Of People and Mangroves: illustrations of a social-ecological system

Linde van de Graaf, University College Utrecht

Apparently I'll always look like a tourist, no matter what I wear. At least, according to Harlee and my research assistant, Juan-David. They made fun of how I blended right in with the crowd, as we were walking around the Palm Beach area. We were on our way to see if we could do some interviews, and were simultaneously analyzing the area for Harlee's paper. To me, the huge manicured hotels, the seemingly endless eateries, souvenir shops and the enormous amount of people on the beach made the place very surreal. Luckily our interviews gave us a totally different feeling, as we were warmly welcomed and treated by our respondents.

I have so many memories like these. Because of my research topic, I was often lucky enough to spend time in Aruba's beautiful nature; going on walks or kayaking, who knew that was all part of the job! Additionally, I got a peak into some Arubans' daily lives, spending time in living rooms and offices, interviewing, listening, and making new friends. In retrospect it feels like I just went adventuring a bunch of times, often accompanied by my dear fellow-researchers. We were investigating a wide variety of topics, but at the same time there were so many similarities between our projects.

Along with ending up in a variety of interesting places, I also deeply enjoyed the conversations these adventures sparked. If I actually were to write down everything I learned through this project, my thesis would amount to just being my diary: new lessons every day. Therefore, like all the other people in this book, I am left feeling incredibly grateful, and would like to use this intro to express some of that gratitude.

To the girls, my fellow researchers. For all the support, the kindness, the fun, for being my DJ, my mom, my fiance, and my friends. For teaching me how to plan (a tiny bit more) and how to moisturize my hair (a tiiiny bit more).
To the people that made this program possible. For more than I can list here.
To Juan-David, my sidekick.
To Tobia, for putting up with us for so long.
To all my respondents, for giving me your time and your thoughts. You've taught me so much!
To my parents and friends, always.
To my supervisor, for giving feedback, freedom and support in precisely the right amounts.
To all the people that discussed my research with me. You've shown me that research is never done alone.
To the Aruban air, for blowing my thoughts away when I needed it.
And to peanuts, for the energy it took to write this.

Thank you!

If you wish to contact me about the research, please email to lindevandegraaf@gmail.com

Of People and Mangroves: illustrations of a social-ecological system.

Linde van de Graaf

Introduction

During a symposium in 'Introduction to Earth and Environment', a class taught at the University of Aruba, a student expressed how wonderfully calm he had found the mangrove forest they visited on their field trip. Another student jokingly mentioned that that had only been possible because he had a cold, and hadn't smelled the place. After the banter the students proceeded to explain the ecological importance of the area. For many of them it had been the first time they directly got into contact with the mangroves. This is one of many examples of interactions that built up this research.

As the students explained in their presentation, mangroves are ecosystems of high ecological and socio-economic value. Yet mangrove forests worldwide also face negative consequences of human actions. Aruba's booming population density and tourism industry suggests that these consequences are especially felt here. These consequences are not isolated events, because the mangrove forest is not an isolated system.

As a member of the Aruban national park mentioned: 'Nature does not end at the borders of the park'. Nature is often perceived as a separate entity from humanity, whilst in reality humans are part of nature within the immensely complex system that is the world. Humans constantly influence and interact with nature around them, and vice-versa. Daniel et al. (2012) emphasize that natural or semi-natural features of the environment are often associated with the identity of an individual or a community. They identify two reasons. First, experiences arising from the natural environment are shared across generations. Second, natural features provide "settings for communal interactions important to cultural ties" (Daniel et al., 2012, p. 8814).

These interactions yield situations that are sometimes sustainable, sometimes unsustainable, and often a mix of the two. Improving the sustainability of our actions is not only important, but it is something we owe to the next generations. However, in order to make our interactions with the rest of nature sustainable, we have to clearly understand those interactions.

This paper is part of a larger research project which aims to shed light on the interactions within a small social ecological system (SES) on Aruba: the mangrove forests. The final research product aims to illustrate the workings of this system through looking at a variety of factors, both social and ecological, in order to finally answer the following research question:

What stimulates people on Aruba to, and what withholds them from interacting with mangroves in a sustainable way?

The importance of the research lies in its contribution to the understanding and creation of more sustainable interactions.

The paper published in this book is a preliminary version of the final product. Within this paper a literature review, the theoretical framework, method and the setting will be presented. Additionally, a small section on preliminary analysis and conclusions will be offered. As the analysis of the data is not complete yet, there will be a large emphasis on the more theoretical part of the study. The preliminary analysis and conclusions will be based on impressions and anecdotes obtained from fieldwork experience rather than proper and thorough analysis of the data.

In order to effectively create an overview of the interactions that are illustrated within this research, Elinor Ostrom's (2009) framework for organizing social-ecological systems (SES) will be used. Using this model, interactions will be divided into four sub-systems: resource system, resource unit, governance system and users. Each subsystem encompasses several variables, ten of which will be illustrated with corresponding interactions in the final research, along with a piece connecting these interactions. In this paper, three variables will be preliminarily illustrated.

The research was conducted with a community-based research approach. This entailed careful consideration of the meaningfulness of the research by various stakeholders, as well as active involvement of those stakeholders throughout the research process. The research aims to reflect local dynamics through Aruban voices, in such a way that it is relevant and meaningful towards the island and its mangrove forests. The paper published in this book will not be able to fully do justice to this concept, as the data has yet to be analyzed. However, this paper aims to illustrate the tip of the iceberg of some observed interactions, which will be elaborated on in the final version of the research. On a bigger scale, this research aims to be a step, however small, forward in the attainment of the Sustainable Development Goals. It could specifically contribute to Goal 14: Life Below Water, 15: Life Above Ground, and 17: Partnerships for the Goals (UN, 2015).

1. Literature review

In this part, a general theoretical background to the paper will be offered, by means of reviewing prior literature. The first part provides information on ecosystem services, specifically nursery grounds and coastal protection. The second part goes into a variety of potential disturbances to mangroves. The third part explains the idea of the 'Tragedy of the Commons', as well as a reassessment of it.

1.1 Ecosystem services

Mangroves can be described as a common resource, because the ecosystem services they provide are not directed at anyone in particular. For mangroves in general, these include being a nursery for a variety of coral reef species during early life stages, capturing outflowing sediment from the mainland (thereby protecting coral reefs), providing coastal protection, as well as wood, thatch, dye and (shell)fish, and storing carbon (Dekker et al., 2016). Two of these ecosystem services relevant to this paper are expanded on below.

1.1.1 Nursery grounds

Firstly, mangroves act as nursery grounds for juvenile fish and invertebrates, which is linked to catches of fish for consumption. Their nursery function is mainly due to three factors: the high abundance of food, the low abundance of predators and the complex physical structure of the trees (Lee et al., 2014, p. 729). Globally, more than two-thirds of fish and shellfish harvests have been directly linked to estuarine nurseries (Lee et al., 2014, p. 729) and as much as 75% of tropical commercial fish species spend part of their lifecycle in mangroves (Dekker, 2016, p. 3).

