

# U A U C U



*Student Research Exchange Collected Papers 2022*





University of Aruba

UCU

UCU

MEMORANDUM OF UNDERSTANDING  
BETWEEN  
UNIVERSITEIT VAN ARUBA (U.A.) ORANJESTAD, ARUBA  
AND  
UNIVERSITY COLLEGE UTRECHT (UCU), UTRECHT UNIVERSITY, THE  
NETHERLANDS  
AGREEMENT

THIS AGREEMENT is made, and entered into as of the 26th of February 2013 by and between University College Utrecht and University of Aruba, hereinafter designated as UCU, and UNIVERSITEIT VAN ARUBA, hereinafter designated as U.A.

In view of their similar dedication to excellence in teaching, research and cultural exchange, the two parties agree to this Memorandum of Understanding with the objective of promoting exchange among their students.

BIJZONDERHEDEN

1. Each academic year during the term of this Memorandum of Understanding, up to two full year students enrolled at University College Utrecht and University of Aruba will be counted as one (1) FTE, those participating in the study abroad program for one fall semester and one spring semester. The enrollment of students from each institution may be for one semester, or for the full academic year. The agreed upon exchange ratio, averaging over a five-year period, shall be six to eight UCU students and six to eight U.A. students, and faculty members of both institutions, participate annually in a joint undergraduate research program. The amount of research phase takes place at the University of Aruba. Details about this joint undergraduate research program are included in an appendix to this MoU.
2. Six to eight UCU students and six to eight U.A. students, and faculty members of both institutions, participate annually in a joint undergraduate research program. The amount of research phase takes place at the University of Aruba. Details about this joint undergraduate research program are included in an appendix to this MoU.
3. Participating students will be nominated by their home institutions based on the following criteria: (a) Academic excellence as reflected in their academic records.



UAUCU  
Student Research Exchange  
*Collected Papers 2022*



# UAUCU

Student Research Exchange

*Collected Papers 2022*

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## Introduction to the seventh edition of the UAUCU Student Research Exchange Collected Papers

This volume includes research reports and personal reflections written by the 2022 participants of the UAUCU student research exchange program. This year's student-researchers are 17 students from the University of Aruba and Utrecht University, six from UA's Sustainable Islands through STEM (SISSTEM) program and 11 from UU's University College Utrecht. They have been working on research in and about Aruba, and supporting each other in that process. Their texts reflect the fundamental aims that the program has had since its inception in 2015: to challenge students to engage actively not only with the content of research, but with each other and the world at large. These challenges, and the rewards of meeting them, are reflected in the personal reflections that contributors to this volume have written as a preface to the summary of their own research.

As in previous editions, the topics of the students' research are wide-ranging, drawing on the diverse backgrounds of their study programs, and yet all related to the sustainable development goals (SDGs) of the United Nations 2030 agenda. The works included here treat, for example, issues of sustainability in tourism and in transportation, coastal ecologies, public participation, food security & food sovereignty, science communication, biodiversity, vertical farming, circularity and waste. The type of research ranges from studies on governance to studies on technology and engineering, anthropology, geology and sociology. We think that the papers also show how participation in a diverse team influenced the authors' approach to their work. The students provided each other with feedback on approaches to their research, and on the content, style, language and structure of their papers. The papers appear as submitted by the authors, including the occasional raw opinion or as yet underdeveloped conclusion. Some of the contributions reflect completed studies, others are preparatory explorations. Most of the student-researchers

are still working on interpretation and presentation of their findings and will finalize these soon in bachelor theses based on the results of the projects presented here.

The 2022 program nevertheless differs from the earlier cycles. The student-researchers taking part find themselves on an island, and in a world, changed by the COVID19 pandemic. We program coordinators have also re-booted the research exchange in a new form, after a year of hiatus forced by lockdowns around the world. The students from Utrecht prepared in November and December for their participation in a renewed preparatory module (Community-engaged research in the Caribbean), and joined the UA students in a new bachelor course at SISSTEM (Interdisciplinary and multidisciplinary approaches to sustainable development in small island states). Together in a classroom at UA, they defined their guiding principles and goals for their participation in the project. These ideas reflect their hopes of working in ways that could be meaningful to others as well as to themselves.

A range of people have also made crucial contributions to the students' success, this year as in 2020 and earlier. We, and our students, appreciate the importance and power of their input to this project as a whole. We especially want to thank UA's Carlos Rodriguez-Iglesias for his help in proofreading the papers in preparing them for publication here and for, together with Tobia de Scisciolo, fostering the collaboration between the UAUCU students and the Academic Foundation Year students in the Research Aruba Program. There are, in addition, many others who have had roles as guides, lecturers, mentors, advisors, facilitators, respondents, interview participants, and engaged citizens: thank you! We hope that you have anticipated work presented in this volume as eagerly as we.

Eric Mijts & Jocelyn Ballantyne  
Project coordinators UAUCU

## Guiding Principles?

We want to be communicative and consistent in communication

We want to be realistic and honest about our expectations towards ourselves and others

We want to value people's time

We want to integrate feedback and criticism in a positive way

We want to shape our research goals in collaboration with local interests

We want to bring patience and empathy into every situation

We want to emphasize that we are aware of our positionality

We want to be open to and value the ideas of others

We want to take care of ourselves

We need to ask for help and not try to do everything by ourselves

We need to be flexible when it comes to our approaches and goals

We want to be explicit in expressing gratitude

## Goals?

We adhere to the guiding principles

Manage time well

Setting subgoals for research

Understand how research overlaps with local perspectives and needs

Develop as a critical thinker

Be supportive of self and others

Put theory into practice

Match research goals with stakeholder interests

Finish the program successfully

Enjoy life

Keep up with courses and research this term

Learn how to set up research

Learn some Papiamentu

Understand the local incentives for conservation of nature

Remain proactive in meeting and engaging with the community

Learn to actively listen to stakeholders

Reach out for help when needed

Have research be incorporated into bigger discussion

Stay driven and curious

Stay engaged even when the project is over

Create connections for the future

Finding focus for directions after graduation

Getting out of comfort zone while acknowledging boundaries



Follow this QR code to surf to some images and the posters presented at the 2022 UAUCU symposium at the University of Aruba.

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Milena Stoilova, University College Utrecht

## **Who knows what the future will bring :-)**

I was having a drink at the UCU bar one night during my first year, when I started talking to Maro. She told me all about this interesting research program in the sunny Caribbean – Aruba – and it got me very excited. Due to the pandemic, the summer program was canceled, and I had lost hope in being able to do the program. And yet, here I am, currently writing this from a café on the beach while enjoying the sun.

While the tropical climate was a huge bonus, the main reason why I wanted to join this program is the premise that one works closely within the community, which as an anthropologist, I found very important. I loved that our research would potentially contribute to everyday lives, give people a voice, tell unheard stories, and hopefully give just recommendations. I felt so connected with my research and with everyone that I interviewed. The stereotype that Arubans are extremely friendly could not be more accurate.

I was anxious to be thrown into the unknown and being away from home for months. Two and a half months felt like a very long time at the beginning, but now I realize that I couldn't have been more wrong. Days, weeks, months flew by and the only question that was in my mind was 'Why isn't this program at least five months?' Regarding the field research, I learned how to be persistent and that sometimes, you need to double, (if not triple) text people if you want to make meetings happen. I remember being nervous while driving to my first interview at the Donkey Sanctuary and knowing that I have to do so many more. Now I wish I could go back in time, back to that first interview and do it all again. It was messy sometimes, but I learned to appreciate the chaos and craziness that comes with field research.

A good friend once said, 'Islands just do something to you' and she was right. The relaxed, laid-back mindset that people have in Aruba made the experience so much better.

The Aruban social life can't be dismissed; from weekly beach tennis games, Latin nights at Salsa Company, boat parties, live music at Bugaloe, dancing on the bar at Moomba, 3 dollars blackjack at the casino, Tuesday Zeerovers nights, to many cocktails and sunsets at the beach. Aruba came to feel like my second home. "You know you can stay in Aruba right, others did", said Eric when I expressed my feelings of sadness about leaving. Who knows what the future will bring :-)

# Sustainable tourism in Aruba: a myth or reality?

## A case study of the Bucuti & Tara Beach Resort

Milena Stoilova

### Introduction

Tourism is one of the biggest sectors worldwide and is especially prominent in small Caribbean island states such as Aruba. Aruba has one of the highest densities of tourism and population in the Caribbean (Cole & Razak, 2004). According to the World Travel and Tourism Council, tourism accounted for 98.3% of Aruba's GDP and generated 47,000 jobs in 2019 (Hepple, 2020). Tourism on the island has accelerated the growth of the population, while also creating new job opportunities, the production of foreign exchange earnings, the facilitation of the use of resources, the promotion of infrastructural works, the transfer of new technological skills into an economy and the creation of positive linkages with other sectors of the economy, such as agriculture (Cole & Razak, 2004). This, however, brings the question to how far and how fast tourism in Aruba can and should expand. A study on the carrying capacity of tourism on the island of Aruba indicated that at the end of 2017, the maximum capacity was reached, overstretching its resources beyond levels that are sustainable (DEACI, 2019). The Caribbean all-inclusive style resort tourism that follows the 'sun, sand, and sea' motto brings up images of social inclusion and economic well-being; nonetheless, this form of tourism also exhausts both society as well as the environment (Peterson et al, 2020; Honey, 1999). Given the climate threats, it is necessary to rethink our human-nature relationship and move to a long-term solution that

is sustainable. An approach to tourism is needed that will provide visitors with the full 'sea, sand, sun' experience, without compromising the island's ecosystems (Cole & Razak, 2004; Flanagan, 1997). One such way is to make the switch to sustainable tourism.

While Aruba is heading towards sustainable tourism, with multiple resorts and organizations trying to make the switch, it is uncertain how many of these efforts are genuine as opposed to based on profit through the attraction of environmentally conscious tourists. Therefore, the goal of my field research in Aruba is to assess the current state of sustainable tourism in Aruba, specifically in the hotel industry. I will be using The Bucuti & Tara Beach Resort (BTBR) as a case study. Through this research, I intend to contribute to a deeper understanding of sustainable tourism in Aruba, while raising awareness on current shortcomings, and providing insights for necessary future improvements. This will be achieved by answering the three following research questions:

1. What forms does sustainable tourism take in Aruba's hotel industry and how are these represented?
2. To what extent does the local community benefit from sustainable tourism?
3. How aware is the local community of sustainable tourism?

## Methodology

My research followed the ethnographic approach often used by anthropologists. According to Brewer (2000), ethnography is “the study of people in their natural habitat by means of methods that analyze their social meanings and ordinary activities, involving the researcher participating directly in the setting, to collect data but without meaning being imposed on them externally”. What is important in this approach is active participation within the community being researched. I did this through interviews with local organizations, a qualitative survey among the resort’s employees, and participant observation during its monthly beach clean-ups. I used Honey’s framework (2008) of ecotourism that is based on ecology, awareness, and community support to assess the resort’s sustainability efforts.

To gain a better perspective on the current state of tourism in Aruba, I interviewed three people that have worked or are currently working at the Aruba Tourism Authority (ATA). Digging deeper into one of the three main aspects of Honey’s framework on ecotourism – community support – I conducted semi-structured interviews of around one hour with representatives from local organizations that receive(d) some form of support from the BTBR. These organizations were the Donkey Sanctuary, Animal Rights Aruba, Turtugaruba, Fundacion Parke Nacional Aruba, Animal Shelter Aruba, Aruba Reef Care Organization and one local artist. Regarding the ecology aspect, I talked to the sustainability managers of the resort, as well as with the owner to gather what the resort does in terms of sustainability and how. Finally, to understand the concept of carbon neutrality, I talked to my fellow student researcher as well as a PhD researcher from the University of Aruba.

## Positionality as a researcher

As indicated earlier, anthropologists use ethnography as their preferred method of research. However, ethnography’s nature tends to be considered as a form of extractivism; one

takes knowledge from the stakeholders and leaves without giving back (Burman, 2018). While I was aware of these issues before the start of my field research, due to my lack of experience with field research I felt unprepared for its implications, especially given my own profile as a Caucasian, European, student researcher. Researchers are powerful agents that have acquired skills in institutional settings such as universities, and this brings an issue with it: devaluing local knowledge (Burman, 2018). My biggest concern was forcing my knowledge and skills onto the community, thus devaluing local knowledge, but also being concerned with the fact that I am not an expert on sustainable tourism.

## Conceptual Framework

This section introduces the important concepts that are relevant for this research.

### *1. Sustainable tourism*

While almost any form of tourism can be, and often is, termed ‘sustainable’, this is often untrue. One could say that sustainable tourism is responsible tourism; it focuses on conserving ecosystems and maintaining biodiversity, respecting local populations and cultures, and providing economic benefit to local communities. Indeed, sustainable tourism is “tourism which can sustain local economies without damaging the environment on which it depends” (Countryside Commission, 1995). According to the Global Sustainable Tourism Council (GSTC), sustainable tourism aims to minimize the negative effects, such as economic leakages, damage to the natural environment, and overcrowding, while maximizing the positive ones, such as job creation, cultural heritage preservation, and wildlife preservation (GSTC, 2021). There are multiple branches that could fall under sustainable tourism, such as: nature tourism, adventure tourism, and ecotourism. Nevertheless, an incorrect assumption tends to be made that, if tourism involves nature, it is automatically sustainable. The

assumption that nature-focused tourism is automatically sustainable also tends to be harmful to sensitive environments which can't withstand even moderate levels of use, or otherwise have no infrastructure (Butler, 1999).

In a world faced with climate change, sustainable tourism has become a necessity instead of a perk. One pragmatic reason is for the longevity of businesses; without the natural beauty of tourism destinations, there will be no future customers (Harms, 2010). Or as Mr. Biemans, the owner of the BTBR, stated: "Aruba is not in the tourism business, Aruba is in the nature business; without our nature, there will be no tourism" (Bucti & Tara Beach Resort, 2018). Moreover, tourists are becoming increasingly aware of their carbon footprint due to their tourism-related travel, making it necessary for tourism destinations to adapt and show they have the same concerns (Harms, 2010).

### *1.1. Ecotourism*

Ecotourism is a branch of sustainable tourism. According to the International Ecotourism Society, ecotourism is a form of responsible travel to natural areas that conserves the environment while sustaining the well-being of local people (WWF International, 2001). Or as Honey (2008) puts it, ecotourism is "the travel to fragile, pristine and usually protected areas that strive to be low impact, responsible, sustainable, and green". She proposes a framework for ecotourism that consists of three main components: environmental conservation (i.e., minimizing the tourist's impact), education and raising awareness (i.e., implementing a code of conduct), and community support and participation (i.e., shifting the economic and political control to local communities or providing funds).

### *2. Neoliberal conservation*

Neoliberal conservation stems, as the name suggests, from neoliberalism. Neoliberalism is based on the idea

that welfare is best advanced via individual freedom and skills, fostered through free markets and international trade (Harvey, 2007). In other words, market-based regulatory infrastructure is expanded, while the role of the state is restricted (Duffy, 2008). Or, as Foucault (2003) puts it, neoliberalism requires "a minimum of economic interventionism, and a maximum of legal interventionism". Thus, the role of the state is to establish this framework, monitor the outcomes and adjust when necessary to be most beneficial, but no further interference is required (Harvey, 2007; Fletcher, 2010). When speaking of neoliberal conservation, one refers to the efforts to conserve biodiversity and ecosystems through human interventions in which non-human phenomena become subject to market-based systems of management (Castree 2003, 2007 & Fletcher, 2010).

### *3. Carbon neutrality*

The tourism industry is an important contributor to climate change. According to Lenzen et al (2018), global tourism accounts for 8% of greenhouse gas emissions (GHGs) due to transportation, as well as an increased demand for goods and services. While it is a global problem, it must be dealt with on a local level, through tailored laws and economic policies, as well as innovative solutions. One of the buzzwords in sustainable tourism is 'carbon neutrality'. Carbon neutrality refers to the process of reducing a company's or organization's net GHG emissions to zero (Strasdas, 2010). This can be done through various implementations, such as increasing energy efficiency of appliances and processes or a substitution of fossil energy sources with renewable energy sources. Emissions can be further reduced through carbon offsetting. For example, one can buy off one's carbon emissions by investing into certified compensation projects which in turn grant carbon credits (Strasdas, 2010). There are four categories of carbon offsets: biological sequestration (i.e., reforestation), renewable energy projects (i.e., solar and wind energy),

energy efficiency (i.e., switching to long-life light bulbs), and reduction of non-CO2 emissions from specific sources (Polonsky et al, 2010).

To become carbon neutral, there are various steps that need to be taken. First and foremost, one needs to measure and analyze its emissions (Strasdas, 2010). Where, when, and why do emissions occur? There are three scopes when calculating one's emissions. Scope 1 refers to the directly responsible emissions, scope 2 refers to the indirect emissions with purchase of electricity, steam, heat and cooling, and scope 3 refers to the GHG emissions among the supply chain (Benson & Puga, 2021). Scopes 1 and 2 are mandatory; however, the Environmental Protection Agency's scope 3 is only recommended since the emissions are indirect (they stem from the emitter's value chain and are therefore hard to measure).

## Results

In this section I will discuss primary findings regarding the current state of tourism in Aruba and the path towards sustainable tourism. I will initially investigate the current state of tourism in Aruba, and then introduce my case study, the BTBR, as an example of sustainable tourism. Thereafter, I will discuss the challenges faced by the island.

### *1. Sustainable Tourism in Aruba*

Small island states like Aruba are highly dependent on tourism, making them vulnerable to external economic shocks (Scheyvens & Momsen, 2008; Gmelch, 2012; Cole & Razak, 2004). As indicated earlier, Aruba follows the 'sun, sea, sand' motto and is famous for its friendly inhabitants. In terms of tourists, the biggest group come from the United States as well as from the Netherlands. In terms of accommodations, there are many hotel chains, such as Hilton, Marriott, and Rui, but also smaller boutique hotels. Moreover, according to one key informant from ATA, cruise ships are an important revenue

of tourism; from approximately two million tourists a year, almost half come from cruises. I interviewed three people that have or are currently working at the ATA, to understand the current form and future ideas of tourism in Aruba. All three of them indicated that Aruba is indeed slowly moving towards a more sustainable form of tourism, but it is not easy. Economic growth is still the priority, but there is awareness that it cannot come at such an environmental cost. The tourism experience needs to be maintained but regulated, following a 'high-value, low-impact-model'. This model was established after a study on the carrying capacity of tourism in Aruba showed that it has been exceeded (Sustainable Travel International, 2019).

