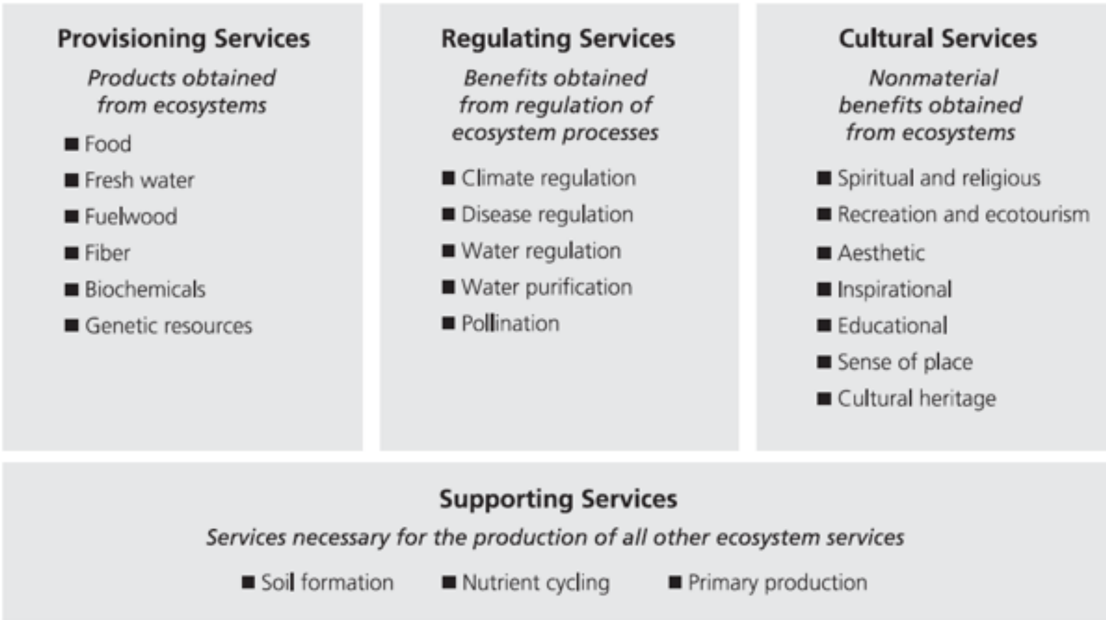


Figure 5 Ecosystem services divided in 4 categories (MEA, 2005).

The importance of these services and the ecosystems providing them can be expressed through three value-domains: ecological, socio-cultural and economic (MEA, 2005; De Groot et al., 2010). The ecological value of ecosystem services is associated with their contribution to the health state of a system, measured with ecological indicators such as diversity and resilience (De Groot et al., 2010; Scholte et al., 2015). On the other hand, economic and socio-cultural values indicate the relative importance people give to a certain ecosystem service, with the main distinction being the use of monetary terms to express economic values (Oteros-Rozas et al., 2014).

The ecosystem services framework is a formal approach to describe and categorize the relationship between ecosystems and society with an emphasis on how ecosystems contribute to human wellbeing. More precisely, which particular benefits can society get from each type of service (MEA, 2005; Daniel et al., 2012).

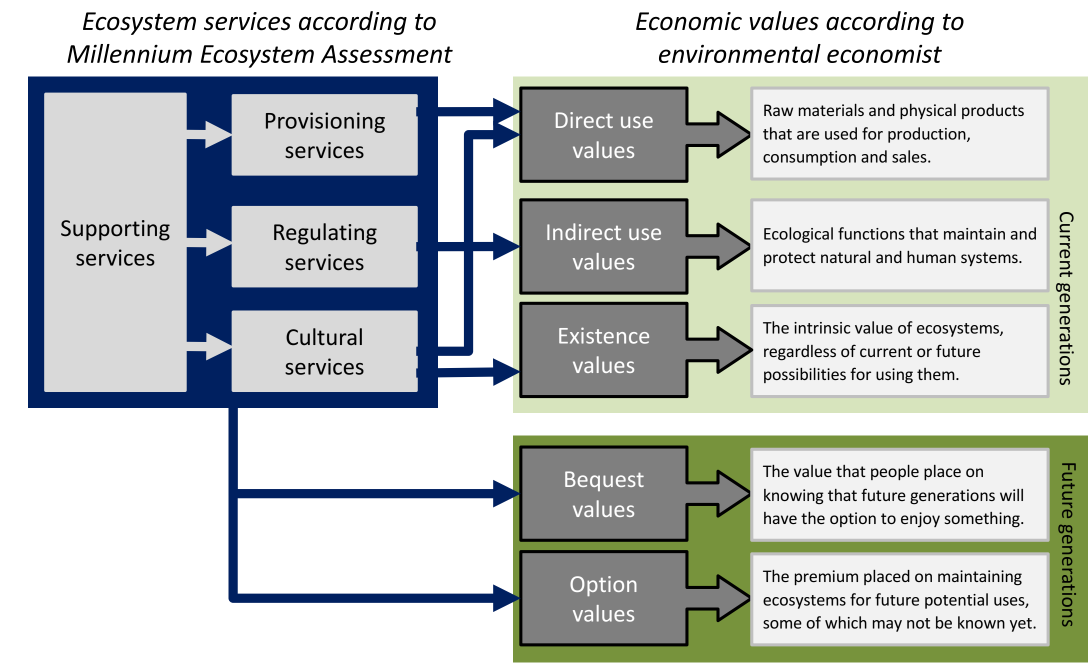


Figure 6 The relationship between MEA and criteria of TEV assessments.

Figure 6 outlines the relationship between the two theoretical frameworks of the MEA description of ecosystem services and the associated values, which environmental economists attribute to nature.

Ecosystem service valuation

The theoretical background of this research lies in environmental economics. The concept of environmental economics revolves around the identification of externalities and their incorporation into analyses. Market failure can arise due to the presence of externalities, institutional failures, imperfect information and public goods[6]. Many ecosystem services are (quasi) public goods, and thereby, do not have a market price and use-levels are difficult to regulate (Mitchell Carson, 1989; TEEB, 2010). A public good is both non-rivalry and non-excludable to other consumers, meaning that there are no specific property rights assigned to it which can lead to unsustainable consumption or usage of the good.

---

[6] For more information on market failures and environmental policy see Baumol and Oates 1988.

As an example, in the case of this specific study, the recreational and cultural services provided by nature on Aruba are public and quasi-public goods. The residents of Aruba have to pay a fee to enter the Arikok National Park, meaning it is excludable (if one cannot pay the price) but non-rival (one person's consumption does not interfere with another person's consumption), making it a quasi public good, also called a club good.

Environmental economists use welfare economics to identify these market failures and recommend policies to correct these in order for economies to perform efficiently and in the best interests of society and its wellbeing (Perman et al., 2003). To find this efficiency, the "values" of the non-marketed goods and services must be derived to calculate true costs and benefits and make this visible to stakeholders and decision makers.

The economic value of an ecosystem service can be classified as use or non-use. Use values are divided into direct use and indirect use values, see figure 7. The first category corresponds to values derived from the direct harvesting or extraction of ecosystem products, such as food or water. Indirect use values, on the other hand, correspond to benefits obtained from the regulating capacity of ecosystems without corresponding to extraction of ecosystem products (Waite et al. 2014; van Beukering et al., 2007).

Non-use values include the existence value (i.e. the value humans place on the knowledge that a resource or species exists), bequest value (i.e. the value of guaranteeing the existence of a resource or ecosystem for the future generation), and option value of ecosystems (i.e. the value humans place on having the option to use or visit the resource or ecosystem in the future). Figure 7 presents the Total Economic Value (TEV) framework and the different use and non-use values that can be assigned to ecosystem services.

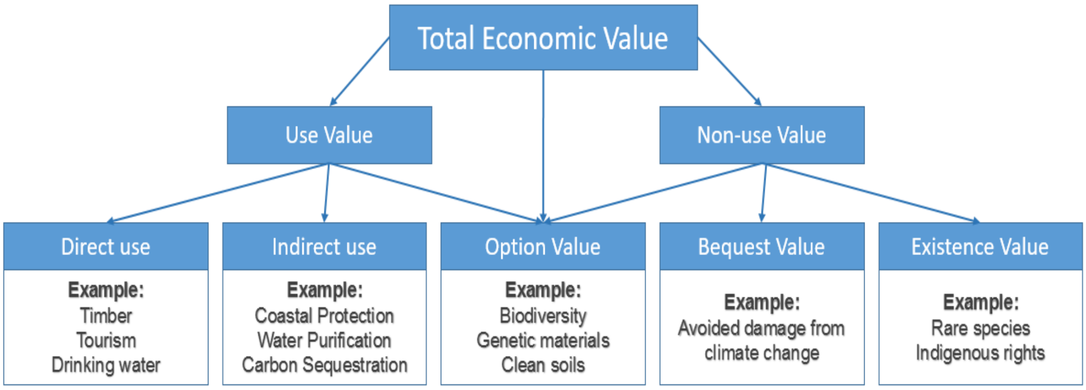


Figure 7 The Total Economic Value (TEV) framework for the valuation of ecosystems services. Adapted from Waite et al. (2014).

Bringing an adaptation of this example to the TEEB Aruba project context, the 7 values that will be assessed under this project could also be classified under this framework. Carbon sequestration, for example, is regulating service (figure 5 and 6) and considered an indirect use value (figure 7). Regarding the direct use values, they can be both consumptive and non-consumptive. In this case, agriculture would be a consumptive use as it implies the extraction of food crops for consumption. On the other hand, tourism would be a non-consumptive or non-extractive use, as it implies the enjoyment of recreational and cultural activities that do not require harvesting of products but still involve the direct presence of the people appreciating it.

As for the non-use values, they all refer to cultural and recreational values (option values). As observed in figure 7, there are certain direct use values which have a non-use component. For this project, that is the case of fisheries, medicinal plants and local cultural ecosystem services. For example, Arubans may be willing to pay for preserving biodiversity or genetic material to ensure the option of having related services in the future, such as the use of medicinal plants which have a cultural significance, or the opportunity to engage in recreational fishing. Moreover, many Arubans who do not snorkel or dive would still associate value with the existence of coral reefs and their diversity within Aruban waters due to heritage-values (cultural identification).

Environmental economics exhibits different techniques for the valuation of ecosystem services. To estimate the value of changes in the provision of

environmental goods and services, environmental economists have developed a number of valuation methods:

- Direct market price methods where markets for environmental goods and services exist.
    - Replacement costs, damage cost avoided, mitigating expenditure, net factor income, production function method.

- Revealed preference methods, based on actual consumer or producer behaviour.
    - Hedonic pricing method and travel cost method.

- A stated preference method elicits information concerning environmental preferences from individuals through the use of surveys, questionnaires, and interviews.
    - Contingent valuation and choice modelling.

- Value transfer estimation of value of environmental good or service based on the results of valuation studies of environmental services at other locations.

Table 2 shows a summary of the valuation techniques used in this report for each value assessed. Each chapter outlines the specific methodology used in the analysis. There is a lack of sufficient data to calculate natural capital valuations for agriculture, medicinal plants and non-use using accepted methodologies. For this reason, the values have been calculated using adapted methods but have not been taken into account in the TEV. Respective values can be found in each chapter.

Table 2 Ecosystem services addressed and valuation techniques used.

Type of ecosystem service	Ecosystem service	Value	Valuation technique
Provisioning	Fisheries	Direct use value	Market based: landed value
	Agriculture	Direct use value	Market based
	Medicinal plants	Direct use value	Market based
Regulating	Carbon Sequestration	Indirect use value	Market based: market price
Cultural	Tourism	Direct use value	Market based: net ecosystem benefits Non-market based: contingent valuation and choice modelling
	Local cultural values	Existence and direct use value	Non-market based: contingent valuation and choice experiments
	Non-use values	Non-use value	Value transfer

It is important to note that the environmental economics approach takes an anthropocentric view on the value of ecosystems. From this perspective, nature will only have value if it provides a service to humans. This is in contrast to the belief that ecosystems and biodiversity have an intrinsic value in itself which justifies their conservation. Economic value provides insight into only one aspect of the overall value of nature (Balmford et al., 2011) and in order to integrate dimensions that cannot be expressed in monetary terms (e.g. intrinsic value, freedom of choice, human rights) other analyses in addition to economic valuation are needed (e.g. livelihoods assessment, vulnerability assessment, capabilities to make choice assessments) (TEEB, 2010).

Ecosystems of Aruba

The aim of this chapter is to synthesize existing ecological and environmental information about Aruba's ecosystems to support the analysis presented in subsequent sections of the report. This chapter consequently provides a synthesis of the current knowledge about the state of the ecosystems of Aruba and the main pressures on the environment. Given the scattered nature of the available data, this ecological ecosystem assessment is mainly qualitative. The assessment is only supported with quantitative information when robust and sufficiently complete data were available.

Aruba's beautiful environment has given rise to its notoriety as a popular tourist destination. It has a varied landscape, with mangrove forests, woodlands, rocky areas, coral reefs and dunes that provide the habitat for the island's flora and fauna.

In total, Aruba claims 236 registered species of bird with two endemic subspecies. Four Important Bird Areas (IBAs) have been designated on the island. Nonetheless, despite the efforts of local conservation associations such as the Aruba Birdlife Conservation, those areas still lack legal protection status.

Van der Perk (2002) distinguishes between ten natural and semi-natural ecosystems present in the terrestrial and marine environment of. Aesthetic and recreational value have been recognized as important functions of six of the island's ecosystems (see Figure 8).

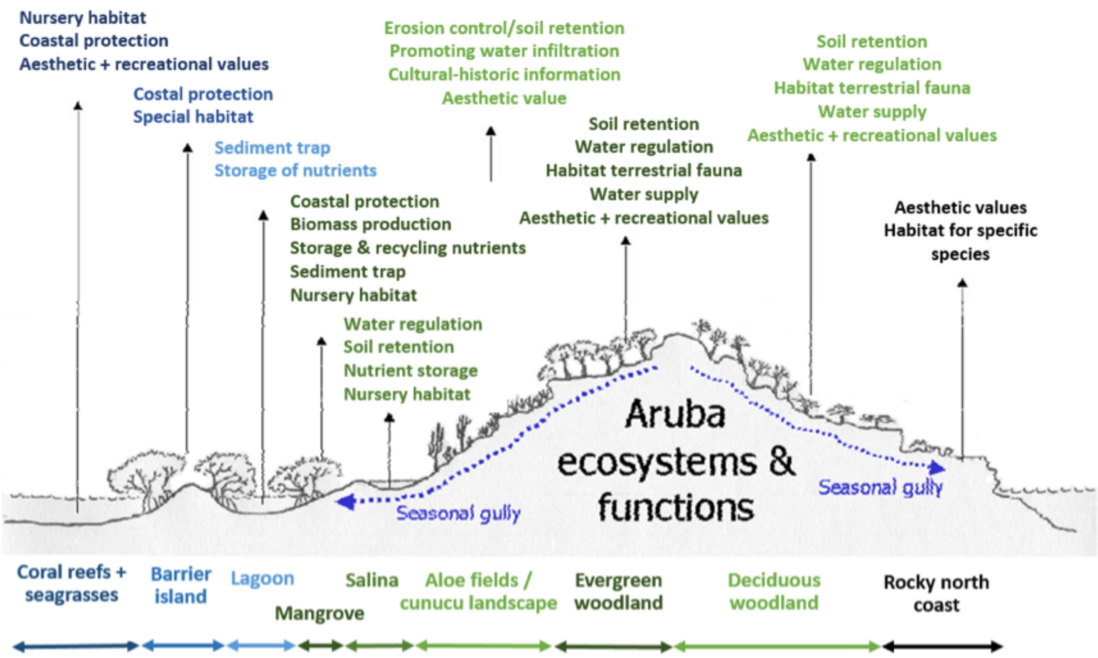


Figure 8 Schematic cross-section of Aruba's main ecosystems and its functions (Adapted from Van der Perk, 2002)

In his analysis of the conflicts between human activities and ecosystem functions in Aruba, Van der Perk (2002) concluded that fragmentation of natural habitats, due to expanding infrastructure and housing in former semi-natural and rural areas, is one of the main causes of ecological degradation. Furthermore, this trend of urban expansion is in conflict with the provision of several ecosystem services provided on the island, including aesthetic and recreational functions of the natural environment. The stakeholder workshop held on Aruba in 2016 brought several ecosystem types into the discussion, similar to those identified by van der Perk (2002), as seen in figure 8. The relevant marine and terrestrial ecosystems are outlined in further detail below and key areas of interest found in figure 9.

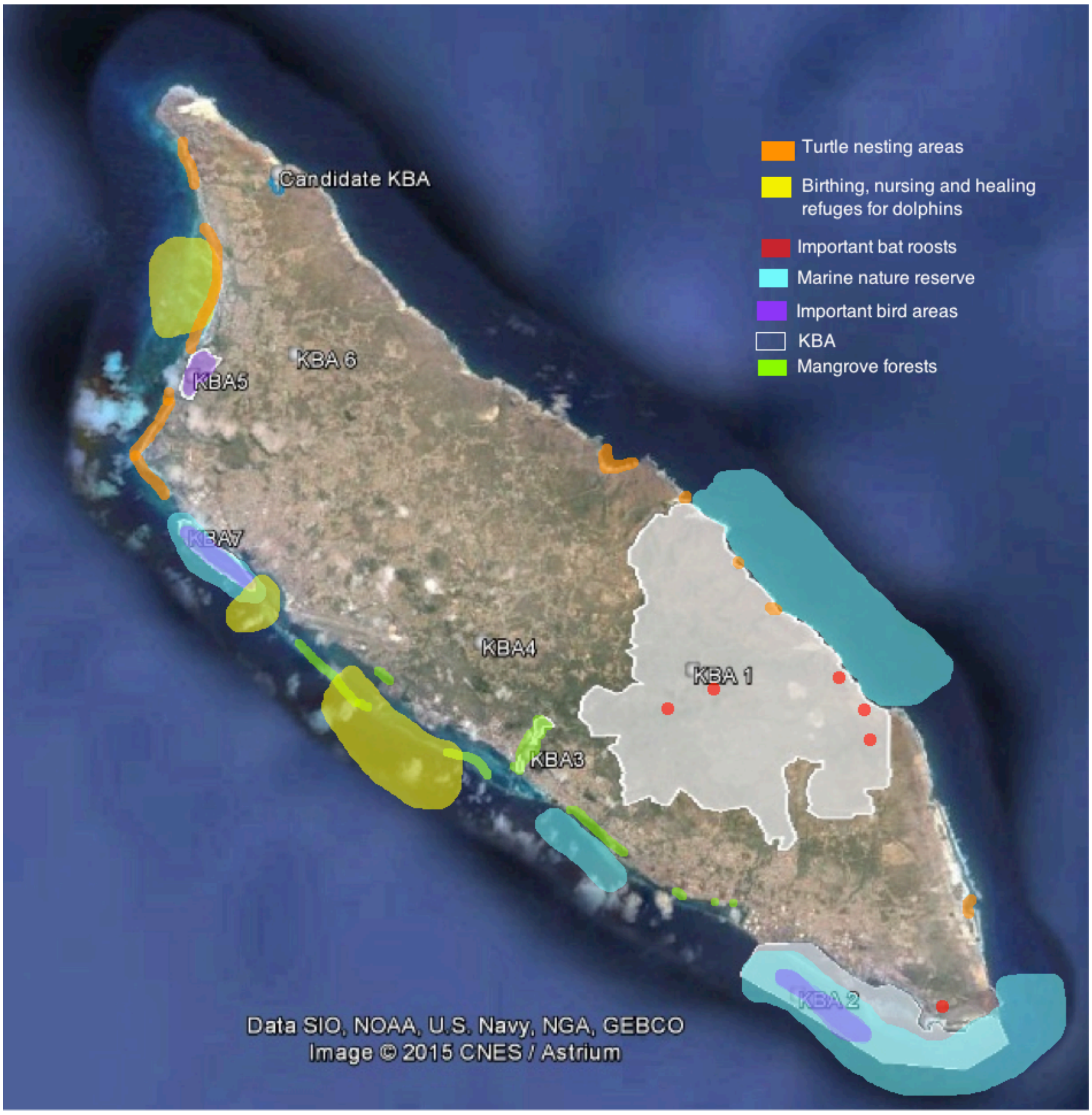


Figure 9 Key area of natural interest on Aruba.

MARINE

Beaches and corals

Aruba is a popular tourist destination, largely owing to its many beaches. They are found along the south-western coast of the island. All beaches are publicly accessible and free, but some beaches, such as Palm beach and Druif beach, receive a particularly high frequency of visitors. Aruba also offers good snorkelling and diving spots owing to its coral reefs, although these are less numerous than the other Dutch Caribbean islands.

Coral reefs are important when considering natural capital for several reasons. Often, they provide invaluable flood and storm protection from waves by acting as a break. Reefs also provide habitat for marine vertebrates, invertebrates, algae and grasses resulting in high levels of biomass important for fishing and attracting snorkelers and divers. Other services provided by coral ecosystems include isolated compounds used for medical research and water purification.

TERRESTRIAL

Arikok National Park

Arikok National Park, which covers about 18% of the island, represents the largest remaining natural area on Aruba and protects some rugged hilly landscapes and cliff coasts with interesting fauna and flora including a variety of drought-resistant cacti, shrubs, and trees. The initial plans for a national park were developed around the 1960's, but Arikok National Park was officially established in 2000 (Oosterhuis, 2016). Generally, Aruba (including the Arikok) is covered in dry thorny wood- and shrub land with many cacti. Along the coast is the landscape subjected by the action of the sea. The trade winds are dominant and blow from the east to the northeast, so the north and east sides of the island are constantly hit by waves. The coastline on these parts of the island is made up of cliffs with some sandy inlets, where 'rooien' (riverbeds) end in the sea (Oosterhuis, 2016).

Rocky shores and Hooiberg

The white beaches and coastlines of Aruba are very popular tourist destinations but the island also has an aesthetically pleasing mainland. The island consists largely of igneous rocks overlain by limestone deposits and has some isolated steep-sided hills that characterize the landscape. Hooiberg, a volcanic formation which reaches 165 metres, is a popular tourist destination (see figure 10a). In some places, immense monolithic boulders of stacked diorite are present, for example the Casibari Rock formation (see figure 10b).

Figure 10 Left, (a) Hooiberg, seen from northern side and right, (b) Casibari Rock formation

Sand dunes

Sand dunes are found extensively along Aruba's coastline and consist of lime sand and finely eroded coral debris (see figure 11a). Coastal sand dunes provide a range of ecosystem services including air, climate, water and natural hazard regulation. For example, dunes can buffer storms providing coastal defence.

Figure 11Left, (a) California Dunes, and right, b) a saliña (after a rain shower).

Salinas, seagrass beds and inland bays

Temporarily and permanently flooded salt marshes, called saliñas, can be found on the leeward side of the island, close to the coast. A saliña is a salty mud plain where runoff flows to after a rain event (see Figure 11b). These are important habitats for birds such as flamingos and herons, which feed on small aquatic animals and plants. Saliñas are threatened in their existence, because they are situated in popular hotel areas. Many of the mud plains have already disappeared due to tourism-based development. As the plains regulate sedimentation in the water, they protect corals against damage. Degradation of this ecosystem would cause increased pressure on corals.

Coral reefs, seagrass beds and mangroves are often found in inland bays. In addition, seagrass beds are important habitat providers for reef fish and invertebrates.

Mangroves and the Spanish Lagoon

Another important area on the island is the Spanish Lagoon providing feeding and breeding areas for water birds and nursery areas for variety of fish species. The Spanish Lagoon, Aruba's only Ramsar designated site, is situated on the southwestern part of the coastline and covers approximately 70 hectares. Comprised of tidal mudflats and well-developed mangroves, it also has a narrow coastal inlet about 2 kilometres long and 200-500 metres wide. Not being a part of the Arikok national park, there is no official environmental management of this area. Although there is a regeneration project underway, the recent construction of a bridge resulted in the loss of mangrove forest.

Mangrove forests are situated along the Spanish Lagoon, along the south west coast and on the rifnan (small reef islands). Compared with the dry, greyish vegetation on Aruba, the mangrove forest stands out by their bright colour and lush leaf deck green (see Figure 2.5b). Recognizable by their tangled root structures, mangroves grow in low-oxygen soil in tropical and subtropical regions. They provide erosion protection from waves and currents and also extensive habitats to fish and other organisms.


Figure 12 Left, (a) The Spanish Lagoon, and right (b), mangroves.

Threats to the ecosystems

The workshop held on Aruba in 2016 provided insight into current perceived threats to the health of its ecosystems, results from the workshop can be seen in figure 13.

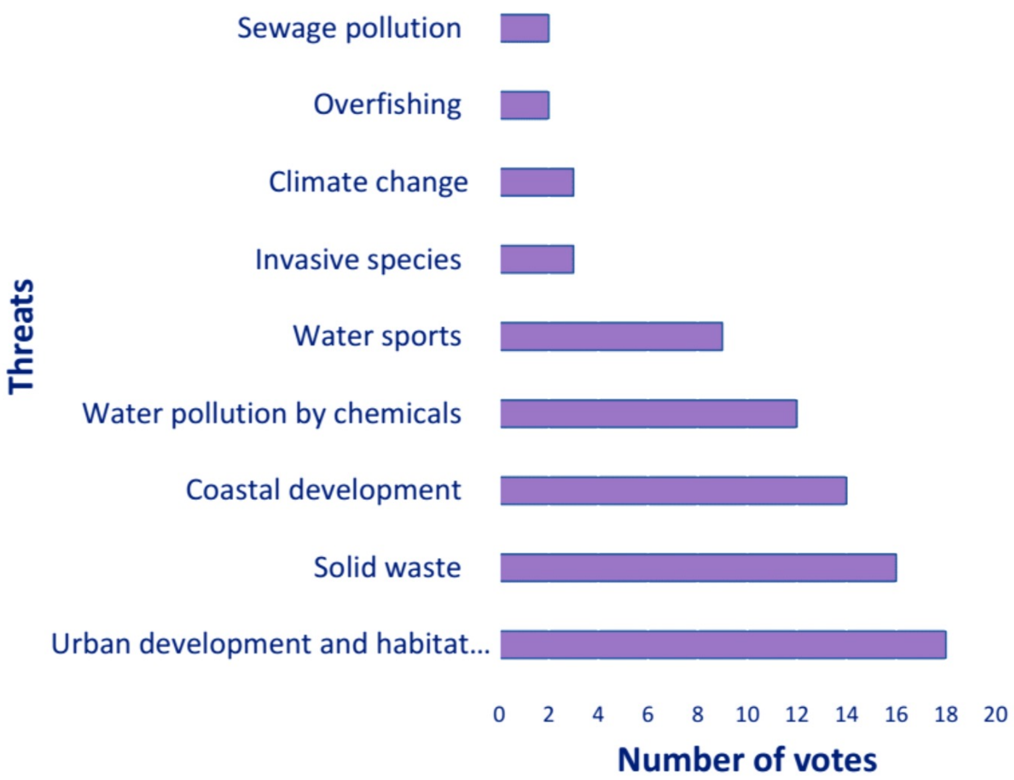


Figure 13 Results of workshop indicating threats to ecosystems by stakeholder voting, 32 participants.