1.1.2 Coastal protection

Coastal protection is the second ecosystem service to be highlighted. This not only includes protection of the geophysical shape of the island, but also protection from damages to buildings and infrastructure. Multiple studies highlight the protective role of mangroves during storms (Braatz et al., 2007, p.5; Zhang et al., 2014, p. 11). A fully

grown mangrove forest can reduce wave energy by 20% per 100m (Lee et al., 2014, p. 730). Aruba is on the southern fringes of the hurricane belt, and tropical cyclones cause considerable destruction roughly once every 100 years (Meteorological Department Curacao, 2016, p.17). Substantial damage was caused in Aruba by Hurricane Ivan in 2004, when a developing spiral band of the hurricane resulted in heavy rain on the island, causing a total of two million florins of material damage (Meteorological Department Curacao, 2016, p.18).

1.2 Disturbances

Although mangroves provide benefits, mangrove forests also experience pressure from a variety of factors. Ellison and Farnsworth (1996, p. 552) identify four classes of anthropogenic disturbance with respect to mangroves: extraction, pollution, reclamation and the effects of global climate change. These disturbances have decreased, or have the potential to decrease the size of the resource system. Due to the small island setting, single occurrences of anthropogenic disturbances can lead to fragmentation of mangrove patches, and increased vulnerability through the edge effect, which is one of the main causes for ecological degradation on Aruba (Dekker et al., 2016, p.5; Van der Perk, 2002).

1.2.1 Extraction

Due to the relative scarcity of mangroves on Aruba, there is currently no commercial extraction of mangrove trees themselves. However, respondents pointed out that, before the introduction of plastic on the island, red mangrove wood (*Rhizophora mangle*) was used for presenting caught fish, and red mangrove propagules were used for strengthening fishing lines. Several respondents also indicated small-scale fishing and harvesting of shellfish for private consumption. Extraction of mangrove-related resources such as fish has the potential to disrupt mangrove-associated food webs. Similarly, a reduction of mangrove forest means a reduction in habitat for juvenile fish, influencing fish yields.

1.2.2 Pollution

In the Caribbean more generally, petroleum is indicated as the prime pollutant of mangrove forests, with oil spills being the main cause (Ellison and Farnsworth, 1996, p. 553). Just in the 1980s 24-31 oil spills were recorded near Caribbean coastlines. Oil persists for decades in mangrove sediments, and studies have also found that the continuous release of toxic hydrocarbon from the sediment back into the water will result in long lasting lethal and sub-lethal effects on marine flora and fauna (Burns et al. 1994, p. 397).

However, in the case of Aruba, pollution of mangroves is most likely to originate from the presence of an open land fill and waste-producing activities on the leeward side of the island. Plastic waste can diminish oxygen intake and growth when it covers mangrove roots (Debrot et al., 2013, p. 38), which in turn can influence the soil quality and the nitrogen cycle (Dekker et al., 2016, p.5). Leachate from landfills can potentially decrease soil pH (Twilley et al., 1998, p. 37) and the frequent fires on the landfill may further contribute to pollution of soil, air and vegetation (Dekker et al., 2016, p.5). Although the presence and potential impact of these activities can be considered as indicators of anthropogenic pressure, the exact impact upon the size and livelihood of mangrove forests on the island is yet to be measured.

1.2.3 Reclamation

Reclamation is most often used as a term indicating the restructuring of lands for habitation or cultivation (Ellison & Farnsworth, 1996, p. 555). Respondents have mentioned replacement of mangrove forests on the island by tourist accommodation, recreation, roads, the airport and the landfill. Many mention the tourism industry as the main cause of mangrove reclamation. Ellison and Farnsworth indicate how mangrove clear-cutting on scales as small as single hectares can result in soil sulfide accumulation and subsequent soil acidification (1996, p. 553).

1.2.4 Climate change

Climate change encompasses a wide array of processes, some of which will be briefly noted here to illustrate potential pressures on mangrove forests. Higher atmospheric temperatures will be associated with subsequent higher soil temperatures, changing weather patterns, rise in sea levels, and ocean acidification. The size of mangrove forests may be dependent upon their resilience to change in water level and soil temperatures, as well as their recovery speed after destructive storms (Ellison and Farnsworth, 1996, p. 558).

1.3 Tragedy of the Commons

Common resources that face threats -like mangroves- have often been analyzed through the model of the 'Tragedy of the Commons' (Ostrom, 2009). This idea was first posed by Garett Hardin. In this idea Hardin proposes a hypothetical village with a common resource: grazing fields open to all herdsmen. Hardin argues that the common nature of this resource inevitably leads to unsustainable use of it. Namely, each herdsman will act from an individually rational perspective: the private benefits of adding more animals exceed the private costs. Additionally, if one herdsman decides not to increase his number of animals, he will not be able to compete with the others. In this way each "is locked into a system that compels him to increase his herd without limit" (Hardin, 1968, p. 1244). Because all herdsmen continuously add animals, the pasture is overexploited. In the end, the pasture will be so degraded that it cannot support any herdsman at all: common resources lead to tragedies. Hardin proposes two solutions to evade the tragedy: privatization of the resource, or imposed governmental control of it (Hardin, 1968).

1.4 Reassessing the Tragedy of the Commons

The idea that resources held in common are prone to unsustainable use and overexploitation has been described as a truism (Berkes et al., 1989, p. 355), and is therefore widely present in discussions on sustainability. However, some problems have been observed with the wide application of this model. Criticisms involve the notion that Hardin fails to take into account the self-regulating capacities of users, as well as their ability to work towards their common interests. Furthermore, Hardin is said to confuse common resources with the absence of property rights. There are many types of property rights that are not based upon governmental control or privatization. Elinor Ostrom (Ostrom et al., 1999), whose work is used in this research, distinguishes four types of property rights, which are shown in Figure 1. The Tragedy of the Commons model is said to undermine the role that these very diverse regulations and institutions have in managing resources, and the two solutions it provides are said to be insufficient to fit the model to a variety of contingent local circumstances (Berkes et al., 2005; Dietz, Ostrom and Stern, 2000; Ostrom et al., 1999).

Ostrom (2009, p. 419) addresses how this model has led to recommendations, policies and solutions that are not embedded within their social ecological setting. If resources are large, highly valuable, unpredictable, mobile and open-access, with a large group of diverse users that does not communicate amongst themselves, has little leadership or knowledge, does not find the resource important and fails to develop rules and norms for management, a tragedy of the commons is generally likely to exist (Ostrom, 2009). However, if these variables are different, users are likely to manage their resources sustainably enough to avoid a tragedy, as research has repeatedly shown (Berkes et al., 1989; Dietz, Ostrom and Stern, 2000; Ostrom et al., 1999). The variables Ostrom mentions here will be reflected within the theoretical framework used for this research.

Property rights	Characteristics
Open access	Absence of enforced property rights
Group property	Resource rights held by a group of users who can exclude others
Individual property	Resource rights held by individuals (or firms) who can exclude others
Government property	Resource rights held by a government that can regulate or subsidize use

Figure 1. Types of property-rights systems used to regulate common-pool resources (Adapted from Ostrom et al., 1999, p. 279)

2. Theoretical Framework

A theoretical framework suitable to investigate the social-ecological mangrove system must conform to several conditions. These conditions will be described below, and will subsequently be used to argue the applicability of Elinor Ostrom's core subsystems developed in a framework for organizing social-ecological systems (SES) (2009) as a suitable framework for this study. Next, the framework will be further explained, and finally connected to the eight design principles as defined by Ostrom (McGinnis and Ostrom, 1992, p.9).