ATA has various projects and ideas planned to make tourism more sustainable. The main direction they are trying to take is to increase environmental awareness, particularly among the local community. Many interviewees claimed that there is high resistance and skepticism coming from the locals because they do not see climate change as an imminent threat. Therefore, ATA started a specific campaign for locals called 'Ban Serio' (translated: let's get serious). Through social media, posters throughout neighborhoods, and guest lectures, the goal was to create awareness among locals to be more mindful of their environment, culture, and safety (Aruba Tourism Authority, 2022). Other projects include: the 'pimp your own cup' during carnival to stop the use of single-use plastic cups with every drink; placing recycling trash bins for plastic and cans on beaches in collaboration with Ecotech and Plastic Beach Party; improving the safety and cleanliness of the beaches through improved maintenance and replenishment of sand; implementing the 'Aruba promise' (tourists can voluntarily sign and promise to preserve the nature, honor the local culture and be attentive to the rules, etc.); and regulating mountain bike trails to preserve the roads and combat erosion.

### *2. The Bucuti & Tara Beach Resort*

BTBR is located on Aruba's beautiful Eagle Beach. The

story of the resort started when Mr. Biemans, the founder and current owner, visited Aruba on a holiday, and fell in love with the place. Indeed, he liked Aruba to the point that, in the 1970s, he moved there permanently and began working on developing the resort. In 1987, the first part of the resort, 'Bucuti', opened. It was immediately a success and, in 2004, it was expanded with a new section, called 'Tara'. This 104-room, romantic, adults-only resort – ranked the #1 hotel for romance in the Caribbean for the period 2015-2021 – is not comparable to other resorts in Aruba. The tranquility of the resort stems from its peaceful and secluded gardens, as well as its lack of tall buildings. The resort has repeatedly received awards for its guest experiences and this is undoubtedly well-deserved. During my visits at the resort, I noticed how friendly the staff was, always eager to visitors around and converse with them. Yet, the resort is not only a perfect getaway for those seeking some romance but has also won multiple awards and certifications due to its achievements in sustainability. It won the Global United Nations 2020 Climate Neutral Now Award, the World Travel & Tourism Climate Action Award 2019, and the National Energy Globe 2019, to name a few. It is certified by Travelife Gold, ISO 9001 for quality standards, ISO 14001 for environmental management, Green Globe Platinum, LEED Gold, but most impressively it became certified CarbonNeutral in 2018– the first certified carbon neutral resort in the Caribbean.

To be able to understand the context of the research results, it is important to emphasize one finding in particular. The initial idea for this research was to investigate ecotourism in Aruba, based on Honey's framework focusing on ecology, awareness, and community support (Honey, 2008). However, during conversations with the employees of BTBR, I concluded that the resort does not represent ecotourism. The owner indicated that the resort is too commercialized and beyond the capacity an ecotourist resort should have. Others also put an emphasis on nature,

low-impact, and minimalism for ecotourism. One of the previous sustainability managers of the resort, said the following:

*"When I think of ecotourism, I think about a treehouse type accommodation in a remote location surrounded by nature."*

Therefore, this resort falls under the category of sustainable tourism, instead of ecotourism, because it represents a degree of over-commercialization and overloaded capacity, despite attempting to be as sustainable as possible. That is why the framework for ecotourism will be maintained, but the term will be adapted into 'sustainable tourism'. BTBR also adapts a similar approach on their website where it shows its efforts in terms of ecology, community support, and education.

### *2.1. Ecology*

According to BTBR's sustainability report from 2020, the resort achieved its goals in terms of ecology. It achieved an electricity reduction of 11.5%, and a 37.4% water reduction in 2019 compared to 2018. However, this was mainly because of the COVID-19 pandemic (Bucuti & Tara Beach Resort, 2020). Furthermore, it prevented 65% of their waste from ending up in the landfill by adopting a mindset of reduce, reuse, recycle. It reduced their plastic consumption by gifting water coolers to guests and discouraging the use of plastic (banning single-use plastic and Styrofoam long before it was discussed in the media) and reduced their paper consumption by implementing an electronic check-in (in fact it is on the path to become 100% paperless). It uses recycling bins for aluminum and green glass, converts cardboard into welcome signs, and donates organic waste to local pig farms. Moreover, it reuses keycards, breads from breakfast to make croutons, and old beach towels for laundry bags and fitness center towels. It purchases in bulk and uses dispensers for toiletries instead of individual packaging.

## 2.2. Carbon neutrality

All these implementations reduce the resort's carbon footprint, but to achieve the status of carbon neutrality, more is needed. The resort used 18% renewable electricity in 2020 through their on-site solar panels. In fact, the resort has the largest on-site solar panel project in the island's private sector (Bucuti & Tara Beach Resort, 2020). Moreover, the resort uses 100% gray water for irrigation; it has eco-fitness treadmills and bicycles that let guests generate electricity that is sent directly to the resort's power grid; staff are incentivized to take public transport, bike, or carpool; it uses ozone-based laundry equipment that requires less water; it has a sustainable cooling system (variable refrigerant flow A/C), and has streamlined transportation to reduce unnecessary shipments and stimulate local purchasing (Bucuti & Tara Beach Resort, 2020). Moreover, to gain better insights into the carbon footprint of their food procurement and to lower these emissions further, the resort is currently working together with a PhD candidate SISSTEM at the University of Aruba. Her PhD research is about the environmental impact of the food consumption of islands, with an in-depth case study of Aruba. Currently, a study is being conducted on the carbon footprint of specific food products from BTBR: beef, chicken, shrimps, canned tuna, and salmon. The resort wants to explore strategies to lower its carbon footprint, by putting a limit on these products.

To be certified carbon neutral by Natural Capital Partners, the resort must annually calculate its emissions from Scopes 1 & 2 and if wanted, Scope 3. The resort calculates all three Scopes on its own. Subsequently, the data is sent to a third party, called SCS global services, for verification. The resort calculates all of its GHGs, also known as indirect emissions, for example, business and employee travel, waste, and packaging and transportation of goods. Even though these indirect emissions are hard to measure, BTBR tries its best. Regarding employee travel, it monitors the

distance of employees from their home to the resort; do they walk, bike, carpool, or take their own car? Regarding the packaging and transportation of food, it calculates the distance from the warehouse (Caribbean Overseas or Tara Eco Supplies – founded by Mr. Biemans himself to supply hotels, restaurants, and grocery stores with sustainable food products) and takes into consideration the amount of the gas and electricity that is used for transportation. While the resort does everything in its power to reduce its own emissions, some emissions are impossible to reduce to zero. Therefore, BTBR buys carbon credits by investing in carbon offset projects. Usually, it invests a big part in the local wind farm in Aruba; however, since the wind farm was not UN-certified this year, it has invested in two other projects. Twenty percent of their offsets go to a UN-certified project regarding an energy-efficient transport in India. The other 80% are invested through the platform of Natural Capital in a REDD+ project on the Amazonian Rainforest in Acre State, Brazil. In 2018, BTBR bought offsets for 850 metric tons carbon equivalent (MTCE), while in 2021, the amount was reduced to 619 MTCE.

## 2.3. Carbon negative

Currently, the resort is on a path to become carbon negative, indicating that it offsets more carbon than you produce. This goal, however, comes with many challenges and requires thinking outside the box. An option to achieve this is to buy more offsets than required. However, that is not how BTBR is trying to become carbon negative. One of the recurring answers from the employees on the challenge to become carbon negative was a lack of awareness from the government and the need for laws to change. Indeed, the owner indicated that there are laws in place that put a cap on the number of solar panels a private business is allowed to install. This is also the main reason why the resort needs to purchase offsets. One idea mentioned was to go off-grid to their own electricity grid system to be able to place more solar panels. Another idea was to become a partial owner of



the wind farm in Aruba. However, multiple key informants indicated that the political nature of the island is profit-based and involves social capital, making such initiatives easier said than done.

#### 2.4. Community support

BTBR sees the importance of supporting the Aruban community. It supports various local organizations through donations, such as the Donkey Sanctuary and Animal Rights Aruba (ARA). It also provides volunteers, for example, during the yearly volunteer days 'Aruba Doet'. The representative of the Donkey Sanctuary recalls when the employees of the resort enthusiastically came to help make lamps out of license plates. During previous years, the Donkey Sanctuary made calendars featuring BTBR, which in turn sponsored the sanctuary by buying calendars. The resort also has a donation box for the sanctuary. Moreover, it collaborates with local pig farms, supplying their organic waste. BTBR has a program called 'Pack for a purpose' with the orphanage 'Imeldahof' (in which guests are encouraged to gift various products and supplies), it provides lunch boxes for reef clean ups with the Aruba Reef Care Organization, it holds educational lectures with Turtugaruba and are mindful of the turtles' nests on Eagle beach. The representative from Turtugaruba, also indicated how impressed she was when they needed funding for a wall to protect sea turtles from crossing a busy street, Mr. Biemans provided funding for it and paid when renovations were necessary. Moreover, the resort also organizes monthly beach clean-ups with its employees and guests on Eagle Beach, as well as collaborating with the Fundacion Parke Nacional Aruba for clean-ups. It also hosts weekly local art nights together with the Aruba Art Foundation, providing a platform for local artists to exhibit their artworks. Finally, Mr. Biemans initiated a foundation funded completely by him called 'Stimami Sterialisami', which focuses on sterilization of stray animals in Aruba. It provides funding for half the amount of sterilization,

making it more appealing for locals to sterilize their pets. This is done in collaboration with veterinarians and clinics, such as the Animal Shelter.

Every organization was generally satisfied with the support they received from the resort, from donations, providing volunteers, lunch boxes, to giving lectures. The organizations indicated that the support received was what they asked for and that every little bit helps. ARA even indicated that BTBR was their biggest supporter with regards to monthly donations. Unfortunately, some of the organizations no longer have a collaboration with the resort for reasons that will be explained later on.

#### 2.5. Awareness

The resort also focuses on raising awareness, educating, and spreading the word about sustainability and sustainable tourism, not only for their own employees, but also their guests, the Aruban community, and other countries too. Everyone from the resort was from the start very eager to help me out with my research. Multiple employees told me they want to do everything they can to raise awareness about these issues and want to share their knowledge with everyone that is willing to listen. The current headengineer and sustainability manager at BTBR, asserted:

*"It is no rocket science what we do. We are happy to share the knowledge we have."*

The resort hosts professors, students, researchers, and everyone seeking knowledge for implementing eco-friendly practices. Mr. Biemans has participated in many interviews explaining the resort's initiatives and practices.

Regarding employee awareness, they must go through an integration process that explains what the resort does and why it is important. One of the previous sustainability managers indicated that it was difficult to change the

employees' perspective on sustainability at the beginning. Therefore, she tried to show them why it is also important for their own health. For example, by explaining to the housekeeping staff why the use of non-toxic detergent and more environmentally friendly products is better for their own health, they came to appreciate it. She also indicated that the employees did a waste training, and when they were shown the whole journey of one product before it got to the resort, the employees started to think twice before throwing something away.

From the qualitative survey that I conducted, I found that some employees decided to work at BTBR precisely because they shared the same vision as the resort, because it has a great team, treats its employees well, and is committed to excellence. Others, however, mentioned that they decided to work at BTBR not because of its sustainability efforts, but because they simply needed a job that pays the bills. Generally, the survey showed that the perspective of employees on tourism and sustainability has changed. They define sustainable tourism as tourism that still allows people to travel within a context of luxury and relaxation while being conscious of mitigating negative environmental impacts. It is tourism that leaves a positive impact on the community and its environment and minimizes carbon footprint and the use of natural resources.

To the question 'Has your perspective on sustainability changed since working here?', most answers were affirmative, for example:

*"I had the idea that sustainability was this huge word that implied that there should be drastic changes, and lots of funds and inefficient practices or only a very niche application to everyday activities. However, by adjusting policies, and tweaking procedures, learning how to do something slightly different and over time, those sustainability practices accumulate into the most sustainable resort in the Caribbean. And by continually trying to improve and to always consider*

*sustainable practices in every aspect, we guarantee that our sustainability practices keep improving."*

*"Yes, it is a part of our daily work life and work goals, and it flows over to personal life and personal goals"*

Nevertheless, when I asked various employees from the front desk and housekeeping during the beach clean-ups their opinion on the resort's environmental practices (such as the beach clean-ups), the answers varied. Multiple employees stated that they do not see the point in beach clean-ups since Eagle Beach is already so clean compared to previous years. They claimed to participate solely because it is mandatory in their contract to do three beach clean-ups a year. One of the housekeeping ladies finds it very tiring:

*"The resort puts high value on hygiene which puts a lot of pressure on us. We must come for the beach clean-up in the morning, but then we must go back to work after. I know it is important to have clean beaches, but they should pay someone else to do it."*

Regarding the awareness of tourists, there are an increasing number of environmentally conscious tourists that come to the resort, but it is still a minority. One key informant indicated that there is also a demographic difference that plays a role in the motivation to stay at BTBR. Younger people were more inclined to visit the resort because of its sustainability efforts (for example, students on their graduation trip). One of the employees suggested continent of origin also plays a role; tourists from Europe are generally more inclined to visit because of sustainability, while tourists from North America will come because they like the resort itself.

When I spoke to some of BTBR's guests during the beach clean-ups, I noticed these differences too. One American guest indicated that she was staying at the resort for the first time, and that friends of her husband recommended it

to them. When I asked what she thought of the resort, she admitted that she had no clue that the resort was doing so much in terms of sustainability, and that she was learning a lot. She realized that individual behavior does make a change and she is happy she got the chance to help with the beach clean-up. However, when I spoke to a younger mixed couple from Sweden and the United States, they indicated the opposite. Their motivation to stay at the resort was mainly because of its sustainability efforts. One of them explained that she is vegan, and BTBR was one of the few resorts that promoted a vegan-friendly menu. The couple was highly impressed by what the resort does. They have stayed at other eco-friendly resorts but in countries that “felt closer to home”, like Iceland. They did not expect to find a similar resort in the Caribbean. Thus, demographics (such as age, ethnicity, and geography) of people seems to play a role in their awareness of sustainable tourism.

## 2.6. Motivation

One aspect that I always tried to be critical of during my research was the motivation behind environmental efforts. Nowadays, more and more businesses try to promote themselves as sustainable, but there is a fine line between the mentality with genuine, intrinsic values regarding the environment, and solely doing it for promotion and profit, something known as greenwashing. I was pleasantly surprised to discover that, if there is one thing that every interviewee from the organizations agreed on, it was the fact that the heart of the owner is in a good place. One local artist that I interviewed who has many of her artworks displayed at BTBR, answers enthusiastically:

*“His motivation is not only implemented in his resort, but also at home. He has seven dogs, some cats, 25 chickens, ducks, and bees at his house!”*

The owner said himself that his motivation to push and become better every day in terms of sustainability comes

from his love for nature and animals. Moreover, he has a long track record of being environmentally friendly since long before sustainability became a commercial trend. During our conversation he also showed his adversity to greenwashing when mentioning other countries, such as Costa Rica, or other resorts in Aruba with questionable practices. Indeed, everyone agrees that his efforts and motivation are genuine. Nevertheless, the interviewees also see the promotional value as a motivation for his resort’s sustainability efforts. One of the interviewees tackled this topic:

*“The resort’s awards and certifications bring free publicity, and, in the end, Mr. Biemans is a businessman that likes to see cost benefit”, and:*

*“The owner has his heart in the right place, but his efforts are intertwined with publicity and profit”.*

One of the guests mentioned something similar during one of the beach clean-ups:

*“I’ve been staying at the resort since 1995, and I have seen it change throughout the years. The resort is doing more and more in terms of sustainability, and I am truly impressed. The owner is a good man, he has a good heart, and he is very approachable, but there is promotional value to it too. I would say it’s 50/50.”*

In essence, it is important to notice that there is nothing bad to be said about such a mentality. This is because when trying to achieve true sustainability at the cost of efficiency, a business will fail.

## 3. Challenges for sustainable tourism

There are various challenges that prevent substantial change in terms of sustainable tourism. Since tourism is Aruba’s main industry, it is very powerful and usually has the final

word. The current sales and sustainable recreation manager at Fundacion Parke Nacional Aruba, commented on the difficulty encountered in banning UTVs and ATVs in the park:

*“The tourism industry has so much economic power. So, whatever we want to process, it’s difficult as of yet. For example, - I’m going back to when we did the ATV/UTV ban – they came up with all these arguments on how many millions the industry was worth.”*

The destination service manager at the Aruba Tourism Authority indicates that one of the biggest challenges for sustainable tourism is changing the mentality of the local community. Although there are different initiatives for a more sustainable development in the future, speed of action seems to be facing some resistance; as anywhere in the world, there is a small group of firefighters in the community; however, the large majority still operates in ‘business as usual’ mode, because they do not see the direct consequences of climate change and therefore the need to make the tourism industry more sustainable.

For BTBR, there are other challenges too. Currently, the resort’s goal is to become carbon negative; however, for now, this can only be achieved with carbon offsets due to the island’s import dependency, especially regarding food. Furthermore, due to Aruba’s inefficient (if not non-existent) waste management, recycling is difficult. BTBR recycles cardboard, cans, textiles, glass, but not plastic. There was once an initiative to collaborate with a company that recycles plastic, Plastic Beach Party, but the prices were too high for the resort, and thus the collaboration failed. Finally, due to the current laws and policies that are in place regarding solar energy, the resort is legally not allowed to invest in more solar panels to reduce its emissions. In other words, the resort is still partially dependent on Aruba’s national electricity provider, which is known to rely on fossil fuels, and is therefore unsustainable. One solution can

be for the resort to move to its own electricity grid but, due to political reasons, this process has been delayed.

## Discussion

### *Carbon neutrality*

As previously discussed, a business can become carbon neutral by buying offsets. Offsets are seen as a win-win solution because emitters invest in environmental projects which receive funding, leading to a decrease in GHG emissions (Benson & Puga, 2021). Nevertheless, there are many downsides to these offset projects that may be overlooked. Buying carbon offsets is not a sustainable solution per se because it shifts responsibility elsewhere, allowing polluters to simply pay their way out of the problem (Benson & Puga, 2021). It follows the ‘out of sight, out of mind’ mantra; developed countries, such as the United States, France, and Germany, buy offsets in developing countries who already emit less, to be able to continue emitting the same amount (Benson & Puga, 2021). Thus, power relations play an important role because companies with sufficient financial capital can buy themselves out of the responsibility to reduce emissions (Dhanda & Hartman, 2011). Nevertheless, it is important to mention that in the case of BTBR, carbon offsets are a last resort as it does everything in its power to reduce emissions first. Whatever is inevitable is then accounted for through offsets.

There is also uncertainty about the efficacy of carbon offset projects (Song & Moura, 2019; Benson & Puga, 2021). According to a report by the European Commission (2016), 85% of offset projects have no visible environmental benefits. There are multiple reasons for this. One of the reasons is many projects are based in remote places in developing countries, making it difficult to monitor them (Benson & Puga, 2021). Workers usually don’t have the resources or money to implement and conserve the environment effectively (Song & Moura, 2019). Furthermore, the criteria

of offset projects are unclear. Regarding the condition of additionality, some projects, such as generating renewable energy from wind farms, are often already well-funded, so extra funds do not offer additional benefits (Benson & Puga, 2021). Regarding non-leakage, the behavior that the offset project is preventing, for example, deforestation, will simply move to a different area (Benson & Puga, 2021).