As seen in the graph, population on the island, local and touristic, puts the terrestrial ecosystem under stress through development. Coastal development and increased nutrient discharge also contributes to the further degradation of the marine environment.

The declining quality of the coral reefs on Aruba follows a global trend. About 27% of the world's coral reefs in 2000 were in such a degraded state that recovery was highly unlikely. Expectations are that this number is going to increase even further (Parsons & Thur, 2007). A meta-analysis conducted by Gardner et al. (2003) revealed that from the 1970s until 2003, 263 study sites showed a high decrease of coral cover from ~50% to ~10%. In terms of biodiversity it is well known that islands have a natural vulnerability to extinctions which are accelerated mainly by habitat loss and invasive species (Traveset and Richardson 2006). Modest transformation represents a threat on islands because scarce resources reach

critical levels easily. The main driver behind the debasement of coral ecosystems are of anthropogenic origin. Unsustainable fisheries, pollution, sediment runoff, physical destruction and climate change all exacerbate the degrading state of corals. Notwithstanding the severity of such human induced stressors, natural events such as storms, hurricanes or coral diseases are also of great importance in the global decline of corals (NOAA, 2011). Below follows a detailed summary of the most important environmental threats on the island.

Overfishing

Fishing techniques, like the use of explosives and overfishing of specific species, contribute to a decline of fish populations, diversity and coral reef all over the world (NOAA, 2008). Little information is available about what the effects of over fishing might have on species diversity around Aruba. Nowadays, fishing practices focus on smaller predators and herbivores such as groupers and parrotfish respectively (Burkepile & Hay, 2008). Due to the general lack of herbivorous fish, algae have the possibility to grow unhindered hereby contributing even further to the stress corals experience. This makes corals even more vulnerable to diseases and death (Debrot & Bugter, 2010). High levels of fishing can reduce genetic variation (due to specific species being overfished), alter ecological balance on the reef and change trophic interactions (McClary, 2010). Illegal fishing in Aruba's waters is also a concern as without monitoring and regulation, control and protection is not possible.

Development and habitat destruction

Dredging, associated with construction of different types of buildings and development of infrastructure can lead to sedimentation. As an impact, the sediments released in water can affect the ecosystem by killing the corals and other organisms providing essential habitat. Sediments also reduce the photosynthetic activity and light availability. An increased level of tourists usually triggers coastal and marine development which causes high levels of sediments being released into the water. Furthermore, deforestation and overall decline in terrestrial ecosystems attenuates the capacity of tree and plant roots to prevent sediment run off. Van der Perk (2002) also showed that mining for building materials on Aruba leads to habitat destruction and fragmentation.

Nutrients

Coral reef systems are characterized by oligotrophic conditions. It is in these conditions that corals have a competitive advantage. However, superfluous amounts of Nitrogen (N) and phosphorous (P) from agricultural surface run-off,

result in eutrophic coastal waters. Such conditions are favourable for algae and allow them to out-compete coral for space (Wieggers, 2007). A study done by Dailer et al. (2012) for Hawaii analysed the effect of N and P on diverse species of algae, using different concentrations of nutrients. The outcome of this study revealed that the growth rate of algae increases with the percentage of wastewater affluent added. This is a threat that could be increased if relevant caution is not exercised during economic development. Also, landfill sites can have negative impacts on the environment, specifically regarding toxic and hazardous leachate. There is a large landfill present on Aruba near a mangrove ecosystem.

Invasive species

Invasive species damage the functioning of ecosystems by disrupting trophic levels. The lionfish (*Pterois volitans* and *Pterois miles*) is a non-endemic fish species that has been one of the main causes of a decline in fish populations. As predators, their numbers have grown and they disrupt the functioning of coral reef ecosystems resulting in a decrease of fish biodiversity. Many programmes have been developed to raise awareness and ask tourists to report their presence (Mumby & Steneck, 2011). In the Bahamas for example, lionfish reduced the number of coral reef fish by 80% (Vermeij, 2012). In addition, the burrowing owl (*Athene cunicularia arubensis*) and brown-throated parakeet (*Aratinga pertinax arubensis*) are examples of terrestrial endemic species to Aruba that are threatened by invasive species such as the boa constrictor.

Climate change

Sea level rise, increased water temperature, a higher frequency of hurricanes and an increase in ocean acidity are part of the IPCC scenarios for climate which represent serious threats for coral reefs. Global warming can make coral reefs more vulnerable to diseases, affect their resilience capacity and can also kill the corals (Debrot & Bugter, 2010). During the 20th century, the average temperature of the world oceans increased by 0.74˚C (Hoegh-Guldberg et al., 2007). It is considered that coral reefs are already at their thermal limits and a further increase will lead to their bleaching, disease and mortality (Hoegh-Guldberg et al., 2007).

This study uses several common frameworks and methodologies for the economic valuation of the ecosystems of Aruba. The following chapter outlines the methodologies of assessment and valuation. Thereafter, each service is explained and valued.

References

Balmford, A., Fisher, B., Green, R., Naidoo, R., Strassburg, B., Turner, R.K., and Rodrigues, A.S.L., (2011). Bringing Ecosystem Services into the RealWorld: An Operational Framework for Assessing the Economic Consequences of Losing Wild Nature. Journal of Environmental Resource Economics, 48, 161-175.

Baumol, W. J. and Oates, W. E. (1988). The Theory of Environmental Policy. Cambridge University Press, Cambrige.

Burkepile, D.E. & Hay, M.E. (2008). Coral reefs. Encyclopedia of Ecology, 1, 784-796.

Dailer, M.L., Smith, J.E. & Smith, C.M. (2012). Responses of bloom forming and nonbloom forming macroalgae to nutrient enrichment in Hawai'i, USA. Harmful Algae, 17, 111-125.

Daily, G. (1997). Nature's services: societal dependence on natural ecosystems. Island Press.

Daniel, T. C., Muhar, A., Arnberger, A., Aznar, O., Boyd, J. W., Chan, K. M., ... & Grêt-Regamey, A. (2012). Contributions of cultural services to the ecosystem services agenda. Proceedings of the National Academy of Sciences, 109(23), 8812-8819.

Debrot, A.O. & Bugter, R. (2010). Climate change effects on the biodiversity of the BES islands. Altera Report 2081, Wageningen. 40 pp.

Gardner, T.A, Côté, I.M., Gill, J.A, Grant, A. & Watkinson, A.R. (2003). Long-term regionwide declines in Caribbean corals. Science (New York, N.Y.), 301(5635), 958-60.

de Groot, R. S., Alkemade, R., Braat, L., Hein, L., & Willemen, L. (2010). Challenges in integrating the concept of ecosystem services and values in landscape planning, management and decision making. Ecological Complexity, 7(3), 260-272.

Hoegh-Guldberg, O., Mumby, P.J., Hooten, A.J., Steneck, R. S., Greenfield, P., Gomez, E., Harvell, C.D. et al. (2007). Coral reefs under rapid climate change and ocean acidification. Science (New York, N.Y.), 318(5857), 1737-42.

McClary, M. (2010). The Encyclopaedia of Earth - Threats to coral reefs. Retrieved June 10, 2012 from http://www.eoearth.org/article/Threats_to_coral_reefs?topic=49513#gen9

Millennium Ecosystem Assessment (MEA) (2005). Ecosystems and Human Well-being. A Framework for Assessment. Millennium Ecosystem Assessment. Washington, DC, Island Press.

Mitchell, R.C. and Carson, R.T. (1989). Using surveys to value Public Goods: the Contingent Valuation Method. Washington, DC: Resources for the future.

Mumby, P.J. & Steneck, R.S. (2011). The resilience of coral reefs and its implications for reef management. In Dubinsky, Z. & Stambler, N. (Eds.), Coral reefs: an ecosystem in transition (509-519).

NOAA (National Oceanic and Atmospheric Administration). (2008). Anthropogenic Threats to Corals. Retrieved May 18, 2012 from http://oceanservice.noaa.gov/education/kits/corals/coral09_humanthreats.html

NOAA (National Oceanic and Atmospheric Administration). (2011). NOAA's National Ocean Service: Coral Reefs. Retrieved May 15, 2012, from http://oceanservice.noaa.gov/oceans/corals/

Oosterhuis, H. J. (2016). Landscape-ecological survey of Arikok National Park, Aruba. MSc minor thesis. Soil Physics and Land Management Group. Wageningen University.

Oteros-Rozas, E., Martín-López, B., González, J. A., Plieninger, T., López, C. A., & Montes, C. (2014). Socio-cultural valuation of ecosystem services in a transhumance social-ecological network. Regional environmental change, 14 (4), 1269-1289.

Parsons, G.R. & Thur, S.M. (2007). Valuing Changes in the Quality of Coral Reef Ecosystems: A Stated Preference Study of SCUBA Diving in the Bonaire National Marine Park. Environmental and Resource Economics, 40(4), 593-608.

Perman, R., Ma, Y., McGilvray, J., & Common, M. (2003). Natural Resource and Environmental Economics (3rd ed.). Harlow,Essex, England: Pearson Education Limited.

Potschin, M. B., & Haines-Young, R. H. (2011). Ecosystem services: Exploring a geographical perspective. Progress in Physical Geography, 35(5), 575-594.

Potschin, M., Haines-Young, R., Fish, R., & Turner, R. K. (2016). Ecosystem services in the twenty-first century. Routledge Handbook of Ecosystem Services, 1.

Scholte, S. S., van Teeffelen, A. J., & Verburg, P. H. (2015). Integrating socio-cultural perspectives into ecosystem service valuation: A review of concepts and methods. Ecological Economics, 114, 67-78.

TEEB (2010) The Economics of Ecosystems and Biodiversity: Ecological and Economic Foundations. Earthscan, London.

Traveset, A., & Richardson, D. M. (2006). Biological invasions as disruptors of plant reproductive mutualisms. Trends in ecology & evolution, 21(4), 208-216.
http://www.caribbeanhotelandtourism.com/wpcontent/uploads/data_center/destinations/Aruba-WTTC-EconomicImpact2015.pdf
Van Beukering, P., Brander, L., Tompkins, E. and McKenzie, E., (2007), Valuing the Environment in Small Islands - An Environmental Economics Toolkit. Retrieved from Joint Nature Conservation Committee (JNCC) website: http://jncc.defra.gov.uk/page-4065
Van der Perk, J.P. (2002). Towards sustainable development of Aruba: Indicators for Ecological Quality. Development of an environmental assessment method for Aruba. VROM Aruba.
Vermeij, M.J.A. (2012). The current state of Curacao's coral reefs. Report for Carmabi Foundation/University of Amsterdam. 34 pp.
Waite, R., Burke, L., Gray, E., van Beukering, P., Brander, L., McKenzie, E., et al. (2014). Coastal Capital: Ecosystem valuation for decision making in the Caribbean. World Resource Institute.
Wieggers, M.W. (2007). Impact of Increased Nutrient Input on Coral Reefs on Bonaire and Curacao. Utrecht University. Report University Utrecht. 66 pp.

3. Local Cultural Services

Francielle Lacle[1], Martina Bubalo[2] and Rosa Pols[2].

[1]Consultant, YABI Consultancy, Boroncana 223A, Aruba.

[2]Research internship, Wolfs Company, Sarphatistraat 370, Amsterdam, The Netherlands.

The following chapter is a summary of the main accompanying report, titled "Cultural Ecosystem Services for the Local Community on Aruba'.

3.1 Introduction

The MEA (2005) definition describes cultural ecosystem services (CES) as "nonmaterial benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experiences".

This research employs a multi-method approach to value the CES of Aruba. For the economic/monetary value we employ both Choice Experiment (CE) and Contingent Valuation (CV). To elicit information within the socio-cultural domain we employed Public Participation Geographic Information System (PPGIS) and Crowdsourcing for CES mapping. These are further elaborated within chapter 2 on data and methods.

The cultural ecosystem services analysed spatially as well as economically in this study are: aesthetic experience, cultural heritage and recreation. Landscape beauty and cultural heritage were identified and ranked as highly important ecosystem services by the local stakeholders during a workshop organized as a part of the TEEB Aruba Project[7]. Considering the context of Aruba case study, all three services are beneficial for both local community and tourists to the island. This research looked at how CES play an important role in the wellbeing of local community as well as tourists. Information on the spatial distribution of these services provides valuable insight for the Aruban government which has set itself a goal to move towards sustainable development with a specific focus on "conservation, preservation and innovation of natural habitats, cultural

[7] Two-day workshop held on Aruba (28th and 29th of April 2016) was organized with the purpose of building knowledge and sharing experiences between different stakeholders from public, private and citizens' organisations directly and indirectly involved in policy, management and investments in nature conservation in Aruba.

expressions, and (land/marine) ecological systems" (The Green Gateway Policy, 2011-2013).

According to Daniel et al. (2012), natural or semi-natural features of the environment are often related to the identity of an individual, or a whole community for two reasons. First, experiences arising from the natural environment are shared across generations. Moreover, natural features provide "settings for communal interactions important to cultural ties" (Daniel et al., 2012, p. 8814). Aesthetic experience can be defined as the preference many people have for being in aesthetically pleasing environments (de Groot et al., 2002). Recreation represents an ecosystem service defined as "recreational pleasure people derive from natural or cultivated ecosystems" (MEA, 2005; TEEB, 2010). Cultural heritage can be defined as "the legacy of biophysical features, physical artefacts, and intangible attributes of a group or society" passed down from past generations, maintained by the present, and bequeathed for the benefit of future generations (Daniel et al., 2012, p. 8814).

Key questions to be answered in this chapter include:

1. What is the cultural ecosystem service (CES) value of Aruba's marine and terrestrial ecosystems to its local community?
2. What is the perception and willingness-to-pay towards management of Aruba's marine and terrestrial ecosystems to its local community?
3. Where are the hotspots of cultural ecosystem services (CES) (aesthetic, recreational and cultural heritage) provision situated for Aruba's local community?

3.2 Methodology

To analyse the cultural ecosystem services on Aruba, a range of valuation techniques was used. Household surveys were carried out and geographical information was used. The methodologies used are outlined in table 3. A more detailed description of the methods can be found in the separate report.

Table 3 Summary of valuation techniques used for CES.

Valuation technique	Description
Contingent valuation	Survey-based technique in which respondents are asked directly about their willingness to pay for the supply of ecosystem services. A direct stated preference method.
Choice Experiment	Survey-based technique in which respondents are asked to select between a set of alternative scenarios including different attributes to elicit the general trade-offs an individual is willing to make. An indirect stated preference method
PPGIS	Spatially explicit data obtained through public participation geographic information system (PPGIS) where respondents participate in a mapping exercise for the identification and valuation of ecosystem services.
Crowdsourcing - social media	Assessment of web-based geospatial information, such as data from social media platforms (e.g. Instagram) as a source of spatially explicit information that can be utilised for mapping cultural ecosystem services

Contingent valuation

When market prices are not available, contingent valuation (CV) can be used to assess values. CV studies ask questions that help to reveal the monetary trade-off each person would make concerning the value or good (Carson, 2012).

Most willingness to pay questions are open-ended questions. This gives respondents the opportunity to state their maximum willingness-to-pay amount freely (Armbrecht, 2014). One disadvantage of this method is that it tends to yield relatively large number of non-responses, as respondents find it difficult to put a monetary value on goods not usually on the market or made to be thought of in daily life. To overcome this problem a payment card format was used, where suggestions of monthly payment were given. A payment card is table or list with suggestions (amounts) of the monthly payment. This table ranged from 1.00 to 120.00 (Aruban florins = AWG). (See figure 14 for CV question provided to respondents).

Are you <u>in principle</u> willing to pay for management of the marine and terrestrial natural environment on Aruba?
What is your maximum amount of <u>monthly contribution</u> you are willing to pay for management of the marine and land natural environment on Aruba? In making a choice, carefully take into account whether you actually can and are willing to pay this amount given your current income level.

Figure 14 CV questions provided to respondents (See Annex X for background questionnaire)

The CV willingness-to-pay towards management of Aruba's marine and terrestrial environment is calculated by multiplying the total number households on Aruba by the percentage of households of the sample that are WTP. Then this number is multiplied by the household's average WTP. In total, there are 34,845 households on Aruba (CBS, 2015).

$$WTP = N° \, of \, households * \, Households \, that \, are \, WTP \, (\%) \\ * \, Household \, average \, WTP$$

Choice Experiment

The Choice Experiment (CE) is an extension of the Contingent Valuation (CV) method. CV, however, is a direct stated preference method whilst CM is an indirect stated preference. Options between different potential scenarios are provided and regression analysis used to calculate significance, coefficients and WTP for each scenario.

The attributes of the CE are described below:

- **A yearly contribution in florins** (& displayed per month) by all households on Aruba, which would be used strictly for the management of the natural environment of Aruba;
- **Marine Protected Area** (MPA) establishment refers to the amount of marine environment that would be managed. It would restrict access for fisherman and for recreational activities (e.g. diving behaviour and designated swimming areas) in the MPA with the purpose of recovery and protection of fish and coral populations;
- **Fish catch per trip** refers to how much fish can be caught for recreational purposes in the seas surrounding Aruba per fishing activity or trip. This can vary due to a change in fish abundance;
- **Beach width** refers to the width of the beach which is available for recreational use, which can vary due to natural erosion and/or by expanding hotel 'palapas';
- **Natural areas on land** refers to the natural habitat of the flora and fauna of Aruba, which can change due to increased construction and infrastructure projects; and
- **Tourist crowdedness** refers to the average number of tourists per day on the island of Aruba.

Public Participation Geographic Information System (PPGIS)

Participatory mapping has been widely recognized as a valuable tool to capture spatial information about cultural values of landscapes at the local community level (Soini 2001; Brown 2005; Tyrväinen et al. 2007). The main aim is to get an understanding of which locations on the island are perceived as the most valuable from the perspective of the local community.

The map of the study area was presented to the respondents as part of a household survey questionnaire. Respondents were asked to point out the most important location for a particular cultural ecosystem service, i.e. recreation, aesthetic value and cultural heritage. The exercise consisted of four questions in total.

Subsequently, a map of significant natural areas on Aruba was created to illustrate the density of the aesthetic, recreational and cultural heritage points within these areas. The map of significant natural areas was based on three sources. Firstly, the insights from a focus group exercise to define the important natural sights and areas. Secondly, two zones designated for future conservation in the spatial plan of Aruba were incorporated (Department of Infrastructure and Planning, 2009). Finally, based on the information about the Arikok National Park, the area of Arikok is represented in three distinct zones. The final map consisted out of thirteen natural areas around which a buffer of 200m was designated. Subsequently, the areas where ranked according to the absolute number of points per square kilometre and respective density.

Crowdsourcing - social media

Crowdsourced data from social media has recently become a significant source of spatially explicit information that can be used for mapping cultural ecosystem services (Casalegno et al., 2013; Pastur et al., 2016; Tenerelli et al., 2016). However, the assessment of web-based geospatial information, such as data from social media compared with more traditional PPGIS tools, has not been widely reported in scientific research (Rouse et al., 2009). Pastur et al., (2016) recognize the need of integrating data collection by using different techniques to develop a more comprehensive understanding of CES.

In order to conduct the analysis of spatial distribution of photographs, they first must be categorized according to the landscape features they capture. Several studies measured aesthetic values of landscapes by analysing the content of images uploaded to websites such as Panoramio and Flickr (Casalegno et al. 2013;

Pastur et al. 2016). In the case of this research, semantic content categorization clusters the photographs according to the landscape value that the photographer tries to highlight so they can be used as indicators of aesthetic appreciation or recreational activity.

Table 4: Main classification of photographs

Main categorization	Explanation
Excluded	Aerial, indoor, urban areas, people[8] as the main subject, cars, cruise ships as the main subject
Coastal landscape	Photographs of the coastline; sub-category chosen according to the dominant feature on the photo
Terrestrial landscape	All photos of terrestrial natural and semi-natural landscape; sub-category chosen according to the dominant feature on the photo
Seascape	Photographs of the seascape (above water)
Underwater	Photographs taken underwater (used strictly as indicators of recreational activity – diving and snorkelling)
Flora and fauna	Close-up photographs of flora or fauna where specific landscape type/feature cannot be defined

Next, each photograph, previously classified as coastal or terrestrial landscape, was assigned to one of the twelve sub-categories according to the dominant landscape feature captured, for example 'beach', 'rocky shore' and 'dune'.

Data collection process

The study is based on both primary and secondary data sources. A wide variety of stakeholders were contacted in Aruba to support the research in conjunction with the use of existing data sources. Many government departments, public and private organizations agreed to support the TEEB Aruba project.

1) Primary data sources:

- Household survey (incl. CV, CE and PPGIS); and
- Expert interviews.

2) Secondary data sources:

[8] In the case of Instagram, photographs which featured people as the main subject and natural environment as a background were included in the analysis.

- Central Bureau of Statistics, Aruba;
- The Nature Conservancy vegetation map & other maps;
- Crowdsource social media; and
- Literature review.

3.3 Results

In total 378 households where interviewed. For the CE, 35 respondents were excluded from the analysis because of one of the following reasons:

- Respondents did not answer the choice questions;
- Respondents indicated to have made random choices in the choice experiment;
- Respondents who systematically chose the status quo (or opt-out option) AND who indicated that the reason for this was that they were not confident that the money will be used as specified (protest response).

For the PPGIS, 353 maps where received of which 345 were correctly filled in and included in the analysis. Each respondent's map of values was digitized and coded using ArcGIS software. Overall, 907 points (2.6 per respondent) were used as indicators of aesthetic value and 816 points (2.4 per respondent) as indicators of cultural heritage value. For mapping the recreational value 1557 points were used.

Next step of data processing included the use of ArcGIS software in order to create density maps for each particular cultural ecosystem service studied. To calculate the density of point features the Point Density tool from ArcGIS Spatial Analyst toolbox was used. This tool calculates a magnitude-per-unit area from point features that fall within a neighbourhood around each cell. The cell size used was 90 meters. The radius of circular neighbourhood was set to default of 783, 95 m. Geographic Coordinate System used for this study was the World Geodetic System (WGS) of 1984, and as Projected Coordinate System we used the WGS_1984_UTM_Zone_19N as it is the best projection for Aruba. To set a geographic area of interest for analysis a 1000 m buffer around the island's coastline was used.

Figure 15: Visualisation of the spatial distribution of TEEB Aruba conducted household survey and key areas of interest used in the survey.

4750 photographs from the social media platform Instagram was analysed for the crowdsourced, social media analysis. Of this, 1098 featured the natural environment and mostly showing the coastal landscape (62%). Regarding the two studied values, photographs interpreted as indicators of aesthetic value account for 63% of the Instagram dataset. 603 points were used as indicators of aesthetic and 304 points as indicators of recreational value to produce density maps of Instagram data. Data processing the ArcGIS software and same settings where used as for the PPGIS exercise. In addition, longitude and latitude information from geo-tags was used to create a point shapefile for each of the three social media datasets. Correspondingly, other point shapefiles were derived for each of the social media sites and values measured.

Contingent valuation

The CV willingness-to-pay towards management of Aruba's marine and terrestrial environment is estimated by multiplying the total number households on Aruba by the percentage of households of the sample that are WTP. 62.7% of the respondents are in principle willing to pay for management of marine and terrestrial natural environment Then this number is multiplied by the households' average WTP. In total, there are 34,845 households in Aruba (CBS, 2015). The household average WTP is 24.81 AWG per household per month (equals 13.78 USD).

$$\boldsymbol{WTP\ monthly} = N° \ of\ households * \ Households\ that\ are\ WTP\ (\%) * Household\ average\ WTP$$

$$\mathbf{542,044}\ \boldsymbol{AWG}\ (\mathbf{301,136}\ \boldsymbol{USD}) = \ 34{,}845 * \ 62.7\ (\%) * 24.81\ AWG\ (\ 13.78\ USD)$$

This leads to a yearly **willingness-to-pay towards management of Aruba's marine and terrestrial environment of 6.5 million AWG (3.6 million USD)**.

Of the respondents that were not willing to pay, 40% are in favour of more management, however stated that this should be derived from existing tax revenues and 39% indicated not being able to financially afford a contribution as their main reason.

Choice experiment

The CE willingness-to-pay towards management of Aruba's marine and terrestrial environment is estimated with the most commonly used choice model, a conditional logit model (e.g., Louviere et al., 2003). The payment vehicle included in the model is monthly household contribution to a management fund, and is included as a continuous variable. For all other attributes a dummy specification is used in order to reveal potential non-linear patterns in preferences. The estimated parameters in the model represent the average contribution of each attribute and attribute level to utility for the sample as a whole. From the parameters, we derive willingness-to-pay (WTP) estimates for the non-monetary attributes by relating their parameter estimates to the estimated contribution parameter. Results are presented in table 5.

Table 5: Conditional logit estimation results and WTP estimates for choice attribute levels

Attribute	Attribute level	b [a]	se [a]	WTP [a]	se(WTP)
Current policy constant	Constant	−0.289*	0.159	−41.3*	22.8
Marine protected areas (reference: 0%)	25%	0.420***	0.113	59.9***	16.2
	50%	0.621***	0.101	88.5***	19.3
	100%	0.751***	0.098	107.2***	18.5
Recreational fish catch (reference: –50%)	+0%	−0.051	0.156	−7.21	22.2
	+50%	0.215***	0.065	30.7***	9.87
Beach width left for local population (reference: 0 meter)	15 meter	0.268***	0.101	38.2**	14.9
	30 meter	0.607***	0.103	86.6***	17.3
Remaining natural areas on land (reference: 20%)	40%	0.098	0.112	13.9	15.9
	60%	0.234*	0.121	33.3*	17.9
	90%	0.632***	0.131	90.1***	21.1
# of tourists (reference: triple)	Double	0.032	0.121	4.54	17.3
	Current number	0.113	0.093	16.2	13.5
Contribution (in AWG per month)	--	−0.007***	0.001		
Number of observations	2,040				
Pseudo R^2-adjusted	0.055				

[a] b = estimated parameter; se = standard error of b; WTP = willingness to pay; se(WTP) = standard error of WTP
***, **, * = statistically significant at 1%, 5%, 10%, respectively

The current policy constant represents a situation in which there is no marine protected area, where recreational fish catch decreases by 50%, where there are no beaches left for the local population, where only 20% of natural areas on land remain, and where the number of tourists is triple the current figure. The constant is negative, which implies that maintaining current policy decreases welfare.

In summary, the results of the CE are as follows:

Marine Protected Area (MPA) establishment: increasing marine protected areas has a strong positive effect on the perceived wellbeing. The effect is bigger for larger areas. The pattern in WTP is displayed in Figure 16. When exploring the existence and sources of preference heterogeneity (a model in which we incorporate people's background characteristics) having a medium or high level of education appears to have a positive effect on preferences for MPA establishment and MPA size, as does the perceived impact of nature on well-being and visiting natural areas when stressed. These effects are plausible when realising that knowledge likely leads to increased environmental understanding and preferences towards nature protection, and that an increased quantity of MPAs has more positive consequences for those who see nature as beneficial to them.