2.1 Conditions for a Theoretical Framework

Firstly, it should conform to an interdisciplinary or multi level approach. Investigating the mangrove forest system is essentially looking at the interactions between components that can broadly be categorized in an ecological and a social system. A suitable framework for this study should focus on social aspects while taking into account the ecological, economic and political setting of the case in order to attain a holistic analysis of the situation.

Secondly, the framework should be flexible enough to conform to the specific setting of the research. Ostrom (2009, p.419) warns against the one-size-fits-all theoretical models that oversimplify resource issues because these have often led to deficient policies and practices. The framework should be flexible enough to accommodate conditions on a small island state (SIS) such as Aruba. Small island states have distinct dynamics and challenges, including amongst others a limited number of stakeholders, relatively close social ties and ecological and economic vulnerability (Polman et al., 2016, p. 270).

Thirdly, the framework should push the research in a direction meaningful to Aruban society and beneficial for the mangrove ecosystem. In order to be community based, the research should be embedded in Aruban society in such a way that Arubans are part of the research. The emerging themes the research portrays should voice Aruban voices, rather than make them conform to a predetermined theory.

2.2 A Framework that Organizes Social-Ecological Systems

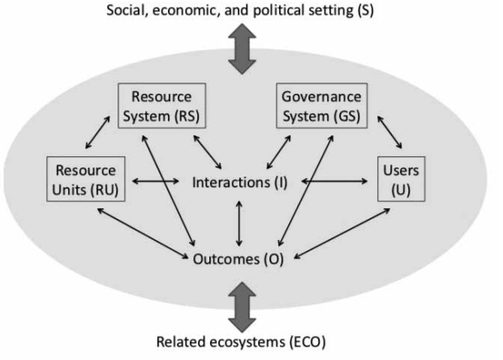

Figure 2 The core subsystems in a framework for organizing social-economic systems (Adapted from Ostrom, 2009)

The core subsystems developed in a framework for organizing social-ecological systems (SES) by Elinor Ostrom (2009) conforms to these conditions. It is tailored to bring ecological and sociological variables together in one model, which makes it adaptable to interdisciplinary research. The framework has also been used to analyze small island states (SIS) before, in a study by Polman et al. (2016). Polman et al. stress that small island settings "are a good example of SES because small islands are very dependent on their unique natural resources/ecosystem for their subsistence and livelihood" (Polman et al., 2016, p. 266). The framework also aims at investigating sustainability, a timely topic for Aruba, where sustainability has been strongly present on the political and social agenda for over a decade.

Ostrom (2009) identifies four core subsystems within a SES (Figure 2). Important to notice is that every aspect of Figure 2 is in interaction with the other parts, and that the entire system is embedded and in contact with the particular setting of the research.

The four subsystems can be explained in the following way (Polman et al., 2016, p. 268-269):

- Resource system (RS) concerns areas harboring important natural resources (mangrove forests, coastal areas, etc.).
- Resource unit (RU) refers to ecosystem services located there, including direct resources such as water or fish, but also indirect services such as carbon sequestration.
- Governance system (GS) includes a range of managerial bodies (governmental, private, or non-governmental) which control the management of the resource systems, for example through rules of usage.
- Users (U) are those who influence and are influenced by the ecosystem services delivered by the resource unit. This includes for instance general health, food provision, safety, recreation and commercial activity.

Figure 3 displays ten variables that correspond to the subsystems. These variables are used for this research. They were selected for two reasons. Firstly, Ostrom (2009) stated that these variables are highly likely to affect the probability of users' self-organization efforts aimed at sustainability'. Secondly, these variables were used in Polman et al.'s research (2016) on St. Eustatius, which is also a SIS. Therefore, it is highly likely that these variables will also resonate with Aruba.

Resource System (RS)	**Governance System (GS)**
RS3 = Size of resource system	GS6 = collective-choice rules
RS5 = Productivity of system	
RS7 = Predictability of system dynamics	
Resource Units (RU)	**Users (U)**
RU1 =Resource unit mobility	U1 = Number of users
	U5 = Leadership/entrepreneurs
	U6 = Norms/social capital
	U7 = knowledge of SES/mental models
	U8 = Importance of resource

Figure 3. Ten variables corresponding to the subsystems. (Based on Ostrom, 2009)

2.3 Design Principles

Drawing on prior research as to why certain common resources are managed sustainably, Ostrom defined eight design principles. A design principle is not to be interpreted as a rule, since it is extremely difficult to find an effective set of rules that is accepted by every community as legitimate and fair, and also matches the wide variety of existing resource systems, as well as their internal complexity and dynamic nature. A design principle is rather 'an essential element or condition that helps to account for the success of these institutions in sustaining the common pool resources and gaining the compliance of generation after generation of participants to the rules-in-use.' (McGinnis and Ostrom, 1992, p.9). In short, design principles are underlying principles that have characterized a wide variety of sustainably managed SES. The previously identified variables, thus, influence the extent to which the principles are present within a SES. The design principles are the following:

1. Clearly Defined Boundaries. The boundaries of the ecological system (in this case the mangrove forest), as well as the social system (the persons participating in the ecological system, the participants) must be clearly defined.
2. Congruence between Appropriation and Provision Rules and Congruence Between Provision Rules and Local Conditions. The rules that regulate the use (time of use, place, technology, and/or quantity) of the resource pool -the mangroves- are related to local circumstances and supply of labor, materials, and/or money.
3. Collective-Choice Arrangements. Most participants affected by the implemented rules can participate in shaping and reshaping those rules.
4. Monitoring. Monitors, who actively audit the resource pool and its condition, as well as the participants' behavior, are accountable to the participants or are the participants.
5. Graduated Sanctions. Participants who violate rules face sanctions that are assessed and graduated (depending on the seriousness and context of the offense). These sanctions are enacted by other participants, by officials accountable to these participants, or by both.
6. Conflict Resolution Mechanisms. Participants and their officials have rapid access to low-cost, local arenas to resolve conflict among participants or between participants and officials.
7. Minimal Recognition of Rights to Organize. The rights of participants to devise their own institutions are not challenged by external governmental authorities.
8. Nested Enterprises. Appropriation, provision, monitoring, enforcement, conflict resolution, and governance activities are organized in multiple layers of interconnected enterprises or organizational layers. (McGinnis and Ostrom, 1992, p.9)

3. Method

3.1 Design

In order to utilize Ostrom's framework for organizing social-ecological systems (SES), opinions and experiences that illustrate the variables related to self-organization on Aruba were collected.

Ostrom's (2009) framework caters to a phenomenological approach through the combination of literature review and in-depth interviews. The qualitative nature of this research design makes it possible to acquire an encompassing view, as it provides rich and diverse data to work with. Dispositions may differ from respondent to respondent and may be misinterpreted if not looked at in depth.

The final research is divided into six parts, corresponding to the four identified subsystems within Ostrom's framework (2009), together with a literature review and a description of the setting in which the research takes place. The setting will be discussed before the variables, briefly illustrating some relevant social, economic and political dynamics on the island with the aim of embedding this particular SES within its context.

Second, each identified variable within the four subsystems will be illustrated with a particular interaction or a set of interactions. These interactions are identified by means of in-depth analysis of the research data. In total, ten different variables will be illustrated in this way (of which three are preliminarily illustrated in this paper), categorized into four parts that correspond to the subsystems.

The conclusion of the research will consist of an evaluation of the sustainability of the perceived interactions within the SES. In order to effectively evaluate the sustainability of these interactions, Ostrom's eight guiding principles (McGinnis and Ostrom, 1992, p.9) will be used as indicators of best practice.