As Song and Moura (2019) indicate, “carbon offsets are like a credit card: the buyer gets all the benefit upfront while it takes a century for the full debts to be repaid”. This is especially relevant for forestry projects – such as the Amazonian project that BTBR is mainly offsetting at – because trees store carbon. Another name for such projects is Reducing Emissions from Deforestation and forest Degradation, Plus inclusion of carbon stock enhancement (REDD+) (Larson et al, 2013). However, as one of the criteria is permanence, REDD+ do not adhere to it because they do not show steady benefits (it takes about 100 years for trees to develop their sequestration abilities) (Song & Moura, 2019). Moreover, if they are cut down or die due to natural disasters such as wildfires, the carbon they have stored is released once again (Benson & Puga, 2021; Dhanda, 2014; Song & Moura, 2019). An investigation on REDD+ done by ProPublica showed that deforestation offset projects in Brazil do not offset the amount of carbon promised. Besides, the data on forestry schemes is very fragmented because there is no central authority (Benson & Puga, 2021; Song & Moura, 2019). Another problem with REDD+ is the power relations that play an important role within the local community (Larson et al, 2013; Corbera & Brown, 2010). REDD+ projects can lead to a loss of local user rights and forest land. Especially if the forest tenure is already unclear or in conflict, powerful stakeholders or outsiders can take the land for their own profit via land grabbing (Larson et al, 2013). The benefits of the rural landholders are dependent on their own entitlement of land and labor and how well they can exercise social and political rights and identities in the context (Corbera & Brown, 2010). Thus, it is uncertain

whether the project that BTBR is investing in will have real environmental benefits.

Another aspect of the resort’s carbon neutrality that needs to be discussed is transportation. During my conversation with the owner, he explained how guests can have a guilt-free vacation by staying at his resort. Since the resort is certified carbon neutral, the guests have no emissions at the resort. Moreover, he explains the concept of ‘carbon free flying’: the possibility of offsetting your flight through the airline company. Together, that would mean that a guest’s whole vacation is emission free. However, one key informant disagrees. He mentions that the tourism industry cannot be fully sustainable due to flying. Indeed, one can make the choice to offset their flight; however, this is solely voluntary. Thus, while the resort claims in itself to be carbon neutral, the next step would be to stimulate and enforce the whole tourism industry to be carbon neutral by including all tourists’ actions.

Furthermore, when calculating food emissions for scope 3, the resort starts from its distributor, Caribbean Overseas and Tara Eco Supplies. This, however, means that the resort can theoretically buy its produce from all over the world – since Aruba is dependent on food imports – and argue that its emissions are low. According to research done by Poore and Nemecek (2018) on the GHG emissions across the supply chain for various food products, animal-based foods (such as beef, lamb, and cheese) have the highest GHG emissions. This, however, is not solely due to transportation as one might expect. In fact, land-use change (i.e. deforestation) and on-farm emissions are the main contributors to these emissions. Considering beef, for example, there is an immense difference between different countries of origin. Originating from Brazil, one kg of beef amounts to 56-432 kg CO<sub>2</sub>eq, while originating from the United States, it amounts to 39-79 kg CO<sub>2</sub>eq (Poore, 2018). Thus, by only starting to measure emissions from their Aruban distributor, BTBR fails to account for most

of their food-related environmental damage, as they leave out the initial cultivation effects (for example water and soil usage, this depends on the farms being bought from), and transportation-related emissions due to importation from abroad.

## Recommendations

### *1. The Bucuti & Tara Beach Resort*

BTBR can be considered a true success story in the field of sustainable tourism. It sets not only an example for Aruba, but also for the rest of the world. Nevertheless, just as some respondents answered in the survey, there is always room for improvement. From my own research, I have the following recommendations:

In terms of ecology, BTBR's initiatives are impressive. Nonetheless, as discussed previously, the concept of carbon neutrality in the hotel industry remains tricky. When calculating carbon emissions, especially for food products, the resort could consider calculating from the source (i.e. the farm abroad) instead of the distributor in Aruba. This will provide more accurate insights into the real emissions of food. Ideally, to achieve BTBR's goals of lowering its carbon emissions even further, the resort could reconsider the value of animal-based products on its menu. Whether that is to source its products from a different country, or limiting these products in general, it will have a huge impact.

Considering the discussion behind offset projects, it is also important for the resort to investigate and re-evaluate their carbon offset projects in terms of environmental benefits and carbon sequestration promises. This is a recommendation not only for the resort, but for every business that is offsetting its GHG emissions. One final recommendation in terms of ecology comes from one of its long-time guests. During the beach clean-up, she displayed

frustration concerning the resort's attitude towards beach towels. She indicated that when guests reserve a bed on the beach, they receive beach towels. However, if someone does not show up, the towels that were placed will be washed regardless. She does not see the point in that, and when she mentioned this issue to some of the employees, they indicated that it is protocol but could not justify it further. Perhaps the resort can reconsider the necessity to wash these unused towels – it would also lower their water and electricity consumption!

As for community support, some of the local organizations that are supported by the resort made some suggestions. The Animal Shelter was frustrated with the development of Stimami Sterialisami. They stated that the initiative was successful, and that many clinics were collaborating with the resort. However, the resort cut some funding, making it too expensive for veterinarians and clinics to work with them. Currently, there is unfortunately only one veterinarian that works with the foundation. The Animal Shelter wished there had been more communication prior to this decision, and that the process behind it had been discussed with them, since no feedback was asked from the clinics working directly with the foundation. The shelter noticed the consequences of this development – there are again more stray animals on the roads. Moreover, Turtugaruba was concerned with the impact on sea turtles of artificial light emitted by the resort. They indicated that, while the resort dims its main lights during nesting season, the restaurant lights stay on, discouraging sea turtles from nesting on the beach.

### *2. The bigger picture – attitude towards tourism and sustainability*

In the conceptual framework I discussed various concepts related to commodifying nature to promote its preservation. While the owner's motivation comes from his intrinsic environmental values to preserve the island's beauty and

allow future generations to thrive on the island, this does not hold for the entire Aruban community. As mentioned in the results section, the current mentality on tourism and sustainability continues to focus on economic growth and expansion, rather than ecological preservation. Mr. Biemans' words are emblematic of Aruba's fundamental problem:

*“Right now, you have the blind teaching the blind how to walk. However, what we need, is for the new generation, who understands our climate change issues, to teach the blind how to see, so they can in turn learn how to walk”*

He indicates that problems stem from both government (top-down) and the local population (bottom-up). According to Mr. Biemans, when it comes to sustainability efforts, Aruba's government is all talk and no action. After years of changing politicians, no drastic policy shifts have occurred. Aruba lacks any form of government-mandated climate or environmental leadership. Unfortunately, this is compounded with the local population's lack of both awareness and interest in environmental degradation, plastic pollution, responsible waste management, and climate change. Hence, most Arubans are not inclined to drastically (or even minimally) change their daily habits. In other words: if the issue is not knocking at your door, it does not concern you. Mr. Biemans shows his frustration on these issues too. He is grateful for the amount of recognition that the resort receives; however, despite the resort's international acclaim, the environmental movement as a whole fails to gain traction in Aruba. He wants the resort to stop being an exception, and become the rule, but no one is willing to truly listen:

*“I felt and many times I still feel like a missionary, preaching my gospel, trying to get people to listen.”*

He further expressed how he felt as though the public perceives him as this “crazy idealistic guy”. In reality,

however, far from a religious fanatic, he is desperately trying to raise awareness for an environmental crisis caused by the negligence of the Aruban people, the Aruban government, and the tourists. Therefore, it is necessary to have a top-down approach spearheaded by the government, as well as a bottom-up approach stemming from the community.

## Limitations

Of course, my research also comes with limitations. First, there is the issue of time constraints. While two and a half months does seem like a substantial amount of time to conduct field research – and indeed a lot can be done – much more could have been achieved if the period was longer. The results that came from conducting my research revealed certain aspects, but with a longer time frame other aspects could have come to light. New information always unravels, but at a certain point a line must be drawn for when to stop. For example, the data collected from the survey among the employees of the resort on awareness was not as complete as expected, since I only received seven responses (out of about 100 employees). With more time available, I could have resent the survey or spoken to some employees personally. Therefore, further research should investigate the awareness of the employees in more detail to be able to draw conclusions and offer better recommendations.

## Conclusion

This research paper aimed to assess the current state of sustainable tourism in Aruba, with a focus on the hotel industry. More specifically, I used the Bucuti & Tara Beach Resort as a case study since it is a world-leader in sustainable tourism and hospitality. I assessed sustainable tourism through three lenses: ecology, community support, and awareness. The analysis was based on primary qualitative data collected from interviews, participant observations and a qualitative survey. I hope to have shed a light on the challenges faced by sustainable tourism initiatives in

Aruba. One key finding is that the island is on the path towards sustainable tourism, even though the path is a difficult one. Even with globally recognized resorts, like BTBR is for its sustainability efforts, the sustainability movement fails because the mentality of people, just like in any other country, is extremely difficult to change. Further research should investigate initiatives to make two-pronged structural changes: from the government, in the form of new electoral platforms and legislation, as well as from the community, in the form of awareness campaigns and grass-roots movements.

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## **Coming to Aruba was a dream come true**

Coming to Aruba was a dream come true. After three and a half semesters that got cancelled by Covid, having the opportunity to go someplace was amazing. I felt like I had arrived in paradise. Experiencing the island is so different than learning about it in Utrecht. That promptly caused me to change my topic in the first week after arriving inspired by what I had seen. This taught me how important it is to be flexible about plans and changes in plans. Between people cancelling on meetings, not responding whatsoever, and inviting me to come immediately, there was always the need to be prepared for anything. I have also learned that there is sometimes little sense in just relying on email contacts. I was able to get much more responses when I just showed up in person.

For conducting my survey, I approached random people. While at first, they seemed a little reluctant, as soon as I explained my research, everyone also got excited about it

and happy to answer any questions or also tell me more things I didn't even think to ask. I met people with the most different attitudes towards coastal changes, however everyone was able to tell me some changes that they have witnessed and could remember. I received multiple offers to follow up on the topic, from offering to walk me to some places, to drive me to find places that have experienced erosion, to take me on a boat trip so that I can also see changes from the sea perspective. I was blown away by the enthusiasm and kindness shown to me and I would love to spend more time here to follow up and refine my research, maybe focusing on a specific kind of change or only one area.

Most of all I learned how much fun research can be if you are researching an interesting topic. Collecting responses and talking to people about changes has truly taught me a lot about what I enjoy but also what research should be like:

fun and interesting throughout. The only thing that was at times annoying was then having to turn all the results and responses into the report for this book. Being able to do research myself has allowed me to follow my interest and be proud of my work. I think there is much more potential for information about coastal change to be collected and used to learn about the island. What I love about my research is that it isn't exclusive to people studying the topic and being experts in their field, but rather open to everyone who is living on the island. This also means that I was able to get to know people in all positions.

Of course, the time here was not only spent on just research but also on fun things; from learning a little Papiamentu, dancing Salsa to spending time on the beach, I had an utterly amazing time here. Thank you to my roommate and friend Sophia for putting up with me, for critically talking over what I want to do and listen to whatever crazy idea I wanted to incorporate next. I also want to thank everyone involved in setting up and facilitating this field research program.

# Remembering the Coast: Assessing the coastline and coastal changes on Aruba by using volunteered geographic information (VGI)

Klara Röhrs

## 1. Introduction

Coastlines have an immense value not only for their surrounding ecosystems but also for their inhabitants. Coastal zones are among the most densely populated areas worldwide (Ranasinghe, 2016) and have extreme economic and ecological value beyond providing a place to live (Barbier et al., 2011).

However, coastlines are under constant change with processes like erosion and accumulation. Sandy beaches are especially vulnerable to influences of the sea. The Caribbean island of Aruba is economically dependent on tourism and its pristine white beaches. As an island it is also limited in space. Therefore, it is especially vulnerable to increased erosion, as this poses a risk to the long-term development and existence of the island. In the absence of a central report on all the kinds of coastal changes that are happening, collecting information to understand these changes therefore has many uses. Shoreline change and evolution patterns are important because they provide insight into the large-scale coastal systems that are complex and dynamic (Apeaning-Addo & Lamptey, 2013).

The words coastline and shoreline are often used interchangeably, as will also be done in this paper. Common use depends on geographical location (Huang et al., 2019).

Conceptually, shore- or coastline describes the boundary between water and land (Dolan & Hayden, 1981). There are however multiple other ways of defining the coastline, for example, as the linear intersection of coastal land and the surface water (Gens, 2010; Li et al., 2002). This intersection can be defined in many ways, either depending on visual signs or defining the boundary by indicators outside the visual light spectrum, like infrared light (Boak & Turner, 2005). For visible indicators, the wet line between water and sand can be used (Boak & Turner, 2005).

Most coastlines can be divided into two types, open coastlines and deltaic coastlines. Open coastlines mostly consist of sandy coasts, gravel beaches, cliffed coasts, and estuaries (Ranasinghe, 2016). Sandy coast can be further divided into barrier islands and mainland coasts, both of which can be found in Aruba. Barrier islands often serve as the first line of defence against storms, waves and rising sea levels and are therefore under extreme threat of disappearance, as they become submerged and cut off from sustaining sedimentation (Moore et al., 2010, 2014). In this paper, I will focus on open coastlines as these are the main types of coastline found in Aruba.

Sandy coast, which are mostly beaches, are very dynamic and under constant influence of changes to the forces from the sea (Ranasinghe, 2016). Even miniature changes in this

complex system can have unpredictable consequences. The concrete impact depends to a substantial extent on the local ecosystem and its surrounding specifications (Cooper et al., 2020; Muehe, 2010; Ranasinghe, 2016). To draw worldwide valid conclusions is therefore difficult; nevertheless, some commonalities can be found including coastal retreat, increased beach erosion, increased danger of flooding, and constant coastal recession (Ranasinghe, 2016). Climate change and its associated repercussions are predicted to affect coastal areas in many different ways - from sea level rise to changes in wave conditions and storm occurrences and intensity (Ranasinghe, 2016).

Sea level rise (SLR) has the nature of a slow process; this means that all impacts from it are also likely to result in long-term changes. Permanent receding movement along most sandy coastlines is a common consequence, especially when also considering other impacts that SLR has on beaches combined with other phenomena caused by climate change such as increased storm intensity (Ranasinghe, 2016). The consistent shoreline retreat can be predicted using the Bruun rule, which is discussed in the next paragraph. It is however important to keep in mind and widely acknowledged that the exact nature of any change is highly dependent on local factors (Cooper et al., 2020; Dean & Houston, 2016; Mentaschi et al., 2018; Muehe, 2010; Ranasinghe, 2016; Vitousek et al., 2017; Vousdoukas et al., 2020a, 2020b).

The Bruun rule, first proposed by Bruun in 1962, is a commonly used method to predict shoreline movement due to sea level rise (Dean & Houston, 2016). The Bruun rule stipulates that with rising waterlevels the active coast zone, which is vulnerable to change, will move as sediments are transported into the sea. If there is no way of sustaining the needed sediments, the shoreline moves inwards (Dean & Houston, 2016). The use of the Bruun rule to predict coastline changes is however not without criticism and its use is the subject of academic debate (Cooper et al.,

2020; Vousdoukas et al., 2020b). As shown by Cooper et al. (2020) the results from the use of the Bruun rule need to be carefully interpreted in the local setting. Both Cooper et al. (2020) and Vousdoukas et al. (2020) agree that the local circumstances of coastline change and the conditions of the land located directly behind the beach are of vital importance in determining the response and the development of the beach. The response of sandy beaches to rising sea levels depends on a multitude of factors, for example the steepness of a beach's profile or sand sediment sizes (Cooper et al., 2020). Therefore, SLR does not necessarily equate to negative sediment transport on the beach as argued by Cooper et al. (2020). Especially with well-developed sandy dune systems to supply the beaches with sedimentation, coastal retreat inwards may be halted.

Storm surges and accompanying storm waves are also likely to be affected by climate change (Ranasinghe, 2016; Vitousek et al., 2017). Vitousek et al. (2017) predict flooding events to occur more than twice as often when calculating an expected sea level rise of 10-20 cm by 2050. This in turn would influence the whole coastal system as it gives the coast less time to recover after such a flooding event, thus also contributing to beach erosion (Vitousek et al., 2017). The swell waves coming from a hurricane, even if the hurricane itself does not pass directly over Aruba, can also lead to significant erosion (Kohsiek et al., 1987; Terwindt et al., 1984) where most of the sediments removed are distributed to other parts of the coastline (Terwindt et al., 1984). During normal conditions, the sediments are slowly redistributed (Kohsiek et al., 1987; Terwindt et al., 1984). Nevertheless, there are cases in which the beach retreats inland with sea level rise. Consequently, different adaptation and management strategies might become necessary for the areas bordering beaches. The material and geomorphology of the material located landwards from the beaches are important factors to determine the development of sandy beaches (Cooper et al., 2020). Especially in locations where retreat is not possible due to either the type of land or due to

human-made structures that are built to protect the inland, beaches are reducing in size and in danger of disappearing due to rising sea level (Cooper et al., 2020; Vousdoukas et al., 2020a).

The North and East coasts of Aruba mostly consist of Pleistocene barrier reef complexes that are being eroded. The South coast is protected by inactive reef barrier islands and a reef back zone (Kohsiek et al., 1987). The West coast of the island mostly consists of coral-sand with occasional small reefs present (Kohsiek et al., 1987). While erosion also occurs along the cliffs and rock dominated parts of the island, sandy beaches are the most vulnerable to erosion (Muehe, 2010).

Aruba is almost tideless with a daily tide of just ~0.13m (Kohsiek et al., 1987). Due to the low tidal varieties, longshore currents that are wave-generated dominate the sand transport along the coast (Kohsiek et al., 1987). In Aruba two different longshore currents can be distinguished. One of them is generated by normal trade winds and leads to waves that bend and refract around the North and South tips of Aruba, before meeting at the most western point of the island, in the vicinity of Manchebo (Kohsiek et al., 1987). The exact meeting area can change depending on the direction of the trade winds. The other wave pattern is related to hurricanes and their swell waves. These waves, which are often generated several hundred kilometres off Aruba's coast, enter the Caribbean area before reaching Aruba. These changes in wave patterns can have a deciding influence on the beach and beach erosion patterns, for example leading to recession; where before there was beach accumulation, the swell waves are typically longer and higher (Kohsiek et al., 1987).