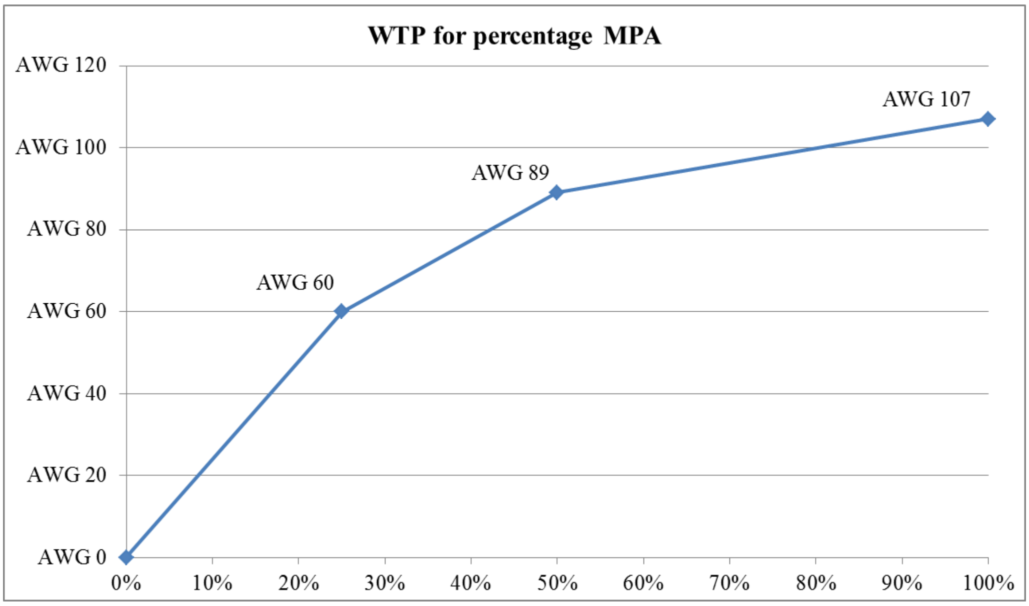


Figure 16 WTP for percentage of MPA (in AWG per household per month)

Fish catch per trip: maintaining recreational fish catch at the current level (compared to a decrease of 50% under current policy) has a small and insignificant effect on utility. Increasing recreational fish catch by 50% (compared to a decrease of 50% under current policy) does have a positive effect on utility. People who perceive nature to be good for their well-being and people with a higher frequency of fishing activities are more positive (negative) about increases (decreases) in recreational fish catch.

Beach width: increasing beach width left for the local population has a strong positive effect on utility. Education and frequency of beach visits have positive effects on preferences for beach width left for the local population.

Natural areas on land: protecting natural areas on land has positive effects on utility, but only when large parts are protected. Under current policy there will be only 20% left of these natural areas, and increasing this number to 40% does not affect utility much. Maintaining 60% and especially 90% has a strong positive effect on utility, and people appear to have a relatively high willingness to pay for natural area protection. The pattern of WTP is displayed in Figure 17.

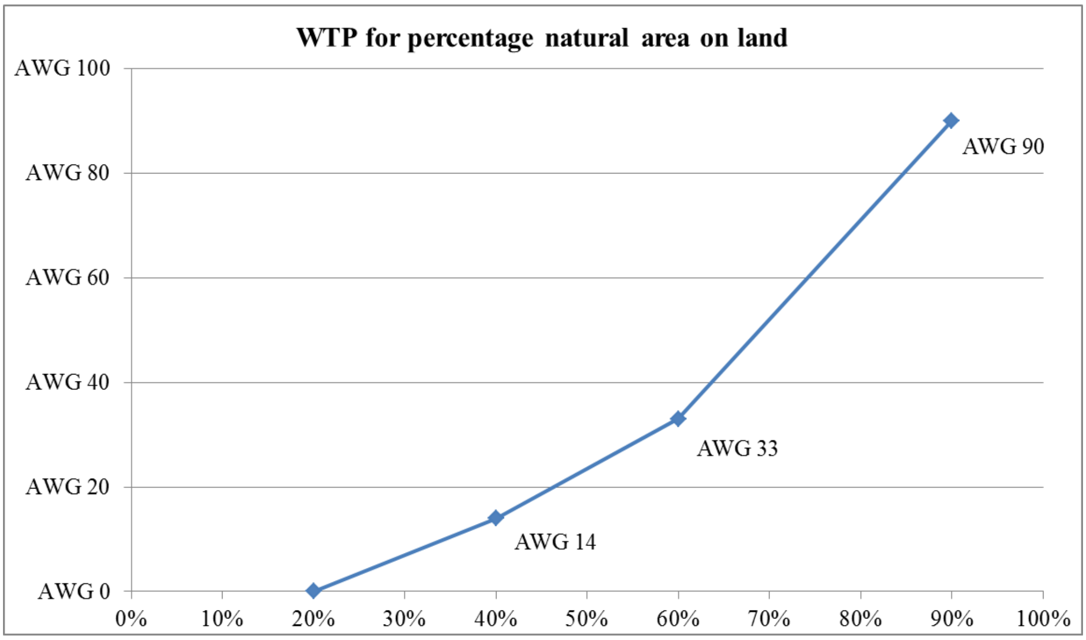


Figure 17 WTP for percentage of natural areas on land (in AWG per household per month)

Tourist crowdedness: under current policy the number of tourists will increase threefold. Average preferences for changes in the number of tourists were neutral, i.e., changes in tourism numbers did not affect average utility and average WTP was low and statistically insignificant. People who are employed in the hotel/restaurant or retail sector are more in favour of more tourists. People who perceive nature to be beneficial for their well-being, households with people that fish and people with a higher frequency of beach visits are less positive or more negative about an increase in number of tourists. This set of results likely reflects that these groups will experience a decrease in use values from nature when tourism increases.

Hotspot mapping - PPGIS

Aesthetic value

Analysis of PPGIS data revealed that three locations on Aruba are perceived as having high aesthetic value for local residents. First is the area of Seroe Colorado and the Baby Beach Lagoon on the southern tip of the island, followed by the western tip of the island with California Lighthouse and the dunes (see figure 18). Third hotspot appears inland in the area of national park Arikok. Here, according to the shape and the size of the hotspot, we can make an assumption that respondents had difficulties to map the exact location in the park area, but rather they allocated the points right next to the name (Arikok) that was featured on the

map. This may imply that it is in fact the Arikok park that has a high aesthetic value for local people.

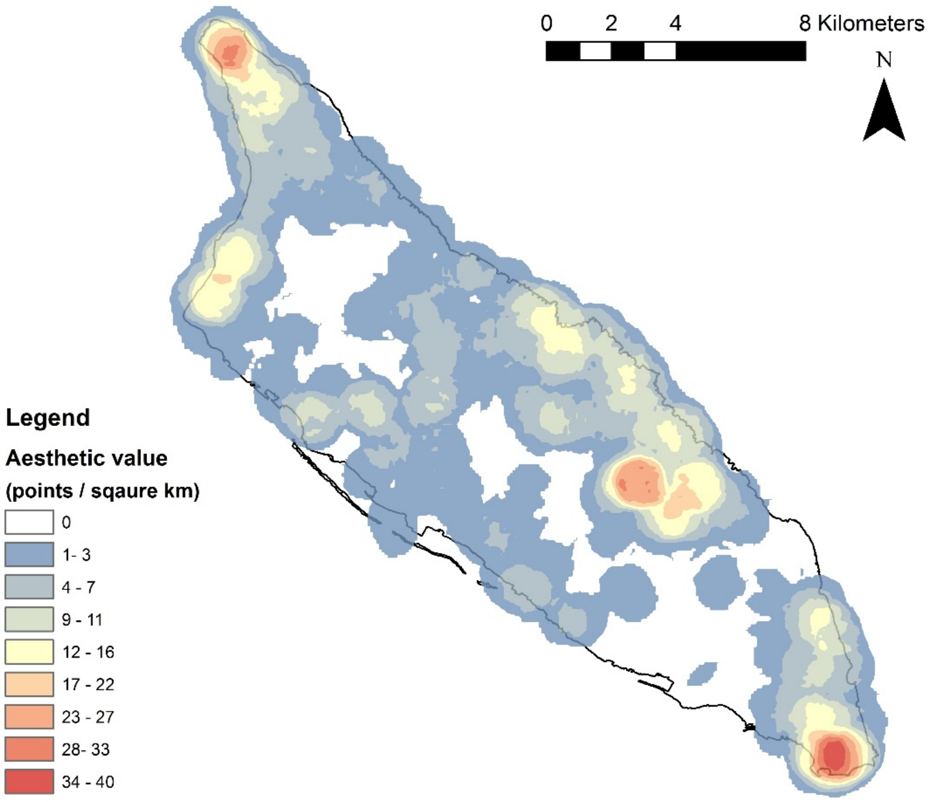


Figure 18 Density of aesthetic value points

These aesthetic hotspot locations in the natural environment of Aruba, two within coastal areas with seascape views (California Lighthouse and the dunes & Seroe Colorado and the Baby Beach Lagoon) and one terrestrial (Arikok National Park), have a value for the local community because of the beautiful scenery. These ecosystem areas, because of their beauty, can serve as an experiential cultural benefit, e.g. people feeling touched by the beautiful scenery, which might include feelings of calm or spiritual enrichment arising from encountering physical attributes in the ecosystem area. The areas can also serve as inspiration for drawing, painting, photography, poetry and storytelling that draw upon the natural environment. It's important to notice that the hotspots for aesthetic value are within less developed areas on the island, especially the conservation area Arikok National Park and the area of the California Lighthouse dunes. The area of the Baby Beach Lagoon is situated close-by to a residential area, however the beach and lagoon is not surrounded by large infrastructure such as other beach areas on the island.

Cultural heritage

Regarding cultural heritage, another CES examined through participatory mapping, there also appear to be several hotspots. As illustrated by figure 19, the main hotspot is located in the region of California Lighthouse and the dunes in the north of the island. One of the smaller hotspots is found in the area of Arikok national park. Similar to the locations of aesthetic value, this hotspot suggests that the majority of respondents consider the national park in general to be an area of special importance for the cultural heritage of the island. Another hotspot of cultural heritage value emerging in the natural environment is the area of Seroe Colorado situated on the southern tip of the island. Lastly, even though it is an urban area, the respondents often recognized Oranjestad – the capital city, as an important element of the island's cultural heritage.

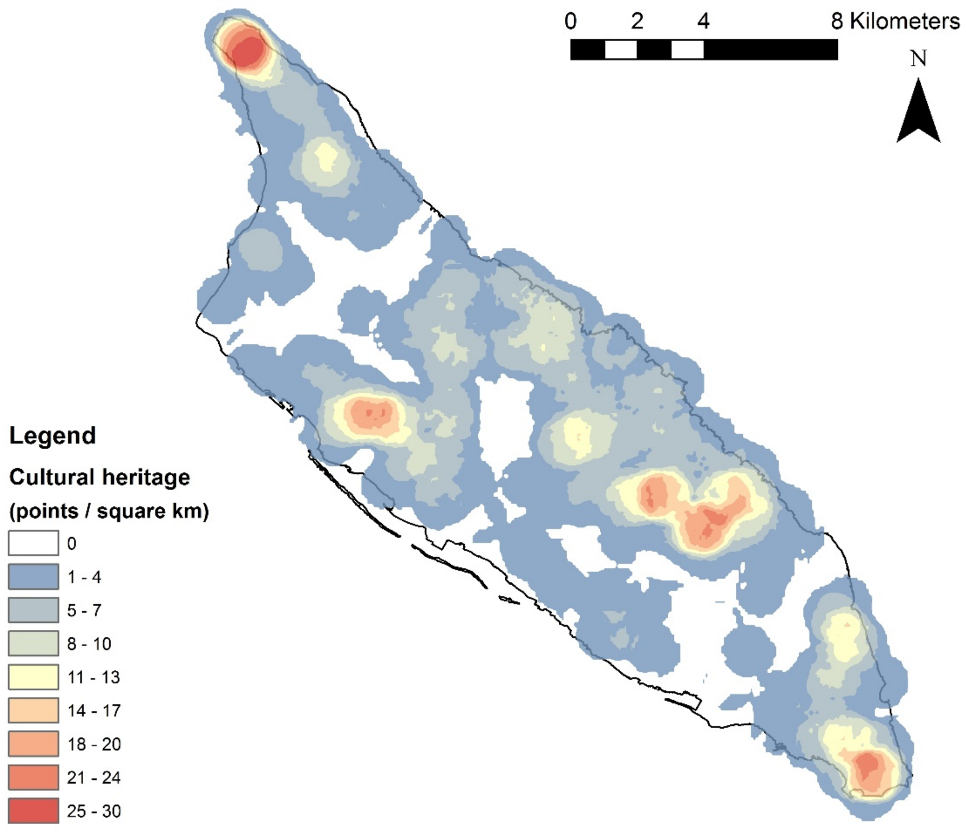


Figure 19 Density of cultural heritage value points

These cultural heritage hotspot locations (California Lighthouse and the dunes, Seroe Colorado and the Baby Beach Lagoon, Arikok National Park and Oranjestad) are valued by the local community as important places of both natural and human history. These areas serve as a place of identity and continuity with the past. People thus feel a sense of belonging to these areas, having memorable experiences or might miss these sites when having been away from them for a

long time. Most cultural heritage hotspots identified on Aruba are also considered an aesthetic hotspot with only the exception of Oranjestad being a cultural heritage valued hotspot but not an aesthetic valued hotspot. This might then suggest that areas considered for pure aesthetic value are areas where there is less infrastructure development.

Recreational value

To map the recreational value of Aruba's environment, we asked the respondents to record the location where they engage in certain recreational activities, both on land and in the water. These activities were then used as indicators of recreational value. As figure 20 shows, several hotspots occurred mostly in the coastal areas of the island. The location with the highest recorded recreational value for the residents of Aruba is the Divi Beach located on the southern part of the island's western coast. Additionally, the areas of Arashi, Boca Catalina and Malmok – the strip of beaches in the northern part of the western coastline also has high importance for the recreation of local residents. Likewise, another popular location is the Baby Beach Lagoon in the south, followed by the Renaissance Beach and Linear Park in Oranjestad.

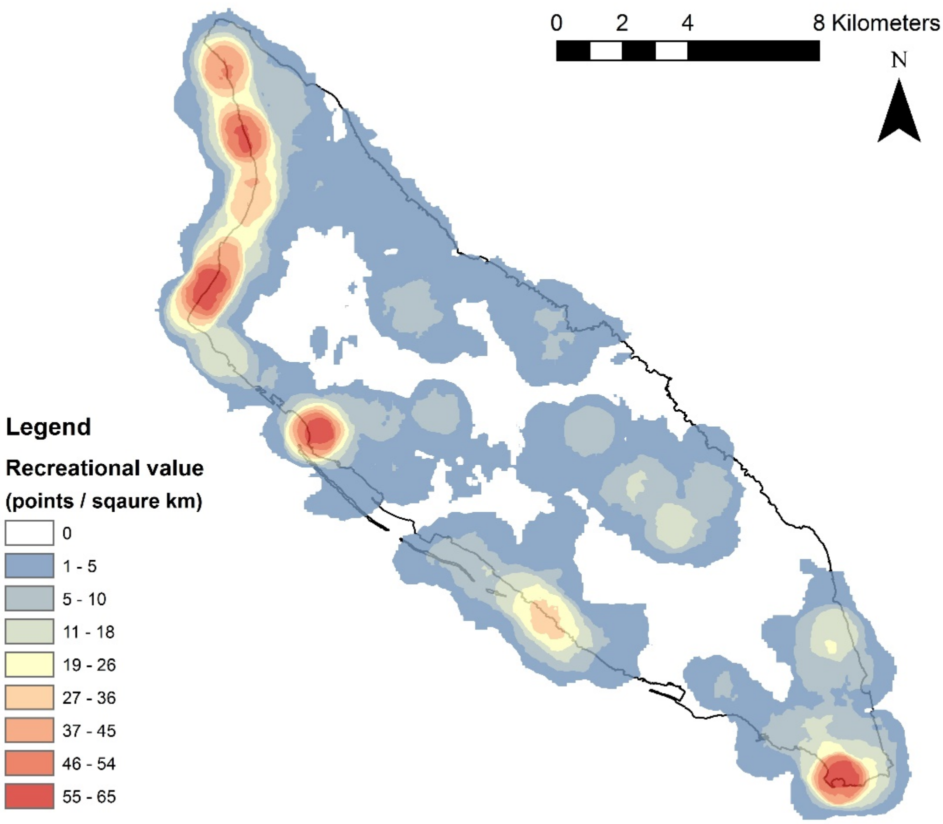


Figure 20 Density of recreational value points

Figure 21 illustrates the locations for each of the six specific recreational activities in coastal and marine natural environment. Going to the beach and swimming/wading are the two recreational activates in the coastal environment in which local residents of Aruba engage the most. The most popular locations for these activities are located on the beaches of the western coast. One other location important for these two activities is the Baby Beach Lagoon on the southern tip of the island. Two locations being the most important for underwater activities such as snorkelling and diving are the area of Malmok Beach on the west, and the mangrove area of Mangel Halto on the southern coast of the island.

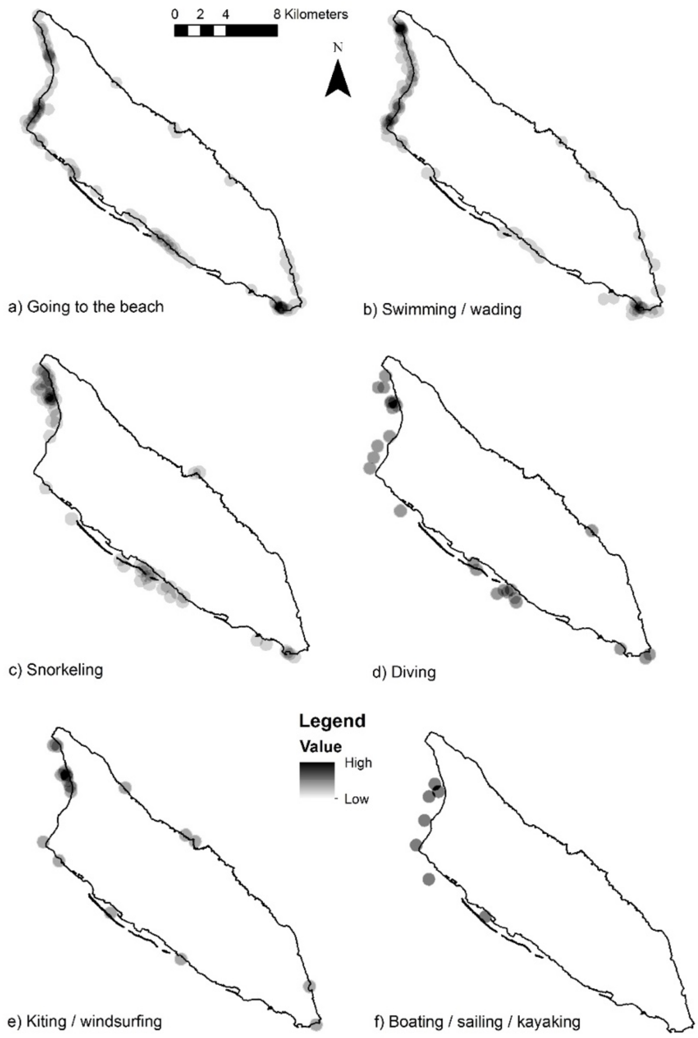


Figure 21 Recreational activities in coastal and marine natural environment.

Regarding the recreational activities in the terrestrial environment, the most popular among the local residents on Aruba are walking and running. As figure 22 shows these activities occur almost on the entire island, but in both cases one specific hotspot emerges in the area of Oranjestad, specifically on the location of newly built Linear Park. Prominent cycling hotspot appears on the western tip of the island near California Lighthouse and the dunes. Location most popular for camping is the Eagle Beach. As for the hiking, the most popular location for this activity is the Hooiberg hill, followed by several locations in the national park area. Bird and wildlife watching occurs the most around the Bubali wetland, but also in the Arikok area.

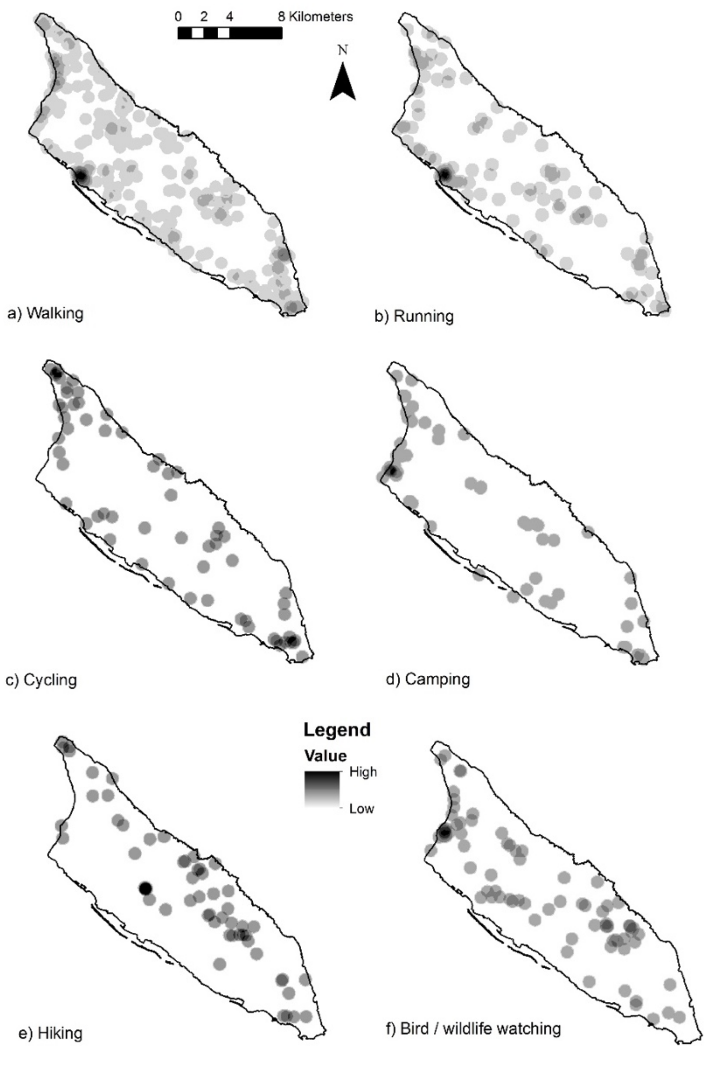


Figure 22 Recreational activities in terrestrial natural environment.

Crowdsourcing - Social Media - Instagram

Locations of aesthetic value:

Aesthetic value hotspots are situated in the areas of Arashi Beach, California Lighthouse and the dunes on the western side of the island. Hotspots of smaller intensity appear in the area of Alto Vista Chapel in the north-west part of the island, as well as in the mangrove area of Mangel Halto on the southern coast.

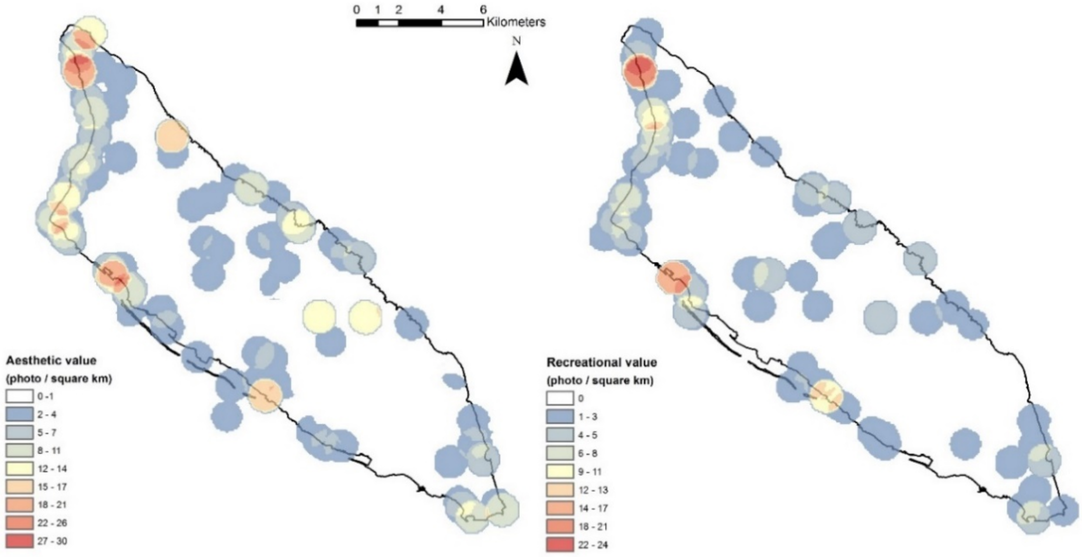


Figure 23 Density of aesthetic value (left) and recreational value (right) points – Instagram

Locations of recreational activity:

The biggest recreational activity hotspot also occurs in the west, in the areas of Arashi Beach and Boca Catalina. This part of the coastline is prominent windsurfing spot on the island. Furthermore, Boca Catalina is a popular snorkelling and diving sight. Furthermore, there is a hotspot in the area of Oranjestad.

Figure 23 shows the recreational activities by Instagram users. Swimming and wading, followed by spending leisure time on the beach are the two types of activities being reported the most.

3.4 Conclusion and recommendations

The TEEB Aruba research shows that nature plays an important role in the lives of the local population, 95% of the local community has the perception that nature has an influence on their overall well-being and the majority finds it extremely influential. Around 70% visit natural environments to destress and relax and natural areas also serve as a bonding opportunity with around 25% of the local community on Aruba visiting a natural environment to spend time with family and friends at least once a week and another 39% at least once a month. The average amount that households are willing to pay per month towards management of Aruba's marine and terrestrial environment can be ranged between 25 AWG (14 USD) (CV) and 64 AWG (36 USD [9]) (CE). Taking the conservative side of the range leads to a yearly willingness-to-pay towards management of Aruba's marine and terrestrial environment of 6,5 million AWG (3,6 million USD) by the local community.

There is a general sentiment on overdevelopment with 81% agreeing with policy to restrict coastal and inland development. The CE results of the attribute Natural areas on land show that utility (welfare) is increased by protecting natural areas on land, but only when large parts are protected. When it comes to infrastructure development specifically related to the main economic pillar of the island, Tourism, there is a sentiment for restriction with 78% agreeing to introduce a moratorium on building hotels. With regards to perceptions on tourist numbers, 60% disagreed with the statement that they are bothered by the increasing number of tourists on Aruba and CE results on attribute Tourist crowdedness indicate that average preferences for changes in the number of tourists where neutral and did not affect average utility (welfare). However, further analysis showed that this average value disguises widely varying opinions and preferences on this topic. People whom are employed in the hotel/restaurant or retail sector are more in favour of more tourists, whilst people who perceive nature to be beneficial for their well-being, households with people that fish and people with a higher frequency of beach visits are more negative about an increase in number of tourists. The latter groups will experience a decrease in use values from nature when tourist numbers increase. There is a critical struggle observed between tourism and environmental and cultural heritage conservation, as it is also considered the bread and butter. However, overall 87% of the local community is in favour of regulation of tourism activities (e.g. tours) and 86% is of the opinion

[9] 1 USD = 1.80 AWG

that existing regulation are currently not optimally enforced and want to see improved enforcement of environmental regulations (e.g. driving in the dunes with a jeep).