Data for these interactions was gathered by means of conducting interviews with relevant stakeholders with the help of topic guides customized for each respondent. These respondents included people connected to government and nature management (3 respondents), non-governmental nature organizations (3 respondents), an enterprise that depends on the mangrove forests, fishermen (3 respondents), residents that live close to mangrove forests (3 respondents) and education (4 respondents).

In total, 16 semi-structured face-to-face interviews were carried out on Aruba addressing issues related to the island's natural environment and mangroves in particular. Of the interviews 11 were conducted in English and 5 in Dutch. One repeat interview was conducted, with the aim of capturing the experience of an event discussed in the first interview. Examples of discussed themes include perceived influences to and of the mangrove forests, threats, solutions, collaborations, conflicts, concerns, management, knowledge and values. Interviews were usually about an hour long, with some exceptions (of both shorter and longer interviews) dependent on the contingent circumstances. Data from the interviews was enriched by careful observation, participant observation during three mangrove-related events and personal communication.

Prior to the interview stage, measures were taken to ensure the community based nature of the research. The research, its aims and its methodology were carefully considered together with four different stakeholders during separate face-to-face meetings. Additionally, a Skype meeting was organized with Linde van Bets, co-writer of the earlier mentioned article "Governance of ecosystem services on small islands: three contrasting cases for St. Eustatius in the Dutch Caribbean" (Polman et al., 2016). The aim of this meeting was to discuss the above-mentioned parts of the thesis, as well as to gain insights into best practices from similar research. Two pilot interviews were also conducted before the offset of the interview stage.

3.2 Sample

Sampling was based on non-probability purposive sampling. The single criterion for the sample was for the respondents to be stakeholders with regards to the mangrove forests. All genders, ethnicities, ages and social statuses were applicable to be part of the sample, although not purposefully searched for. Aruba as an island defined the physical boundaries of the SES.

A snowball sampling method was employed, with the aim of getting complementary interviews with managers and the very diverse group of users. The number of respondents was fitted to the time limit of the research.

3.3 Ethical considerations

Consent, confidentiality of data and privacy were observed during this study. Participation was entirely with informed consent, attained through the use of consent forms. An additional verbal explanation of the study and its aims was given along with the overt clarification that the interviewee can stop the interview or refuse to answer a question at any time. At the end of the interview, all respondents were debriefed by means of providing the interviewer's contact information. Furthermore, the respondents each received the transcripts of their interviews for them to evaluate. An active attempt was made to remove elements from the research records that indicated the subjects' ID.

4. Setting: Aruba

This section describes the tip of the iceberg of the setting in which this research has taken place. It includes a sweeping tour of the natural landscape, the various industries of the island, population dynamics, sustainability practices and postcolonial ties. These themes are highlighted to indicate the importance of taking the specific natural, social, economic and political setting into account when looking at a SES (Ostrom, 2009, p. 420).

4.1 Natural Landscape

Aruba, being a tropical island within the Caribbean, has a tropical steppe, semiarid hot climate, with wind blowing 95% of the time from the north- and southeast (Ridderstraat et al., 2014, p. 247). Due to the wind the northeast side of the island is constantly subject to wave action, causing that part of the island to be composed of cliffs. The cliffs are alternated with inlets created by 'rooien' (riverbeds) connecting to the ocean (Polaszek et al., 2018, p. 34). Towards the inland the vegetation is dominated by wood- and scrublands, commonly called the 'cunucu'. On the leeward side of the island, where the ocean is a lot calmer, temporarily or permanently flooded salt marshes or saliñas can be found, as well as the island's only inland lagoon. Aruba's so often advertised white beaches are here, from which one can view a number of barrier islands (Polaszek et al., 2018, p. 35). In total, Van der Perk (2002) identified ten different ecosystems on Aruba (figure 4), one of which are mangrove forests. Mangroves grow on the various barrier islands, along the lagoon and near the saliñas (figure 4). The brightly green and lush canopy of the mangrove trees stands out in the otherwise arid and greyish vegetation (Polaszek et al., 2018, p. 34; figure 5).

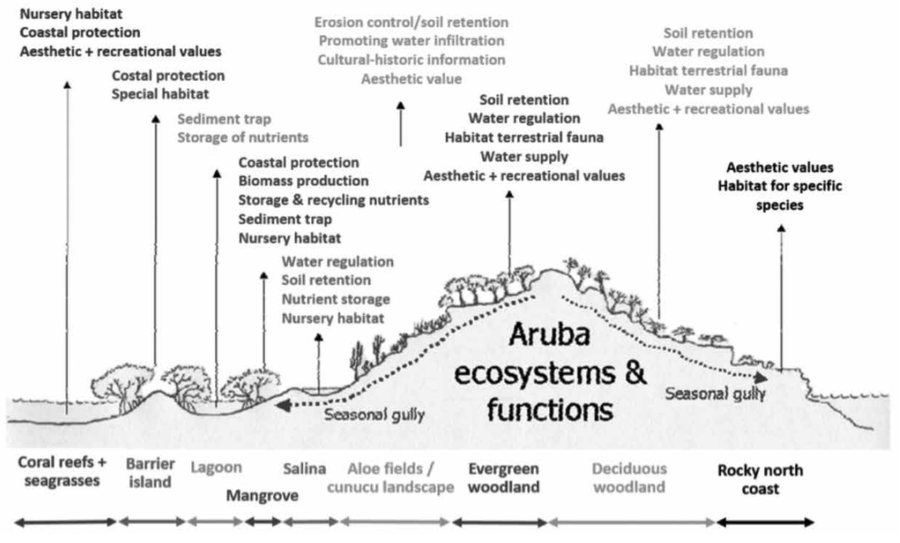

Figure 4. Schematic cross-section of Aruba's main ecosystems and its functions (Adapted from Van der Perk, 2002)

Figure 5. The brightly green and lush canopy of the mangrove trees stands out in the otherwise arid and greyish vegetation (Adapted from a respondent's private collection). Photo taken by Villegas Anibal Luis.

4.2 Industries

This landscape has contributed to the various industries that have made their mark on Aruban history. It provided gold and phosphate, as well as earth that can grow aloe and beaches that attract tourists (Bongers, 2018; Derix, 2016). Two industries that have made a considerable impact on the island within the last century are the oil and tourism industries. The biggest of two refineries on the island (Bongers, 2018, p. 131), the Lago oil refinery was inaugurated on January 29, 1929 (Ridderstraat, 2008, p. 237). The Lago refinery caused substantial immigration, with 21 languages being represented in 1929 (Ridderstraat, 2008, p. 40). The Lago refinery closed in 1985 (Ridderstraat, 2008, p. 255), and although the refinery has been reopened and closed a number of times since then, the main economic focus of the island shifted to tourism (CBS Aruba, 2016, p.7). In 2016, the total contribution of the travel and tourism industry accounted for 88.1% of Aruba's GDP (Van Zanten et al. 2018, p. 10), and 89.3% of total employment (Van Zanten et al. 2018, p. 7). Currently the tourism industry is Aruba's main industry, making it an important contributor to many interactions on the island.