In response to developments such as a receding coast or disappearing beaches, several measures have been developed. One of them is sand nourishments that are intended to replenish the beaches with sand sediment

supply. For nourishments, sand is manually placed on the coast, mostly on the beaches, to supply them with the material needed to sustain them (Hanson et al., 2002; Schasfoort & Janssen, 2013). Sand is mostly dredged up close by and transported to the coast by using specialised equipment. While the impacts on the coastal ecosystem can be disruptive due to the compacting of sand and disturbance of the coastline, it is overall a preferred coastal defence measure, when compared with so-called hard defences like seawalls (Hanson et al., 2002; Schasfoort & Janssen, 2013). Seawalls fixate the coast and do not allow for beach movement, which in the case of Aruba would likely cause the disappearance of beaches.

This paper will therefore focus on assessing the overall state of the Aruban coast, as well as what measures have been taken to protect it.

## 2. Methods

For my research, I use a dual method approach that combines volunteered geographic information with satellite image-based analysis.

GIS is commonly considered a top-down method with little connection to the general public (Goodchild, 2007). However, the rise of the internet has allowed everyone with access to contribute in the form of Volunteered Geographic Information (VGI). VGI describes the contribution of information to a map by volunteers or untrained citizens (Elwood, 2008; Goodchild, 2007). Combining classical GIS science and map work with the options of adding, collecting, and organising data on maps not only by scientists or trained professionals, opens the door to include a wider public in any kind of map creation (Elwood et al., 2012; Goodchild, 2007). VGI allows any participant to feel a sense of connection and ownership towards the research, since everyone can contribute to it and every input is treated as equal (Elwood et al., 2012; Goodchild, 2007;

Ricker et al., 2013). By choosing VGI I wanted to connect my research to the community on the island. Instead of a top-down approach in which only the input of a few educated individuals is considered, by using this method, the community and people affected the most by coastline changes in Aruba had an impact on the project. Through this, I made sure that I did not only consider places deemed worth considering by academic literature but also by the local people.

For collecting the VGI every person living in Aruba was considered and their input welcomed. Different ways of making a living, place of living as well as typical recreational locations all have an input on the type of changes that are observed and brought forward.

To collect the VGI, I created a survey using Survey123 by ArcGIS. This software was chosen as it allows for map-based questions in which respondents are presented with a map with which to interact. For example, pinpointing locations or marking areas by drawing on them is possible. The survey was created using the corresponding software ArcGIS Survey123 connect, and then published through the ArcGIS website. This resulted in a short link and a QR code that can be easily shared to make distributing and collecting responses easier. The survey was available in both English and Papiamentu in order to reach a broader audience. While Papiamentu is one of the official languages of Aruba, English is also widely spoken (Aruba, 2022).

The survey started by introducing me and the topic. My email address was provided in case of questions, concerns or other issues that may arise while filling out the survey. Anonymity was assured. Furthermore, respondents were asked to share the survey with anyone (friends and family) that might be interested. Consent for recording and using answers is asked; this was the only question on the survey that participants were unable to skip. Only after consent

was given, the rest of the survey questions appeared. The first question of the survey asks respondents to mark the location of coastal changes by drawing on a map. The baseline map is set to Aruba, showing satellite imagery overlaid with names. For this question, multiple submissions were possible to allow respondents to mark more than one change. An explanation on how to navigate the map and how to draw on it were added. In the next question, the respondents were asked to describe the nature of the changes marked. This question was open-ended to allow respondents to report all kinds of changes that they had noticed instead of setting the tone beforehand. The next question is similar in setup, asking participants to locate affected areas on the map; however, it asks specifically about erosion. Next, the survey asks whether there are any known measures already in place to protect the coast. To understand respondents' motivation to reply to the survey, the next question uses an open-ended question to ask what they value about the coast. These answers give an overview of how the respondents connect to the coast. Next, the survey moves on to ascertain the approximate amount of time spent on the coast and the reasons for being on the coast/ beach as well as coastal activities they participated in. For example, a fisherman has a different perspective on the coastline than a regular beachgoer might have. In the next step, there is the opportunity to add pictures of coastal changes in case the respondents have them and describe what coastal change they depict. Finally, demographic questions about age are asked using multiple-choice options. Since many people are migrating to Aruba, the next question asks how long people have been in Aruba, to give an overview of the timeline of changes they possibly could have witnessed. Finally, the opportunity is provided to leave an email address to get access to the research report that participating in this survey contributed towards. The survey questions in English and Papiamentu, as well as the options for multiple-choice questions, are provided in a digital appendix to this report.



In addition to sending out the survey via online channels such as email or social media, I conducted several interviews in person. After testing out my survey in a pilot project, I noticed a certain reluctance toward having to answer questions or draw on a touchscreen. Especially older people seemed hesitant to deal with an online survey. To address this issue and ensure that these stakeholders were also included, I conducted interviews. The interviews were completely based on the survey and aimed at either filling in the survey together or gathering all the information covered in the survey. Conducting these interviews provided me with the opportunities to ask in a more elaborate manner and go into more detail by assessing facial impressions. I could, if necessary, clarify and elaborate on the questions and answers given; for example, I could provide examples or help with drawing on the map. I compare the results from the interview and from the online survey with each other to see whether there are any noticeable differences in the responses.

The method of selecting the stakeholders for the interviews and survey can be best described as convenience sampling. Through contacts at the university and following their recommendations of people to meet and areas to visit, I aimed to achieve an occupationally diverse sample. At the end of every interview, I asked whether there was anyone that they could recommend I talk to. Through this snowball sampling method, I hope to further spread my survey beyond just the people I talked to.

Stakeholders were first identified at various locations. For example, local fishermen, people working on the coast or close to the coast were asked whether they would be willing to talk to me. Additionally, I sent emails to previously identified stakeholders asking for either the survey to be filled out or a meeting to be set up. Depending on the location I either filled in the information on my device (laptop or phone) or took extensive notes on paper and filled in the survey later, if there was no table close by or a complete concentration on my phone seemed inappropriate.

While conducting my survey and gathering data, I aimed to include as many different stakeholders as possible. In principle, every person in Aruba can be considered a stakeholder due to the small dimensions of the island and the strong dependencies on the coast and its properties for the economy (van Zanten et al., 2018). On top of that, I aimed at including scientists researching coastlines, local fishermen, and divers, among others.

The data collection based on VGI might be limited by the quality and the scope of the data submitted (Elwood et al., 2012; Flanagan & Metzger, 2008). I address these possible shortcomings by comparing the results collected to the ones that I collected in the interviews structured around the survey. By doing that I can also ensure that the questions were understood the way I intended them. Overall issues of credibility cannot be completely resolved. Nevertheless, the physical limitation of Aruba (not being very big) ensures that “local” knowledge is collected in every case. While I don’t offer the opportunity for the collected knowledge to be peer-to-peer assessed (Flanagan & Metzger, 2008), overall credibility can still be ensured by comparing different accounts of the changes with each other. Furthermore, by including stakeholders that focus on the coast for their work, and that represent traditional sources of credibility, I can use these accounts for confirmation of the data provided by general residents of Aruba.

To further add credibility to the VGI collected, the coastline is analysed using satellite images, which also allow for the quantification of changes reported. Publicly available satellite images from the Landsat and Sentinel satellite missions are used to extract the coastline and track changes over time. I use the open-source software toolkit CoastSat that utilises Python language. The workings of CoastSat can be summarised in three steps: retrieval of the satellite images from Google Earth Engine, 2: shoreline recognition and extraction and 3: the intersection of the shoreline with cross-shore transects.

The images are obtained from Google Earth Engine and pre-processed to remove cloud cover and improve pixel resolution before applying an algorithm to detect the shoreline (Vos, Splinter, et al., 2019). Due to this picture correction CoastSat works best for sandy shores. This makes it suitable for this research, as most changes are expected to occur on the sandy beaches on the island. After running the pre-analysis with the Jupyter notebook and setting up a reference shoreline to ensure that any sandy pixels detected will be in the vicinity of the real shoreline and false positives can be avoided, the pictures are manually evaluated and sorted to avoid misidentifications of the shoreline due to clouds or bad lighting conditions.

As a final step, the coastline evolution over time is plotted and can be used for further analysis (Vos, Splinter, et al., 2019).

One of the disadvantages of using satellite imagery is that white water is often misidentified and therefore the shoreline is wrongly positioned (Pardo-Pascual et al., 2018). CoastSat can accommodate for that and identify the coastline even with white water present (Vos, Splinter, et al., 2019). The coastline is defined as the contact line between the water and the land at the moment of image acquisition (Vos, Splinter, et al., 2019). More applications and an example can be found in Vos, Harley, et al. (2019).

### 3. Results

#### a. From the survey

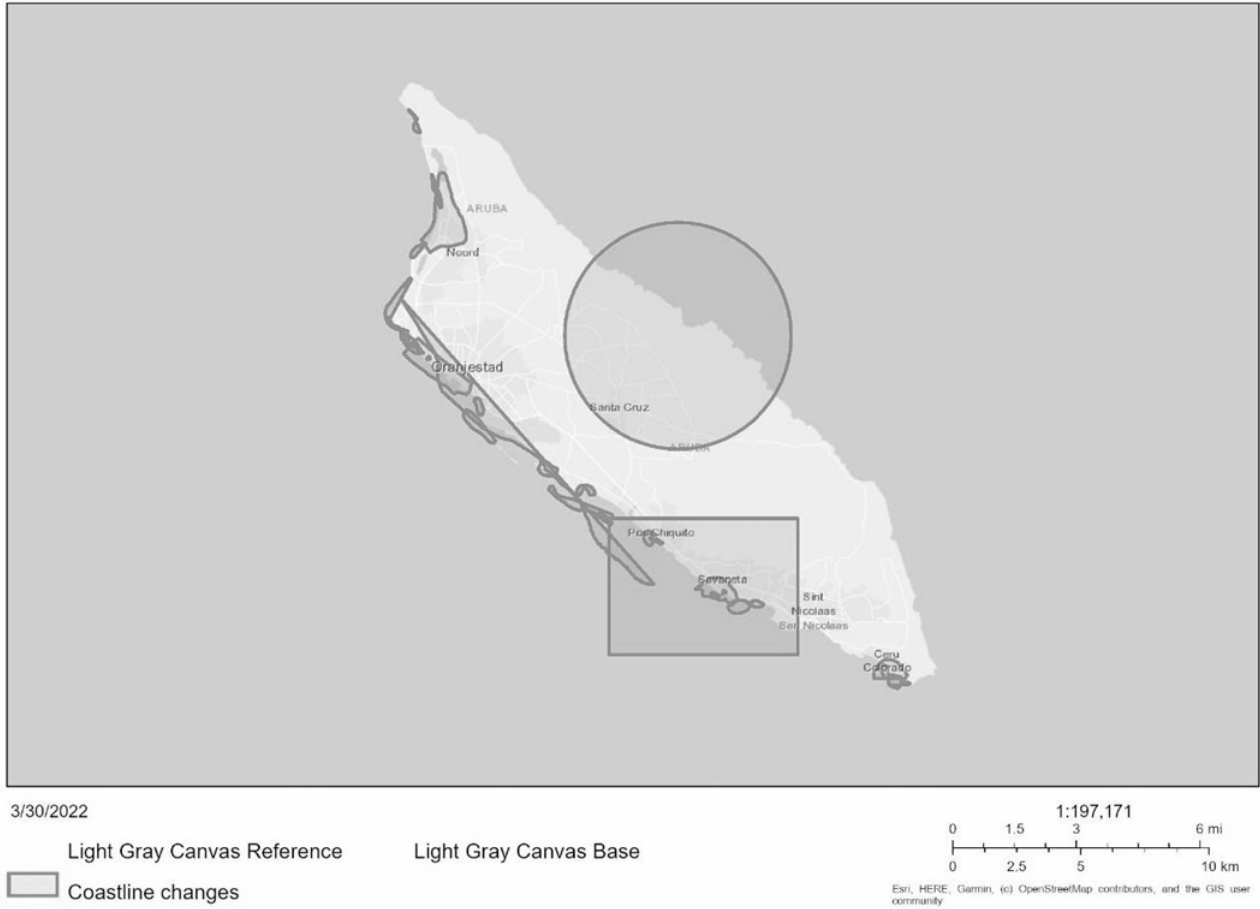
For this paper, only preliminary results will be considered, which means responses received as of 23.3.2022. In this period, 17 responses were collected, 7 of these in structured interviews.

Responses/ age groups	Younger than 20	20-29 years old	30-39 years old	40-49 years old	50-59 years old	60 and older
Counts overall	0	3	5	5	2	2
Interviews	0	1	0	4	1	1

In total, 36 shapes were recorded for coastal changes. The size of the area marked varied from 9.3 m<sup>2</sup> (min) to 5067.8 m<sup>2</sup> (max) and the average size of the area marked was 300 m<sup>2</sup>. The structured interviews resulted in 13 areas marked. In general, the areas marked as having experienced coastal changes by interviewees were smaller and more precisely catered to single locations on the map. Locations mentioned by the interviewees include but are not limited to Baby Beach, Eagle Beach, reef islands, Hadicurari beach, Manchebo and Druif beach. All of these are located on the West side of the island, covering the entire length from North (Hadicurari) to South (Baby Beach). Among the changes frequently mentioned are the disappearance of beaches/erosion (4 mentions), as well as the cutting down of mangroves (2 mentions), although one respondent also described an area in which the mangroves had recovered and grown in height.

When looking at all responses combined, multiple-marked areas are relatively big, also covering a significant amount of land away from the coast. Among the places marked multiple times are Baby Beach, Hadicurari beach, Arashi beach, Curacabai and immediate surroundings, Druif and Manchebo beach. The changes that are noticed frequently are the deforestation of mangroves, building developments and erosion.

### coastchange\_complete




*Figure 1: Map showing the areas marked to have experienced coastal change, all responses.*

coastchange\_interviews1



3/30/2022

- Light Gray Canvas Reference
-  Coastline changes
- Light Gray Canvas Base



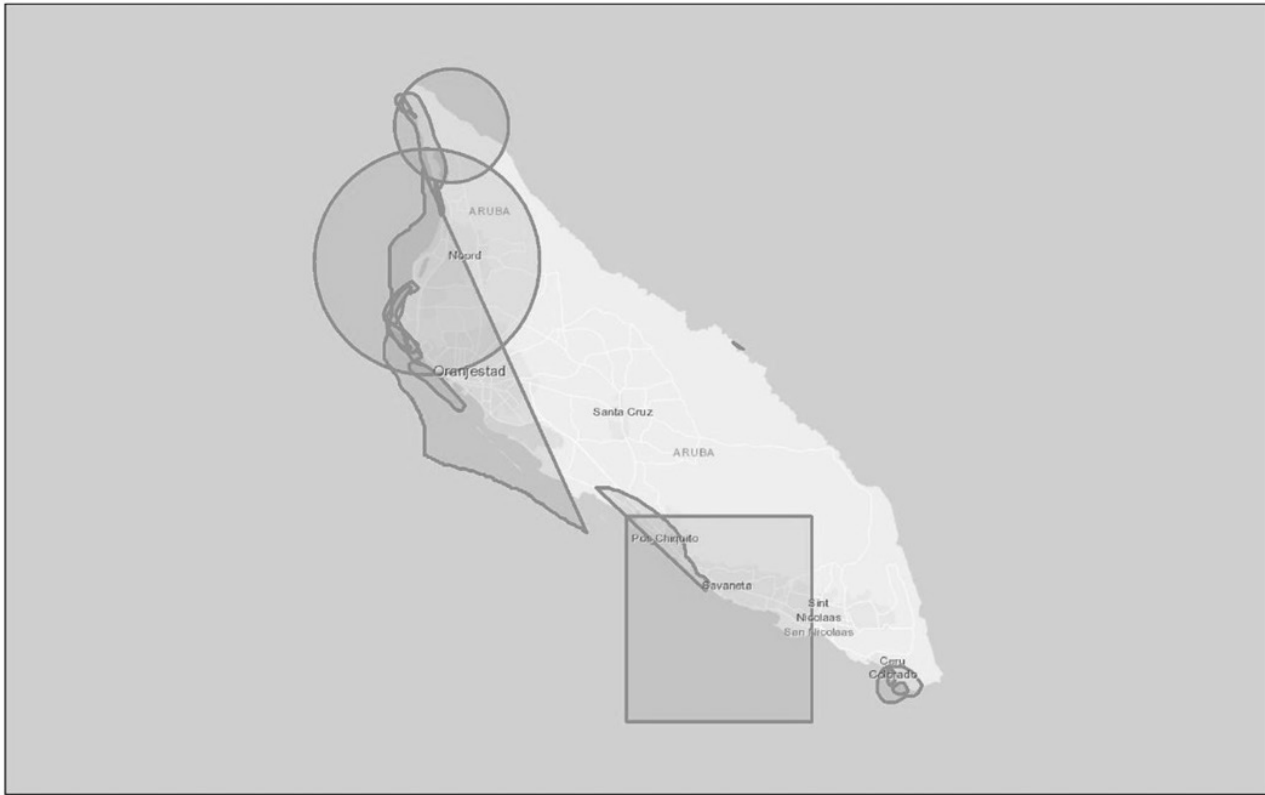
*Figure 2: Map showing the areas marked to have experienced coastal change, responses from the interviews structured around the survey.*

The locations marked to have experienced climate change in the interviews and in the entire sample mostly overlap; the latter group identified some additional locations not found in the responses from the smaller group of interviewees. Regarding the kind of changes described, an overlap can also be seen (mangrove deforestation, erosion), although the factor of coastal development was often brought up in the overall sample but wasn't mentioned as often in the interviews.

Overall, 21 areas marking erosion are included in the results, with the area marked varying from  $7.5\text{m}^2$  to  $4943\text{m}^2$ . The average size of the locations marked is  $700\text{m}^2$ . From the structured interviews, the areas marked are again mostly smaller and therefore more precise in comparison to the entire sample. The location marked most often is Manchebo/ Eagle beach. More than half of the smaller group marked this area as having experienced erosion. A second location is in the vicinity of Baby Beach.

All in all, these answers from the interviews fit with the results when all the responses are combined. As with the question on coastal change, additional locations were identified by the group as a whole, but overall, they overlap with results from the interviews in that there are more markings in Manchebo as well as the vicinity of St. Nicolaas. Additional locations include Arashi as well as the area surrounding Savaneta.

### erosion\_complete

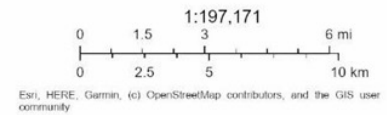


3/30/2022

Light Gray Canvas Reference

Light Gray Canvas Base

 Coastline changes



*Figure 3: Map showing the areas marked to have experienced Erosion, all responses.*

### erosion\_interviews1



3/30/2022

Light Gray Canvas Reference

Light Gray Canvas Base

Coastline changes

1:197,171  
0 1.5 3 6 mi  
0 2.5 5 10 km  
Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community

*Figure 4: Map showing the areas marked to have experienced erosion, responses from the interviews structured around the survey.*

A certain overlap can be seen between the areas marked for coastal change and erosion. The main areas mentioned for both coastal change and erosion are Manchebo/ Druif beach, Baby Beach, and Mangel Halto. However, as there were already multiple mentions of erosion as the kind of changes observed for the first question, this overlap can be easily explained. Multiple respondents described an overall deterioration of the western coast (“all along the West coast, beaches have disappeared”). Other long-term changes reported are more related to the development of buildings along the coast. In Aruba, sand nourishments are selectively used to fill up beaches after strong erosion events. It is important to notice that this practice mostly occurs at tourist hotspots (on the west coast close to the high-rise hotels), while other areas are not encountering this treatment.