More information regarding the relevance of these assessed ecosystem services in public policy is provided in the associated report, ‘Cultural Ecosystem Services for the Local Community on Aruba’.

3.5 References

Armbrecht, J. (2014). Use value of cultural experiences: A comparison of contingent valuation and travel cost. Tourism Management, 42, 141-148.

Brown, G. (2005). Mapping spatial attributes in survey research for natural resource management: methods and applications. Society and natural resources, 18(1), 17-39.

Carson, R. (2012). Contingent Valuation: A practical alternative when prices aren't available. Journal of Economic Perspectives, 26(4), 27-42.

Casalegno, S., Inger, R., DeSilvey, C., & Gaston, K. J. (2013). Spatial covariance between aesthetic value & other ecosystem services. PloS one, 8 (6), e68437

CBS (2015). Housing. In Statistical Yearbook 2015 (p 100).

Daniel, T. C., Muhar, A., Arnberger, A., Aznar, O., Boyd, J. W., Chan, K. M., & Grêt-Regamey, A. (2012). Contributions of cultural services to the ecosystem services agenda. Proceedings of the National Academy of Sciences, 109(23), 8812-8819.

de Groot, R. S., Wilson, M. A., & Boumans, R. M. (2002). A typology for the classification, description and valuation of ecosystem functions, goods and services. Ecological economics, 41 (3), 393-408.

Department of Infrastructure and Planning. (2009) Ruimtelijke Ontwikkelingsplan

Louviere JJ, DA Hensher, JD Swait, 2003, Stated Choice Methods: Analysis and Applications, Cambridge University Press, Cambridge.

Millennium Ecosystem Assessment (MEA) (2005). Ecosystems and Human Well-being. A Framework for Assessment. Millennium Ecosystem Assessment. Washington, DC, Island Press.

Pastur, G. M., Peri, P. L., Lencinas, M. V., García-Llorente, M., & Martín-López, B. (2016). Spatial patterns of cultural ecosystem services provision in Southern Patagonia. Landscape Ecology, 31(2), 383-399.

Rouse, L. J., Bergeron, S. J., & Harris, T. M. (2009). Participating in the geospatial web: collaborative mapping, social networks and participatory GIS. In The Geospatial Web (pp. 153-158). Springer London.

Soini, K. (2001). Exploring human dimensions of multifunctional landscapes through mapping and map-making. Landscape and Urban Planning, 57(3), 225-239.

TEEB (2010). The Economics of Ecosystems and Biodiversity: Ecological and Economic Foundations, ed. Kumar P. (Earthscan, Oxford, UK).

Tenerelli, P., Demšar, U., & Luque, S. (2016). Crowdsourcing indicators for cultural ecosystem services: A geographically weighted approach for mountain landscapes. Ecological Indicators, 64, 237-248.

The Green Gateway Policy 2011-2013 (2010). The Government of Aruba Ministry of Economic Affairs, Social Affairs and Culture.

Tyrväinen, L., Mäkinen, K., & Schipperijn, J. (2007). Tools for mapping social values of urban woodlands and other green areas. Landscape and urban planning, 79(1), 5-19.

UNFCCC (2005) Climate Change - Small Island Developing States.

4. Tourism

Sacha van Duren[1], Francielle Lacle[2], Boris van Zanten[1,3] and Vanessa Soberon Forsberg[4] and Pieter van Beukering[3].

[1]Consultant, Wolfs Company, Sarphatistraat 370, 1018 GW Amsterdam, The Netherlands.

[2]Consultant, YABI Consultancy, Boroncana 223A, Aruba.

[3]Institute for Environmental Studies, VU University, De Boelelaan 1087, 1081 HV Amsterdam, The Netherlands.

[4]Research internship, Wolfs Company, Sarphatistraat 370, 1018 GW Amsterdam, The Netherlands.

The following chapter is a summary of the main accompanying report, titled 'The Value of Aruba's Natural Capital for the Tourism Industry.'

4.1 Introduction

Aruba is considered as a high tourist destination with 1,072,082 stay-over tourists and another 582,313 cruise tourists visiting Aruba in 2014 (CBS). Nearly 60% of those come from the United States (US Department of State, 2016). Aruba is a very popular tourist destination because of the variety of ecosystems and natural attributes of the island such as white-sand beaches, coral reefs, rugged coastline, and desert environment (Encyclopaedia Britannica A). In addition, other important touristic features are located in the Arikok National Park, which has mountains, rock formations and a natural pool.

In 2016, the direct contribution of the travel and tourism industry to Aruba's GDP was U.S. $ 790.5 million which equals 28.6 % of Aruba's GDP, see Table 6 (World Travel & Tourism Council, Economic Impact Aruba 2017). "The direct contribution of the travel and tourism industry reflects the 'internal' spending on travel and tourism (total spending within Aruba on travel and tourism by residents and non-residents for business and leisure purposes) as well as government 'individual' spending - spending by government on travel and tourism services directly linked to visitors, such as cultural services (e.g. museums) or recreational services (e.g. national parks)."

Table 6 The tourism industry on Aruba in numbers (visitor exports is 65.7% from total exports, not 65.7% of GDP).*

	Annual value 2016 (AWG.)	Annual value 2016 (U.S. $)	% of GDP
GDP Aruba	4,946.2 million	$ 2,763.3 million	-
Total Contribution Travel & Tourism Industry	4,357.7 million	$ 2,434.5 million	88.1 %
Direct Contribution Travel & Tourism Industry	1,415.1 million	$ 790.5 million	28.6 %
Visitor Exports	2,965.4 million	$ 1,656.7 million	65.7 % *

The total contribution of travel and tourism considers 'wider impacts' (i.e. the indirect and induced impacts) on the local economy of Aruba. The indirect contribution includes the GDP and jobs supported by:

- Travel and tourism investment spending is an important aspect of both current and future activity that includes investment activity such as the purchase of new aircraft and construction of new hotels;
- Government 'collective' spending, which helps travel and tourism activity in many different ways as it is made on behalf of the 'community at large' e.g. tourism marketing and promotion, aviation, administration, security services, resort area security services, resort area sanitation services; and
- Domestic purchases of goods and services by the sectors dealing directly with tourists including, for example, purchases of food and cleaning services by hotels, of fuel and catering services by airlines, and IT services by travel agents.

The induced contribution measures the GDP and jobs supported by the spending of those who are directly or indirectly employed within the travel and tourism industry." As can be seen in Table 1 the total contribution of the travel and tourism industry was US$ 2,434.5 million in 2016, which accounts for 88.1% of Aruba's GDP.

Furthermore, as mentioned in the introduction, the total contribution of the travel and tourism industry to employment (including wider effects from investment, the supply chain and induced income impacts) was 42,500 jobs in 2016, which corresponds to 89.3% of total employment on Aruba (World Travel & Tourism Council, Economic Impact Aruba 2017). The direct contribution of the travel and tourism industry to employment was 15,000 jobs in 2016, which equals 31.3% of total employment on Aruba.

Key questions to be answered in this chapter include:

1. What are the most important natural features of Aruba to cruise and stay-over tourists and where are they located?
2. What is the willingness-to-pay of tourists on Aruba for enhanced nature protection?
3. What is the added value of tourism?
4. What is the TEV economic value of tourism as an ecosystem service?

4.2 Methodology

This study is based on two different methods to conduct the economic valuation of tourism in Aruba, the market price method and contingent valuation. In addition, participatory value mapping was used to indicate key areas of importance and value.

Table 7 List of valuation techniques used in this study.

Type of technique	Valuation technique	Description
Market-based techniques	Market price	A technique based on the revenue from sales of goods or services obtained from ecosystems. Costs of other inputs are subtracted.
Non-market techniques	Contingent valuation	Survey-based technique in which respondents are asked directly about their willingness to pay for the supply of ecosystem services.
	Participatory mapping	GIS-based mapping technique to gather information from stakeholders about areas of interest.

Market price method

To determine the monetary value of the natural capital on Aruba that is relevant for the tourism industry both primary and secondary data will be collected. Using results from the tourist exit survey, estimates of total expenditure in several categories will be made. Additionally, the added value of the tourism industry is estimated by using data on contribution to GDP and production costs. An ecosystem dependency ratio is also calculated to indicate the proportion of expenditure that is directly related to the environment. The equation used to

calculate values is outlined below and more detail is provided in the accompanying report 'The Value of Natural Capital for Tourism on Aruba':

$$Net\ Value\ of\ Ecosystems\ of\ Aruba\ for\ Tourism =$$

$$\sum_{i=1}^{n} \#\ Tourists * (Mean\ Expenditures)_i * (Ecosystem\ Dependency\ Ratio)_i * Value\ Added\ Ratio$$

Contingent valuation

During the survey, tourists were asked directly if and how much they are willing to pay for nature protection on Aruba. The sum of all these willing-to-pay prices for nature protection indicate the total willingness-to-pay of tourists for nature protection on Aruba. This hypothetical monetary value might be interpreted as a measure of the potential extra benefits of Aruba's ecosystems to the local economy of Aruba.

The data for this study is collected by conducting a tourist exit survey at the airport and the harbour of Aruba. For sampling purposes, tourists at the airport were likely to be stay-over visitors and tourists at the harbour were likely to be cruise visitors. As mentioned before 1,072,082 stay-over tourists (SOTs) and 582,313 cruise tourists (CTs) visited the island in 2014 (CBS). In order to draw statistically significant conclusions, the target sample size was set at conducting 540 surveys (290 stay-over visitors and 250 cruise visitors).

Participatory value mapping

Participatory mapping is a tool to process this information geographically. It makes use of different techniques, from simple to more complex, e.g. detailed cartographic techniques using GPS and geographical information systems technology (GIS). Tourists can appreciate a certain location for either its recreational value and/or its aesthetic value. During the tourist exit survey tourists are asked to appoint the locations where they engaged in recreational activities (marine and terrestrial) and to appoint the locations, which they perceive as having a high aesthetic value.

For further information regarding the methodology, see the associated report, “The Value of Aruba’s Natural Capital for the Tourism Industry”.

4.3 Results

Representativeness of the sample

This section of the report explains briefly the results of the descriptive statistics from the tourist exit survey conducted in Aruba.

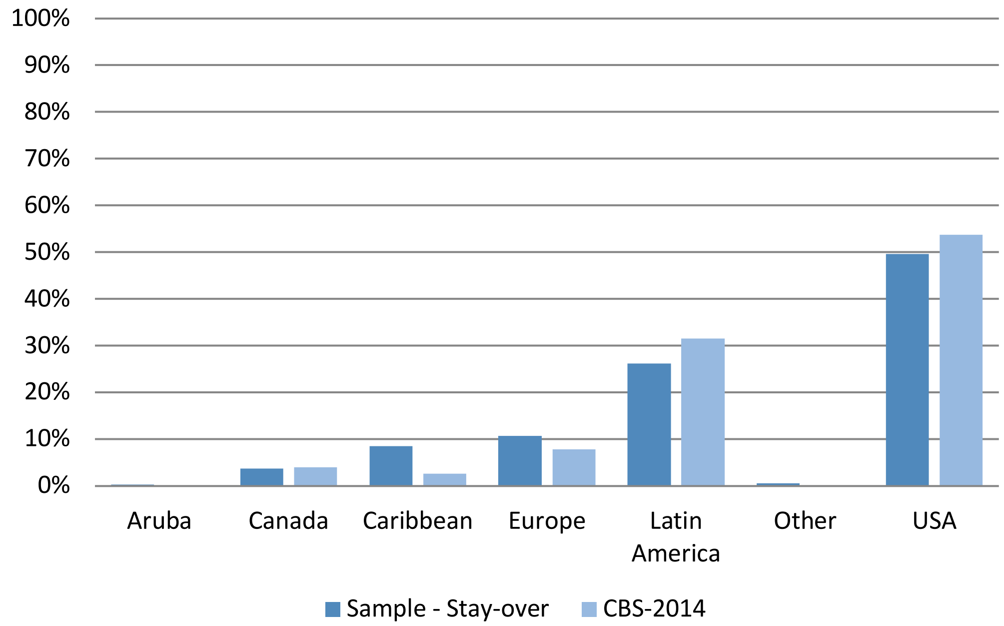


Figure 24 Country of residence of tourists

Figure 24 shows the origin of tourists visiting Aruba. The SOTs’ sample distribution is similar to the CBS (2014) data. The majority of tourists come from the USA and Latin America corresponding to around 50% and 30% respectively.

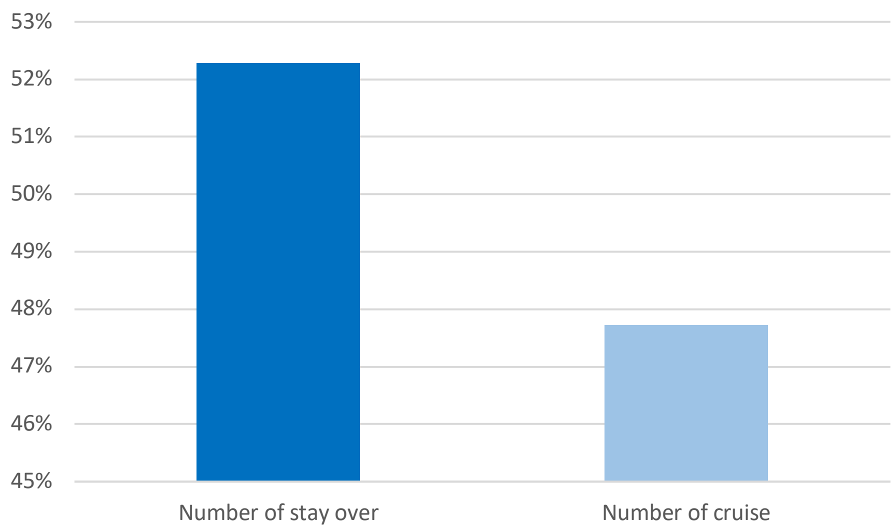


Figure 25 Percentage of stay-over and cruise visitors

Figure 25 shows the percentage distribution of SOTs and CTs. The latter are less with 48% of the sample while stay-over tourists have the highest participation with 53%.

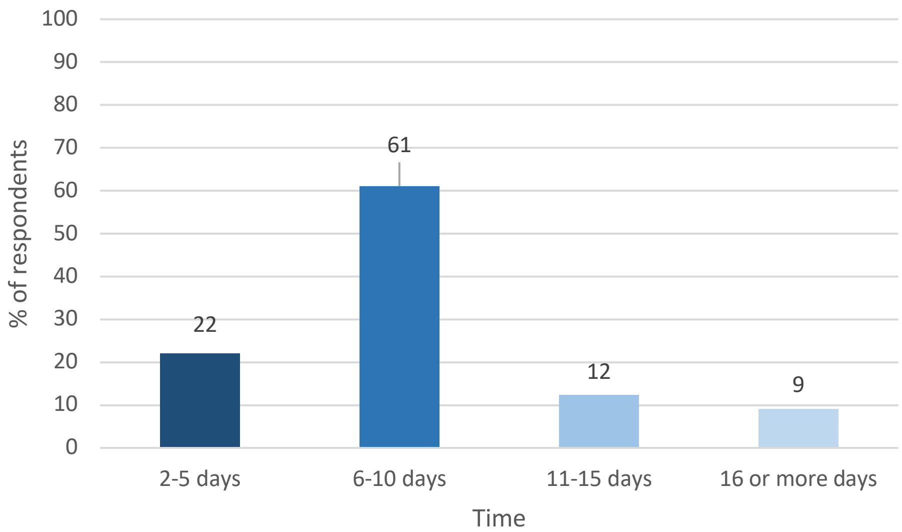


Figure 26 Length of stay and percentage of respondents

Figure 26 shows the length of time that tourists stay on the island and the corresponding percentage of respondents. According to the results, most of the tourists (61%) stay on the island for between 6 and 10 days. Likewise, 7 days is the most common answer among respondents. A shorter stay of 2 to 5 days is the second most popular answer with 22% of the respondents selecting this option.

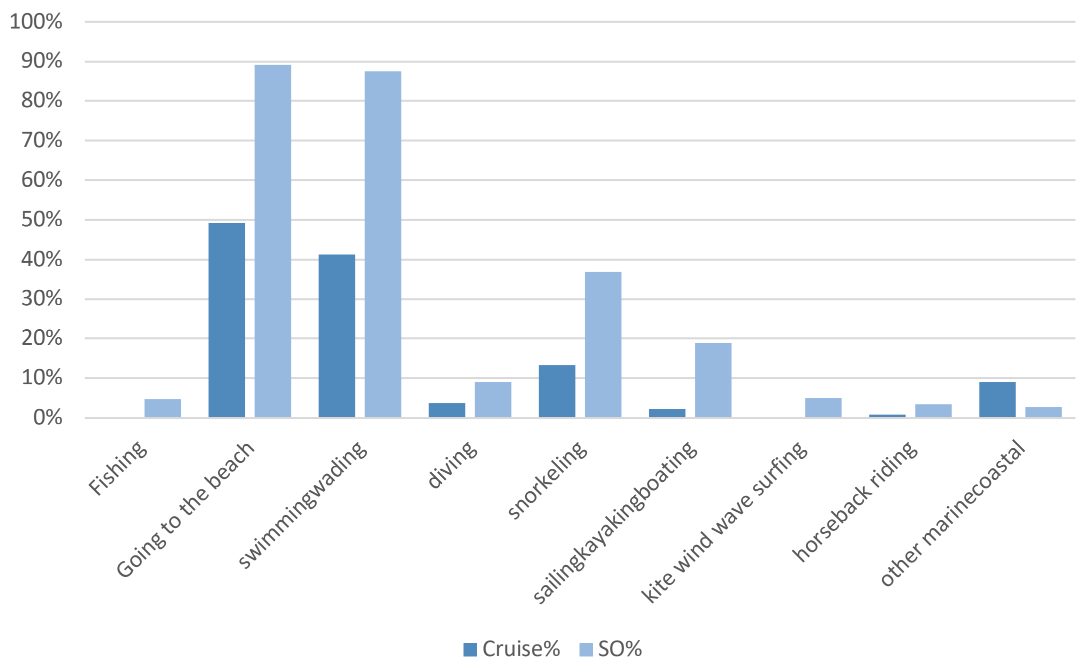


Figure 27 the participation rate of tourists in activities in coastal and marine nature in Aruba

Figures 27 and 28 show the preference of tourists (SOTs and CTs) to participate in the different activities Aruba offers. 89% and 87% of the SOTs indicated that they went to the beach and also swim during their stay on Aruba. In the case of CTs, the same activities presented the highest percentages with 49% selecting the beach and 41% swimming and wading. Activities such as horseback riding and surfing (kite and wave) are not so popular between both, SOTs and CTs.

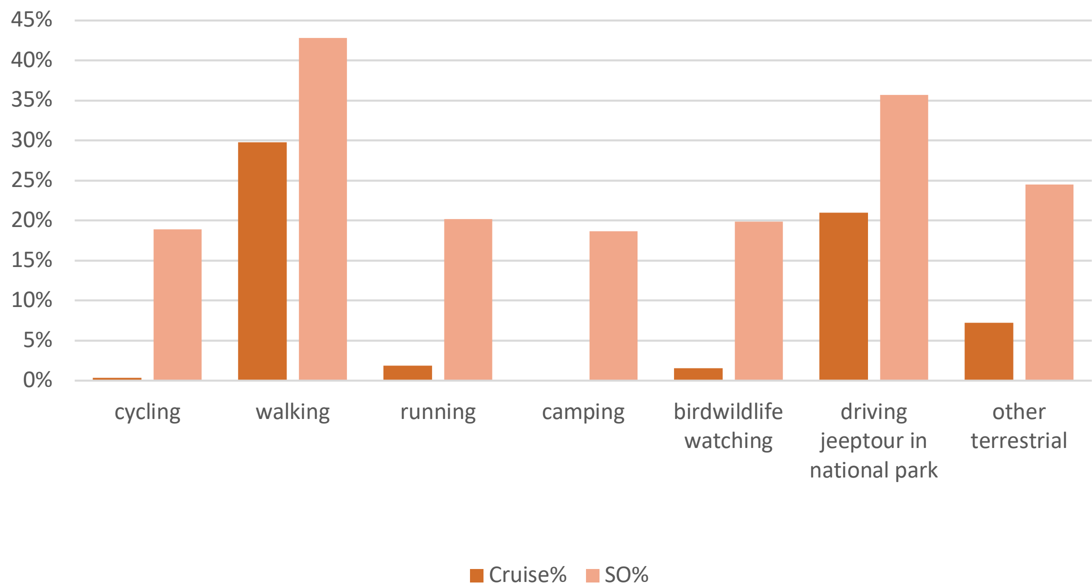


Figure 28 participation rate of tourists in activities in terrestrial nature in Aruba.

The most popular terrestrial activities for CTs are walking and driving a jeep to tour the Arikok national park. 29% of CTs stated that they went walking and 21%

selected the jeep tour during their stay in Aruba. SOTs also selected these two activities as the most popular.

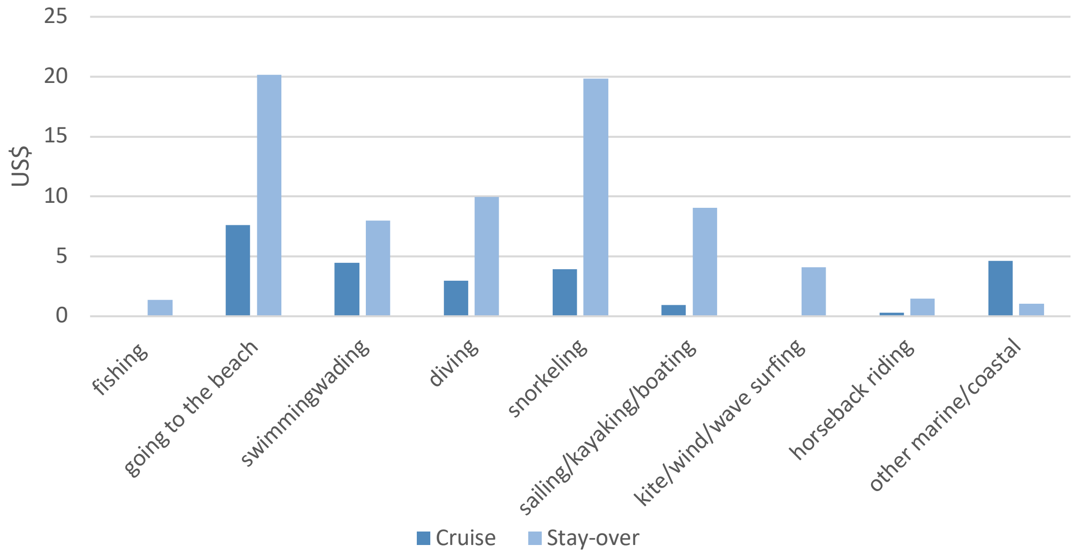


Figure 29 mean expenditures per tourists on activities in coastal and marine nature

Figure 29 shows that most of the expenditures for SOTs in terms of marine nature are related with going to the beach and snorkelling, for which expenditures are around $20 per tourist. Less money is spent on fishing and horseback riding for both types of tourists.

Net ecosystem benefits

The annual net ecosystem benefits (i.e. the value of ecosystem services in the tourism industry) are estimated at US$ 253 million for SOTs and US$ 16 million for CTs and amount to a grand total of US$ 269 million dollars annually.

Table 8: Quantification of annual net-ecosystem benefits of cruise and stay-over tourism.US Dollars.

	Stay-over tourists	Cruise tourists	Total
Direct Nature Related Annual Expenses	$105,002,031	$20,644,106.51	$125,646,137
Per Tourist	$97.94	$35.45	$75.95
Indirect Nature Related Annual Expenses	$929,237,794	$26,530,180	$955,767,975
Per Tourist	$866.76	$45.56	$577.71
Total Annual Expenses	$1,034,239,825	$47,174,286	$1,081,414,111
Per Tourist	$964.70	$81.01	$653.66

	Stay-over tourists	Cruise tourists	Total		%
Gross Value Ecosystems - Direct Nature Related	$105,002,031	$20,644,106	$125,646,137		25.6
Gross Value Ecosystems - Indirect Nature Related	$424,661,672	$13,265,090	$437,926,762	+	74.4
Gross Value Ecosystems Aruba for Tourism	$529,663,703	$33,909,196	$563,572,899		100.0

	Stay-over tourists	Cruise tourists	Total
Gross Value Aruba's Ecosystems for Tourism	$529,663,703	$33,909,196	**$563,572,899**
Net Value Aruba's Ecosystems for Tourism	$252,649,586	$16,174,686	**$268,824,272**

Contingent valuation

Table 9 shows the results of the WTP by the tourists per visit in dollars. As mentioned before, the data is skewed to the right (and non-normally distributed). Both the mean and the median can be used as indicators of the WTP value in dollars per visit.

Table 9. The mean and median willingness to pay of tourists who indicated to be willing to pay for enhanced nature protection

Variables	Cruise WTP	Stay-over WTP
	Values (Dollars/visit)	Values (Dollars/visit)
Mean	11.97	14.28
Median	7.5	7.5
Standard Deviation	10.47	12.42
N Valid	133	133

Table 9 represents the WTP of both SOTs and CTs. The SOTs (45%) are WTP more than cruise visitors, although a higher percentage of the cruise sample (54%) indicated that they are WTP an environmental fee for the contribution to nature protection. Considering the contributions of both types of visitors, the total WTP in a year using the mean amounts to US$ 10,304,280.

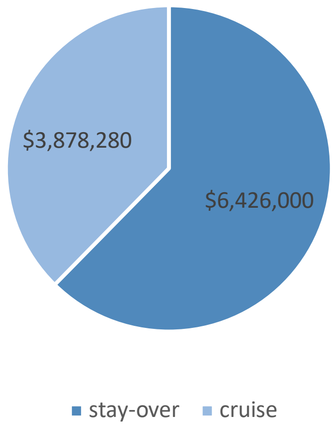


Figure 30 Mean willingness to pay for enhanced nature protection by cruise and stay-over tourists.

Participatory mapping and tourism hotspots

A total of 352 maps were used to map the recreational value, but 175 maps were not used because they were not correctly filled out (either because they had no data or because they included more recreational points than allowed). Similarly, 258 maps were used to map the aesthetic value and 279 were not used because they were not filled in appropriately. It was not possible to link the maps with the survey data because there was not an identification to connect the maps and the surveys.