4.3 Population

One way in which these industries have influenced the island is through their impact on population size (figure 6). Settlement started being reported in 1920, nine years before the refinery opened (CBS Aruba, 2018, p. 1). As a result of the booming tourism and subsequent construction industry, many migrants came to the island over the past 20 to 30 years. In 2010 the foreign-born population on Aruba accounted for no less than 34.5% of the total population, with a total of 133 nationalities living on Aruba (CBS Aruba, 2018, p. 1). In 2015, the population of Aruba was about a 110 thousand people, or 612 inhabitants per square kilometer (CBS, 2017, p.13). On top of that, more than 1.6 million tourists visit the island every year (Van Zanten et al. 2018, p. 7), making Aruba a densely populated island.

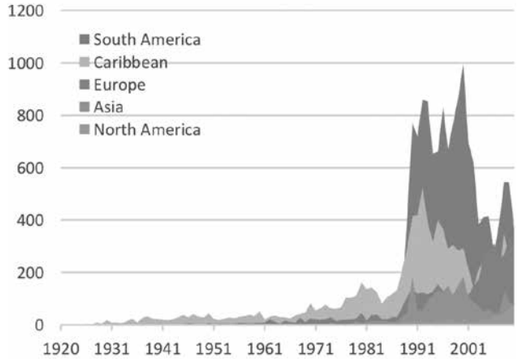

Figure 6 Immigration to Aruba (Adapted from CBS Aruba, 2018, p.1)

4.4 Sustainability

As a reaction to -amongst other things- the expanding population size, a focus on sustainability began to emerge on the island. An early example of this was the establishment of the Nos Aruba 2025 Project in 2008. The goal of the project was to bring stakeholders together to discuss and act upon sustainable development. This project determined twelve sustainable development priorities within Aruba's four sustainability themes: economic, political, social and environmental (Nos Aruba, 2008). Aruba's sustainability aspirations were recently reflected in the establishment of the Center of Excellence for Sustainable Development of Small Island States (SIDS) in 2016 (UNDP, 2018). The UN Sustainable Development Goals are widely used in projects and research on the island, for example within this research project.

4.5 Postcolonial ties

Not only do international organizations like the UN leave their mark on Aruba, there is also still a considerable influence from the Netherlands. Aruba was the first to leave the Netherlands Antilles in 1886 and become a constituent state within the Kingdom of the Netherlands (currently the other constituent states are Curacao, Sint Maarten and The Netherlands). The strong ties Aruba maintains with the Netherlands continue to influence the social, political, economic and educational make-up of the country. For example, a large proportion of the books used in the educational system are written and published in the Netherlands (Herrera, 2003). This form of overseas knowledge creation is of major influence for the Aruban society and also ties back into sustainability challenges, as Sustainable Development Goal 4 (SDG 4) is to 'Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all' (UN, 2015).

5. Preliminary Analysis

This part provides some preliminary illustrations to three variables within Ostrom's (2009) framework, namely: RS3 Size of the Resource System, RS5 Productivity of the Resource System and U1 Number of Users. As mentioned above, the preliminary analysis will be based on impressions and anecdotes gathered from fieldwork experience rather than proper and thorough analysis of the data. Additionally, a focus on the theoretical part of the study will be reflected within the illustrations. This

is especially true for the first variable, since it merely describes where the boundaries for the resource system were set.

5.1 RS3: Size of the Resource System

Mangroves, even without taking the social system into account, are linked to other ecosystems on various levels. SIS are sometimes referred to as large ocean states (Jumeau, 2013, p. 2), indicating the key role oceans play for SIS. Mangrove forests are situated on the borderline between ocean and land, and therefore form a connecting factor between the island's ecosystems and the ocean surrounding it, for example through ecosystem services such as being nursery grounds for fish and crustaceans (Lee et al., 2014, p. 729). Mangroves also provide habitat to a large number of birds on Aruba (Polaszek et al., 2018, p. 36). The mobility of these birds further connects the ecosystem to other terrestrial ecosystems.

Although it is important to take into account that the mangrove resource system is closely connected to the both marine and terrestrial resource systems around it, it is also imperative to maintain a sense of focus. The fact that Aruba is a SIS, and therefore to an extent an isolated system, makes the boundaries of that system relatively clear. Therefore, this research considers the physical borders of the resource system to be at the edges of the mangrove forests on Aruba.

Mangrove forests cover a total of 171 hectares on the island (0.96% of the island's total area) (Polaszek et al., 2018, p.122) and are located along the Spanish Lagoon, along the southwest coast and on the rifnan (small reef islands) (Polaszek et al., 2018, p.36; figure 7). The Spanish Lagoon accounts for the largest area of mangroves as it covers approximately 70 hectares. It is the country's only inland lagoon system with mangroves around it. It is also the only Ramsar designated site (Ramsar, 1980). The Ramsar convention, or Convention on Wetlands, is the intergovernmental treaty that provides the framework for the conservation and wise use of wetlands and their resources. The lagoon is located on the southwestern part of the coastline and is made up of both mangroves and tidal mudflats. It also has a narrow coastal inlet about 2 kilometers long and 200-500 meters wide (Polaszek et al., 2018, p.36). This area became an extension to the Aruban National Park in February 2017 (Parke Nacional Arikok, 2017, p.3), and is therefore the largest governmental property of mangroves on Aruba.

Figure 7. Distribution of mangrove forests on Aruba (Adapted from Polaszek et al., 2018, p. 33, modified to specifically show mangrove distribution)

5.2 RS5: Productivity of Resource System

Ostrom argues that when a resource system's current productivity is extremely high or extremely low, users of that system are unlikely to undertake action. 'Users need to observe some scarcity before they invest in self-organization' (2009, p.420).

This section will first elaborate on the productivity of mangrove forests and the ways in which Arubans benefit from mangrove forests. It proceeds to illustrate how respondents perceive the Tragedy of the Commons on the island. It concludes that, regardless of the extent to which a tragedy of the commons is present within this SES, the idea of it has an influence on the system. Specifically, it influences the perception of scarcity of the resource system.

The productivity of mangroves on Aruba is, as seen in the literature review, hardly to be found in directly extractible products. Therefore, when asked about the ways in which mangroves influence people on Aruba, ecosystem services are most frequently discussed. Mangroves provide a number of ecosystem services that link back into people's livelihoods. Two examples of these were given in the literature review, namely the nursery grounds and the coastal protection that mangroves provide.

Besides being directly influenced by these ecosystem services, many Arubans also benefit indirectly through their involvement in the tourism industry. Currently Aruba experiences more than 1.6 million tourists visiting the island per year (Van Zanten et al., 2018, p. 7), and the total contribution of the travel and tourism industry accounted for 88.1% of Aruba's GDP (Van Zanten et al., 2018, p. 10), and 89.3% of total employment in 2016 (Van Zanten et al., 2018, p. 7). At the moment the net value of ecosystems for Aruba's tourism industry is calculated at US$ 268,824,272 (Van Zanten et al., 2018, p. 25). Fish consumed within the tourism industry that developed within mangrove forests, and damage to buildings that could be avoided due to mangrove coastal protection are two examples of ecosystem services that are important to Aruba's tourism industry.