In the interviews, there were mostly no measures reported, with only one respondent mentioning that the only measures are located close to the high-rise hotel tourist areas to protect the beaches there. This is in line with the feedback from the entire sample, with most respondents reporting no measures taken to protect the coast; however, there were mentions of other measures taken that either proved ineffective or only very limited in location (“Signs to not drive on the beach which are not respected.”). All answers to this question are included, in anonymised form, as a digital appendix to this paper.

What is valued about the coast varies more. While in the interviews respondents mostly comment on the beaches (3 mentions) and the inherent beauty of the coastline, in other responses there is more emphasis on the ecological importance of the coast as a highly complex ecosystem (5 mentions).

Overall, most respondents visit the beach frequently with more than half reporting that they go every day and 41% go once a week. Free time is the most frequent reason for

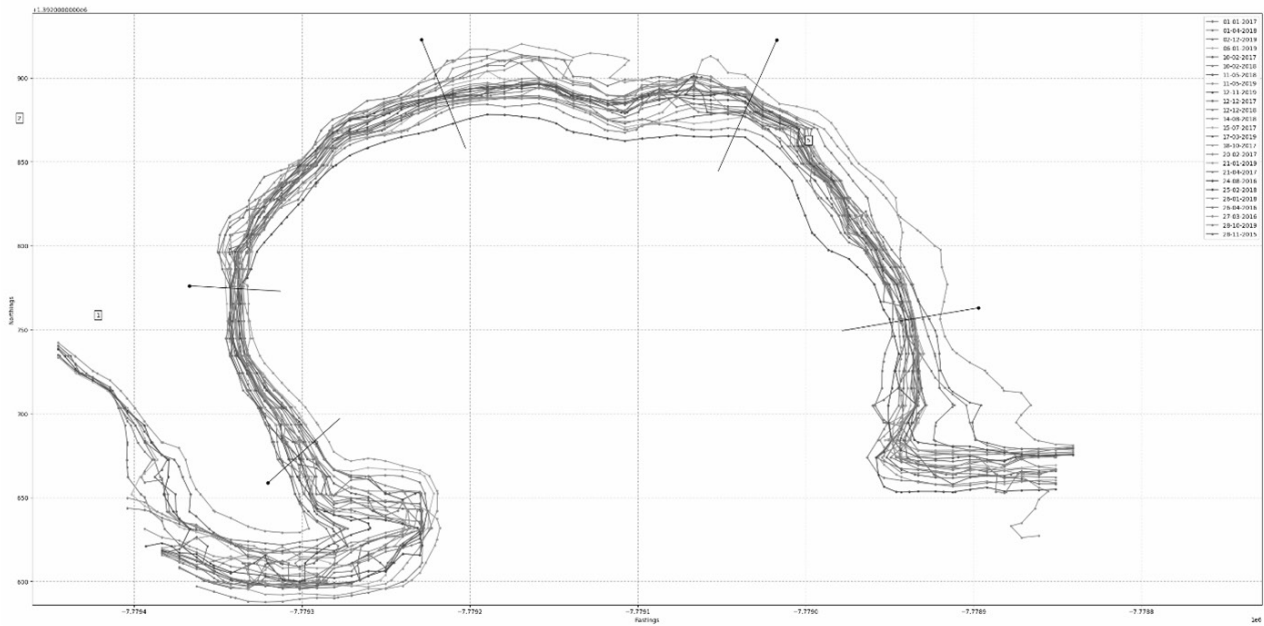
visiting the coast (11) with work the second most mentioned (5) (multiple answers possible). Most people working on the coastline report that they work in water sports.

Overall, there are many similarities in the responses from the interviewees when compared to the group as a whole. The main difference is that, in the interviews, the areas marked were smaller and more precise, although the overall location did not change much. The biggest difference could be seen when focusing on the value that is attached to the coast. In this question, it still became visible how every respondent attached at least some value to the coast either for economic reasons (tourism), ecological or aesthetic reasons.

#### b. From satellite

While originally intended to cover the multiple areas that were repeatedly marked in the survey, due to time limitations for this paper the satellite analysis is limited to one area, Baby Beach. The period of analysis is also short and limited for now. This satellite image analysis represents a preview into what could be possible once all the results from the survey are completed and analysed. Setting the GPS parameters at [-69.8555, 12.4663],[-69.9445, 12.4663],[-69.9445, 12.4054],[-69.8555, 12.4054] and including the timeframe from 2015 to 2020 resulted in 388 images available for analysis in that time frame and location.

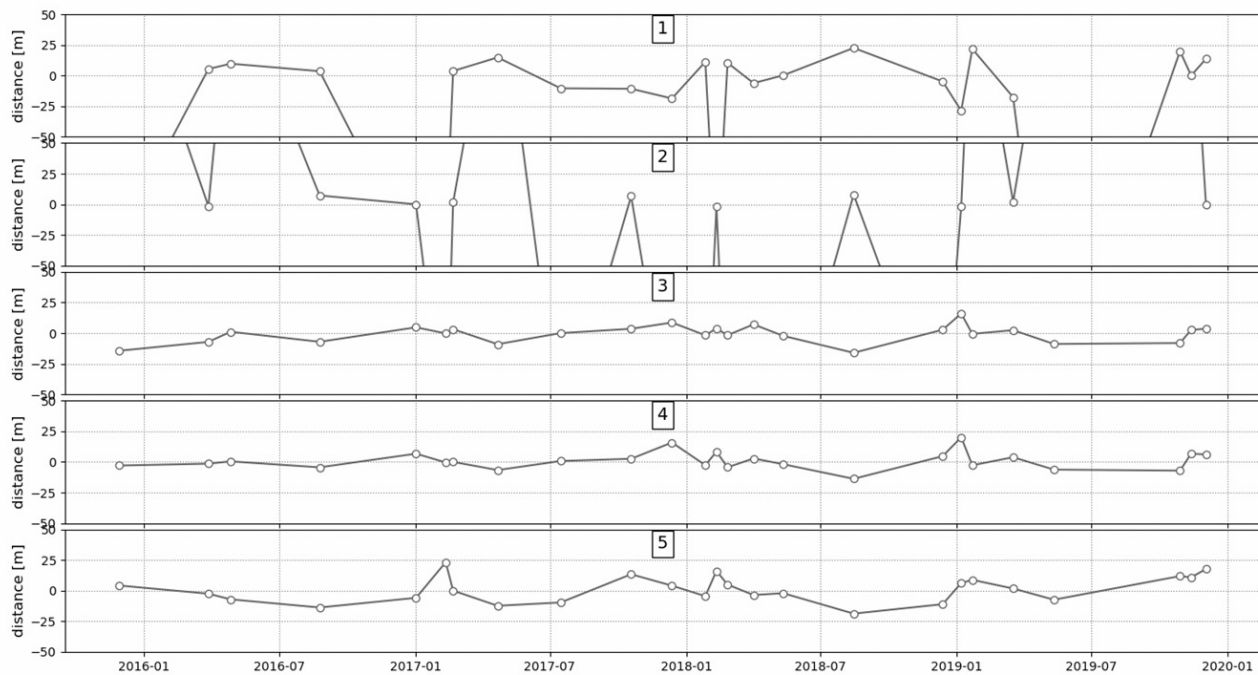




*Figure 5: Shoreline variations over time of Baby Beach 2015-2020 created by CoastSat with the locations of the five transects. They are numbered starting with one in the lower-left corner and going clockwise. There seem to be no coherent trends all over the bay, rather a back and forth of erosion and beach accumulation.*

As can be seen, the automatically extracted shoreline varies over the years. Especially at the edges of baby beach, the variation is wide. However, the overall line between water and land is not varying much.

In the next step, 5 transects are laid over the coastline and the deviations of the coast along these transects are calculated. The variations along these transects can be seen here:



*Figure 6: Shoreline movement along the five transects as determined by CoastSat at Baby Beach 2015-2020. While the shoreline widely varies at transects 1 and 2, it shows fewer variations at transects 3-5.*

There is no obvious reason for the differences in shoreline movements when comparing these transects, and further analysis into them is needed. Additional satellite image analyses at different locations and over longer periods are needed to conclusively be able to compare the results from the VGI to the insights coming from the satellite analysis.

#### 4. Discussion

There are several limitations to the results of this paper. Firstly, using a survey comes with its form of limitations, for example technological and language barriers, as well as limited reach and only a very selective sample. I tried to make the survey as accessible as possible by providing additional explanations to help facilitate the responses. However, I acknowledge that the technology used might still provide a barrier not only to participating but also to the quality of the responses. Often areas marked were big and imprecisely placed. One respondent also reported the survey website freezing and then crashing, in the process losing all progress made on the survey. While I cannot estimate how these difficulties overall influence the responses, they support the observation made that the responses on the map from the structured interviews are generally smaller and more precisely placed.

While piloting the survey I also noticed a certain reluctance in responding on a technical appliance such as a smartphone, especially for older respondents. When comparing the responses given on the survey without me being close, I however cannot confirm that this influenced the results.

Another limitation might be the language barrier. Offering the survey in both English and Papiamentu addressed part of this issue; however, not having the survey available in Spanish, which is also widely spoken on the island, the overall reach might also be limited on these grounds. Furthermore, all interviews were conducted in English,

meaning that depending on the respondent there might have been a language barrier present as well. While I am confident that I was able to explain the questions sufficiently to the interviewees that the answers are eligible, in explaining I might have given biases or subconsciously excluded possible answers. This might be seen when comparing the changes described by the respondents overall in comparison to the responses from the structured interviews. While overall several respondents mention the development of the coast with new hotels and buildings, only one respondent in the interviews mentioned this to me. Nevertheless, I judge the influence from this to be relatively small and overall negligible.

Another limitation linked to the survey may be the limited reach. I tried to use stakeholders to provide the next contacts and to ask them to spread it in their network; however, with very little idea of the success and amount of people reached by this. At the end of the survey, I asked respondents to spread the survey to interested friends and family; however, the overall limited number of responses makes me doubtful about the number of instances this was done. It is important to note that these are preliminary results, and that further data collection is ongoing while this paper was written. The results will be updated with additional responses.

The results of the survey might also be further limited by the responses themselves. While overall I have responses from people of different ages, the youngest generation of people under 20 years old is still missing in the results. Generally, I have many people who come into contact with the coast as a part of their work. Considering the many tourists and the popularity of the beaches and coastline of Aruba to them, this does not come as a surprise. This extended contact with the coast can only serve as an added advantage to my results although with a possible bias that sites that are more popular with tourists are also more commonly brought up in response to the survey instead of the entire island being equally reported on. This could also be seen in the results

as many of them focus on places where many tourists are, such as Eagle beach, Baby Beach and Manchebo, while only one response marks a location on the East side of the island. However, when considering Aruba's geology this can also be explained by the fact that most beaches that are more vulnerable to changes and for which it is easier to observe changes are also located on the West and not the East side of the island.

Overall, I have not noticed a significant difference in the answers given by my interview partners when comparing them to the overall responses, except that the areas marked are mostly smaller. This leads me to believe that generally the unsupervised survey responses can be trusted to be truthfully reported to the respondent's knowledge and the map created by the VGI to be an accurate representation of coastline changes.

Choosing this type of satellite analysis means that there are aspects left out due to the construction and limitation of the image processing software. For example, changes that occur mostly on land like deforestation, which was often mentioned in the survey, are not covered in the satellite analysis, as the software toolkit focuses on the border between water and land.

Almost all changes were reported along the sandy beaches. This matches up with the literature as beaches are the most vulnerable to change when comparing them to cliffs or rocky shores (Muehe, 2010). Subsequently, most areas marked were located on the West side of the island, as there are more beaches located there. However even on the East side, there are a few inlets with beaches, however, so far none of the responses has indicated changes there. I find this unbelievable since the East side is even more exposed to the most easterly trade winds and therefore wave actions (Kohsiek et al., 1987). The non-mention of these beaches and other locations around the East coast is probably more due to a lack of reporting and due to less frequentation than a lack of change.

From Kohsiek et al. (1987) and Terwindt et al. (1984), I expected changes to have occurred around Manchebo as this is where the waves refracted around the North and South tip of the island meet up and therefore the area is under constant change. This was confirmed with the VGI as many responses reported changes at these locations. However, the changes reported at Baby Beach were more unexpected as it presents a sheltered bay with land arms almost enclosing it and protecting it from the sea. This could perhaps also explain the varied changes detected in the satellite analysis.

No beach accumulation was reported, only erosion. Considering the rising sea levels and the non-existence of dunes to supply the beaches on Aruba, this is also not surprising. As buildings are built next to the beach, the beaches have no opportunity to retreat, rather they erode as they have no access to additional sediment supplies. Furthermore, considering the geology of Aruba it is also difficult for the beaches to sustain themselves. Many beaches are located next to the limestone plateau that makes up most of Aruba's flat western part of the island (Schmutz et al., 2017). Instead of eroding to form new sand, the solid rock also leaves the beaches with no space to go as storms and rising sea levels take their toll.

When comparing the results of the map created by the VGI and the satellite analysis, it is difficult to draw conclusions from them. While on the map there are many areas marked as having changed, some of the reported changes focus more on other developments instead of only erosion. While the satellite analysis shows quite a variation of the shoreline over time with erosion and accumulation, overall, the changes are not that significant. However, this could also be due to the location of the selected area. Further image comparisons will show whether there are only minor changes all along the coast of Aruba or whether this was due to the protected location site of Baby Beach. To fully ascertain what other factors could have contributed to these changes and whether these variations are in line with the

reported changes, more in-depth and follow up interviews would be needed that are outside the scope of this paper.

This paper has shown that there is much potential in the use of VGI to assess the state of the coastline. When conducting the interview and sending out the survey I was met with much enthusiasm on the topic, showing also that more in-depth follow up work on the topic would be welcome. While the map presented in this paper is in no way complete, it already shows the areas that are evaluated as vulnerable and subject to change by Aruban residents.

VGI based maps are therefore ideal for finding these potential areas. Nevertheless, the information submitted by respondents is mostly qualitative. This makes it harder to gauge the timeframe and quantity of the changes that are reported. For quantifying changes and being able to put numbers to the satellite analysis is needed. However, with the satellite analysis, it is only possible to focus on one beach (coastal area) at the time, while with VGI an approach is possible that focuses on the island as a whole, therefore being able to provide insights into how areas are connected and how changes on the land (for example the deforestation of mangroves) can influence that coastline. This mixed methods approach of identifying areas of interest which will then later be analysed with satellite imagery has therefore proven successful.

## 5. Conclusion

There is no doubt that changes in and around the coastline are occurring in Aruba. These changes are driven by a multitude of factors, some natural and some anthropogenic in origin. Sea level rise and changes in storm direction and intensity undoubtedly have already left their traces on the highly dynamic coastal system, with beaches disappearing. Due to the intense development close to the coast and Aruba's unique geology, no retreat of the beaches is possible. This has also been reported in the survey.

Collecting data on these changes can be done in multiple ways as demonstrated in this paper. Residents and people living in Aruba hold much valuable knowledge about the changes that they have witnessed. Including the perspective of the people most directly influenced by changes is necessary before attempting to draft any plans at addressing them.

The VGI collected from the people living in Aruba reveals a high interest and concern for the changes that impact the coast. Almost every person marked locations as having experienced erosion, which shows the high level of concern and the importance seen in protecting the shoreline from this. Furthermore, as no or only insufficient measures of protection are reported this clearly shows that there is a need felt by people living on Aruba to invest in protection and if necessary, restoration of the coast.

While the VGI is not representative of the impression of the entire island, it provides a small insight. This method of data collection could be expanded to include more people on the island to increase the potential impact it can have. The interviews I have conducted and the presentation of my survey with the mapping questions sparked much interest in every respondent I talked to. As soon as I introduced my research and started asking questions every respondent was proud to share their opinion on where and what kind of changes they remember.

The future potential for VGI is immense for collecting all kinds of data. Although the Directorate of Nature and Environment of Aruba already administers and publishes surveys on different topics on their website (Directorate of Nature & Environment, 2022) this could be expanded to many more areas. Further research could also focus on potential measures that could be put in place to address the vulnerability towards coastal change of the people living in Aruba.

## 6. Acknowledgements

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## **Aruba changed my understanding of research**

Googling Aruba you see one uniform image of white beaches, turquoise water and hotels. Coming to Aruba I realized that this picture is nothing more than one depiction of a multifaceted island. It is one perspective, however, Aruba is full of contrasting perspectives. Tall touristic developments, right next to local cunucu houses. Pristine white beaches in the south and a rocky and wild north shore. Densely developed urban areas, contrasting open and protected nature. A push to renovate and modernize, while preserving the cultural heritage and history. Understanding, seeing, and experiencing this contrast was unique and beautiful. In any other country I have lived in, these differences may exist, however, distance and size detached them from one another. In Aruba scale introduced all these elements as one holistic interconnected system, rather than several detached environments.

Furthermore, throughout my time in Aruba, I was able to meet a diverse set of people from different walks of life.

These interactions in many ways combine to be one of my most valuable lessons and rich experience in Aruba. Everyone I have met has been so welcoming and open, and has offered me so much more than just information. Many took the time to talk, listen and throw in some life advice when necessary.

Lastly, research has often been presented to me as a straight forward model, however my experience in Aruba made me realize that there is no one format to conduct research, no one way to reach people. Learning from people, asking for advice has been central in guiding my research. I initially ran into several barriers, showing up to open office hours, but lacking an appointment or showing up to meetings on time, having to wait for everyone else to come. However, listening to others and integrating their advice allowed me to adapt my research, and understand research as an evolving process influenced by local dynamics.

Aruba taught me so much, about myself, about research, about the island, and about people. A list of everything could fill a whole book. However, some of the most important ones for me, outlined above, center around Aruba's local context, the people I encountered and how my time in Aruba changed my understanding of research. Research is not a project, but a process of experiences which has many outcomes, only one of which is a paper.

Finally, I want to take this opportunity to thank the people who have helped me throughout my research.

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# Learning to play it by ear: Understanding barriers to public participation in urban planning on Aruba

Carlotta Marie Henning

## Introduction

Urban planning is a dynamic field. Practices continuously change based on challenges and issues experienced by urban planners. Thus, research often trails behind in evaluating new planning practices. In the last decades an increased focus has been put on including the community in urban planning, and “Public Participation” has become a prominent buzzword in urban planning.