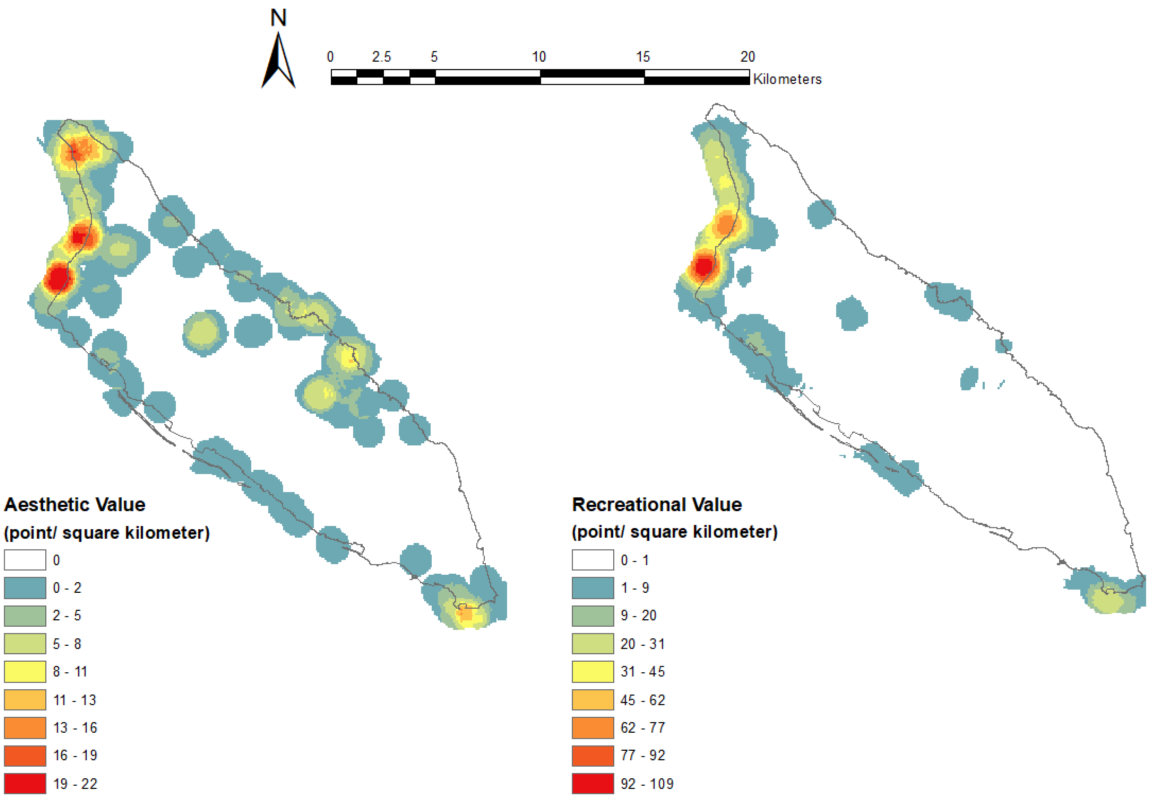


Figure 31: Density points of aesthetic (left) and recreational values (right) as indicated by tourists on Aruba.

Figure 31 shows the results of the density analysis of the participatory mapping exercise conducted with tourists to define the aesthetic and recreational values of Aruba. 438 points were used as indicators of aesthetic value and 780 points as indicators of recreational value. The locations of hotspots were the three highest clusters with aesthetic and recreational values.

The areas with the highest aesthetic values are situated mainly across the coastline. The most important hotspot is Eagle Beach, follow by Palm Beach, and California Light House. Moreover, like the areas with the highest aesthetic values, the areas with the highest recreational values are located mostly across the coastline. The area with the highest recreational value is Eagle Beach, followed by Palm Beach. In addition, the most often reported coastal and marine activities are swimming / wadding and going to the beach, while the most often reported terrestrial activity is walking. The Arikok National Park is located on the continent. Although it is not a hotspot, Arikok National Park has a higher aesthetic appreciation than recreational value.

Social Media

The following are the results from the analysis of the social media data, which includes the perception about aesthetic and recreational values from tourists and

households. Figure 32 shows the results of the density analysis for the Panoramio and Flickr datasets. The first map was created from 2,174 points of aesthetic value. The second map, representing recreational value, consists of 257 points in total. Table 10 shows the number of points used for creating aesthetic and recreational value density maps from Flickr and Panoramio data.

Table 10. Number of analysed point features (Panoramio and Flickr)

Social media	Aesthetic value (number of points)	Recreational value (number of points)
Panoramio	1212	173
Flickr	962	84
Total	2174	257

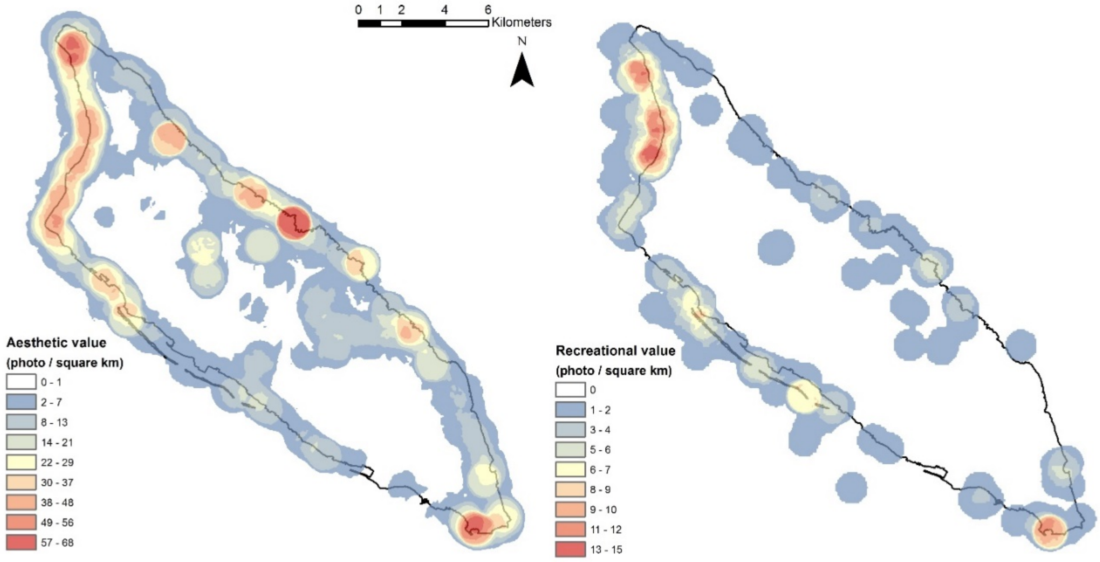


Figure 32. Density points of aesthetic ((left) and recreational value (right) – Panoramio & Flickr (Includes tourists and households).

Locations of aesthetic value

According to the density analysis of Panoramio and Flickr images, areas of high aesthetic value are mainly situated along the coastline with three sites arising as the most prominent hotspots (over 49 photos per square kilometre). First one is the location of California Lighthouse including the dune area on the northern tip of the island. Second hotspot location is the area of Baby Beach Lagoon on the southern tip. Finally, the largest hotspot of aesthetic value is situated on the location of Natural Bridge, a former popular natural attraction that collapsed in 2005.

Locations of recreational value

The main hotspots are situated in the area of highest tourism activity along the western coast of the island including three white beaches (i.e. Malmok, Palm Beach and Eagle Beach). Another recreational hotspot arises in the area of Baby Beach Lagoon on the southern tip of the island. Figure 32 also shows different recreational activities detected within Panoramio and Flickr dataset.

4.4 Conclusion

Total tourism value

To provide an estimate of the total tourism value, it is necessary to draw on the net ecosystem benefits, the tourists' expenditures and the willingness to pay for enhanced nature protection.

The willingness to pay of CTs is US$ 3,878,280 dollars and for SOTs is US$ 6,426,000 dollars and amount to a grand total of value of US$ 10,304,280 dollars. The net ecosystem benefits are calculated at US$ 191,344,400.

This research attempts to identify the variables that influence tourists' WTP for nature conservation, but this research does not focus on explaining these relationships. Even though there was no significance in the variables influencing the WTP and the amount tourists are WTP for nature protection, it is necessary to extent the analysis to identify which variables or specific conditions have a strong influence in the WTP of tourists.

The total value of tourism can be used as an indicator to demonstrate the importance of the tourism as an ecosystem service for the island. Thus, it is necessary to maintain and design strategies to improve the natural environment (degraded areas) in order to increase the benefits that ecosystems are providing to the local livelihoods.

4.5 References

CBS Aruba. (2016, January). GENERAL VISITORS STATISTICS. Retrieved August 08, 2017, from http://cbs.aw/wp/index.php/category/tourism/general-visitors-statistics/

Encyclopedia Britannica A. Retrieved April 12, 2017, from https://www.britannica.com/place/Aruba.

Evans, K., deJong, W., Cronkleton, P., Sheil, D., Lynam, T., Kusumanto, T., Pierce Colfer, C.L. 2006.

US Department of State. (2016, October 31). U.S. Relations With Aruba. Retrieved August 01, 2017, from https://www.state.gov/r/pa/ei/bgn/22491.htm

WTTC. (2015). Travel & Tourism Economic Impact 2015(Publication). London: World Travel & Tourism Council. doi:http://www.caribbeanhotelandtourism.com/wp-content/uploads/data_center/destinations/Aruba-WTTC-EconomicImpact2015.pd.

5. Fisheries

Sacha van Duren[1] and Byron Boekhoudt[2].

[1]Consultant, Wolfs Company, Sarphatistraat 370, 1018 GW Amsterdam, The Netherlands.

[2]Marine Biologist, Department of Agriculture, Husbandry and Fisheries, Local Government Aruba, Piedra Plat 114-A, Paradera, Aruba

5.1 Introduction

Fisheries, or specifically the ecosystems providing the habitat for fish to breed, develop and grow are considered provisioning ecosystem services. This is equal to the portion of gross primary production that is extractable as food (Costanza et al., 1997). On Aruba, fishing is a cultural activity, as well as an economic one. Fishing in Aruba is important for locals, as well as tourists. Islanders rely on local fishing, whether for subsistence, commercial or recreational purposes. To maintain the fishing industry, it is of great importance to protect the biodiversity, the ecosystem and the coral reefs surrounding Aruba. The study area is the Exclusive Economic Zone (EEZ) of Aruba.[10] Exclusive economic zones are sea zones constructed by the United Nations Convention in the Law of the Sea and every state has special rights over its EEZ regarding the exploration and use of marine resources. An EEZ stretches from the baseline out to 200 nautical miles (370 km) from its coast. In case of overlapping zones it is up to the concerned states to delineate the actual

[10] Source picture: Reconstruction of total marine catches for Aruba, southern Caribbean, 1950-2010, D. Pauly, S. Ramdeen & A. Ulman, 2015. (link)

maritime boundaries but generally any point within the overlapping zone belongs to the nearest state.

Aruba is located on the northern fringe of the South American Continental shelf and has extensive shallow water areas (Weidner et al., 2001). Therefore, demersal and reef-associated fish such as snappers and groupers seem to be of greater importance for the fish catch than in other parts of the Lesser Antilles (Weidner et al., 2001). In Aruba's EEZ both reef-associated and non-reef species can be found. Non-reef species, mainly (bentho-) pelagics, rely on foreign ecosystems for most of their lives while reef-associated fishes rely for most of their lives on the quality of the reef in Aruba's EEZ.

The fishing activities on Aruba can be split into three distinct categories: industrial, artisanal and recreational fishing. For industrial and artisanal fishing, the main purpose of going fishing is to sell the fish, while the main purpose of recreational fisheries is leisure. Stated differently, artisanal and industrial fishing are usually done within "working hours" while recreational fishing is usually done within someone's leisure time. Both locals and tourists enjoy recreational fishing on the island. Research has shown that 26% of the entire local population of Aruba practices fishing at least once a year (Pols et al., 2016). Artisanal fishing is further divided into subsistence and commercial fishing. Both ways of fishing are done by traditional boats using small scale gear but the difference between the two practices is the fact that subsistence fishing considers the fish catch that is mainly consumed by fishermen, their families and friends while commercial fishing considers the fish catch that is intended to be sold on the market (Pauly et al., 2015).

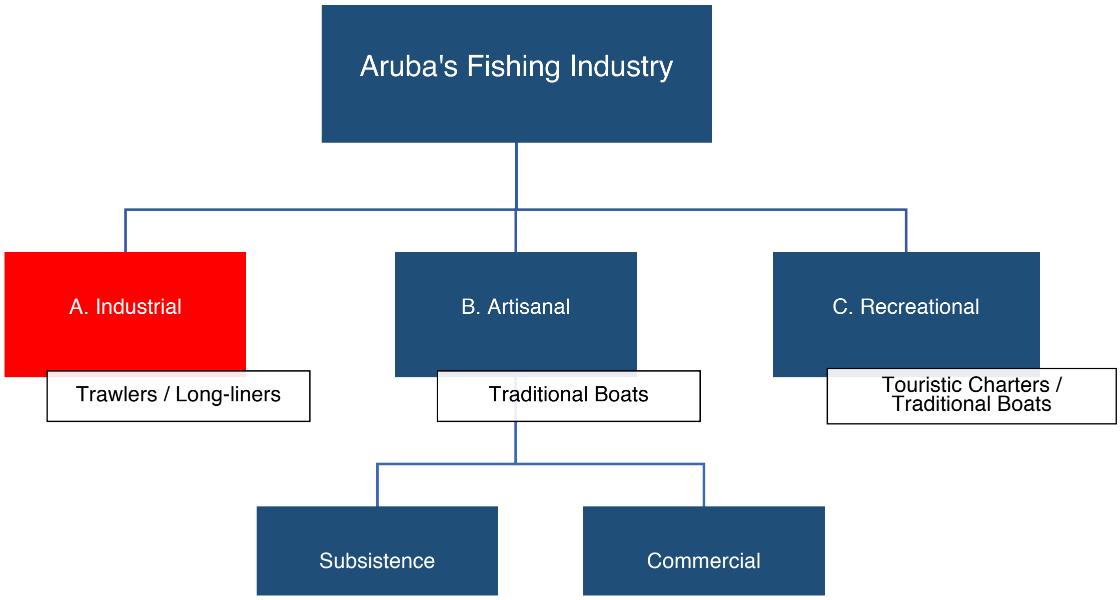


Figure 33 Schematic overview of the Fishing Industry on Aruba.

The industrial box in figure 33 is red since industrial fishing in Aruba's EEZ is mostly done illegally by foreign countries (Pauly et al., 2015). In 2014 the Aruban department of the Coast Guard reported 28 arrests for illegal fishing (Annual Report 2014).[11] Comparing this with other Caribbean islands this amount of arrests for illegal fishing is rather high. In 2014 the Coast Guard department on Curacao, also responsible for Bonaire, reported 15 arrests for illegal fishing and the department on Sint Maarten, also responsible for Saba and St. Eustatius, reported only 4 arrests for illegal fishing in the same year. This implies that illegal fishing is a relatively important issue in Aruba's EEZ. Furthermore, Aruba itself does not have any industrial trawlers fishing in its EEZ, therefore the value of the industrial fishery does not contribute to the local economy of Aruba. There might exist certain fishing access agreements between Aruba and foreign countries, but during an interview with local expert MSc. B. Boekhoudt from Santa Rosa, the local governmental department of agriculture, livestock and fisheries, it appeared that he is not aware of such agreements.[12] However such agreements can be tacit and based on historic rights, but more commonly these agreements are explicit and involve compensatory payment for the coastal state (Pauly & Zeller, 2016). Nevertheless, the landed value of the fish illegally caught by foreign countries is incorporated in this report, since the fish was caught within the borders of Aruba's EEZ.

[11] The Coast Guard of the Kingdom of the Netherlands, Annual Report 2014, page 9 (link)

Figure 33 also states the type of fishing boat used within each fishing sector. Artisanal fishery and recreational fishery by the local population are done by traditional fishing boats, see figure 35.[12] Foreign industrial fishing is carried out by long-liners and trawlers, see respectively figure 34 and 37. Long-liners use baited hooks, on offshoots of a single main line, to catch fish at any depth. Trawling can be divided into midwater trawling and bottom trawling. The latter is a fishing method responsible for the greatest environmental damage. This trawling drags a net weighted down with extremely heavy cables and rollers over the ocean floor, scraping everything in its path, including all sea creatures and plant life-forms, as well as the habitat necessary for their survival. Bottom trawling was banned in Venezuela in 2009 and industrial fish catch by Venezuelan bottom trawlers declined significantly since then (Pauly et al., 2015).

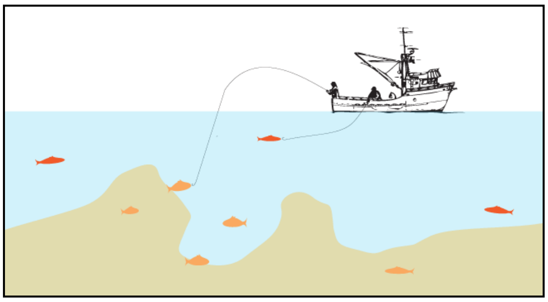


Figure 35 Fishing with traditional boats

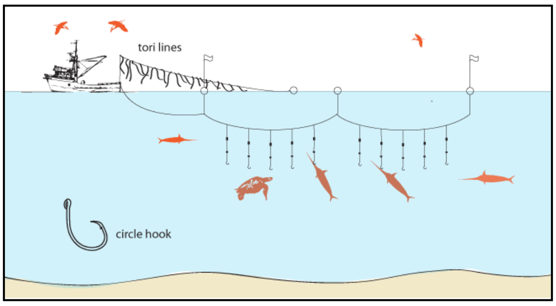


Figure 34 Industrial fishing with long-liners

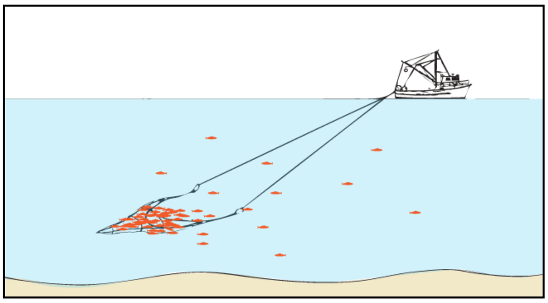


Figure 37 Industrial fishing with trawlers

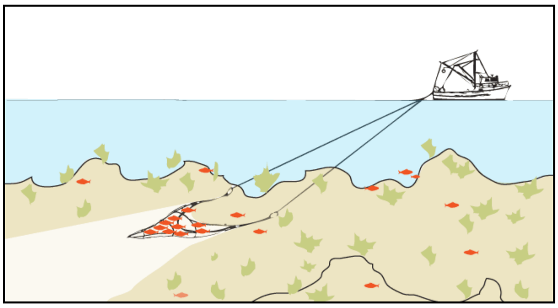


Figure 36 Industrial fishing with bottom trawlers

5.2 Methodology

Market Price Method

To support the analysis of Aruba's fishery valuations, a range of methodologies can be used such as the production function approach, net factor income and the market price method. For this study, the market price method was chosen due to the available data. In addition, the travel cost method was used for one aspect of the calculations. The common approach to calculate the welfare that is created by an ecosystem is called the market price method (Hein, 2010; Van Beukering et al., 2007). This method is based on the economic theory of consumer surplus and producer surplus, which can calculate the (public) welfare that is created within a market.

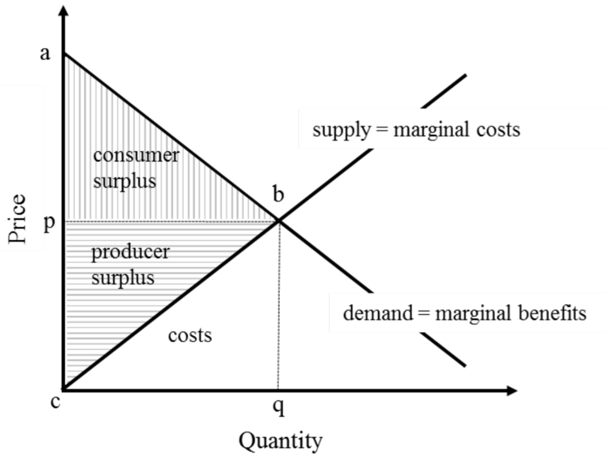


Figure 38 Graph of the consumer surplus and producer surplus

The producer surplus (PS) is defined as the difference between the actual market price and the price at which producers are still willing to sell their product or provide their service, see the horizontally shaded area in figure 38. A so-called producer surplus occurs when the current market price is *higher* than the price at which producers are still willing to sell their product or still willing to provide their service. The price at which producers are still willing to sell is inherently related to the production costs and typically this price is not likely to drop below the production costs. The consumer surplus (CS) is the difference between what consumers are willing to pay for a good or service (demand curve) and its actual market price, see the vertically shaded area in the graph in figure 8. A so-called consumer surplus occurs when the consumer is willing to pay *more* for a good or service than the current market price. The intuition behind the consumer surplus is based on the economic theory of marginal utility, which states that the price a certain individual is willing to pay for a good or service is determined by the amount of utility that person expects to receive from that good or service. In this context, the utility is a quantifiable variable and reflects an individual's amount of utility he/she (unconsciously) assigns to a good or service. The amount of utility each individual assigns to a good or service obviously varies based on everyone's own preferences. However, the more a consumer has of a certain good or service, the less utility he/she is likely to assign to an extra piece of the same good or service.

In the valuation of ecosystem services, the producer surplus must be considered if there are costs related to "producing" the ecosystem good or service (Freeman, 1993; de Boer et al., 1998). For example, in the case of fish stocks as a source of food, these costs relate to the costs incurred by fishermen to carry their harvesting activities. With respect to consumer surplus its estimation is not as straightforward, since demand curves (i.e. the consumers' willingness to pay prices) for any good in general and for ecosystem services in particular, are very difficult to estimate in practice (Costanza et al., 1997). However, if these data are available, the formula to calculate the welfare created in an industry that can be attributed to an ecosystem (or natural resources in general), is the sum of the producer and consumer surplus (Costanza et al., 1997), see formula (1):

$$Welfare\ Created\ by\ Ecosystem = Consumer\ Surplus + Producer\ Surplus \tag{1}$$

Where the consumer surplus is defined in the following formula:

$$Consumer\ Surplus = Consumers'\ Willingness\ to\ pay\ prices - Quantity * Market\ Price \tag{2}$$

As stated above consumers' preferences, the consumers' willingness to pay prices, are rather difficult (if not impossible) to estimate in general. This is also the case for Aruba's fishing industry. Estimating the consumer surplus would imply asking every consumer on Aruba at which price he/she is willing to buy fish. So, in this report the fishery value, i.e. the welfare that is created by the marine ecosystem of Aruba, does not consider the consumer surplus, since there are no data available on consumers' preferences.

Also stated above, the producers willing to sell price is inherently related to the production costs and typically this price is not likely to drop below the production costs. Stated differently; the minimum price at which the producer is still willing to sell his product is equal to the marginal production costs, the production costs of a single unit of the product. For the application of the market price method to Aruba's fishing industry we assume that the price at which the producers are still

willing to sell their product is exactly equal to the marginal production costs. Using this assumption, the following equation holds for the producer surplus:

$$Producer\ Surplus = \ Quantity * Market\ Price - Total\ Production\ Costs \tag{3}$$

Note that formula (3) equals the net value. Not subtracting the total production costs in formula (3) results in the gross value, see formula (4) and (5).

$$Gross\ value = Quantity * Market\ Price \tag{4}$$

$$Net\ value = Quantity * Market\ Price - Total\ Production\ Costs \tag{5}$$

In these formula's quantity is represented by annual fish catch, the market price is the average market price over that year and the total production costs are the production costs of all producers in that same year. Stated differently both gross and net value are represented by annual data.

Valuation of fisheries Aruba

For the industrial fishery (cell A, red box in figure 39) value only the gross value of formula (4) is presented, since data on the production costs are not available due to the illegal character of this industry. For the artisanal fishery (cell B in figure 39) the gross value of formula (4) is presented and the total production costs are computed based on the estimated amount of fishermen on Aruba. This makes it possible to estimate the net value in formula (5) or the so-called producer surplus in formula (3) for the artisanal fishery. Subtracting the estimated total production costs from the gross value of the artisanal fishery results in the net value of the artisanal fishery. However, note that according to the theoretical background a consumer surplus should also be taken into account when calculating the welfare that is created within an ecosystem but due to the available data the consumer surplus is not taken into account for this valuation study.

The valuation of the recreational fisheries (cell C in figure 39) is slightly different than the valuation of the industrial and artisanal fisheries. Using the total production costs to obtain the net recreational fishery value does not make sense since the purpose of going fishing within the recreational fishery sector is leisure and not to produce the fish and subsequently sell it on the market. As mentioned earlier, recreational fishing is done within someone's leisure time. This means that

the recreational fishery value should also contain a value for the perceived quality of the fishing experience. The travel cost method can be used to estimate the economic value associated with ecosystems or sites that are used for recreation. The basic assumption of this method is that the costs involved with visiting the site or using the ecosystem for recreational purposes can be interpreted as the willingness to pay (King & Mazzotta, 2000). Stated differently, the total costs of local recreational fishing in fact represent the value of recreational fishing done by the local population on the island.

Data collection

Data Local Government Aruba

Santa Rosa, the department of agriculture, livestock and fisheries of the local government of Aruba, keeps track of the local fish catches by estimating the annual catch of groupers, snappers & jobfishes, wahoo and marine fishes, see figure 39 (Boekhoudt, 2015). The estimated catch data include artisanal, recreational and subsistence fisheries; industrial fishery is not included. As can be seen in figure 39, between 2006 and 2011 some fluctuations in the total fish catch occurred but after 2011 the total fish catch has largely remained constant, although it has declined slightly since 2011. The graph also indicates that the catch mainly consists of marine fishes, wahoo and snappers & jobfishes. Groupers only account for a relatively small part of the catch.

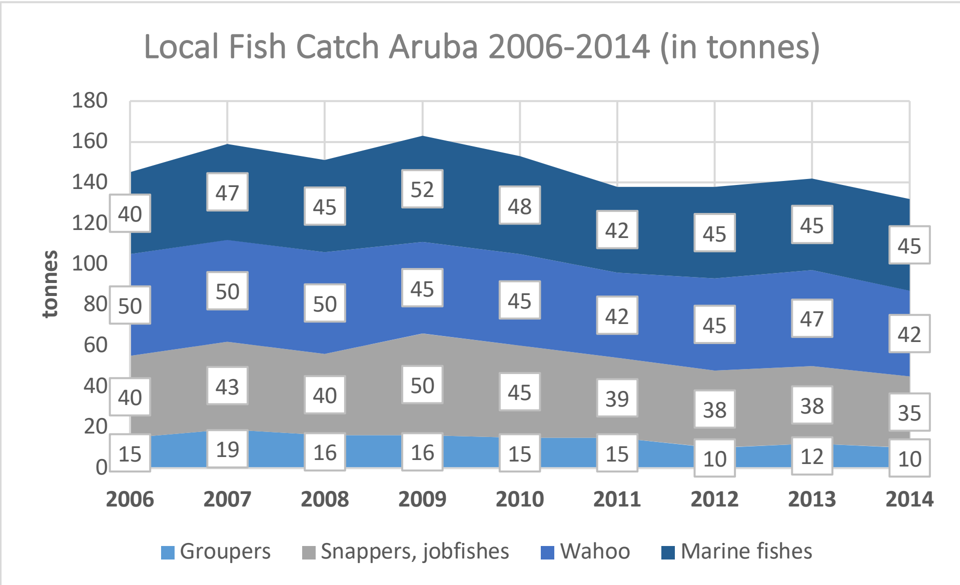


Figure 39 Local Fish Catch Aruba 2006-2014 (Santa Rosa, Local Government of Aruba)

Regarding the fish price on Aruba, there are two main categories (Boekhoudt, 2015). The groupers, snappers & jobfishes and wahoo belong to the so-called "bon pisca" (good fish) with an average price range per kg. of 10-18 AWG (Aruba Florin). On the other side the average price range per kg. of the marine fishes is 7-8 AWG, see table 11. Based on the interview with MSc. B. Boekhoudt, civil servant working at Santa Rosa, an unknown percentage of the marine fishes also belong to the "bon pisca", so the fish price of this part within the marine fish catch is higher.