It is often pointed out how consumers within this same tourism industry provide pressure on the mangrove forests. One respondent noted:

> *Because personally I want to oppose a lot of touristy entertainment things that they're offering and developing on the island. The large hotels do that especially. With palm island is kinda the same thing, they're making use of a reef basically which consisted of mangroves. Took away some of that to create entertainment. So it feels kind of, not good. (laughs) really making use of it in that way. At the same time you can just walk a few miles away, a few meters away from that section, you can just enter what was originally the full island, the full reef. So it feels kinda weird to see that this is what it was.*

During the interviews several examples of coastal construction plans that affect mangrove areas were mentioned. For instance, a plan to develop a resort called Zoetry in the Pos Chikito mangrove area called 'Isla Di Oro' was halted in 2016; a privately owned mangrove area next to the Spanish Lagoon has been cleared for development purposes; and stories were told about the mangrove forests that used to grow in the area where the Ritz hotel is now constructed. On the relationship between development and nature, the following was stated:

> *You have this particular terrain which has some environmental value or it has some financial value to a developer, I would say 99/100 times he [indicating the Minister of Spatial Development, Infrastructure and the Environment] would go for the latter and would take the financial interest over the environmental interest. I think you can see - it is demonstrated the best - you can see we have a plan of ruimtelijke ordering which is set by law [indicating the Spatial Development Plan] - it clearly defines what areas serve what purpose and those boundaries are constantly threatened by new development where there is hardly any regard - especially for those that are regarded as highly important nature areas.*

These examples illustrate the statement that economic gain has recurrently had the potential to be valued over the

conservation of mangroves. A partial explanation given for this is that people perceive a direct dependence on the tourism industry for their livelihood, but don't perceive this direct dependence for ecosystem services. One respondent called that "*the catch-22 that we have.*"

For instance, a direct dependence of fishermen on fish is not greatly emphasized. When asked about the way in which mangroves influenced them or people on the island, none of the fishermen mentioned the nursery function of fish. This is not to imply that they didn't know about it. It merely illustrates how it wasn't at the top of their minds.

In contrast to that, many respondents mentioned clearly that mangroves provide coastal protection. One respondent stated:

> *Dan mag je blij zijn dat ze [indicating mangroves] er zijn hoor. Want ze houden een heleboel tegen. Want we hebben, nou in al die jaren hebben we drie keer, hebben we storm gehad. De eerste keer toen we het huis aan het bouwen waren, en die andere, nog twee keer. Maar dan vliegt de zee -vliegt de keuken in he?*
>
> *Then you're happy they're there [indicating mangroves]. Because they block a whole lot. In all those years we've had three storms. The first one when we were building the house, and the other one, two other ones. But the sea flies into the kitchen, you see?*

However, it was highly questioned whether perceived dependence on coastal protection outweighs dependence on the economy. In the case of the previously mentioned construction plans, several respondents expressed that they didn't think developers cared. Others stated that they thought construction would take place in an ethical way, and indicated plans that would diminish the effect upon the mangroves. These included building above the mangrove roots for the Zoetry resort and leaving some of the mangroves intact for the Ritz hotel.
The way respondents analyze the SES greatly resembles the idea of the Tragedy of the Commons (Hardin, 1968). Hardin's work was only explicitly referred to once during an interview, but comments like the ones mentioned above show how Hardin's model was implicitly present in many conversations. Respondents talked about the concept without talking about the theory. Many respondents concluded that people act from an individually rational perspective, which leads to overexploitation of the mangrove forest.

It is important not to jump forward to conclusions and boldly proclaim that the SES of mangroves on Aruba mirrors the Tragedy of the Commons. Instead, I'd like to stress that the idea of the Tragedy of the Commons is clearly present on Aruba. Therefore, the idea itself influences and creates interactions within the SES.

One of the interactions it creates is linked to the productivity of this resource system. If people express pressures on mangroves are very low, they generally think that mangroves are also abundant. However, if people are aware of the pressures on mangroves, they generally accentuate the decline of mangroves by providing an explanation emphasizing the valuing of personal and economic gain over conservation of mangrove forest. Therefore, the extent to which people refer to the Tragedy of the Commons dynamics is connected to the extent to which they perceive scarcity.

5.3 U1: Number of Users

In order to say anything useful about the number of users, we first need to define who qualifies as a user within this study. Therefore, this section will start by discussing this topic. After defining the number of users, the diversity of this group will be highlighted, as well as its implications for perceptions of who uses the mangroves ethically and who doesn't.

As mentioned in variable RS3, it is important to acknowledge that SES are always linked to other SES on various levels.

Ecosystem services provided by Aruban mangroves are often global services. For instance, mangroves sequester carbon (Dekker, 2016, p. 4), which mitigates climate change. In this sense, the entire world population can classify as a user. However, it is also -again- imperative to maintain a sense of focus. Just as the boundaries of the resource system were determined to be at the edge of the mangrove forest itself, the number of users will be limited to the people on the island (temporary visitors included). Of this population, the research has focused on users that are closely connected to the mangrove forest (specifics can be found in the method section).

Aruba is a small island, which suggests the number users would also be small. Yet large or small is always a matter of comparison. Compared to bigger countries or even the world population, there is a very limited number of users of this resource system. However, due to the high population density and the subsequent social dynamics mentioned in RS5, most respondents agreed that the number of users of this SES is (too) high. Take for instance the following comment:

> *The impact that we're having as a society is far greater than when your grandparents were living here and the society was, maybe not even 20% of what it is now. But we're living in different times now. And what your grandparents were doing is not something you can still be doing because it's not possible, there is just too many people.*

With the high immigration rates of the past decades, and 133 nationalities represented on the island, Aruba indeed knows a wide variety of inhabitants (CBS Aruba, 2018, p. 1). This diversity of users present has implications for the dynamics within the SES.

Ethical use of mangroves was frequently connected to a distinct (often ethnic) group on the island. In many interviews a divide was made between groups that were environmentally aware, and groups that were not. Reoccurring groups included: tourists (sometimes especially American tourists), locals, immigrants from various countries, young and older people. Which of these were and were not environmentally aware was, interestingly, not unanimously agreed upon.

The following paragraphs illustrate what was mentioned above. Firstly, several organizers of nature-related events mentioned that their participants usually originated from the Dutch community. These events included organized walks, as well as more activist events such as protests.

Consequentially it was noted that the Dutch community on Aruba was the community that cared most about nature. Examples from two interviews are given below:

> *Maar zij [indicating American immigrants during the time of the Lago refinery] gaven om de natuur en de Nederlander geeft om de natuur, maar de doorsnee Arubaan niet. Hebben ze nooit gedaan.*

> *But they [indicating American immigrants during the time of the Lago refinery] cared about nature and the Dutchman cares about Nature, but the average Aruban doesn't. They never have.*

> *In Nederland is verder met natuurbehoud en bewustwording van maatschappij - een maatschappij […] die de belangen ziet van natuur en dieren. Wij zijn nog - we hebben mensen die ervoor vechten - maar we staan nog steeds in babyschoentjes.*

> *The Netherlands is ahead with nature conservation and awareness within society -a society […] that sees the interests of nature and animals - but we're still taking babysteps.*

However, this notion was nuanced during other interviews in two ways. Firstly, it was mentioned how traditional

ways of using nature were disregarded. For instance, when talking about the catching of various currently protected marine species, one fisherman noted:

> *[…] all that is now protected [indicating marine species]. But it's the outside influence, on the whole island, it's affecting our island and our culture, that's what I think. And honest, they came to our island and most of the people that do that they're not locals, and they enforce it. […]. I grow up doing that, you want me to eat a sandwich with the cheese of peanut… 'pindakaas' [peanut butter], or butter. But no, we eat fish and we eat food. It's against what I do.*

Additionally, several forms of knowledge and care for mangroves came up during interviews with people who indicated that they did not attend nature-related events. Consider the following quote:

> *So, I would like to [participate in nature events] since it's a nice result. But in a way it's also very hot outside and most of them. Or not most of them, but at a certain time it gets too hot, and then I don't really like want be there anymore. Cause then it's just flame and I don't have any zin to do it [do not feel like doing it].*

This respondent is one of those that, despite not attending nature-related events, did portray knowledge of ecosystem services such as coastal protection and the various types of habitat mangroves provide. Furthermore, the knowledge was present that mangroves grow very slowly and that there would be severe (ecological as well as legal) consequences to cutting them.