Public participation in urban planning originates from the 1960’s with Davidoff (1965) and Friedman (Friedman & Huxley, 1985). At the time, Davidoff (1965) acknowledged that for planning to accommodate the variety of needs and issues experienced by society, and to become fairer, it needed to put the communities at its center, since the community holds much of the contextual knowledge (Davidoff, 1965).

Since then, the notion of community-based planning has evolved and become widespread. This is reflected in many national legal frameworks, which not only recommend but require planners to consult the public during planning. Aruban planning is no different; planners must consult their local population before implementing large urban development projects (Centraal Wettenregister, 2013). However, while the need for participation is acknowledged

and initial processes were put in motion, it is unclear if these processes lead to genuine participation.

In recent years, practice is increasingly limited by low participation from the public (Innes & Booher, 2010). This phenomenon is not specific to urban planning, and is often referred to as the crisis of democracy in academia (Innes & Booher, 2010). Mitigating this issue of low participation is central when focusing on public engagement in urban planning. Thus, it is imperative to consider what barriers limit public participation in urban planning. Consequently, academics have shifted from outlining the benefits of participation to exploring what barriers limit participation in urban planning (Liu et al., 2018). However, the literature exploring barriers emphasizes the western context and large urban areas (Brownill & Parker, 2010). Thus, non-western and small-scale contexts, such as the Aruban, are largely neglected. Consequently, considering the academic field, it would be relevant to conduct similar research on barriers to participation in Small Island States (SIS) such as Aruba.

For the Aruban context, public participation may be especially relevant, because it is a SIS. Many SIS have pledged to work closer with the SDGS (sustainable development goals) which require public participation in urban spaces as a subgoal of goal 11 (United Nations, n.d.). Beyond that, public participation is a central component in building up

social resilience (Bass et al., 1995), which in turn plays a role in reducing vulnerability in smaller communities (Bass et al., 1995). Thus, considering public participation in urban planning is of interest to Aruba's context as a SIS.

This paper aims to bridge the academic gap and address local relevance by establishing an overview of the current situation of public engagement in urban planning, while expanding on current barriers to participation in top-down and bottom-up initiatives in Aruba. This leads to the research question: "What are the main barriers explaining the current situation of participation in urban development and renewal in Aruba?" The hypothesis extrapolated from the literature is that Aruban participation likely predominantly falls under token participation. As for barriers, this paper hypothesizes that they will largely overlap with the ones from the literature, but that elements such as culture or government relations may be more central in Aruban planning than in other contexts, due to the island's small size.

The paper addresses the question by using a combination of semi-structured interviews with government, organizations and experts, as well as an extensive survey that was distributed among the local population. Thus, this research predominantly relies on qualitative data to understand the landscape of public participation in Aruba.

## **Context**

### *Aruba's context: History of urban development*

There is little literature on the urban development of Aruba. However, literature on urban development in the Caribbean can be seen mirrored in Aruba (Conway et al., 2004). Like many Caribbean islands, Aruba primarily has seafront urbanization and settlements. These are often centered around harbors and other industries such as the former oil refinery in San Nicolas (Conway et al., 2004). Furthermore, older urban developments in the Caribbean are often categorized by uncoordinated

structures (Conway et al., 2004). Recently, many Caribbean islands, including Aruba, have shifted towards tourism to sustain their economy and wellbeing. This shift to tourism has also altered the urban landscape. Academics have increasingly classified this as touristic gentrification, which pushes out the local population from harbor areas and their livelihoods (Conway et al., 2004).

Furthermore, Aruba's landscape has increasingly experienced urban sprawl (Cole & Razak, 2009). This means that city areas keep increasing and pushing outwards. This comes with the cultural goal of having a small plot of land with a one-story house, called a cunucu (Conway et al., 2004). This image has continuously represented success in Aruban culture. The issue with this urban sprawl is that it keeps expanding and infringing on vulnerable nature areas on the north coast. Consequently, a focus on making urban areas more livable and denser may be central in protecting other areas of the island (Conway et al., 2004).

### *Aruba's context: Current urban development*

To discuss public participation in Aruba, one first needs to establish what the current planning framework looks like.

As in other countries, Aruba has a variety of factions which participate in urban planning and are involved through a variety of projects. However, unlike many other contexts in Aruba, urban planning is centralized at a national level (Robert Maduro, personal communication, 2022). The DIP (Department of Infrastructure and Planning) is responsible for monitoring, developing new plans and guiding holistic development on the island. This shifts the perspective of urban planning from local to national, which differs from many other planning contexts.

The DIP was central in developing the ROPV (Ruimtelijk Ontwikkelingsplan) in 2019, a national zoning plan that guides and defines what type of urban development is possible

on the island in the next 5 years (Centraal Wettenregister, 2013). The plan subdivides the island into different areas and defines what development is permitted in each, e.g. residential, touristic, nature. This ROPV creates the framework and guidelines for how urban planning works on the island (Centraal Wettenregister, 2013). Furthermore, the ROPV also clearly outlines what public participation requirements the government must abide by during urban planning (Centraal Wettenregister, 2013). Consequently, a large role of the DIP is ensuring that landowners adhere to the guidelines of the ROPV and develop their spaces accordingly. The DIP is also responsible for maintaining and providing communal facilities such as schools and green spaces. Lastly, the DOW (Dienst Openbare Werken) is responsible for maintaining and updating roadworks and transport infrastructure when necessary (Centraal Wettenregister, 2013).

## Methodology

### *Terminology*

#### *Public participation*

What constitutes public participation is vague, and often changes based on the context. Most commonly, public participation is a combination of the local population's ability to engage in urban development processes, and the extent to which they do so (Innes & Booher, 2004). For this paper, participation in urban development is divided into two main notions: bottom-up and top-down. Top-down refers to public engagement in official planning initiatives, which originate in the government (Laurian & Shaw, 2009). Bottom-up refers to planning initiatives, which originate and are situated outside of the government (Miraftab, 2017).

#### *Urban planning*

Planning has conventionally been considered an action by planners (Miraftab, 2017). However, in recent years several planning theories include bottom-up initiatives as genuine

and necessary forms of altering the urban landscape, and consider them part of urban planning (Miraftab, 2017; Purcell, 2014). Consequently, in this paper urban planning encompasses both actions by planners, and community-based initiatives that alter the environment.

#### *Theoretical framework: Arnstein's Ladder of Participation*

To evaluate participation and its position one needs to acknowledge that participation is not binary. Public participation can be seen as a spectrum from none to complete citizen control. For this paper, the spectrum is oriented around Arnstein's (1969) ladder of participation.

Arnstein (1969), provides a spectrum to understand different participation levels and their impacts. Her framework sorts participation into eight rungs grouped into three main levels. The lowest rung is non-participation; this includes the categories manipulation and therapy. These categories create forums which pretend to include the public in urban development. However, these forums provide no transparent information, nor opportunities for community feedback. Thus, creating no real possibility for participation. The next rung, token participation, includes informing, consultation and placation. These structures usually promote unilateral streams of information, and no platform for accountability or shift in power. Lastly, the highest level of participation, citizen power, includes partnerships, delegating power and citizen control. These forums give an opportunity for citizens to engage in the process of co-creation, through bilateral streams of information and a shift in power. Ultimately, citizen control provides citizens the opportunity to influence and manage the development of their urban space (Arnstein, 1969).

#### *Operationalization of the research question*

The research question is operationalized through 3 sub-questions, which are answered throughout the paper:

- What is the current situation of public participation in urban planning?
- What are the main barriers to public participation in government initiatives?
- What are the main barriers to public participation in bottom-up/independent initiatives?

*Data collection*

*Literature review*

The literature review in this paper summarizes and organizes the existing academic knowledge and background around public participation (Rowley & Slack, 2004). The literature review initially focuses on establishing the academic necessity of considering public participation in planning (Rowley & Slack, 2004). Furthermore, the review is used to contextualize current research and to summarize previous papers around barriers to public participation in urban planning (Knopf, 2006). Altogether, the literature review works not only to further contextualize the research but also to provide a summary of prior findings (Knopf, 2006; Rowley & Slack, 2004).

To conduct the review some central search strings were established. These strings included terms such as barriers, public participation, urban planning, urban development, SIS etc. The different terms were combined in various ways and put into search engines, such as Google Scholar, and WorldCat, among others. For the articles found, title and abstract were scanned for relevance. To widen the scope of papers, the ‘cited by’ and ‘cited papers’ functions were used to find other relevant papers, leading to a snowball sampling technique.

*Interviews*

Interviews were chosen because they allow a more flexible

and personal approach to creating knowledge. Interviews allow for a direct interaction and thus insight into a person’s experiences and opinions, as well as expertise and knowledge that may be localized and specific (Legard et al., 2003). The interviews were semi-structured to allow for a clear direction in the conversation, while providing necessary flexibility to account for new insights and ideas (Legard et al., 2003).

Relevant participants were identified through internet searches, conversations with stakeholders, and through snowball sampling, where previous interview subjects were asked for recommendations. Consent was established through e-mails in advance and by signing a consent form prior to the interview. Interviews ranged from 30-90 minutes.

The interviews cover questions around personal/ organization background, the current landscape of participation in Aruba, both top-down and bottom-up, and what barriers respondents experience, both top-down and bottom-up.

Interviews with government officials were conducted to provide a clearer picture of what official processes are in place in current planning approaches. Interviews with organizations and people provided a bottom-up perspective on planning, since they may be aware of possibilities to participate in government forums, while being connected to the community and their perspective.

Type of interview	Sample
Government	Robert Maduro (DIP)
Organizations	Daniel B. Tecklenborg (CEDE Aruba) Clifford Rosa (Stichting Rancho) Charleson Oduber & Fahrina Mattheeuw (FCCA) Anne E. Witsenburg (Monuments Fund) Armand Hessels (Deugdelijk Bestuur Aruba)
Experts	Thais G. Franken (Lecturer University of Aruba)

### *Survey*

A survey was utilized because it provides an opportunity to reach a larger segment of society, while accommodating both quantitative and qualitative data to understand the importance of different barriers in urban planning on Aruba.

A survey also addresses the language barrier, since the official languages in Aruba are Papiamentu and Dutch (Dijkhoff & Pereira, 2010). However, interviews could only be conducted in English. By translating the survey to Papiamentu, a broader set of people may be able to respond. Furthermore, surveys often have a lower time investment than interviews (Fricker & Schonlau, 2002). Consequently, a larger segment of the population may be able to respond to the survey, rather than interviews.

The survey uses the secure and easy-to-use software Qualtrics. The survey initially asks for basic demographics, and then moves on to establish the current landscape of participation, with a set of statements evaluated through a Likert scale. It later addresses barriers through multiple-choice questions.

The survey was distributed through social media by Stichting Rancho and their network, and directly with some local Arubans.

The survey has received 30 responses to date, of which 53% were male and 47% female. Sixty percent of the respondents were over 50, and the remainder ranged from 30-50 years old. Overall, the sample was quite evenly distributed across different urban areas in Aruba, and most had stayed in their neighborhood for more than 10 years. Most respondents (50%) live with their partner and children, 25% live alone, and another 25 with their partner.

### *Data Analysis*

To analyze the interviews a discourse analysis for both patterns

and information was conducted (Whiting, 2008). Initially themes extrapolated from the literature review, covering different barriers, were applied to the interviews to see how these barriers appear in the different interviews. Furthermore, the information from the interviews was also used to inform the context of the paper. Overall, the interviews were analyzed for patterns around public participation and participatory barriers to create an indication of Aruba's participation landscape and common barriers in urban planning.

Analysis of the survey was a predominantly quantitative analysis of the multiple-choice questions. The multiple-choice questions were used to indicate trends in society for the current level of participation and what barriers to participation are more relevant.

Overall, the output of this analysis resulted in a system map that indicates different barriers to public participation in Aruba. A system map creates a visualization of different factors that create the system, and how the interaction of these different elements influence the system.

## **Literature review**

### *The need for public participation*

Currently, public participation is a prominent buzzword in urban planning discourse (Aleshire, 1970). Thus, it is central to understand why public participation is such a prominent concept in urban planning.

Primarily, a shift in the goals of urban planning in the 60/70s outlined accommodating the community as a core goal, which generated a need for local knowledge. Davidoff (1965) argued that the purpose of urban planning is to provide cities that can accommodate citizen's needs and support the community. He further argued that the local communities possess the most contextually relevant knowledge, thus requiring public participation for good urban planning (Davidoff, 1965).

Furthermore, public participation is central to permit fair and just decision making processes, as argued by Sen (Basta, 2015). In Sen's philosophy, fairness is not about providing everyone with a universal good, but rather about providing universal access to goods. Consequently, a decision should be adapted to the specific context to become fair (Basta, 2015). This context can only be identified through engaging with and consulting the community (Basta, 2015; Campbell, 2006).

Lastly, beyond the planning field, the political democratic model that most countries abide by, innately requires participation as part of the system. A democracy as a fundamental trait acknowledges the sovereignty of their population (Hofmann et al., 2020). By acknowledging this sovereignty of citizens, this system promotes public participation as a pillar necessary in public arenas for a democratic society (Hofmann et al. 2020).

Consequently, there are several reasons that understanding and introducing public participation in planning is essential. The most prominent reasons are the goals of planning theory, for fair decisions and the democratic political system.

#### *The benefits of public participation*

While necessary, public participation also provides a variety of benefits. These benefits further acknowledge the importance of focusing on public participation as a central component of urban planning.

First, including the community enables better planning processes. Participation facilitates the implementation of the final outcomes because the communities were involved and have a better understanding of their impact (Damer & Hague, 1971). Furthermore, including the community in the planning process also improves the communication culture in planning practices (Aleshire, 1970).

Furthermore, participation can also improve the final product of the planning process. When local populations are asked to participate, otherwise neglected issues such as sustainability are more likely to be raised (Amado et al., 2010). Public participation may also provide more innovative solutions (Fagence, 1977). Furthermore, the use of local specific knowledge makes the solutions better adapted and integrated in the local context and therefore more robust (Fagence, 2014).

Lastly, participation also benefits the community it is conducted in. Primarily, participation can foster more resilient communities (Aleshire, 1970). Participation can also increase local agency and power by mobilizing the community (Laskey & Nicholls, 2019). Thus, it may lower the threshold of future participation (Aleshire, 1970).

To conclude, previous research and literature confirm that participation can offer a variety of benefits to the planning process itself, the solution generated and the community itself.

#### *Common barriers to public participation in urban planning*

To create a framework and foundation which can guide the research, this section of the literature review elaborates on common barriers to public participation in urban planning identified in prior research. The barriers identified have been sorted into 3 main categories for clarity. These are universal, top-down and bottom-up barriers.

#### *Universal barriers*

Universal barriers encompass barriers that affect participation regardless of context. These barriers include the characteristics of the participants themselves and resources (money, knowledge and time).



Participant characteristics are central in limiting participation regardless of context, since participation always depends on the public. A prominent barrier for participation is a lack of identification with the place by the public (Arnstein, 1969; Liu et al., 2018; Macnaghten & Jacobs, 1997; Quayle, 1995). Research shows that an increased level of attachment often leads to a higher level of participation (Jordaan, 2015). Moreover, the cultural context and social structure surrounding participants also influences the extent to which they participate (Hilbrandt, 2017). For example, a hierarchical social structure often enforces a lack of trust between citizens and authority figures, which reduces people's willingness to participate (Williams, 2020). Lastly, since public participation is a relatively time intensive process, personal demographics, which influence available time/freetime, can be prominent barriers to participation (Bedford et al., 2002; Innes & Booher, 2004; Liu et al., 2018).

Another limitation of participation regardless of context is limited resources and knowledge (Laurian & Shaw, 2009; Liu et al., 2018). Participation is a resource intensive process that requires extensive time and knowledge from planners as well as the community. Furthermore, it also requires extensive monetary resources to maintain in the long run (Bobbio, 2019). Thus, in a low resource context, resources may be a prominent barrier for both top-down and bottom-up processes.

### *Top-down barriers*

Some barriers identified in literature are specific to top-down initiatives in planning. The 4 main categories identified for top-down barriers are: forum characteristics, processes of participation, relation between government and citizens and information flows.

Characteristics of the participation forums themselves can be a central barrier. Academics often argue that even if

forums for participation are in place, these will not foster accurate representation (Arnstein, 1969; Bedford et al., 2002; Cupps, 1977; Laurian & Shaw, 2009; Liu et al., 2018). Often, people attending will represent extreme opinions and not the middle ground, thus limiting possibilities for gaining an accurate image of the public opinion (Innes & Booher, 2004; Laurian & Shaw, 2009).

On the other hand, the process of participation can also limit communities' ability to speak up. Lack of flexibility through the participation process prevents new stakeholders and ideas from being included (Innes & Booher, 2010; Liu et al., 2018). Similarly, lack of accountability may limit people's willingness to engage (Innes & Booher, 2000, 2010; Laurian & Shaw, 2009). Lastly, the point at which participants are involved in the planning processes may also matter (Kahila-Tani et al., 2016). If they are only involved in the end stages of the development process, the participation has less impact.

Another common barrier focuses on the relationships between government and citizens. Mistrust in the government by citizens is a prominent barrier for public participation (Arnstein, 1969; Innes & Booher, 2010; Laurian & Shaw, 2009). Even if forums are present, if the participating population does not trust the current government to implement the solution, they will not participate.

One last and central barrier to participation is information disclosure. Primarily the lack of information provided by governments prevents the public from being aware of different issues (Gordon et al., 2011; Innes & Booher, 2004; Laurian & Shaw, 2009; Liu et al., 2018; Quayle, 1995). Another issue is unilateral information flows either to or from the participants. This prevents bilateral communication streams from forming, which are central for genuine participation (Arnstein, 1969; Innes & Booher, 2004a; Laurian & Shaw, 2009; Liu et al., 2018).

*Bottom-up barriers*

Bottom-up initiatives experience several barriers that differ from top-down initiatives. For bottom-up initiatives, legalities, mobilization, integration with the government and open data are prominent barriers to participation.

One prominent issue of bottom-up initiatives is legalities (Innes & Booher, 2000, 2004; Laskey & Nicholls, 2019). Urban landscapes and especially the alteration thereof often comes with an extensive set of regulations of what is permitted and what is prohibited (Laskey & Nicholls, 2019). Thus, navigating how to initiate change while still being in line with governments is a central barrier.

Furthermore, bottom-up initiatives often require a certain level of mobilization and support within the community, more so than top-down planning (Laskey & Nicholls, 2019). Thus, cohesion within the neighborhood and knowledge around mobilization may be central barriers to public participation (Laskey & Nicholls, 2019).

Integrating with government initiatives is also a central issue experienced by bottom-up initiatives and often a vital component in making these initiatives long-lasting and healthy (Simonsen et al., n.d.).

Lastly, a prominent barrier for bottom-up initiatives is the lack of public data (Conradie & Choenni, 2014). Open data opens a breeding ground for ideas, transparency, and innovation. Lack of data thus provides a barrier for spontaneous participation.