Table 11 Fish prices on Aruba 2017 (Santa Rosa, Local Government of Aruba)

	"Bon pisca (good fish)"	Marine fishes
Price per kg. range (AWG)	AWG. 10 -18	AWG. 7 - 8
Average price per kg. (AWG)	AWG. 14	AWG. 7.5
Average price per kg. (US $)[13]	$ 7.80	$ 4.18

In addition, Santa Rosa annually estimates the number of fishermen on Aruba. As can be seen in figure 40 the number of occasional and part-time fishermen on Aruba has risen significantly between 2010 and 2014, while the number of full-time fishermen remains more or less constant over this period (Boekhoudt, 2015). Full-time fishermen spend at least 90% of their working time fishing or receive at least 90% of their income from fishing. For part-time fishermen, this percentage lies between 30% and 90% and for occasional fishermen holds that they spend at most 30% of their working time fishing or receive at most 30% of their income from fishing (FAO, 2002).

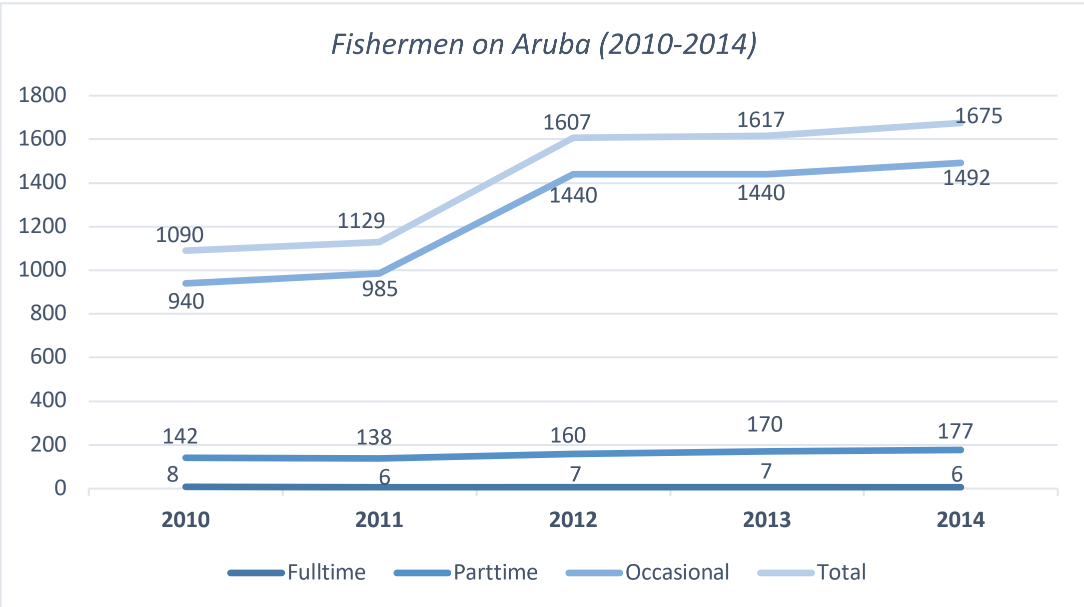


Figure 40 Fishermen on Aruba 2010-2014 (Santa Rosa, Local Government of Aruba)

[13] Based on exchange rate d.d. 09-10-2017: AWG 1 = US $ 0.56.

According to the same interview with local expert MSc. B. Boekhoudt (2017) the amount of fishing boats on Aruba is estimated at 3035 in total. The amount of traditional boats on the island is estimated at 3000; 1800 for artisanal fishery and 1200 for recreational fishery done by the local population. However these estimates seem rather high since they also include old and inactive fishing boats. Furthermore comparing the total amount of fishermen in 2014 on Aruba stated in figure 40 (=1675) with the estimated amount of tradiotional fishing boats, 3000, suggests that almost every fishermen has two fishing boats. But according to the local expert interview fishing boats are most of the time shared by fishermen on Aruba, so it is assumed that the actual amount of active fishing boats on the island is much lower. The amount of touristic fishing charters in 2017 offering tourists fishing excursions is estimated at 35. This estimate on the other side is relatively low considering the fact that Aruba has a thriving marine-based tourism industry based on game fishing and scuba-diving (Pauly et al., 2015).

Table 12 Estimated amount of fishing boats on Aruba (interview local expert MSc. B. Boekhoudt, 2017)

Fishing boat	Type of fishing	Estimated amount 2017
Traditional boat	Artisanal fishery	1800
Traditional boat	Recreational fishery by local population	1200
Touristic charters	Recreational fishery by tourists	35
Total	**All types**	**3035**

Sea Around Us - introduction

Consistent and reliable island-wide fisheries catch data are a challenge for many Caribbean countries (Pauly et al., 2015). Sea Around Us is an international research initiative by the Institute for the Oceans and Fisheries within the University of British Colombia (Canada) and it provides reconstructed data on fish catches and landed values in U.S. dollars worldwide starting in 1950 for individual EEZ's. The database provides landed values of fish caught by major groupings of species based on ex-vessel prices in combination with spatially allocated catches. Ex-vessel prices represent the price of the fish catch received by the captain at the point of landing. Distribution and cleaning costs for example are not considered. The data sets consist of official reported data and reconstructed estimates of unreported data (including major discards). A review of all available literature (peer-reviewed and grey, online and archived) was undertaken to obtain the information required to reconstruct the total fisheries catches (artisanal, subsistence, recreational, and foreign/industrial) for the period 1950-2010 using the methods of Zeller et al. (2007). The official reported data are mainly extracted from the Food and Agriculture Organization of the United Nations (FAO) FishStat database, while the reconstructed data of the fish catch are estimated using time

series. The data presented, which are all freely available, are meant to support studies of global fishery trends, to support the development of sustainable fishery policies and to support the conservation of the marine ecosystems worldwide.

Within the Sea Arounds Us database the fish catches and the landed values can be selected for different criteria, for example year, fishing entity, scientific name of the fish, functional group and fishing sector (i.e. industrial, artisanal, subsistence and recreational). The database also reports which part of the fish catch is actual landings and which part was discarded. For an overview of all criteria see the Sea Around Us database.[14] Furthermore a so-called uncertainty factor is included in the database to account for estimation errors in the time series of the reconstructed catch data according to Zeller et al. (2015). See table 4 for the uncertainty scale and explanations. The authors of the reconstructions have assigned a score for the catch estimate to each reconstruction by fisheries sector (industrial, artisanal, etc.) in each of three periods (1950-1969, 1970-1989 and 1990-2010) expressing their evaluation of the quality of the time series, i.e., (1) 'very low', (2) 'low', (3) 'high' and (4) 'very high', seen in table 13. The final uncertainty score mentioned in the Sea Arounds Us database consists of the mean of the uncertainty scores reported by different authors in combination with the evidence in the data.

Table 13 Sea Arounds Us Uncertainty Scores (Zeller et al., 2015)

Uncertainty Score	Quality of the Time Series	+/- (%)	Corresponding IPCC criteria
4	Very high	10 %	High agreement & robust evidence
3	High	20 %	High agreement & medium evidence **or** medium agreement & robust evidence
2	Low	30 %	High agreement & limited evidence **or** medium agreement & medium evidence **or** low agreement & robust evidence
1	Very Low	50%	Low agreement & low evidence

To validate the reconstructed catch data the estimated landed values of Sea Around Us are compared to other fishery valuation studies of other Caribbean islands. As can be seen in table 14 the fishery valuation study of Bonaire calculated a reef-associated gross value of US$ 445,317 in 2012 and a total gross fishery value of US$ 918,178 (Schep et al., 2012). The Sea Around Us landed values for the same year of the reef-associated fish and of the entire fish catch (reef and non-reef) are

[14] The Sea around us database for Aruba's EEZ can be downloaded here link.

respectively US$ 531,854 and US$ 1,454,868. The difference between the gross values of the fishery valuation study of Bonaire and the Sea Around Us landed values is bigger for the entire fish catch (US$ 1,454,868 - US$ 918,178 = US$ 536,690) than the difference between the two values for the reef-associated fish (US$ 531,854 - US$ 445,317 = US$ 86,537), so the Sea Around Us landed values seem to approach the reef-associated gross value of Bonaire better than the total gross value of Bonaire.

For Saba & St. Eustasius the reef-associated gross value in 2014 was US$ 1,570,575 (Cado van der Lely et al., 2014a; 2014b) and the Sea Around Us Landed value of the reef-associated fish in the same year was US$ 1,617,149. Cado van der Lely et al. (2014a: 2014b) did not include a total gross value of the entire fish catch so it is not possible to compare this gross value with the Sea Around Us landed value. The difference between the reef-associated gross value of the fishery valuation study of Saba & St. Eustasius and the Sea Around Us reef-associated landed value is US$ 1,617,149 - US$ 1,570,575 = US$ 46,574. This relatively small difference suggests that the Sea Around Us landed value more or less matches the gross value of the fishery valuation study of Saba & St. Eustasius. Based on these comparisons it is assumed that the Sea Around Us landed values can be used for the fishery valuation of Aruba.

Table 14 Comparison of Fishery Valuations and Sea Around Us Landed Values (in U.S. $)

Data	Bonaire (2012)		Saba & St. Eustasius (2014)	
	Reef-associated	Reef & non-reef	Reef-associated	Reef & non-reef
Fishery Valuation Gross Value	$445,317	$918,178	$1,570,575	N.A.
Sea Around Us Landed Value	$531,854	$1,454,868	$1,617,149	$1,620,315

Sea Around Us Data for Aruba

The Sea Around Us cumulative reconstructed domestic fisheries catches of Aruba were estimated over 36,300 tonnes which is 75% more than the 20,676 tonnes reported by FAO on behalf of Aruba (Pauly et al., 2015). However, it should be noted that this Sea Around Us amount is likely to be a conservative estimate based on the limited information available (Pauly et al., 2015). Although imports play an

important role in meeting local seafood demand, which is magnified by tourism, small-scale artisanal fishing is likely to be underestimated (Pauly et al., 2015). According to the Sea Around Us database the estimated total fish catch for 2014 in Aruba's EEZ is 1,617 tonnes, see the last row of table 15. The table also presents the estimated fish catch for each sector, industrial, of the fishery industry on Aruba in the second column. The estimated recreational fish catch is the highest, i.e. 752 tonnes in 2014, and the estimated fish catch within the artisanal – subsistence subsection is the lowest, i.e. 31 tonnes in 2014. Furthermore, a distinction is made between the fish catch within the reef and fish catch from elsewhere in Aruba's EEZ, non-reef fish catch. See the third and the fourth column of table 15 for an indication of the estimated reef and non-reef fish catches. Reef fish catch considers small reef associated fish (<=30 cm), medium reef associated fish (<=60 cm), large reef associated fish (<= 90 cm), medium demersals (30 - 89 cm), other demersal invertebrate, large rays (>=90 cm), lobster & crabs and shrimps. Non-reef fish include mainly (bentho-) pelagic species.

Table 15 Estimated Fish Catch Aruba 2014 in tonnes (1 ton = 1000 kilograms)

	Estimated Fish Catch Aruba 2014 (tonnes)				
	Total Catch	**Reef**	**Non-reef**	**% Reef**	**% Non-reef**
Industrial	691 t	359 t	332 t	52 %	48 %
Artisanal – Subsistence	31 t	27 t	4 t	87 %	13 %
Artisanal - Commercial	143 t	82 t	61 t	57 %	43 %
Recreational	752 t	282 t	470 t	37.5 %	62.5 %
Total Fish Catch Aruba	**1617 t**	**750 t**	**867 t**	**46 %**	**54 %**

Finally, the last two columns of table 15 present the percentage of the reef fish catch and the percentage non-reef fish catch of the total estimated fish catch in Aruba's EEZ in 2014. It can be seen that 87 % of the estimated artisanal – subsistence fish catch consists of reef related fishes and 57 % of the estimated artisanal – commercial fish catch consists of reef related fish. This makes sense since, both ways of fishing are done by traditional boats using small scale gear and mostly operating around the reef near the coast. Furthermore table 16 shows that only 37.5 % of the estimated recreational fish catch consists of reef related fish, this also makes sense since recreational fisheries by touristic charters make use of larger fishing boats and modern equipment which are intended to fish at the open sea. At last, table 15 shows that 750 tonnes or 46 % of the total estimated fish catch can be attributed to Aruba's reef.

Next to fish catch estimations, the Sea Around Us database contains the landed values of the fish catch. Table 16 shows the landed values of the fish catch for Aruba's EEZ in 2014. Note that the landed values are presented in U.S. dollars, this is done for all countries in the Sea around us database to make comparisons worldwide easier. The same table set up as used in table 15 (fishery subsections, reef and non-reef catch including percentages) is used in table 16.

Table 16 Estimated Landed Values Fish Catch Aruba 2014 in U.S. dollars

	Estimated Landed Value Fish Catch Aruba 2014 (U.S. $)				
	Total Catch	**Reef**	**Non-reef**	**% Reef**	**% Non-reef**
Industrial	$2,113,261	$900,783	$1,212,475	43 %	57 %
Artisanal – Subsistence	$149,589	$134,477	$15,112	90 %	10 %
Artisanal - Commercial	$567,036	$440,431	$126,604	78 %	22 %
Recreational	$1,622,284	$422,191	$1,200,093	26 %	74 %
Total Landed Value Aruba	**$4,452,169**	**$1,897,882**	**$2,554,287**	**43 %**	**57 %**

As can be seen in table 16, 43 % of the total landed value of Aruba's fish catch can be attributed to the reef. Comparing the reef and non-reef percentages of table 15 and table 16 gives an indication of the perceived quality of the reef fish. Stated differently, has each tonnes of reef fish the same landed value? One would expect that these percentages more or less show the same results for the four different fishing sectors; industrial, artisanal – subsistence and commercial and recreational. However the reef percentage of the artisanal – commercial fish catch in table 15 of 57 % is much lower than the reef percentage of the artisanal – commercial landed value in table 16 of 78 %. This would mean that the reef fish caught within the artisanal – commercial industry is much more valuable than the reef fish caught in other fishing sectors. However looking closer within the database it appears that the big difference in reef percentage between artisanal – commercial fish catch and artisanal – commercial landed value is caused by the fact that the reef fish catch in 2014 contains 38 tonnes of snappers (medium reef associated fish <=60 cm) which translates into US$ 322,126 landed value. At the same time the non-reef fish catch contains 47 tonnes of mackerels, tunas & bonitas (large pelagics >=90 cm) which translates in only $ 47.777 landed value. Note that the estimated landed values in combination with the estimated fish catch imply the landed value (ex-vessel price) per kg. fish. Logically this price differs per fish type, i.e. the ex-vessel price of the aforementioned snappers is $ 8.50 per kg. while the ex-vessel price of the mackerels, tunas & bonitas is $ 1.59 per kg. This explains the big difference of the landed value of the reef fish in the

artisanal – commercial fishing sector compared to the landed value of the reef fish. However the ex-vessel price of the mackerels, tunas & bonitas of $ 1.59 per kg. is extremely low and therefore disputable.

As mentioned before industrial fishing in Aruba's EEZ is only done illegally by foreign countries. Table 17 shows the estimated fish catch and the corresponding estimated landed values in 2014 of these foreign countries. It can be seen that Venezuelan trawlers and long-liners have caught 287.86 tonnes of fish in Aruba's EEZ in 2014. This corresponds to a landed value of US$ 1,157,008, which is 55 % of the total landed value within the industrial fisheries category. Also, Cuba and Taiwan have caught significant amounts of fish in Aruba's EEZ in 2014, respectively 166.08 tonnes and 237.05 tonnes, see table 17.

Table 17 Estimated Landed Values Fish Catch Aruba 2014. (In US$).

Industrial Estimated Fish Catch EEZ Aruba 2014	Catch (tonnes)	Percentage	Landed Value ($)	Percentage
Cuba	166,08 t	24 %	$467,703	22 %
Korea (South)	0,394 t	0 %	$877	0 %
Taiwan	237,05 t	34 %	$487,667	23 %
Venezuela	287,86 t	42 %	$1,157,008	55 %
Unknown Fishing Country	0,003 t	0 %	$4,50	0 %
Total Industrial Fisheries	**691 t**		**$2,113,261**	

The Sea Around Us database contains the following uncertainty scores and corresponding confidence intervals for the landed values of the reconstructed fish catch of Aruba in 2014, see table 18. Note that for the illegal industrial fisheries in Aruba's EEZ in 2014 no uncertainty score is available, as is the case for all the other industrial fishery estimations in other years starting in 1950. The fact that there is no uncertainty score might be related to the fact that industrial fishing is often done illegally. Furthermore, both for the reconstructed catch data of the recreational and the artisanal – subsistence fishing sector of Aruba in 2014 the uncertainty score is 1, "very low" quality of the time series, see table 14 for details on the uncertainty scales. This means that the data presented earlier for the recreational and artisanal – subsistence fishing sectors can vary a lot; +/- 50%. The uncertainty score of the reconstructed fish catch data of the artisanal – commercial fishing sector is 3, "high" quality of the time series. This indicates that the results presented earlier for the artisanal – commercial fishing sector can vary +/- 20%. So the reconstructed catch data for this fishing sector are definitely more accurate, but there is still some uncertainty left. Based on the uncertainty scores table 18 also presents a lower bound and an upper bound of the estimated landed values for each fishing sector of Aruba in 2014. Especially the confidence intervals

[lower bound; upper bound] of the landed value of the recreational and artisanal – subsistence fisheries are rather big due to the low quality of the time series.

Table 18 Sea Arounds Us uncertainty scores and confidence intervals of the reconstructed fish catch data for Aruba in 2014. (In US$)

Fishing Sector	Uncertainty Score	+/- (%)	Lower Bound Landed Value 2014	Upper Bound Landed Value 2014	Landed Value 2014
Industrial	-	-	-	-	$ 2.113.261
Artisanal - Subsistence	1	50%	$ 74.795	$ 244.384	$ 149.589
Artisanal - Commercial	3	20%	$ 453.629	$ 680.443	$ 567.036
Recreational	1	50%	$ 811.142	$ 2.433.426	$ 1.622.284

5.3 Results

Gross Fishery Value

The Sea Arounds Us landed values of the artisanal – subsistence, artisanal – commercial and the recreational fishing sector are respectively US$ 149,589, US$ 567,036 and US$ 1,622,284, see table 19 below. Adding these values of each fishing sector results in the total gross fishery value of Aruba: US$ 2,338,909 as can be seen in table 19. This value does not include the illegal industrial fisheries by foreign countries. Adding the landed value of the industrial fisheries results in the estimated gross value of Aruba's EEZ including the illegal industrial fisheries of US$ 4,452,170.

Table 19 Gross Fishery Value Aruba's EEZ (in U.S. $)

Gross Fishery Value Aruba's EEZ	Annual Value 2014
Artisanal Fishery – Subsistence	$ 149,589
Artisanal Fishery – Commercial	$ 576,036
Recreational Fishery	$ 1,622,284
	+
Gross Fishery Value excl. Industrial Fishery (illegal)	**$ 2,338,909**
Industrial Fishery (illegal)	*$ 2,113,261*
	+
Gross Fishery Value incl. Industrial Fishery (illegal)	*$ 4,452,170*

Costs of Fishing

The costs of fishing are computed based on the number of fishermen estimated by the local government of Aruba, see figure 20. The estimated amount of full time, part time and occasional fishermen in 2014 is respectively 6, 177 and 1492, see also table 20. It is assumed that both full time and part time fishermen work within the artisanal fishery sector and occasional fishermen are assumed to fish for recreational purposes. As stated before, full time fishermen spend at least 90% of their working time fishing or receive at least 90% of their income from fishing (FAO, 2002). For part time fishermen, this percentage lies between 30% and 90% and for occasional fishermen holds that they spend at most 30% of their working time fishing or receive at most 30% of their income from fishing (FAO, 2002). To calculate the amount of FTE's for every sector, the middle of each interval [90%,100%]; [30%,90%] and [0%,30%] is used, resulting in the average time spend on fishing of respectively 95%, 60% and 15% as can be seen in table 20.

Table 20 Assumptions and data used to calculate the costs of fishing with traditional boats

Fishermen	Sector	# Fishermen 2014	% Time	FTE	# Fishermen on boat	# Active Boats
Full time	Artisanal	6	95%	5.7	2	2.85
Part time	Artisanal	177	60%	106.2	2	53.1
Occasional	Recreational	1492	15%	223.8	2	111.9

Multiplying the number of fishermen in 2014 with the average amount of time spend on fishing results in the FTE's. Furthermore, it is assumed that traditional boats are staffed on average with two fishermen. This is in accordance with other Caribbean fishing studies (Schep et al., 2012). Dividing the amount of FTE's by the average number of staffed fishermen results in an estimation of the number of *active* traditional fishing boats on Aruba. For the artisanal fishing sector this results in 2.85 + 53.1 = 55.95 active traditional fishing boats. The estimated amount of active traditional fishing boats on Bonaire was 29 in 2012 (Schep et al., 2012), so that would suggest that the artisanal fishing industry on Aruba has twice as many traditional fishing boats than the artisanal fishing industry on Bonaire. For the recreational fishing sector dividing the amount of FTE's by the average number of staffed fishermen results in 111.9 active traditional fishing boats, see the last column of table 20. The recreational fishing sector mentioned here considers only recreational fishing done by the local population; the active traditional fishing boats are not used by tourists. Note that within this calculation not every single fisherman has its own fishing boat but all traditional fishing boats are assumed to be shared by local fishermen. This is in accordance with information from the local expert interview. According to the local expert the annual fixed costs of traditional fishing boats are $4,422.73 and the variable costs per trip are $33.52, see table 21.

Table 21 Overview annual costs traditional fishing boats (in US$).

Traditional Boats	# Active Boats	Annual Fixed Costs	Total Annual Fixed Costs	# Trips	Variable Costs per trip	Total Annual Variable Costs	Total Annual Costs
Artisanal Fishery	55.95	$4,422.73	$ 247,451	225	$33.52	$421,970	**$669,421**
Local Recreational Fishery	111.9	$4,422.73	$ 494,903	225	$33.52	$843,940	**$1,338,843**

It is assumed that annually every traditional fishing boat is not being used for 7 weeks on average due to holidays and bad weather. This results in 52 – 7 = 45

available weeks and 45 * 5 = 225 available days for fishing trips, see table 21. The total annual fixed costs are computed by multiplying the estimated amount of active traditional fishing boats by the annual fixed costs, resulting in US$ 247,451 total annual fixed costs for the artisanal fishery and US$ 494,903 for the local recreational fishery, see table 21. The total annual variable costs are computed by multiplying the number of trips by the variable costs per trip and by the estimated amount of active traditional fishing boats. As can be seen in table 21 this results in the total annual variable costs of US$ 421,970 for artisanal fishery and US$ 843,940 for local recreational fishery. Adding the total annual fixed costs and the total annual variable costs result in the total annual costs of US$ 669,421 for artisanal fishery and US$ 1,338,843 for local recreational fishery as can be seen in the last column of table 21.

Net Artisanal Fishery Value

The gross value of the artisanal fisheries is calculated by adding the Sea Around Us landed values of the artisanal – subsistence and commercial fisheries, which results in US$ 149,589 + US$ 576,036 = US$ 725,625, see table 22.

Table 22 Annual Values of the Artisanal Fishery Industry in Aruba's EEZ (in US$).

Artisanal Fishery EEZ Aruba	Annual Value	
Landed Value Artisanal Fishery – Subsistence	$149,589	
Landed Value Artisanal Fishery - Commercial	$576,036	
		+
Gross Artisanal Fishery Value EEZ Aruba	**$725,625**	
Total Production Costs Artisanal Fishery	$669,421	
		- -
Net Artisanal Fishery Value EEZ Aruba	**$56,204**	

This gross value reflects the landed value of the fish caught for subsistence and commercial purposes with traditional fishing. Note that the total annual costs for the artisanal fishery (US$ 669,421) presented in table 21 match the so-called *total production costs* stated in formula (3) and formula (5) of the methodology. As can be seen in table 22 subtracting these total production costs of the gross artisanal fishery value results in the *net* artisanal fishery value for Aruba of US$ 725,625 - US$ 669,421 = US$ 56,204. This net artisanal fishery value of US$ 56,204 is the added value of the marine ecosystem for the local economy on Aruba. The total production costs of the artisanal fishery account for 92% of the gross artisanal fishery value, which is extremely high compared to other studies. For Bonaire, the total production costs are only 44% of the gross annual fishery value (Schep et al., 2012). This suggest that the costs of traditional fishing boats on Aruba might be

overestimated and that the net artisanal fishery value is likely to be underestimated.

Recreational Fishery Value

As discussed before, using the total annual costs of the local recreational fishery stated in table 21 as *total production costs* to obtain the *net* recreational fishery value does not make sense since the purpose of going fishing within the recreational fishery sector is leisure and not to *produce* the fish and subsequently sell it on the market. However, the amount of money spent on local recreational fishing, which is equal to the annual costs, reflect the value of recreational fisheries for the local population using the so-called travel cost method. Note that the total annual costs of the recreational fisheries are calculated based on the number of occasional fishermen which implies that the total annual costs only reflect the value of the recreational fisheries of the *local* population and not the value of the recreational fisheries by tourists. So, based on the travel cost method the local recreational fishery value is US$ 1,338,843, see the last column of table 21 above and table 23 below.

Table 23 Annual Values of the Recreational Fishery Industry in Aruba's EEZ

Recreational Fishery EEZ Aruba	Fishing is done by	Annual Value
Travel cost method: Total Costs Local Recreational Fishery	Local population	**$1,338,843**

5.4 Conclusion

The total gross fishery value of Aruba's EEZ, excluding the illegal industrial fisheries by foreign countries, is US$ 2,338,909. The Sea Around Us landed value of the fish illegally caught in Aruba's EEZ by foreign countries equals US$ 2,113,261. Venezuela gains most of the foreign countries fishing in Aruba's EEZ with 55% of this landed value. Since industrial fishing is done illegally and by several foreign countries it is complicated and almost impossible to trace back the total production costs. Therefore, only the gross value of the illegal industrial fisheries is stated in this report. Although it would be interesting to trace back the total production costs of the foreign trawlers and long-liners in future research to gain a better insight in the dynamics of the industrial part of Aruba's fishing industry since it is likely that the industrial illegal fisheries effect the other fishing sectors in Aruba's EEZ through fish stocks and other environmental interactions.

The net artisanal fishery value and the annual value of the local recreational fishery value together give the best indication of the welfare created for Aruba by its marine ecosystem. Welfare created by the marine ecosystem consists of economic and social gains. The net artisanal fishery value of $56,204, estimated with the market price method, is the added economic value of the marine ecosystem for the local economy on Aruba. The local recreational fishery value of US$ 1,338.843, estimated with the travel cost method, is the added social value of the marine ecosystem for the local population. The total production costs of the artisanal fishery are extremely high, 92% of the gross annual artisanal value, and therefore disputable. Obtaining primary data on the total production costs of the artisanal fishery too is also interesting for future research.