To conclude, there is a multitude of ways in which people use, know and care about the Aruban mangrove forests. Some actively participate in events, some adhere to more traditional forms of use, and some passively know and care. Yet not everyone agreed on who interacted with nature in an ethical way, and who didn't. This begs the question in which ways and to what extent these identified groups communicate with each other. Perhaps communication could open up unexploited ways to combine efforts towards sustainability. For instance, increased communication could accentuate how users that don't attend nature events still contribute to sustainability, or how they could do so even more.

A similar multitude of practices seem to be reflected on the management level, which will be dealt with more specifically in the final version of this project. Still, it is important to highlight the connection between the interactions on the user level and the management level. This connection is partly due to the small island setting of this SES, where user groups can be closely connected to different parts of management. Therefore, it is highly possible that different entities concerned with mangrove management adhere to different perceptions of who uses them ethically. The presence of these perceptions could have implications for communication and the nature of relationships between participants (on both governance and user levels) of the SES.

6. Preliminary Conclusions

As mentioned in the introduction, the conclusions presented here will be based on impressions and anecdotes obtained from fieldwork experience rather than proper and thorough analysis of the data. Therefore, all conclusions are preliminary and cautiously formulated. The final version of this research project aims to be able to make a statement on the extent to which there is or isn't a tragedy of the commons at work on the island, but this will be put aside for now.

Through the preliminary analysis, some interactions have been illustrated that might influence the sustainability of the SES. In this preliminary conclusion, the interactions that potentially hinder sustainability will be explained

first, after which the interactions that potentially help the sustainability of the SES are discussed. Finally, these interactions will be related to two of Ostrom's guiding principles (McGinnis & Ostrom, 1992, p.9).

6.1 Interactions that Hinder

Firstly, the smallness of the resource system could potentially hinder its sustainability. Ostrom (2009, p. 420) notes how 'very small territories do not generate substantial flows of valuable products'. Besides comments on the previous use of mangroves and propagules for making wooden hoes, presenting fish and strengthening fishing lines, and some small-scale fishing and harvesting of shellfish for private consumption, the mangrove forest does not seem to generate large flows of valuable products. However, it seems that many respondents would also qualify ecosystem services as 'valuable products'. Still, the low generation of tangible products by the resource system might lead to a low valuation of the system. Therefore, participants could be less likely to organize themselves in efforts towards the system's sustainability.

This ties into the second interaction: the seemingly present idea that participants are unlikely to organize themselves in efforts towards the system's sustainability. Many respondents concluded that people act from an individually rational perspective, which leads to overexploitation of the mangrove forest, thereby echoing the idea of the Tragedy of the Commons. The presence of this idea could undermine efforts towards sustainability, as participants might not believe they will succeed in those efforts. Additionally, the idea that another participant is likely to overexploit the resource might influence one's willingness to collaborate in a negative way.

One way to potentially overcome these hindrances is through increased communication and understanding of participants' different viewpoints. However, the third potential hindrance relates to communication and understanding. It appears like these could be improved between the participants of the SES. There is an apparent discrepancy in valuing of active participation in nature events versus traditional uses of mangrove forests, passive forms of knowledge and care. This discrepancy might hinder organizing efforts toward sustainability collectively.

6.2 Interactions that Help

On the brighter side, the smallness and location of the resource system also suggests remarkable advantages. The boundaries of the mangrove forest are relatively easily defined, which ameliorates the costs of monitoring them and gaining ecological knowledge (Ostrom, 2009, p. 420). Additionally, a large part of the mangroves is situated within one area, namely the Spaans Lagoon. Use of this area can be restricted, since it is government property. Therefore, the smallness and location of the mangroves are likely to benefit the sustainability of the system.

Furthermore, the presence of the idea of the Tragedy of the Commons could also have beneficial effects in terms of sustainability. The notion that mangroves are being overexploited could have an alarming effect on the participants, therefore inspiring them to organize more sustainable actions.

Lastly, in terms of communication, the small island setting of the SES could offer opportunities. In a small island like Aruba, participants tend to be closely connected. This implies that reaching out to other participants in efforts towards greater sustainability might be relatively easy.

6.3 The Guiding Principles

Two of Ostrom's (2009) design principles seem to be at work within these interactions. Since her design principles have characterized a wide variety of sustainably managed SES, this is a good sign for the mangrove system on Aruba. Design principles 1 and 8 are reflected in the following way:

1. Clearly Defined Boundaries. As mentioned above, the smallness and location of the mangrove forests could make it relatively easy to define the boundaries of the system.
8. Nested Enterprises. This principle indicates that appropriation, provision, monitoring, enforcement, conflict resolution, and governance activities are organized in multiple layers of interconnected enterprises or organizational layers. The small island setting of the SES implies that the participants (both on the user and management levels) are closely interconnected. As mentioned before, communication likely increases the extent to which this interconnectedness is utilized. Therefore, there will be a greater emphasis on communication (both strengths and weaknesses) within the SES in the final research product.

The final research project will aim to provide a more thorough set of illustrations of the SES. Through these illustrations, it will look at the presence or absence of a Tragedy of the Commons, and analyze how the illustrations relate to the sustainability of the system. Therefore, if you're interested in the final version, feel free to contact the author at lindevandegraaf@gmail.com.

Bibliography

- Nos Aruba 2025 Project. (n.d.). Retrieved April 4, 2019, from http://www.nosaruba2025.aw
- Berkes, F., Feeny, D., McCay, B. J., & Acheson, J. M. (2005). The Benefits of the Commons. In The Environment in Anthropology (pp. 355–360).
- Boersma, A. (2018). 3 lessons from a small innovative centre supporting big ocean states.
- Bongers, E. (2018). De kolibrie op de rots.
- Burns, K. A., & Yelle-Simmons, L. (1994). The Galeta Oil Spill. IV. Relationship Between Sediment and Organism Hydrocarbon Loads. Elsevier, 38(4), 397–412.
- Central Bureau of Statistics Aruba. (2017). Quarterly Demographic Bulletin. 2017–2018. Retrieved from http://cbs.aw/wp/index.php/category/population/population-population/quarterly-demogrphic-bulletin/
- Central Bureau of Statistics Aruba. (2017). RECENT MIGRANTS.
- Central Bureau of Statistics Aruba. (2015). Statistical Yearbook 2015. Retrieved from http://yearbook2015.cloud-pages.com/#page/66
- Daniel, T. C., Muhar, A., Arnberger, A., Aznar, O., Boyd, J. W., Chan, K. M. A., … von der Dunk, A. (2012). Contributions of cultural services to the ecosystem services agenda. Proceedings of the National Academy of Sciences, 109(23), 8812–8819. https://doi.org/10.1073/pnas.1114773109
- Debrot, A. O., Meesters, H. W. G., Bron, P. S., & de León, R. (2013). Marine debris in mangroves and on the seabed: Largely-neglected litter problems. Marine Pollution Bulletin, 72(1), 1. https://doi.org/10.1016/j.marpolbul.2013.03.023
- Dekker, S. C. (2016). Mangroves of Aruba: past developments, current status and future conservation opportunities. (1), 1–28.
- Derix, R. R. W. M. (2016). The history of resource exploitation in Aruba.
- Ellison, A. M., & Farnsworth, E. J. (1996). Anthropogenic Disturbance of Caribbean Mangrove Ecosystems: Past Impacts, Present Trends, and Future Predictions. Biotropica, 28(4), 549–565.
- Government of Aruba. (2019). Naar een duurzame inrichting van Aruba (Vol. 2019).
- Hardin, G. (1968). The Tragedy of the Commons. Science, 162(June), 1243–1248. https://doi.org/10.1126/science.162.3859.1243
- Herrera, J. (2003). Language planning and education in Aruba: Contexts and contradictions. Retrieved from https://repository.arizona.edu/handle/10150/280478
- Jumeau, R. (2013). Small Island Developing States, Large Ocean States. Expert Group Meeting on Oceans,