## **Results**

### *Landscape of public participation in Aruba*

Considering the interviews and survey, two main dimensions of the current situation of public participation in urban development in Aruba become apparent. One

part of the development originates in governments, while another is initiated by organizations and thus is more bottom-up.

### *Participation in government initiatives*

The current situation of public participation in government initiatives was presented through an interview with Robert Maduro from the DIP. This interview clearly presents that the ROPV is currently used as the fundamental framework to guide decision-making processes and planning projects (Robert Maduro, personal communication, 2022).

When considering public participation, the ROPV together with the LRO (Landsverordening Ruimtelijke Ontwikkeling), a legislative framework, presents a clear legal requirement to public participation in urban planning in Aruba (Robert Maduro, personal communication, 2022). When considering legislation, the LRO stipulates exact participatory guidelines for the public under the ROPV (Centraal Wettenregister, 2013). Articles six and seven define that the information around urban development plans needs to be available to everyone and plans must be submitted to all Dutch and Papiamento newspapers (Centraal Wettenregister, 2013). After informing the public, the public has one month to submit a written opinion challenging the plan. The more people sign, the more weight the challenge carries. After the submission, the minister has three months to decide on the complaint. While this document outlines a clear opportunity for public participation, the final decision-making power is given to the minister of planning.

The implementation of this legislative framework is initially confirmed by the DIP (Robert Maduro, personal communication, 2022). The DIP continuously publishes “Verkavelingsplannen” about new development on

their website and in newspapers in line with ROPV guidelines. Furthermore, while developing the ROP and ROPV, public forums were held in several communities throughout the island for both information and feedback (Robert Maduro, personal communication, 2022). However, while these pathways of feedback and information communication are upheld, these initiatives seem not to encourage co-creation. This is supported by the survey, where 80% of respondents indicated that they feel their feedback is not integrated in the final solution, and 52% feel like they cannot hold the government accountable.

Based on data in this paper, the previously outlined government framework for participation is not necessarily reflected in the perception of participation in official urban planning by NGOs and local communities. In the interview with Thaïs G. Franken (personal communication, 2022) she mentioned that while the channels may exist, few people know about them. This is further supported by Clifford Rosa who mentions that while there are forums, they are mostly informational (personal communication, 2022). Similarly, when looking into the survey, 80% of respondents feel they receive no information about urban planning, and only 15% feel they can gain additional information online. Thus, these responses illustrate that the participatory government framework may not trickle down to the local population.

#### *Participation in bottom-up initiatives*

When considering bottom-up planning, the results suggest that participation happens both through private stakeholders such as NGOs and directly by the community. These initiatives take the form of both physical development through purchasing property and non-physical initiatives.

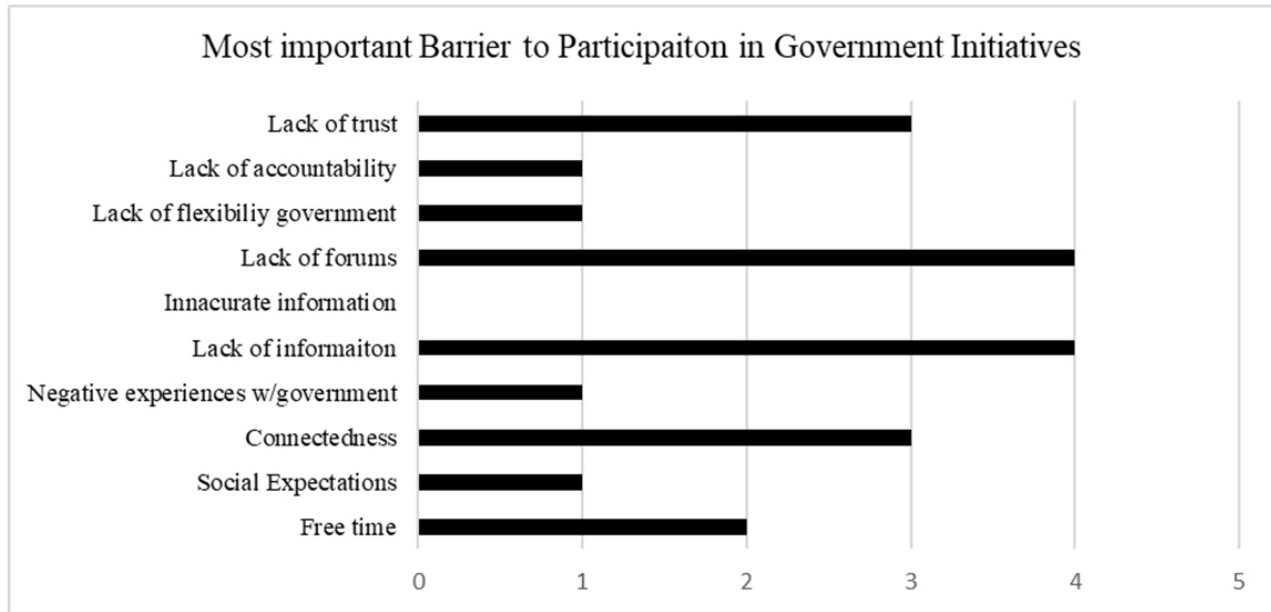
From the interviews it seems that many foundations involved

in urban planning in Aruba do this outside the government, by buying property and creating their own development. For example, the Monuments Fund buys buildings to renovate (Anne E. Witsenburg, personal communication, 2022). When renovating the building they actively include the community, both through targeted interviews and open forums within the community. Similarly, FCCA develops social housing by purchasing their own property (Charleson Oduber, personal communication, 2022). They attempt to engage the public in their projects through a combination of social media, social events, and official requests. In recent years, they have also focused more on asking the local population what they would want to see in their neighborhoods (Fahrina Mattheeuw, personal communication, 2022).

A different aspect of public participation was highlighted through the survey and CEDE Aruba. CEDE Aruba previously worked on establishing community centers and now focuses on building capacity in these and map community needs, with the end goal of creating capacity in the neighborhood to initiate their own planning and lobby for their own needs (Daniel B. Tecklenborg, personal communication, 2022). While this may still be a work in progress, the survey implies that some initiatives like these already exist. Participants mention a few initiatives such as community gardens and clean-ups, though most respondents do not see any community initiatives at all.

#### *Main barriers to participation in government initiatives in Aruba*

The results from interviews and the survey indicate 4 main potential barriers to public participation: cultural background and values, lack of information, government and citizen relations, and number and type of forums. While other barriers are also mentioned, these seem most prominent.



*Figure 1: Most important barriers to public participation perceived in government planning, based on survey responses*

Community structures such as cultural values, cohesion and connectedness were mentioned in several interviews, as well as the survey, as significant limitations to public participation. This barrier was mentioned by Armand Hessels (personal communication, 2022). He revealed that in his experience there is no culture for supporting organizations and participating in foundations in Aruba. Considering the interview with Anne E. Witsenburg

(personal communication, 2022), this barrier may be reinforced by the somewhat hierarchical social structures in Aruba. Furthermore, Thaïs G. Franken mentioned that Aruban children are often raised to respect authority, which may also explain the cultural context (personal communication, 2022). Similarly, in the survey three participants considered connectedness in the community as the most important barrier to participation (Figure 1). This low level of connectedness could relate back to the authoritative parenting, which may split the older and younger generations (Thaïs G. Franken, personal communication, 2022). Thus, the responses suggest cultural

values in Aruba are a barrier to participation, and these may be reinforced by the hierarchical community structure and low connectedness.

Another barrier prominently indicated in the survey and also confirmed in the interviews is information flow. In the survey, four respondents cited information as their most important barrier (Figure 1). This is confirmed in interviews, which indicated that many communities do not know what the current process of participation is due to lack of information (Thaïs G. Franken, personal communication, 2022). While the DIP publishes their information in newspapers and on their website, these channels may exclude younger demographics and prevent the information from reaching the local population (Thaïs G. Franken, personal communication, 2022). Furthermore, Clifford Rosa suggests that many participation forums are predominantly informative, thus predominantly creating unilateral information streams (personal communication, 2022). Consequently, the results imply that current information structures may limit the populations' ability to participate in urban planning, due to mostly unilateral information streams and limited information channels.

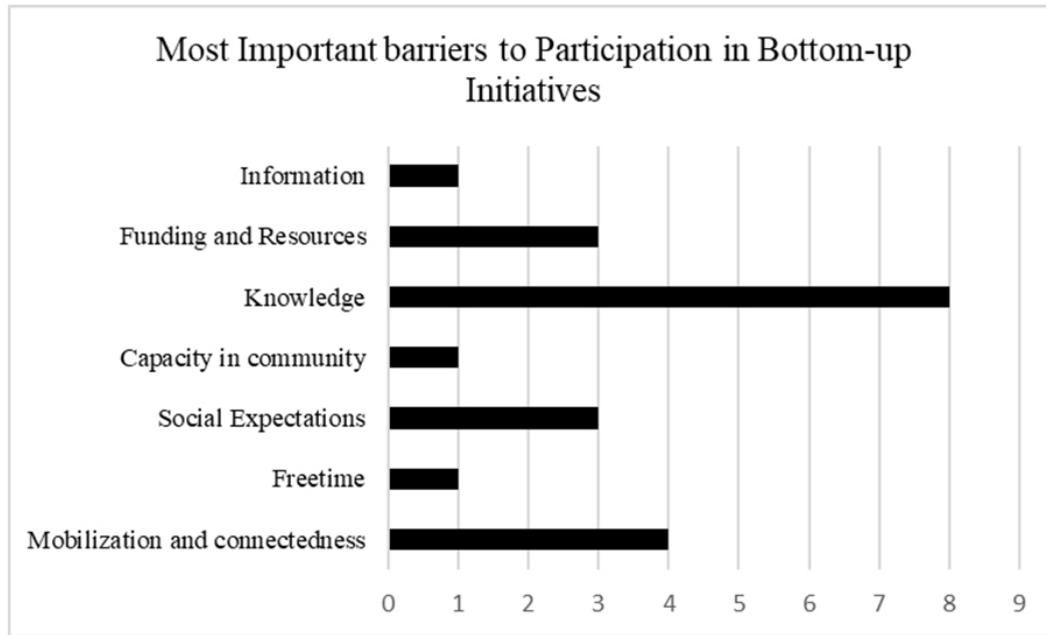
Another issue illustrated both in the survey and interviews is the lack of trust between governments and the local population. When looking at the survey, mistrust is mentioned as the most important barrier by three participants (Figure 1). Anne E. Witsenburg highlighted an example from the Monuments Fund, when they were trying to contact a new property owner (personal communication, 2022). Connecting with this owner proved difficult and at some point a member of the government initiated a connection. This introduction of the government broke off the contact with this property owner for a significant period afterwards. This example may indicate some mistrust from the local population, when the government becomes associated with a project. One component of this mistrust

may be the discontinuation of projects between different government periods, which creates a lack of consistency (Charleson Oduber, personal communication, 2022). Armand Hessels also suggests that local experience reflects that speaking out against the government can negatively impact someone's situation e.g., permits taking longer to be approved (personal communication, 2022). Overall, interviews and the survey indicate a tentative mistrust between the local population and government, which may be perpetuated by differential treatment and discontinuing established projects.

Lastly, lack of forums is mentioned both in interviews and the survey as a prominent barrier. In the survey, four participants highlighted lack of forums as their most important barrier for participation. Currently, the only constant pathway to participate in urban planning is by submitting a signed letter to the DIP (Robert Maduro, personal communication, 2022). However, as mentioned by Thaïs G. Franken, many people do not know about this pathway of participation (personal communication, 2022). Lastly, the interview highlighted that current pathways of participation predominantly focus on informing or receiving feedback over co-creation (Robert Maduro, personal communication, 2022). Consequently, the responses indicated lack of forums as an important barrier, which may be reinforced by the focus on information and receiving feedback over co-creation in current forums, and the lack of awareness of available forums by the public.

#### *Main barriers to participation in bottom-up initiatives in Aruba*

When considering responses to bottom-up initiatives, participants indicated the following as central barriers: knowledge (including capacity and information) within the community, legalities in relation to the government, resources and funding and community characteristics.



*Figure 2: Most important barriers for participation in bottom-up planning, based on the survey*

One prominent barrier highlighted in interviews and surveys is the issue of knowledge around urban planning. In the survey, eight participants considered knowledge the most important barrier (Figure 2). This overall lack of knowledge and capacity within the local population is also recognized by Daniel B. Tecklenborg (personal communication, 2022). He mentions that currently communities may not have the means to advocate for and identify their own needs. This may partly be an issue

of lack of open data. For example, the Monuments Funds has been unable to gain insight into a government's list of privately owned monuments, which would facilitate their work (Anne E. Witsenburg , personal communication, 2022). Similarly, there is a continuous lack of transparency of data from government reports (Armand Hessels, personal communication, 2022). Consequently, lack of knowledge is illustrated as an important barrier, which may also be attributed to lack of open data and community capacity.

Another limitation for bottom-up initiatives suggested

through interviews is legalities. When considering the urban planning context of Aruba, private development permits and permissions are issued by the DIP (Robert Maduro, personal communication, 2022). Interviews mention that these processes are slow and complicated, which can limit development opportunities (Anne E. Witsenburg, personal communication, 2022). For example, when the Monuments Fund tried to acquire the permission to use a plot behind one of their monuments as a parking lot, it took over a year to get the permit (Anne E. Witsenburg, personal communication, 2022). Thus, the interviews indicate that bottom-up initiatives may still be limited by the bureaucracies of the government.

Responses also indicate funding as a prominent barrier to bottom-up planning. In the survey three respondents considered funding the most important barrier (Figure 2). Interviews elaborate that finding continuous streams of funding, rather than project-based funding, is difficult and reduces the capacity building possibilities of the community (Daniel B. Tecklenborg, personal communication, 2022). Consequently, current responses highlight funding as a barrier for bottom-up urban planning, which may be attributed to the tendency toward project-based rather than continuous funding.

Lastly, for bottom-up barriers, the community structure including factors such as connectedness and social expectations, is cited as a barrier to participation. Four participants in the survey mentioned connectedness, and three listed social expectations as the most important barrier (Figure 2). These barriers are also seen by the FCCA in their planning practices (Fahrina Mattheeuw, personal communication, 2022). They mentioned that one reason people did not want to participate is that they want to maintain their privacy, a tendency seen more in old than new residents. Thus, community structure is presented as an indicative barrier to public participation, perhaps reinforced by a desire to maintain privacy.

## Discussion and Conclusion

### *Discussion of results*

#### *Situation of public participation in urban planning*

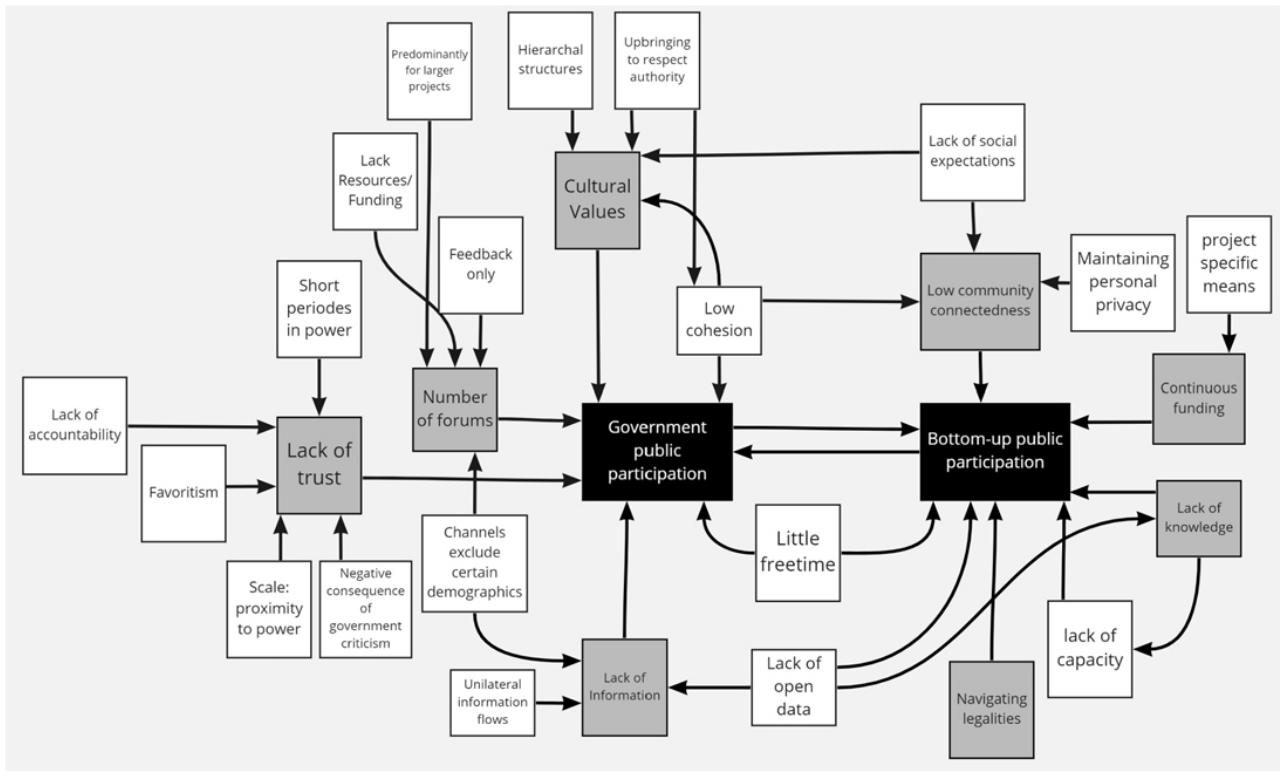
When considering the current situation of urban planning, it overlaps with what was hypothesized as well as with current global trends extrapolated from literature. When using the framework of Arnstein (1969) as a guide, the current preliminary results place Aruban urban planning within the realm of token participation. When considering Arnstein's definition of tokenism one can see that the Aruban government predominantly has unilateral streams of information about urban projects and development. This falls within the rung of information presented by Arnstein. Furthermore, current forums for participation mostly conform to consultation. Thus, while feedback is requested, it is largely requested on already existing plans and without an accountability process. Furthermore, Aruban urban planning is also situated within the element of placation, since while opportunity is given to the community to express disagreement, the final decision is awarded to the minister. Consequently, when using Arnstein's (1969) ladder of participation, current government initiatives in Aruba seem to fall under token participation. This aligns with the literature on public participation, which confirms that implementation of public participation lags behind globally, and many governments deal with issues of token participation (Kahila-Tani et al., 2016).

Some exceptions in Aruba can be seen when considering bottom-up planning initiatives through organizations. Many of these initiatives also predominantly consult with the local populations on existing plans, leading to token participation. However, some focus on increasingly shifting power and creating capacity for the community to lobby for and create their own projects. These initiatives would shift some power to the communities and thus move the participatory planning landscape towards citizen control and out of token

participation. However, these types of projects seem rare and for now not continuous, leaving token participation as the dominant system of urban planning in Aruba.