5.5 References

Boekhoudt, B. (2015). Piscamento na Aruba, Santa Rosa, department of agriculture, livestock and fisheries, Local Government of Aruba.

Cado van der Lely, J.A., Warning, A.E., Schep, S.W., Van Beukering, P. & Wolfs, E. (2014). The Total Economic Value of Nature on Saba, IVM Institute for Environmental Studies, VU Amsterdam, Netherlands.

Cado van der Lely, J.A., Warning, A.E., Schep, S.W., Van Beukering, P. & Wolfs, E. (2014). The Total Economic Value of Nature on St. Eustatius, IVM Institute for Environmental Studies, VU Amsterdam, Netherlands.

Costanza, R. et al. (1997). The value of the World´s Ecosystem Services and Natural Capital. *Nature*, 387, 253-260.

de Boer, B., Jansen, H., Hueting, Lambooy, J. and R., Reijnders, L. (1998). The concept of environmental function and its valuation. *Ecological Economics*, 25(1), 31-35.

FAO (2002). CWP Handbook of Fishery Statistical Standards. Section K: FISHERS. CWP Data Collection. In: Food and Agriculture Organization of the United Nations, Fisheries and Aquaculture Department [online], Rome.

Freeman, A.M. (1993). The measurement of environmental values and resources: theory and methods, *Resources for the Future*, Washington DC.

Hein, L. (2010). Economics and ecosystems: efficiency, sustainability and equity in ecosystem management. UK: Edward Elgar Publishers.

King, D.M. & Mazzotta, M.J. (2000). http://www.ecosystemvaluation.org, University of Maryland.

Kustwacht voor het Koninkrijk der Nederlanden in het Caribisch Gebied (2014). *Samen Sterk*, Jaarverslag 2014.

Law of the Sea. "Part V – Exclusive Economic Zone, Article 56". United Nations.

Pauly, D., Ramdeen, S. & Ulman, A. (2015). Reconstruction of total marine catches for Aruba, southern Caribbean, 1950-2010. Working Paper. Vancouver, Canada: Fisheries Centre, University of British Columbia.

Pauly, D. & Zeller, D., editors (2016). Catch Reconstruction: concepts, methods and data sources. Online Publication. *Sea Around Us* (www.seaaroundus.org). Vancouver, University of British Columbia.

Pols, R. (2016). Nature Valuation on Aruba: a perspective from the local community. MSc. Thesis at Institute for Environmental Studies, VU University Amsterdam, Netherlands.

Schep, S.W., Johnson, A.E., Van Beukering, P. & Wolfs, E. (2012). The fishery value of coral reefs in Bonaire Applying various valuation techniques, IVM Institute for Environmental Studies, VU Amsterdam, Netherlands.

Van Beukering, P., Haider, W., Longland, M., Cesar, H., Sablan, J., Shjegstad, S., Beardmore, B., Liu, Y. & Omega-Garces, G. (2007). The economic value of Guam's coral reefs. University of Guam Marine Laboratory Technical Report No. 116.

Van Beukering, P. Brander, L., Tompkins, E. & McKenzie, E. (2007). Valuing the environment in small islands – an environmental economics toolkit. Peterborough: Joint Nature Conservation Committee (JNCC), 128 pp. (ISBN 978 1 86107 5949).

Weidner, D.M., Laya, G.E., & Serano, J.A. (2001). World swordfish fisheries: an analysis of swordfish fisheries, market trends and trade patterns, past-present-future. *National Oceanic and Atmospheric Administration, National Marine Fisheries Service* (NMFS), Vol. IV. Latin America, Part B. Caribbean, Section 4. Montserrat to Puerto Rico. Chapter 17. The Netherlands Antilles and Aruba. pp. 1053-1145. NMFS: Silver Spring, Maryland.

Zeller, D. & Pauly, D. (2016). Marine fisheries catch reconstruction: definitions, sources, methodology and challenges, *Global Atlas of Marine Fisheries: Ecosystem Impacts and Analysis*. Island Press, Washington, D.C.

Zeller, D., Booth, S., Davis, G. & Pauly, D. (2007). Re-estimation of small-scale fishery catches for U.S. flag -associated island areas in the western Pacific: the last 50 years. *Fishery Bulletin*, 105(2): 266-277.

Zeller D, Harper S, Zylich K and Pauly D (2015) Synthesis of under-reported small-scale fisheries catch in Pacific -island waters. *Coral Reefs*, 34(1): 25-39.

6. Agriculture

Francielle Lacle[1] and Rendell de Kort[2].

[1]Senior consultant, YABI Consultancy, Boroncana 223A, Aruba.

[2]Consultant, Cornerstone Economics, G.M. de Bruynewijk 57, Aruba.

6.1 Introduction

Until the end of the 19th century economic activity on Aruba mainly included the husbandry of cattle and export of Brazilwood. Agriculture gradually diminished in significance as the economy diversified away from this sector. The start of the 20th century was characterized by natural resource extraction, including: limestone, phosphate and gold (Derix, 2016). Although the cultivation of Aloe for export from ca. 1890 to 1945 did form a significant source of revenue, in modern times, agriculture and other economic activity have largely been crowded out by tourism. This was particularly evident since Aruba obtained its autonomous status within the Kingdom of the Netherlands in 1986. So much so that Aruba ranked second among tourism destinations in terms of relative contribution[15] of travel and tourism to GDP in 2016 and jobs in the tourism industry accounted for an estimated 89.3 percent of total employment (World Travel and Tourism Council, 2017).

Agriculture and livestock are provisioning services by terrestrial ecosystems (van Beukering, 2007). Agriculture can enhance services such as the regulation of soil and water quality, and carbon sequestration, especially in comparison to degraded land. Agriculture can also cause disservices, such as loss of habitat, nutrient leakage, erosion and pollution by pesticides. Livestock on the island can also cause a disservice through extensive uncontrolled grazing by introduced feral goats (Capra hircus) in Arikok National Park. This affects the conservation of vegetation, especially indigenous plants such as Palisia cora (Bursera simaruba), Giron (Crataeva tapia), Kiviti (Croton Niveus), Huñagato (Pithecellobium platylobum), Mahawa (Ficus brittonnii), Huliba (Capparis odoratissima) and Huliba Macho (Capparis indica) (Bholasing, 2013 and Natuur & Landshap structuurnota

[15] Direct, indirect and induced.

1996)[16]. It is possible to create a win-win situation under sustainable agricultural and livestock management (Power, 2010)[17].

Despite its diminished relative importance, the following chapter will show that agricultural activity through the formal economy along with its activity in the informal economy holds great value to Aruba and offers potential to improve standards of living. The main constraints found for development of the sector through stakeholder consultation were; access to affordable and reliable water, diseconomies of production scale/ high labour costs and market access.

The following chapter outlines the methodology, followed by an estimate of the economic value of agriculture and livestock, concluding with a brief discussion.

6.2 Methodology

It should be noted that the analysis is constrained by the limited availability of relevant data on the island in various domains. For this reason, the estimation for an economic value of the agricultural sector is not included in the Total Economic Value (TEV) of the TEEB research, however given its relative importance according to stakeholders an estimation of this value is made within this paragraph as well as an assessment of the data constraints to be able to have a clearer view on the ecosystem service and future potential.

The Central Bureau of Statistics (CBS) for instance does not have recent annual accounts available at the moment, which could otherwise provide an indication of the volume of production. Furthermore, the most recent conducted income and expenditure survey (2016) is extrapolated from a consumption basket, which has remained unchanged since the year 2000.

Detailed information within sectors such as agriculture is also challenging, since these are not frequently measured on the level of individual entities. According to the CBS, this is because agriculture and livestock generally are not pursued as the main economic activity of neither households, nor businesses. Most individuals that are active in this field do this as a side activity accompanying the main

[16] Indigenous plants are often unable to recover from constant consumption and trampling, resulting in their replacement by more tolerant and resilient non-native species.

[17] For this approximation to an economic value of the agricultural sector, the assumption is made that production methods are produced in a win-win situation (in a sustainable manner).

economic activity that allows them to make a living. Also, agricultural production rarely takes place as the main activity of a legal entity, meaning that most of the actual agricultural production is captured within other sectors where the entities in question are classified. Therefore, given the limited size of direct contribution to GDP, not much emphasis is placed on the collection of detailed sector data by CBS.

Given the limited available information and in order to conduct a more recent assessment of the economic value of agriculture and livestock, the value of agriculture is therefore estimated based on the number of economically active agricultural producers reported according to the Department of Agriculture, Husbandry and Fishery - Santa Rosa (2014). The obtained value is then multiplied by the estimated revenue of a representative farm producing local crops for domestic consumption (output). An estimated share of intermediate consumption obtained from the CBS[18] is subtracted from the output to obtain an estimate of gross value added. For livestock, an average price of meat is obtained, from which a share of intermediate consumption[19] is removed. This is then multiplied by the total volume of meat produced data received from the Veterinary Service Aruba (2017). These relationships are described in the following expressions:

$$\boldsymbol{Agricultural\ value} = (representative\ farm\ output - intermediate\ consumption) * quantity\ of\ agricultural\ producers$$

$$\boldsymbol{Livestock\ value} = (average\ price - intermediate\ consumption) * volume\ of\ meat\ produced$$

6.3 Results

Traditional farming is the dominant land use for agricultural purposes, followed by husbandry (livestock) and horticulture. Although aquaponics is listed as the fourth most frequent land use, it must be noted that this activity does not by definition require land use. However, for completeness sake it is included in the overview (See figure 41).

18 Estimates are based on anonymous reporting of representative farm financials.

19 Intermediate consumption consists of the value of the goods and services consumed as inputs by a process of production, excluding fixed assets whose consumption is recorded as consumption of fixed capital; the goods or services may be either transformed or used up by the production process.

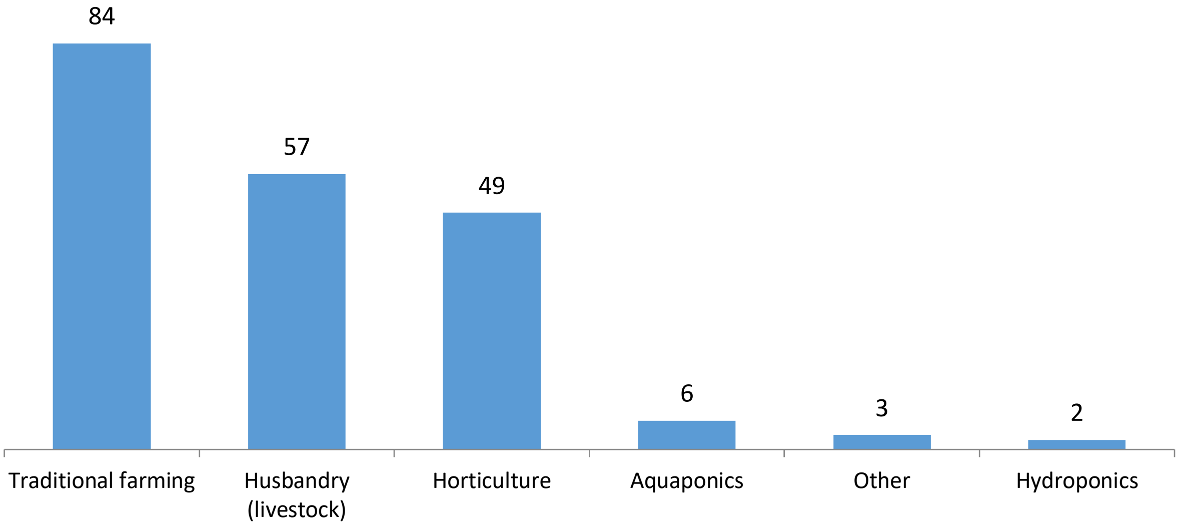


Figure 41 Census of entities economically active and non-active in the primary sector according to land operation use Santa Rosa, 2014..

In terms of the type of crops produced, okra is listed as the most frequent crop, followed by hot pepper. However, most agricultural producers appear to have a diversified crop production. Figure 42 provides an overview of the top 15 most cultivated crops in Aruba.

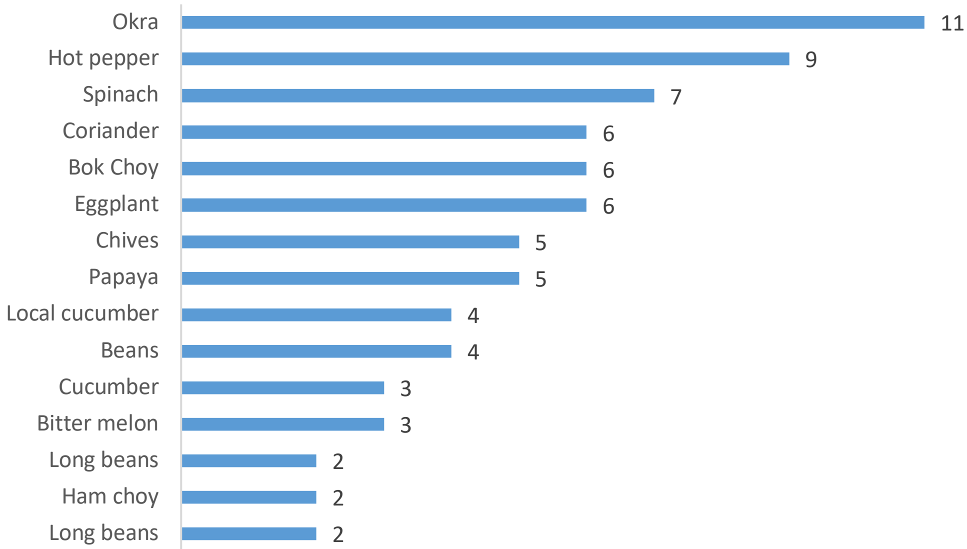


Figure 42 Census of entities economically active and non-active in the cultivation of crops, Santa Rosa, 2014.

Agriculture

Table 24 provides an estimate for the agricultural value based on the formula proposed. According to the calculated estimate, in Aruba agriculture yearly accounts for approximately US$ 0.5 million. This only considers the economically active participants registered by Santa Rosa.

Table 24 Agricultural value calculation (in US$)[23]

Volume (number of entities)		
Economically active		20
Registered but not active[20]		112
Production approach (per participant)		
Output	$	76,766
Intermediate consumption	$	51,416
Gross value added	$	25,350
Total gross value added		
Economically active	$	507,006

Livestock

Economic transactions relating to livestock in Aruba exhibit a strong cyclical behaviour. The great majority of slaughter takes place in the month of November and December in preparation for the strong demand for local meat during the Christmas holiday season. However, in comparison to the volume of meat that is yearly imported to Aruba, locally slaughtered meat amounts to less than 0.01 percent. Data obtained from the local Veterinary Service Aruba (2017), which is the only legal entity entrusted to slaughter in Aruba, indicates the consumption of meat in figure 43.

[20] Registered but not active in this context refers to agents that produce goods and services for the purpose of selling them to third parties that engage in this activity on average for less than 4 hours per week. This group is considered to engage in agriculture as a hobby.

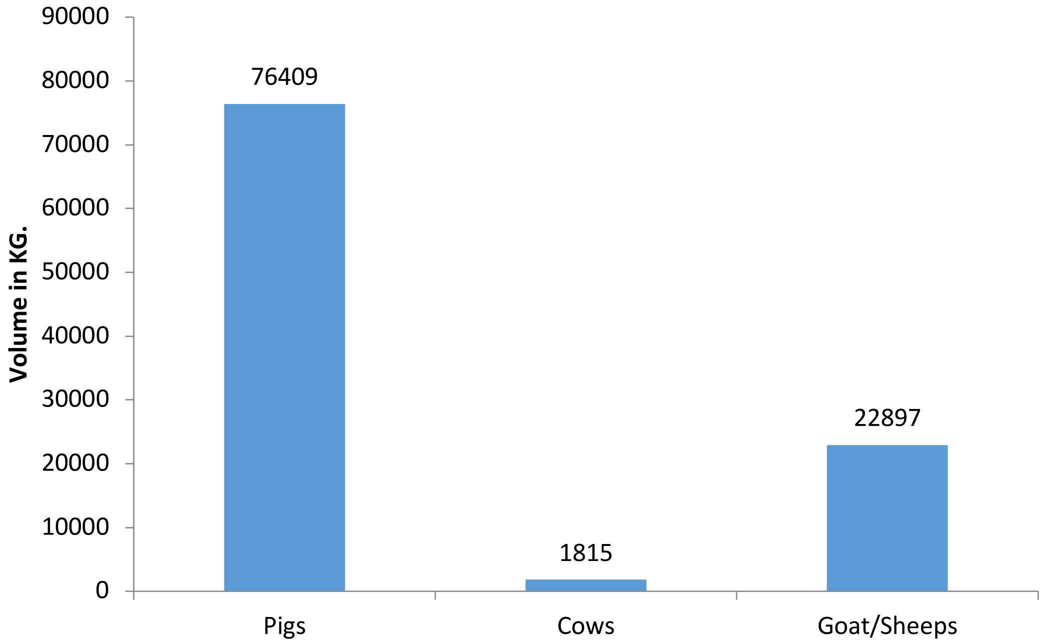


Figure 43 Slaughter weight in Aruba (in KG.) (Veterinary Service Aruba, 2017)

Contrary to agricultural activity, the source of volume data for livestock is likely to contain both activities in the formal sector as well as the informal sector, since practically all large animals destined for consumption are deemed to be slaughtered through Veterinary Service Aruba, regardless of the economic status of the clients.

Table 25 Livestock value calculation (Veterinary Service Aruba, Cornerstone Economics, CBS, 2017)

Meat (in Kg)	
Pigs	76,409
Cows	1,815
Goat/Sheep	22,897
Average price per Kg[21]	US$ 10.54
Intermediate consumption	US$ 351,796.79
Total gross value added	US$ 714,254.08

Informal sector

The informal economy plays an important, yet often overlooked, role in economies throughout the world. Informal activities can provide a much-needed source of income for a great number of people. However, many agricultural goods are not traded directly in well-functioning markets and so readily observable

[21] The current average price for red meat on the Aruban market was estimated based on supermarket survey data obtained from Cornerstone Economics (2017).

prices for them are not available. In addition, the informal sector is not included in national account estimates.

Although literature on the informal sector is scarce, an IMF study measuring the informal economy in Latin America and the Caribbean finds that for selected Small Island Developing States (SIDS), on average, the informal sector accounts for around 26 percent of GDP (Vuletin, 2008).

The informality can take many forms, it is well known that on a small scale many households partake in some sort of agricultural activity, be it cultivation or livestock for own consumption or to share with family and friends. According to Santa Rosa 2014 survey around 112 farmers fall within the economically inactive group, meaning that farming is done less than 4 hours a week and is mainly performed as a hobby. However, the output generated by these households is not measured in official statistics.

6.4 Conclusions & Discussion

The presented estimates suggest a contribution close to US$ 0.5 million by agriculture and US$ 0.7 million by livestock, totalling a combined added value of US$ 1.2 million.

As a small open economy with limited domestic production, Aruba relies excessively on international trade for its food consumption, exposing it to external shocks and burdening its net foreign assets position. Given the previously mentioned high import intensity of 75%, substitution or opportunity cost of imported food with locally produced goods leads not only to additional value boosting GDP, but also reduced imports. The import substitution effect should not be understated considering that imports contribute negatively to GDP. In essence, local produce increases GDP both through its contribution to GDP as well as through the corresponding decrease in imports. In terms of foreign exchange, decreased imports reduce foreign exchange outflows, while any additional exports generate demand for the local currency, both strengthening Aruba’s net foreign assets position. In this regard, local agriculture offers a promising avenue for boosting GDP and current constraints including market access, diseconomies of production scale and the affordability and reliability of water are areas to address to enable the sectors potential.

Apart from the direct economic contribution, local agricultural production also benefits the community by contributing to food security. To strengthen the collective position of agents operating in this area, it would be advisable to create collaboration and promote engagement through a collective. Considering the size of production that takes place outside the scope of national statistics, it appears advisable to reach out to agents active in the informal sector to provide this group with guidance and expertise to scale their production and ensure sustainability.

Given the opportunity cost and the potential contribution of the sector towards food security and well-being, it should be noted that the limited availability of relevant and current data on the island hampers a clear view on the sector and how best to further develop and support the farmers community. Due to capacity constraints and the relatively small size of the agricultural sector, the Central Bureau of Statistics does not collect detailed information on this sector. Data that would be relevant to collect is information on crop types, the related annual production and their related market prices. However, agricultural entities don't easily submit year reports to the Central Bureau of Statistics and agricultural activity that takes place in the informal sector remains challenging to capture.

6.5 References

Bholasing, J. (2013). Dinner or Destruction? - An Economic analysis of the impact of feral goats in Arikok National Park, Aruba. Master thesis - IVM Institute for Environmental Studies

CBS (2017) H. Koolman, personal communication.

Central Bank of Aruba (2017)

Cornerstone Economics (2017) Supermarket survey

Derix, R. (2016). The history of resource exploitation in Aruba. Landscape series: 2.

Dresscher, E. (2009). Aruba, an island navigating a globalizing world: A brief history. Journal of the National Archeological Museum Aruba, issue no.1.

Santa Rosa (2014). Economic census of the primary sector.

Van Beukering et al. (2007). Valuing the environment in small islands. An environmental economics toolkit.

Power, Alison G. 2010. “Ecosystem Services and Agriculture: Tradeoffs and Synergies.” Philosophical transactions of the Royal Society of London. Series B, Biological sciences 365(1554):2959–71.

Veterinary Service (2017) R. Bareno, personal communication.

Vulletin, G. (2008). Measuring the informal economy in Latin America and the Caribbean. IMF working paper.

World Travel and Tourism Council (2017). Travel & Tourism Economic Impact 2017 Aruba.

7. Medicinal Plants

***Timothy Polaszek*[1]**

[1]*Consultant, Wolfs Company, Sarphatistraat 370, 1018 GW Amsterdam, The Netherlands.*

7.1 Introduction

Medicinal plants play important roles in many traditional societies. Their collection and usage not only contributes to sources of potential income, but is also part of societal health and identity, especially in non-Western societies. Whereas in the "developed" world, 25% of all pharmaceutical products are directly based on plants and plant derivatives, in non-Western societies, this number exceeds 75% (Principe, 1991).

This chapter attempts to devise a methodology to provisionally value the economic contribution of wild medicinal plant on Aruba. Comparable studies on Bonaire and St Eustatius (Lacle et al., 2012; Fenkl et al., 2014) have similarly attempted to place an economic value on this practice.

The use of a pharmaceutical product is usually to alleviate symptoms of an illness and this has a consequential effect of reducing further medical treatment and thus reducing potential expenditure and increasing life quality. It is possible to capture the increase in life quality through revealed and stated preference methods such as contingent valuation and the choice method, or through market-based methods to value the financial benefit that the reduced number of visits to the doctor have.

7.2 Methodology

Interviews were carried out to analyse local perspectives towards medicinal plant use on Aruba. To estimate a value associated with this practice, per capita pharmaceutical expenditure is inferred by using the per capital expenditure of the Netherlands as a proxy. This figure, then adjusted for the difference in gross domestic product (GDP), is multiplied by the island population.

To estimate the expected reduction in pharmaceutical expenditure due to medicinal plant use, the figure (25%) used in a comparable study for Bonaire was incorporated (Lacle et al., 2012). In the Bonaire study, the value of reducing the

number of general practitioner visits was also incorporated into the overall figure. Due to a lack of information regarding these visits, this was excluded from the calculation.

$$\boldsymbol{Gross\ Medicinal\ Plant\ Value} =$$
$$\%\ population\ using\ medicinal\ plants * \frac{medical\ expenditure\ NL\ (USD)}{Aruba\ GDP\ factor} * 0.25$$

7.3 Results

Results from the household survey for the cultural ecosystems report indicate the level of wild medicinal plant use on Aruba. Proportion of answers by survey respondents is shown in figure 44 below. It was that 76% of the Aruban population use wild plants for medicinal uses.

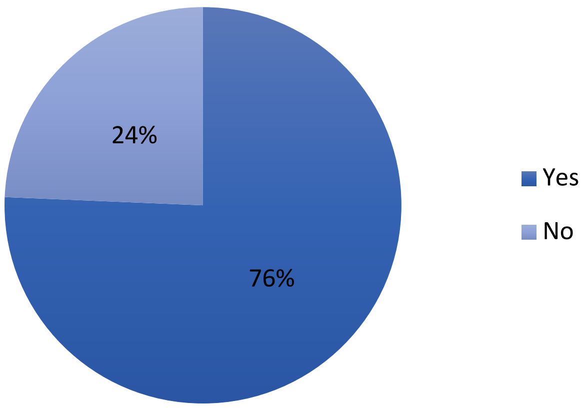


Figure 44: Do you make use of medicinal plants grown on Aruba?

The expenditures related to pharmaceuticals are estimated to be US$ 213.69 per capita per year. This number is based on the calculation presented in Table 26.

Table 26 Estimated medical expenditures

Indicator	The Netherlands	Aruba
GDP per capita (USD$)	53,540 (2011)	25,324 (2011)
GDP factor	1	2.114
Medical expenditure (USD$)	451.75[22]	213.69
Medicinal Plant users	N/A	76%
Population	16.29 million	102,053

To calculate the reduced amount spent on medication by the local population, the average spend on medicine per person in the Netherlands was adjusted for the lower GDP of Aruba. This results in an average spend of US$ 213.69 per person. Assuming a reduction of 25% usage of modern medicines, this amounts to a national saving of **US$ 4,143,464**.

7.4 Discussion

Culturally, the use of wild plants on the island is highly regarded. This can be inferred from the high proportion of the population that engage in their use. Therefore, it is important to include this in the valuation. It is difficult to associate a high level of certainty with the calculation of a potential reduction in medical bills. Although this is likely the case, more primary data is needed to further analyse this aspect of the island economy and increase the level of accuracy. For example, medical expenditure and detailed plant use and types would be extremely useful to assign more meaningful values.

Limitations

When attempting to value underrepresented ecosystem services, there often arise methodological difficulties and accuracy issues. The time spent to collect the plants and preparing them for medicinal use were not taken into account. The plants are also often used to add flavour to food instead of being used solely for medicinal reasons. The expected reduction in conventional pharmaceutical use is also an assumption, as is the principle of direct substitutability in this case, which may not correspond to reality. However, 76% of the local residents use wild plants and this relevant ecosystem service provides benefits to the majority of the population of Aruba. It is important to take this value into account.

[22] Pharmaceutical expenditure per person in the Netherlands in 2011 (€325) multiplied by the EUR-USD exchange rate at the time (1.39) (SFK, 2012; XE.com).

7.5 References

Fenkl F, Laclé FA, Schep SW, van Beukering P, Brander L, Wolfs E (2014) “The local cultural and recreational value of nature on St Eustatius”, Institute for Environmental Studies VU University Amsterdam, the Netherlands.

Lacle F, Wolfs E, Van Beukering P, Brander L (2012), “Recreational and cultural value of Bonaire’s nature to its inhabitants”, Institute for Environmental Studies VU University Amsterdam, the Netherlands.

Principe, P. (1991). Valuing the biodiversity of medicinal plants. In Akerele, O. et al. (Ed.), The conservation of medical plants. Cambridge: Cambridge University Press.