Seas and Sustainable Development: Implementation and Follow-up to Rio + 20, (April), 1–7.
- Lee, S. Y., Primavera, J. H., Dahdouh-Guebas, F., Mckee, K., Bosire, J. O., Cannicci, S., … Record, S. (2014). Ecological role and services of tropical mangrove ecosystems: A reassessment. Global Ecology and Biogeography, 23(7), 726–743. https://doi.org/10.1111/geb.12155
- Meteorological Department Curacao. (2017). Hurricanes and Tropical Storms in the Dutch Caribbean. Retrieved from http://www.meteo.cw/Data_www/pdf/pub/Hurricanes and Tropical Storms DC.pdf
- Ostrom, E. (2007). A General Framework for Analyzing Sustainability of Social-Ecological Systems. 325(June), 1–53.
- Parke Nacional Arikok. (2017). A management plan for Spaans Lagoen Aruba. (November).
- Polaszek, T., Lacle, F., Van Beukering, P., & Wolfs, E. (2018). The Economics of Ecosystems and Biodiversity, Aruba.
- Polman, N., Reinhard, S., & Kuhlman, T. (2016). Governance of ecosystem services on small islands: three contrasting cases for St. Eustatius in the Dutch Caribbean. 11(1), 265–284.
- Ramsar. (1980). Het Spaans Lagoen. Retrieved from https://rsis.ramsar.org/ris/198
- Ridderstaat, J., Oduber, M., Croes, R., Nijkamp, P., & Martens, P. (2014). Impacts of seasonal patterns of climate on recurrent fluctuations in tourism demand: Evidence from Aruba. Tourism Management, 41, 245–256. https://doi.org/10.1016/j.tourman.2013.09.005
- Ridderstraat, J. R. (2008). LAGO story: the compelling story of an oil company on the island of Aruba. Oranjestad: Editorial Charuba.
- Susan, B., Fortuna, S., Broadhead, J., & Leslie, R. (2006). Coastal protection in the aftermath of the Indian Ocean tsunami: What role for forests and trees ? Proceedings of the Regional Technical Workshop, 236.
- Twilley, R. R., & Chen, R. (1998). A gap dynamic model of mangrove forest development along gradients of soil salinity and nutrient resources. Journal of Ecology, (86), 37–58.
- United Nations Development Program. (2014). poverty eradication Sustainable consumption and production Sustainable cities and settlements peaceful and non-violent societies, capable institutions health and population dynamics Employment and decent work for all. (82), 20–23. Retrieved from http://www.igbp.net/download/18.62dc35801456272b46d51/1399290813740/NL82-SDGs.pdf
- United Nations. (2015). Sustainable Development Goals. Retrieved from https://www.un.org/sustainabledevelopment/sustainable-development-goals/
- 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.
- van Zanten, B., Laclé, F., van Duren, S., Soberon, V., & van Beukering, P. (2018). The Value Natural Capital for the Tourism Industry of Aruba. (January).
- Wolfs, E., Laclé, F., Bubalo, M., van Beukering, P., & Pols, R. (2017). Cultural Ecosystem Services (CES) for Local Community in Aruba.
- Zhang, K., Liu, H., Li, Y., Xu, H., Shen, J., Rhome, J., & Smith, T. J. (2012). The role of mangroves in attenuating storm surges. Estuarine, Coastal and Shelf Science, 102–103, 11–23. https://doi.org/10.1016/j.ecss.2012.02.021

Mirre Stevens, University College Utrecht

Here comes the sun, and I say "it's all right"

If you would have asked me at the start of my bachelor's thesis whether I would've successfully completed an independent research project on Aruba, I probably would have laughed at you. I did not think myself capable of this, and honestly there were moments throughout entire process where I considered quitting. As you're reading this right now, I didn't, and I'm so very glad I didn't. Instead I asked for help, pushed through, gave up a little, and learnt some valuable lessons along the way.

The thing people tell you about research in advance, is that it's going to end up changing in practice, and your expectations are going to be changed. That's a fundamental part of the difference between theory and practice, and I think that a lesson I learnt both from the iterative learning process of doing an independent research project for my bachelor thesis, but also majorly from living the island life on Aruba for almost three months.

The preparatory course, and over 300 articles of literature I read in preparation for this did not at all prepare me for arriving on Aruba, but I suppose that's also an inherent component of doing community based research that didn't actually click with me until I was actually here. As the researcher, you're not the expert, you're a person with a passion for answering a question, and this project allowed me to do so with the collaboration and support of a whole book full of brilliant minds.

I'd like to thank every single person I shared even a couple of minutes of conversation with, from the people on the bus to San Nicholas, the locals and tourists alike hiking through Parke Arikok, the students at UA sharing their tablespace with me. I'd specifically like to mention Duan and Olinda from StimAruba for inviting me on hikes and walking tours to see Aruba, and sharing their wonderful knowledge of the vegetation. I'd like to thank Giancarlo Nunes from Parke Arikok for collaborating with me on this project, joining me in the field, and sharing his knowledge. I'd like to thank Maarten Eppinga for approving my initial proposal and introducing me to my supervisor, Angeles Garcia-Mayor, who has been a lifesaver and a fountain of passion and knowledge. Thanks to Tobia for inviting me along on the AFY fieldtrips and getting my first hand-on experiences with research on the island. I'd like to thank Annemieke, Tatiana, and Marretje for listening to my rants and rambles about experimental design, and lending a helpful perspective. I'd like to thank my family and friends back home who gave me buckets of support in making this decision. I'd like to thank the rest of the UAUCU girls for their continued support, laughter, banter, singing and studying sessions. Last but not least, I'd like to thank Eric Mijts and Jocelyn Ballantyne for their continued support from the start of the preparatory class, and for making this programme a possibility.

I had an amazing time, watching sunrises and sunsets on all the coasts and beaches of the island. Getting sunburnt at each and every single one of them. Exploring all of the small food places, supermarket, fruiterias and batido stands. I probably have some hearing damage from blasting the radio and vast collection of playlists that we've accumulated over our time here. I've got an entire collection full of photographs that I'm going to spend weeks editing and cleaning up when I get back home, sending them around with funny captions and memories. That, and writing up the more extensive and final version of my thesis, because that also needs to be done.