Stichting Farmaceutische Kengetallen. 2012. Data en feiten 2012 Het jaar 2011 in cijfers. https://www.sfk.nl/publicaties/data-en-feiten/data-en-feiten/data-en-feiten-2012
accessed 1/10/2017.

8. Non-use value

***Boris van Zanten*[1, 2].**

[1]*Consultant, Wolfs Company, Sarphatistraat 370, 1018 GW Amsterdam, The Netherlands.*

[2]*Institute for Environmental Studies, VU University, De Boelelaan 1087, 1081 HV Amsterdam, The Netherlands.*

8.1 Introduction

Non-use values in environmental economics express the worth placed on aspects of natural systems and attributes called ‘option’, ‘bequest’ and ‘existence’ (Krutilla, 1967). The option value is summarised as a willingness to pay for the opportunity to choose from alternative uses of a natural environment in the future. Bequest value is the willingness to pay for the ability of future generations to benefit from a natural system. Existence value is the willingness to pay for the preservation of a particular natural system (Greenley et al., 1981).

Traditional, or market-based, valuation techniques are not appropriate when assessing non-use characteristics. A common way to calculate non-use values is through stated preference surveys to determine the willingness-to-pay (WTP) for the conservation of ecosystem services/goods and biodiversity.

Assessing the non-use value of Aruba would add to a better understanding of the TEV of the island. However, a stated preference survey has not been carried out for this project, so non-use values of Aruba cannot be assessed with primary data. Nevertheless, Wolfs Company and IVM have done this type of valuation for the Caribbean Netherlands (Bonaire, Saba and Sint Eustatius) to assess the value that the Dutch population, as well as non-Dutch residents living in the Netherlands mainland, assign to nature in these islands. Even though Aruba and the islands of the Caribbean Netherlands have major differences, the results derived from this study can be taken as a reference for what needs to be done and can be expected for Aruba (van Beukering et al., 2012).

8.2 Methodology

Using the values for comparable, but different, study sites is known as the ‘benefit transfer’ approach. Boyle & Bergstrom (1992) define benefit transfer as, “the transfer of existing estimates of non-market values to a new study which is

different from the study for which the values were originally estimated." This is a popular method when not enough time or funds are available to gather primary data for context specific analysis.

The objective of the non-use study for the Caribbean Netherlands was to assess the value that Dutch people, as well as non-Dutch residents living in the Netherlands mainland, assign to nature in the Caribbean Netherlands. This research applied two different stated preference techniques to determine the Willingness-To-Pay (WTP) of those living in the Netherlands for the conservation of ecosystem services and biodiversity in the Netherlands' mainland and the Caribbean Netherlands: the contingent valuation method (CVM) and choice experiments (CE).

This study applied several combinations of survey modes (i.e. face-to-face and online surveying) and valuation techniques (i.e. CVM and CE). Drawing lessons from the literature, the face-to-face survey was designed to encompass an economic valuation exercise based on the CVM. There were three version of this questionnaire that tested the respondent's answers altering the order of presenting the questions for the WTP for nature in the mainland Netherlands, the Caribbean Netherlands and the combination of both. In all three versions, the WTP questions were preceded by a minimal (but sufficient) amount of information about the good to be valued.

After presenting this general information, the respondent was asked whether he or she would be willing to pay additional taxes for the protection and possible improvement of nature. If the respondent said yes, he or she could then give an undefined amount or choose an amount from a payment card with fixed payment levels per month.

Next, an online survey was designed to supplement the face-to-face survey, testing for methodological influences on the valuation of non-use values of nature in the Netherlands mainland and the Caribbean Netherlands. The online survey contained a CE allowing for a greater level of detail about the good to be valued based on attributes of nature conservation and payment methods, and different levels of degradation/conservation.

8.3 Discussion

Overall, a substantial proportion of respondents were willing to pay higher taxes for nature protection. Both methods provided new insights into the way people value the non-use values of nature in a national and local context. The surveys

provided evidence for a nationalistic and community-based influence on the valuation of nature. Both the CVM and the CE methods showed that locally-oriented Dutch citizens value nature in their own neighbourhood or country relatively higher than citizens with a global perspective or foreigners who live in the Netherlands and who place a lower value on improvement of nature in their own environment

Both surveys also showed that the values for nature, both in and outside of the Netherlands, depend heavily on the emotional mind-set of the respondent. For example, individuals who are unconcerned about the state of nature in general value improvements of nature less than those who are concerned about nature. In the same fashion, consumer confidence proved to be a strong explanatory variable for valuing nature protection: individuals with a high level of optimism regarding the overall state of the economy and their personal financial situation have a higher WTP for nature protection.

By adjusting for preference and payment uncertainty, the aggregated amount for the non-use value for nature improvements in the Netherlands is estimated at €34 million and €18 million for the Caribbean Netherlands. Also, it was observed that the aggregated non-use value would be higher if environmental policies improve current nature, instead of only keeping nature at a constant level. Policies that aim at improving the quality of natural systems are therefore more likely to receive public political and monetary support.
As mentioned earlier, this study was only for the islands known as the Caribbean Netherlands and it did not include Aruba. The results from the study can't be extrapolated for Aruba because of many reasons, one of them is the difference in their legal status. Since 2010, the islands of Caribbean Netherlands are officially part of The Netherlands and have the constitutional status of special Dutch municipalities. This means that the local residents have to pay taxes to the Netherlands' treasury, but are also entitled to claim government service and support at a level comparable to what is provided in the mainland. That is not the case for Aruba, which is an independent country and has its own tax legislation.

Nevertheless, within this non-use study for the Caribbean Netherlands, it was determined that a significant factor that determines the WTP of the respondents was the level of familiarity with the place itself. In that sense, the study showed that Aruba and Curacao are the most popular destinations among the respondents. Hence, it can be speculated that the answers of the respondents were partly influenced by the knowledge or ideas they have from these islands. If a similar study would be carried out for Aruba, it is logical to infer that similar

outcomes would come out as a result regarding a positive WTP of the respondents.

8.4 References

van Beukering, P., Botzen, W., & Wolfs, E. (2012). The non-use value of nature in the Netherlands and the Caribbean Netherlands.
Boyle, K. J., and J. C. Bergstrom (1992), Benefit transfer studies: Myths, pragmatism, and idealism, Water Resour. Res., 28(3), 657–663
Greenley, D., Walsh, R., & Young, R. (1981). Option Value: Empirical Evidence From a Case Study of Recreation and Water Quality. The Quarterly Journal of Economics, 96(4), 657-673.
Krutilla, John V., "Conservation Reconsidered," American Economic Review, LVII (Sept. 1967), 777-86.

9. Carbon sequestration

***Boris van Zanten*[1, 2] *and Tatiana Becker*[3].**

[1]Consultant, Wolfs Company, Sarphatistraat 370, 1018 GW Amsterdam, The Netherlands.

[2]Institute for Environmental Studies, VU University, De Boelelaan 1087, 1081 HV Amsterdam, The Netherlands.

[3]Consultant, Future is Now, Oranjestad, Aruba.

9.1 Introduction

Carbon sequestration refers to the process of capture of carbon dioxide and its long-term storage (Zarate-Barrera & Maldonado, 2015). In the coastal ecosystems of Aruba, carbon is stored in mangroves, tidal salt marshes and seagrass meadows. In terrestrial ecosystems, tropical shrubs and dry forests store carbon. The soil, vegetation and water in these ecosystems are referred to as carbon pools and the sum of the carbon stored in them is known as the carbon stock (Howard et al., 2014, IPCC 2006, IPCC 2014).

With regard to carbon sequestration in coastal and terrestrial ecosystems, this analysis focuses on the carbon sequestration in long-term carbon pools (e.g. soil and sediments, where carbon may prevail for centuries or millennia), as these are the most important pools in terms of carbon emission mitigation potential (Howard et al., 2014). The current carbon stock is additionally estimated as a reference for the analysis of potential future interventions.

9.2 Methodology

The carbon estimation methods used in this study are based on simplified assumptions and global average values. As such, these methods are less accurate and lead to a higher uncertainty in the results than approaches based on specific field data. According to the tiers of detail identified by the Intergovernmental Panel on Climate Change (IPCC), this type of assessment is classified in the tier 1 (IPCC, 2006; IPCC, 2014). Tier 1 estimates may have a high error for aboveground and belowground carbon pools, but are useful as default estimates when no site-specific data is available for an initial assessment (IPCC, 2006; Howard et al., 2014).

In this study, the carbon sequestration in coastal ecosystems corresponds to the annual potential for accumulation of carbon in the sediments of mangroves, salt marshes and seagrass beds, which are the main long-term carbon pools identified

in Aruba. The annual accumulation rate of carbon in terrestrial ecosystems is estimated for carbon pools dry forests and tropical shrubland.

To estimate the carbon sequestration potential (Cseq) for a specific year, rates of carbon accumulation (r_i) per ecosystem type (i) are multiplied by the area of each ecosystem (a_i) in Aruba, as follows:

$$Cseq = \sum_{i=1}^{n} r_i \cdot a_i$$

Global average rates of carbon accumulation in sediments (for coastal ecosystems Laffoley and Grimsditch, 2009; Table 27 and for terrestrial ecosystems IPCC, 2006; Chapter 4, Table 4.9) serve as surrogate values for r_i and give a general indication of the carbon sequestration potential. The spatial extent of each ecosystem is obtained from the combined habitat map that has been developed for TEEB-Aruba based on The Nature Conservancy terrestrial habitat map, the ROP (spatial development plan, 2009) and an expert map of Aruba's benthic habitats.

Table 27Long-term rates (r) of carbon accumulation in mangroves and seagrass (Laffoley and Grimsditch 2009, IPCC 2006)

Ecosystem	**Long-term rate (r_i) of carbon accumulation (Mg/ha/year)**
Mangroves	1.39
Seagrass	0.83
Salt marshes	2.10
Tropical dry forests	0.47
Tropical dry shrubs	0.47

This analysis also includes the complementary calculation of carbon stock based on global average factors (table 28) The actual carbon stock in mangroves and seagrass is determined by multiplying the global average values of carbon stock ('Si') presented in table 28 by the total area of each relevant ecosystem ('ai') in Aruba, as presented in the following equation:

$$Cst = \sum_{i=1}^{n} S_i \cdot a_i$$

Table 28 Global average values of carbon stock in the biomass and top 1 m of soil in mangroves and seagrass (Howard et al., 2014; IPCC, 2014)

Ecosystem	Global average carbon stock (Mg/ha)
Mangroves	386
Seagrass	108
Salt marshes	255
Tropical dry forests	126
Tropical dry shrubs	53

Coral reefs are not included in the analysis, as these are considered net or potential carbon dioxide producers due to calcification processes (Suzuki and Kawahata, 2004; Ware et al., 1991). At the time of this study, no site-specific information was made available to estimate the rates of carbon production in the coral reefs of Aruba.

Economic valuation of carbon sequestration

The economic value of carbon sequestration estimated in this study represents the value of annual flows of carbon from the atmosphere to coastal carbon pools, given the actual extent of mangroves and seagrass beds in Aruba.

The total economic value of annual carbon gains in the present (EVt) is estimated as the product of the carbon sequestration potential (Cseq) and the price (P) per ton of carbon dioxide that could be compensated through a hypothetical carbon market. This is summarized in the following formula:

$$\mathrm{EVt} = 3.67 \cdot \mathrm{Cseq} \cdot \mathrm{P}$$

The conversion factor included in the formula (i.e. 3.67) corresponds to the ratio of the molecular weights of carbon and carbon dioxide. This ratio is used for estimating the equivalent carbon dioxide that can be produced if the carbon stored in the system is released to the atmosphere (Howard et al., 2014).

The selection of the price for estimating the economic value of the carbon sequestration service is based on the mechanisms established by the UN Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol. It is important to note that emission reductions related to oceanic carbon are not currently guaranteed under these mechanisms. Furthermore, no specific carbon trading schemes have been implemented for terrestrial carbon in Aruba. Hence,

the price used in this analysis provides only a reference of a hypothetical market that does not exist at present.

In this study, we use the price of 1 Mg of carbon dioxide in emission trading systems as the measure to monetize carbon fluxes in coastal ecosystems. Approximately 70% of the global carbon dioxide emissions are priced through emission trading systems in a range that varies from around US$1 to US$9 per Mg of carbon dioxide emissions (Kossoy et al., 2015). Since this price range has remained relatively stable in absolute terms during the past two years (Kossoy et al., 2015), this is used as a representative measure of price for the estimation of the economic value of carbon. For the sake of simplicity, the price used in the calculations is the median of the range selected, estimated at US$5 per Mg of carbon dioxide emissions.

9.3 Results

In this study, the estimation of the economic value of carbon sequestration focuses on seagrass, salt marshes, mangroves, tropical dry forest and tropical shrubland ecosystems, since these are the main carbon pools identified in Aruba. Global average values of carbon stock (Howard et al., 2014; IPCC, 2006; IPCC, 2014) suggest that the carbon potentially stored in around 171 ha of mangroves could reach 66,006 Mg in Aruba. Seagrass bed covers a significantly larger area in the benthic habitats of Aruba (1,044 ha) and store more carbon due to this (112,752 Mg). Salt marshes store approx. 61,000 Mg. Terrestrial dry forest ecosystems have the largest geographic extent (7,733 ha) and store 974,400 Mg, while an approximate 78,700 Mg of carbon is stored in shrublands.

Table 29 Carbon stock in Aruba (Mg)

Ecosystem (ha)	Total carbon stock (Mg)
Mangroves (171)	66,006
Seagrass (1,044)	112,752
Salt marshes (239)	61,100
Tropical dry forests (7,733)	974,400
Tropical dry shrubs (1,484)	78,700

To estimate the annual economic value of the carbon sequestration service provided by coastal and terrestrial ecosystems, the carbon sequestration potential is estimated based on the global average value of annual accumulation of carbon (Laffoley and Grimsditch, 2009; IPCC, 2006). The obtained results suggest that the highest carbon sequestration potential is found in seagrass beds in coastal ecosystems and dry forest ecosystems on land (Table 30).

Table 30Carbon sequestration potential in coastal and terrestrial ecosystems in Aruba (Mg/year)

Ecosystem (ha)	**Carbon sequestration potential (Mg)**
Mangroves (171)	240
Seagrass (1,044)	870
Salt marshes (239)	500
Tropical dry forests (7,733)	3640
Tropical dry shrubs (1,484)	700

To assign a monetary value to the carbon sequestration potential, the results presented in Table 30 are firstly converted to carbon dioxide units based on the ratio of the molecular weights of carbon and carbon dioxide (i.e. 3.67). Considering a price of US$5 per Mg of carbon dioxide, the total economic value of this service is estimated at approximately US$108,983 per year (Table 31).

Table 31 Economic value of the carbon sequestration service per year (US$)

Ecosystem (ha)	**Economic value of carbon sequestration (US$/year)**
Mangroves (171)	$4,363
Seagrass (1,044)	$15,900
Salt marshes (239)	$9,226
Tropical dry forests (7,733)	$66,696
Tropical dry shrubs (1,484)	$12,799
Total value carbon sequestration	$108,983

Most of the economic value of the carbon sequestration service estimated in Aruba originates from tropical dry forest, due to their large spatial extent (7,733).

In term of total value, seagrass come in second. In comparison to the dry forests, the value per hectare of seagrass is higher (10 – 20 US$ in Figure 45), but covers only 1,044 hectares. The highest per hectare values are found in the salt marshes in Noord and Spaans Lagoen. (>30 US$ in Figure 45).

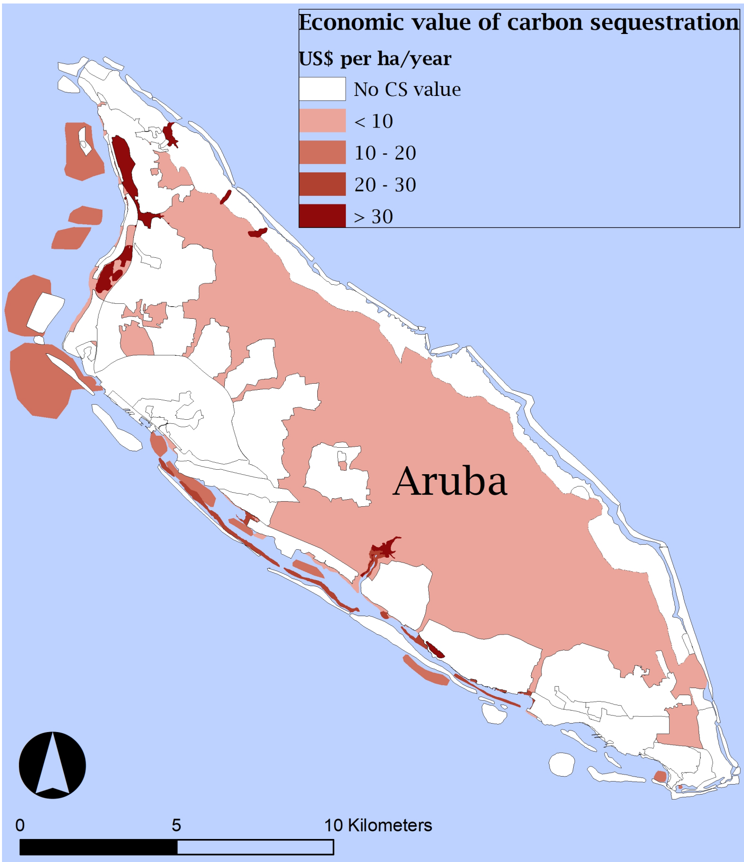


Figure 45 Spatial distribution of the economic value per hectare of carbon sequestration in Aruba

9.4 References

Howard, J., Hoyt, S., Isensee, K., Telszewski, M., Pidgeon, E. (eds.) (2014). Coastal Blue Carbon: Methods for assessing carbon stocks and emissions factors in mangroves, tidal salt marshes, and seagrasses. Arlington: Conservation International, Intergovernmental Oceanographic Commission of UNESCO, International Union for Conservation of Nature. 180 pp.

IPCC (2006). 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Prepared by the National Greenhouse Gas Inventories Programme, Eggleston H.S., Buendia L., Miwa K., Ngara T. and Tanabe K. (eds). Kitakyushu: IGES.

IPCC (2014). 2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands, Hiraishi, T., Krug, T., Tanabe, K., Srivastava, N., Baasansuren, J., Fukuda, M. and Troxler, T.G. (eds.) Geneva: IPCC.

Kossoy, A., Peszko, G., Oppermann, K., Prytz, N., Klein, N., Blok, N., Lam, L., Wong, L. and Borkent, B. (2015). State and Trends of Carbon Pricing 2015 (September), Washington, DC: World Bank.

Laffoley D. and Grimsditch, G. (eds.) (2009). The Management of Natural Coastal Carbon Sinks. Gland: IUCN. 53 pp.

Suzuki, A. and Kawahata, H. (2004). Reef Water CO2 System and Carbon Production of Coral Reefs: Topographic Control of System-Level Performance. In M. shimoyi et al. (eds.), Global Environmental Change in the Ocean and on Land (pp. 229-248). Tokyo: Terrapub.

Ware, J. R., Smith, S. V. and Reaka-Kudla, M.L. (1991). Coral reefs: sources or sinks of atmospheric CO2? Coral Reefs 11: 127-130.

Zarate-Barrera, T. G., & Maldonado, J. H. (2015). Valuing blue carbon: carbon sequestration benefits provided by the marine protected areas in Colombia. PloS one, 10(5), e0126627.

Concluding remarks

The relevance of natural capital for the wellbeing of Aruba's local population, as well as that of its visitor population, is clear. Services provided by Aruba's environment benefit the human population directly and indirectly. This research project has attempted to quantify some of the key services. Those beneficiaries that were considered as part of the total economic valuation (TEV) were: local cultural values, tourism, fishing and carbon sequestration. As an additional component, values for agriculture, medicinal plants and non-use were calculated to provide indications and for the ability to compare between studies.

The total valuation of the key services in this study is US$ 287.3 million. This is the aggregated value of the following:

- The willingness to pay that residents of Aruba have for management of Aruba's natural environment;
- The proportion of total tourist expenditures that would not have occurred in the case of environmental degradation;
- The willingness to pay that visitors to Aruba have for management of Aruba's natural environment;
- The value derived by Aruba's artisanal and recreational fishers;
- The value derived by illegal fishers in Aruba's exclusive economic zone; and
- The monetary value associated with carbon sequestration of the island's biota.

Additionally, there were three important services addressed outside of the scope of the TEV, due to data and method constraints. These were the following:

- The value that the agricultural sector derives from natural capital, estimated at US$ 1.2 million;
- The value that households derive from medicinal plant use provided by the environment, estimated at US$ 4.1 million; and
- The non-use (existence, bequest and option) of Aruba's environment, estimated at US$ 6.0 million.

Key data was missing for precise and accurate calculation of these values. These are small sectors of the economy but are significant, especially when seen from a cultural identity point of view. Therefore, any further study should consider more extensive data collection to expand upon this research.

Degradation of the environment results in losses across every sector. However, the industry that is the most dependent on natural capital is the hotel and accommodation sector for stay-over visitors. Marine, or terrestrial, or beach degradation would result in huge losses of tourists and this has impacts across the economy. Aruba's economy is over 90% dependent on tourism and so the wellbeing of its population is heavily dependent on natural capital. Any development plan of Aruba should consider natural capital as crucial element in decision making.

Annex

28/29 April 2016 Aruba workshop participants list

Day 1: Learning event 'Natural Capital on Aruba' 28th of April 2016

Minister di Turismo, Transporte, Sector Primario y Cultura	Zaandam	Indra	Policy advisor	Government
Departamento di Naturalesa y Medio Ambiente (DNM)	Boekhoudt	Gisbert	Director	Government
Directie Landbouw, Veeteelt en Visserij en Mar kthallen (DLVVM) Santa Rosa	Maduro	Natalee	Director	Government
Bureau Innovatie (BI)	Peters	Bianca	Director	Government
Bureau Innovatie (BI)	Avanindra	Dagmara	BI consultant	Government
Bureau Innovatie (BI)	Broeksema	Esther	BI consultant	Government
Directie Volksgezondheid (DVGH)	Croes	Clayton	Policy advisor	Government
Government	Carvahal	Juliet	Green Agenda coordinator	Government
Ministerio di Asunto Economico, Comunicacio n, Energia y Medio Ambiente	Arends	Richard	Chief of staff	Government
Departamento di Infrastructura y Planificacion (DIP)	Kock	Maryanne	Jurist	Government
Ministerio di Asunto Economico, Comunicacio n, Energia y Medio Ambiente	Dijkhoff	Maria	Director	Government
Departamento di Infrastructura y Planificacion (DIP)	Dammers	Isabel	Director	Government
Dienst Openbare Werken (DOW)	Croes	Marlon	Director	Government
Directie Landbouw, Veeteelt en Visserij en Mar kthallen (DLVVM) Santa Rosa	Franken	Facundo	Ing.	Government
Departamento di Cultura Aruba (DCA)	de Rooi	Gijs	Policy advisor	Government
Departamento di Naturalesa y Medio Ambiente (DNM)	Croes	Shahayra	Public relations officer	Government
Public Diplomacy	Nicolaas	Ghislaine	Trainnee	Government/Y oung professional
Utilities N.V.	Hoevertsz	Frank	Director	Industry
Freezone Aruba	Peterson	Greg	Director	Industry
WEB Aruba N.V.	Oduber	Luis	Director	Industry
Aruba Ports Authority (APA)	Figaroa	Jossy	Director	Industry
Utilities N.V.	Geerman	Ghislaine	Green conference manager	Industry
Aruba Airport Authority N.V. (AAA)	Boekhoudt	Mauricio	Strategic of Advisor	Industry

WEB Aruba N.V.	Boey	Filomeno	Advisor Sustainable Water Technology & Chair Sustainable Water University of Curacao	Industry / Academic
Setar N.V.	Boekhoudt	Alvin	Jurist	Industry
Aruba Hotel and Tourism Association (AHATA)	Rasmussen	Vanessa	Environmental committee administrator	Industry
Aruba Chamber of Commerce	Agius Cesar eo- Lejuez	Daphne	Director	Industry
Aruba Airport Authority N.V. (AAA)	Boekhoudt	Mauricio	Strategic of Advisor	Industry
Banco Central di Aruba (CBA)	Figaroa-Semeleer	Jane	Director	Industry/Government
Banco Central di Aruba (CBA)	Peterson	Ryan	General Mngr Economic Policy	Industry/Government
UNDP COE Aruba	Granadillo	Michael	Project manager	NGO
Aruba Marine Park Foundation	Davelaar	Rudy	President	NGO
Stimaruba	Rasmijn	Olinda	President	NGO
Fundacion Parke Nacional Arikok (FPNA)	Peterson	Greg	Chairman of Board	NGO
MFA	Eckmeyer	Ruby	Coordinator research Arts & Culture at UA	Academic
Blue blocks project	Beke	Patrick	Project manager	Young professionals
Global Shapers Oranjestad	Lopez	Tyson	Incoming curator	Young professionals
UNOCA / Korteweg	de Lannoy	Cado	Project manager	Young professionals
University of Aruba	Arends	Zoe	Student	Academic

Day 2: Workshop socio-economic valuation of ecosystem services 29th April of 2016

Aruba Hotel and Tourism Association (AHATA) - Environmental Committee	Rasmussen	Vanessa	Environmental committee administrator	Industry
Departamento di Asunto Economico,Comercio y Industria (DEHZI)	Dijkhoff	Maria	Director	Government
Departamento di Infrastructura y Planificacion (DIP)	Dammers	Isabel	Director	Government
Departamento di Naturalesa y Medio Ambiente (DNM)	Boekhoudt	Gisbert	Director	Government
Departamento di Naturalesa y Medio Ambiente (DNM)	Kock	Robert	Marine biologist	Government

Directie Landbouw, Veeteelt en Visserij en Markthallen (DLVVM) Santa Rosa	Maduro	Natalee	Director	Government
Oficina Central di Estadistica (CBS)	Derix	Ruud	Head Spatial (GIS) and Environmental Statistics	Government
Aruba Marine Park Foundation	Davelaar	Rudi	President	NGO
Freelancer researcher	Becker	Tatiana	Consultant	Academic
Departamento di Naturalesa y Medio Ambiente (DNM)	Croes	Shahayra	Public relations officer	Government
Aruba Tourism Authority (ATA)	Kock	Isha	Product specialist	Industry (Tourism)
Aruba Tourism Authority (ATA)	Becker	Manou		Industry (Tourism)
Departamento di Infrastructura y Planificacion (DIP)	Kock	Maryanne	Jurist	Government
Departamento di Infrastructura y Planificacion (DIP)	Dammers	Isabel	Director	Government
Directie Volksgezondheid (DVGH)	Croes	Clayton	Policy advisor	Government
Departamento di Cultura Aruba (DCA)	Tromp	Shailynie	Policy advisor	Government
MFA	Eckmeyer	Ruby	Coordinator research Arts & Culture at UA	Academic
Department of Foreign Affairs	Nicolaas	Ghislaine	Trainee	Government
Universidad di Aruba (UA)	Croes	Ghislayne	Student	Academic
Universidad di Aruba (UA)	Vasquez	Danyela	Student	Academic