*Situation of main barriers to public participation in urban planning*

When considering the results, they largely overlap with the hypothesis. Consequently, the barriers mentioned in Aruba are mostly reflected in those extrapolated from the literature review. However, as hypothesized, the barriers highlighted as important in Aruba differ somewhat from other contexts (Brownill & Parker, 2010).



*Figure 3: A system map summarizing the results based on the survey responses and interviews*



The system map in Figure 3 provides a visual overview of barriers relevant to the Aruban context, but moreover it describes the connection between the different barriers. The black boxes reflect the core elements which this paper is focused on understanding, the grey boxes are the barriers which have been indicated as most prominent based on the survey and interviews, and the white boxes are other elements that have been identified to influence the main barriers, based on the interviews. The arrows describe, in a simplified manner, the direction of influence of the barriers. The results show that barriers to participation in urban planning have to be understood as an interlinked network. Specific barriers may be perceived as more prominent by organizations and the public, but these barriers are still interacting with and being influenced by other components.

It follows from the above that, when considering barriers to participation in Aruba, one has to acknowledge the other elements which influence the highlighted barriers for a holistic understanding of what limits public participation. For example, in government initiatives, when considering lack of trust as a barrier, it may appear as quite intangible and hard to address. However, when considering background elements such as lack of accountability to the public or favoritism by the government, the barrier becomes multifaceted and more concrete. Similarly, in bottom-up initiatives, when considering funding as a barrier, it is important to understand that the barrier may be perpetuated by funding being project-specific. Thus simply increasing funding opportunities may not change the participation landscape.

Overall, both the literature and Aruba's context acknowledge participation as a network of barriers which continuously interact and influence each other (Innes & Booher, 2004). Thus, focusing on barriers in isolation may neglect the bigger picture and reduce the effectiveness of any intervention addressing public participation in urban planning.

### *Implications*

The results indicate that the prominent barriers to public participation in Aruba may differ from other contexts. A natural conclusion may be that Aruba's urban planning could benefit from reconsidering participatory structures beyond the dominant framework. Consequently, it could be interesting to focus more on planning initiatives outside the government. These notions of planning largely originate from non-western context and thus could provide a new perspective (Miraftab, 2017).

Furthermore, the interconnectedness of barriers indicated in the results may suggest that a future intervention and participation structure should attempt to address multiple barriers and stakeholders at the same time. This would allow for a larger shift in the planning landscape, as well as promoting lasting change.

Consequently, a starting point to change participation in urban planning in Aruba might be empowering community centers and collaborating with civic organizations. By creating continuous funding for these community centers, one could also support capacity building in the adjacent communities. Moreover, these community centers are separate from the government, thus they may bridge the issue of mistrust in government. Furthermore, they can link the government and community, by passing on government information and lobby community needs to the government, creating bilateral streams of information.

Focusing on community centers would move away from government-centered planning structures. Moreover, it would address a multitude of barriers at the same time and could have a positive impact on both bottom-up and top-down urban planning initiatives in Aruba.

### *Limitations*

One prominent limitation of the study is the sample of the survey and the interviews. While the interviews still cover a broad set of organizations in and out of urban planning, the survey only had 30 responses. While this may be able to show an indication in landscape, it can by no means be used to generalize or draw any broader conclusions on the Aruban context. Thus, sample size is one of the largest and most prominent limitations of this paper, and any results and conclusions drawn from the data need to be considered in light of this.

Another limitation is that Aruba has two official languages (Papiamentu and Dutch), neither spoken by the researcher. This limited communication and connection between the researcher and the local population. It further limited the interview sample to English speakers. Additionally, the distance between the researchers and the Aruban culture may have limited the connection between the researcher and the context (as suggested by Farahani, 2010).

Lastly, the framework, ladder of participation (Arnstein, 1969), is quite old and has experienced some criticism. For one, the framework makes a clean split between people in power and people without power (Maier, 2001). Furthermore, the model splits the various levels of participation into eight categories; however in reality there are many more levels of participation (Maier, 2001).

#### *Future research*

There is much future research needed to draw broader conclusions on the Aruban situation of urban planning, and how to move forward.

Primarily, it would be interesting to conduct research which focuses more prominently on the community and their needs and wants. This would require a larger focus on interviews and a survey with significantly more responses to provide an on-the-ground perspective. Conducting such research may

provide a clearer picture of how the community interacts with and understands participation in urban planning. This may be central, since public participation, while involving several stakeholders, primarily relies on the community to become active and interested.

Furthermore, it would be interesting to study how the increased push towards smart cities globally is mirrored in Aruban participation. To what extent are digital tools used and how do they impact the situation? This may be important, since digital participation has become increasingly popular due to its user friendliness and time efficient characteristics. Consequently, such tools may also be of benefit in Aruba.

#### *Conclusion*

Overall, it is clear that participation in urban planning in Aruba is maintained and limited by a multitude of barriers. Thus, increasing participation in Aruba's urban planning cannot be done through one intervention or by one stakeholder. While the government may play a key role in affording more freedom and funding, NGOs and foundations may be central in creating capacity within the community and supporting the population in finding their own way to participate in urban planning. Consequently, participation in urban planning in Aruba is a complex issue and needs to be addressed as such to afford genuine change.

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## Food for Thought

When I decided to go to Aruba, hitchhiking on the back of a motorcycle with friendly bikers from Curaçao was not the image I had in mind. But... “islands just do something to you.” This island in particular makes you trust in the possibility of the help and friendship of strangers, including those strangers who travelled with me from Utrecht, and quickly became friends. The beautiful memories we now share, including swimming with turtle families at Tres Trapi, regular visits to an unopened pool bar in Rancho, cracking open a coconut washed up on an empty beach, dancing at carnival, and Tuesday dinners at Zeerovers, are too many for me to pick a favorite. An instant addiction to beach tennis will be the one directly taken back to Utrecht though, as Lynn and I made a promise to buy a set with our tournament winnings. I think Jocelyn read me incredible well when she recommended the program to me already in my first week at UCU.

Of course, the experience hasn't been all Balashi and sunset swims, but with a topic like food, I've been constantly reminded of how personally relevant the research we do is to the people we meet who help us understand Aruba and guide the questions we ask. My topic originated from conversations with alumni of the program, leading to the choice of a strange concept of 'food sovereignty,' to the confusion of my supervisor and everyone I mentioned the term to. The amount of passion I've encountered on the subject, from researchers and everyday encounters alike, has pushed me throughout our weeks here, and will continue to drive my research as I keep working.

I've been extremely lucky to have the help and advice of a few people in particular. A special thanks to Jocelyn, Eric and Carlos for guiding us throughout the experience, showing us the best meals, and introducing us not only to a beautiful island but all the people who

were invaluable to our research. Thank you to Amber for, from our first introduction onwards, continuing to make introductions, giving advice, and inviting me to meetings. Thank you also to Gregory, for meeting with me every few weeks as I had incessant ideas and questions, and somehow not tiring of it, despite having an insane amount of jobs and projects to combine already. Thank you to Daphney, for despite already having a research partner, also helping me to translate my survey on top of that. Thank you to Ginelly and Clifford from Stichting Rancho for welcoming me into your space, including me in all you do, and showing me the incredible effort you put in to support your community. Finally, thank you to the whole UAUCU group. I've loved the experiences, both confronting and impactful as well as lighthearted and fun, that we've all shared.

This island will be a difficult one to say goodbye to, but I think it'll be an 'until next time,' after the community we've found here. This place has given me inspiration not only for cocktail recipes to bring back to the UCU bar, but also for my future, since, in the most direct way, I've received more life and career advice here, including from strangers, than ever before.



# **‘If the Ship Stops Sailing’: How can food sovereignty in Aruba be protected in public policy and developed as a notion in international human rights law?**

Karlijn van der Loo

## **Introduction**

The COVID-19 pandemic in 2020 brought the issue of dependency on food importation to the forefront in Aruba. This called for the development of a new conceptualization of the right to food which could better protect against exogenous shocks. The new focus thus became the development of self-subsistence, central to the notion of food sovereignty. Food sovereignty remains a complicated and expansive idea, which has yet to establish political and legal clarity for its implementation.

Initially, a literature-based discussion of food sovereignty goes stepwise through the definition of food security, various criticisms of this approach, the emergence of food sovereignty, and unpacks criticisms, regional differences, and the operationalization of food sovereignty. This is a process which seeks to clarify and consolidate the many different approaches to food sovereignty. Ultimately, the notion is too broad to encompass everything in the operationalized approach in Aruba. Therefore, contextual information on the Caribbean, Latin America, CARICOM, and the Kingdom of the Netherlands informs what is deemed most relevant for Aruba.

Through interviews with stakeholders in agriculture, researchers, NGOs, and community gardening, food

needs on the island are mapped out beyond the basics encapsulated in food security. Particular themes emerge from these interviews and guide the focus of surveys and the review of a data collection method of the Department of Agriculture, Livestock, and Fishery (Santa Rosa). These themes include collaboration, sharing of knowledge, and democratic control.

Based on information gathered from field research in Aruba and an analysis of the policy level of implementing food sovereignty, the research will examine if and how food sovereignty rights could be derived from international human rights law.

## **Methods**

As a starting point for application of food sovereignty to Aruba, an understanding of the notion of food sovereignty is essential. Food sovereignty can be seen as more of a political movement than an operationalized approach to policy or law. Therefore, it must be operationalized in order to evaluate the possibilities for its application in Aruba and international human rights law.

The field research is done from a community-based (CBR) approach. CBR was chosen for the purpose of conducting research useful to the community, and in line with the

principles of food sovereignty itself. The food sovereignty movement aims to put the community at the center of food policy, while taking into account existing power inequalities.

Interviews were conducted with stakeholders in commercial local agriculture, animal husbandry, the SDG commission, Santa Rosa, foreign affairs, NGOs, hotels, researchers, and experts in law. The individual participants were purposively selected based on their positions and experiences and subsequently snowball sampling was used to increase sample size and contact participants who were otherwise not reachable. Interviews were conducted in a semi-structured manner, with questions guiding participants towards the targeted themes of food sovereignty, but allowing significant space for respondents to interpret the questions and elaborate as they wished. Additional informal meetings such as attendance to brainstorming sessions for fund applications with researchers and NGOs guide the understanding of relations between interviewees and the questions asked during interviews.

Two surveys were created, targeting different populations relevant to food sovereignty. The first, designed in collaboration with Alejandra Moreno Ramirez, inquired into food access, preferences, production, COVID-19 impact, and opinions on the import-local balance. This survey was distributed to general households in Aruba. The second survey targeted parts of the population interested in the production and/or consumption of locally produced food. Questions focused on the reasons behind choosing for locally-produced food, for growing it, and on support from the government. This survey was distributed in a more targeted manner through a WhatsApp group and Facebook groups for the buying and selling of locally-produced food.

The final intended field research component is review of Santa Rosa's efforts to encourage data collection and with interview and survey results, the recommendation of further

possibilities. This intends to target obstacles to registration at Santa Rosa and the sharing of data on local production. By exploring the obstacles and possible incentives, the goal is to uncover the reasons behind a lack of communication and collaboration, and work on developing an improved method.

The legal component of the research will first lay out the international legal responsibilities of Aruba and the Kingdom of the Netherlands in order to see where the various responsibilities of different parties would lie for rights which have been expressed to be necessary from the community's needs. International treaties and case law will be examined to uncover where human rights related to food sovereignty could be derived from international law.

## **Food Sovereignty**

### **Introduction**

In order to operationalize food sovereignty in Aruba, the notion must be unpacked and funneled down into a usable, concrete definition which can be clearly tied to various existing human rights in international law. The emergence of the notion of 'food sovereignty' is attributed to the failure of the present global food system based around the neoliberal, free-trade focused conceptualization of 'food security.' Food sovereignty problematizes this system and provides a critique as well as an alternative which encompasses a variety of human rights based approaches to the right to food production, consumption, and distribution. The notion comes down to self-determination, or rather, sovereignty, taking control away from large corporations and exploitative international trading structures.

### **Food Security: Definition and Criticisms**

The definition of food security, as the concept under critique by the food sovereignty movement, lays the foundation for

understanding its critical responses. The FAO provides the following, commonly accepted definition.

“Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life.”

(*Food Security*, 2006)

The evolution of the definition to include nutritional value, safety, and food preferences was partially precipitated by La Via Campesina (LVC) through their participation in the creation of the UN World Food Summit definition of 1996 (Patel, 2009). The four main dimensions are: physical availability, economic and physical access, food utilization, and stability of the first three elements (*Food Security*, 2006). Further explanation of these dimensions does justice to the components included. Physical availability concerns the supply of a sufficient amount of food production, stock, and trade (*An Introduction to the Basic Concepts of Food Security*, 2008). Economic and physical access looks to households in relation to their income, spending, and market prices. Utilization entails nutritional value of food, its preparation, diversity of the diet, and intra-household distribution. Finally, stability is an issue of consistency over time. Food security can only exist when external shocks cannot cause periodic lapses in access to food.

The critiques of food security precipitated the emergence of the food sovereignty movement. The first main critique concerns an economic argument against global capitalism and the inclusion of food in neoliberal free trade (*Nyéléni 2007 Forum for Food Sovereignty*, 2007). Neoliberal theory is based on comparative advantage and assumptions of perfect competition and maximization of self-interest, theoretical concepts which may not consider the many imperfections in the market. Food supply chains are said to have lengthened as a result of this internationalized system, creating significant distance between producers and

consumers. It additionally presumes that economic growth is the best indicator for ending poverty and food insecurity. The neoliberal international system consists of various international policies under the guidance of the WTO and backed by the UN and FAO such as the ‘Agreement on Agriculture,’ and allows significant power to be held in the hands of monopolizing transnational agribusiness corporations. Unequal trade rules such as export subsidies and limits on domestic support have resulted in what McMichael (2014) calls ‘value-chains’ which creates a particularly competitive market where producers have little to no control. This results in dispossession of both land and landed knowledge as well as debt risks where funds from the global north which intend to serve as international development aid result in significant control over smallholders. Ultimately it displaces such producers through land grabbing and the dumping of cheap imports.

The international system based on food security additionally leaves out considerations of the environmental impact of food production, distribution (transportation) and consumption. Lee (2007) explains the distinction made between food security as an ‘economic rationalist discourse,’ and food sovereignty as a ‘green rationalist discourse.’ The ways in which the food consumed is grown, considering the use of pesticides and growth of GMOs, as well as transportation by land, water, and air internationally should be taken into account.

An additional critique of the food security based international system looks at the human aspect of how it leaves out social inequalities and exclusionary practices. Such rights focus particularly on women, indigenous people, and peasants (*Food Security vs Food Sovereignty: What’s the Difference?*, 2021). The modern food system is seen by some (Murdock & Noll, 2015) as being the cause of food insecurity, social exclusion, malnutrition, and deepening poverty. Given the argument by Patel (2009) that the food security definition and framework was developed in the context of ‘watered down Millennium

Development Goals,' it is logical that it would be exclusive of interlinked injustices. Similarly, a critique of lacking emphasis on food source and who determines it emerges from limited control of food supply and demand. There are levels of lacking community, national, and regional control which obstruct democratic participation.

### **Food Sovereignty: An Introduction, Definition, and Regional Interpretations**

These critiques lead to the development of food sovereignty as the critique itself. A starting point in creating an operational definition of food sovereignty in the Aruban context is that of LVC, the organization which is often said to have coined the term in their first conference in 1997 (Agarwal, 2014).

The most commonly accepted definition of food sovereignty today comes from the Nyéléni declaration of the 2007 forum for food sovereignty, held by LVC, with the main elements listed below.

- Right to define own food and agriculture systems
- Consumers' rights to control food and nutrition
- Healthy and culturally appropriate food
- Empowers peasant and family farmer-driven agriculture, artisanal fishing
- Land, territories, water, seeds, livestock and biodiversity in hands of producers
- Ecologically sound and sustainable methods
- Resist and dismantle the current corporate and food regime
- Prioritization of local and national economies and markets
- Transparent trade
- Social relations free of oppression and inequality between men and women, peoples, racial groups, social and economic classes and generations
- Social and economic sustainability

The lengthy definition encompasses a wide variety of interacting human rights. The specific rights demanded by the food sovereignty movement differ regionally, represented in the way LVC and the International Planning Committee for food sovereignty (IPC) structure the movement around regions, one of which is Latin America and the Caribbean. This creates the issue of a dichotomy between Aruba being situated in the Caribbean, just 24km of the coast of Venezuela, and its legal boundedness to Europe.

For the Caribbean context, import dependency is pinpointed as a weakness which was illustrated clearly during the COVID-19 pandemic (Immink et al., 2013; Macaroff, 2021; Beckford, 2012). Similarly, for Latin America, Macaroff identifies that developing self-sufficiency in production particularly by small or medium-sized producers is key to developing food sovereignty. This invokes particular and necessary legislation reforms, involving land distribution, prohibiting privatization of water, environmental legislation, promoting healthy eating, no signing of free trade agreements, and more.

### **Food Sovereignty: Critiques and Limitations**

#### ***Contradictions***

Both Agarwal (2014) and Patel (2009) outline various aspects where food sovereignty rights can contradict each other and act counterproductively. The movement argues for promoting local food crops simultaneously with farmers' right to choose (Agarwal, 2014). This leads to conflicts when farmers might rather produce cash crops which they can export and then purchase food with. The level at which there is food sovereignty can also be contradictory when the definition has evolved to encompass not only national sovereignty, but also the local, possibly down to the household level. The national might not encompass the variety of needs existing throughout the scale. Finally,

at the smaller scale where the democratic decision-making about food sovereignty would ideally occur, there may be contradicting individual and group interests. Food sovereignty has shifted towards the importance of group decisions; however, this raises questions of how representative such decisions are, when they might again exclude smaller voices (Patel, 2009).

### ***Wording of Sovereignty***

Such issues lead to a question of who is actually the sovereign in ‘food sovereignty’, as well as a debate over the decision to use the word ‘sovereignty’ at all. Taken literally and legally, food sovereignty would remove food from the international sphere in order to make each state entirely self-sufficient. McMichael (2014) considers the wording of ‘sovereignty’ to be closely tied to issues of territory and self-determination. This territorial character is about self-determination over land, and is inherently linked to economic questions through production of food needs. Coming back to the democratic principles of food sovereignty, it must be defined at what level the democratic decision-making should take place, who is the sovereign (over what territory), who is allowed to participate, and to what extent and how these principles will be enforced.

### ***International Trade***

One of the biggest conflicts between food security and food sovereignty is that of international trade, which is often argued as one of the weaknesses of the movement as it argues against neoliberal international food trade as it currently exists as a part of the mandate of the WTO, but does not offer a clear and viable alternative. The movement is often misinterpreted as being against international trade completely. The Nyéléni Declaration of 2007 clarifies that, “Food sovereignty does not negate trade, but rather, it promotes the formulation of trade policies and practices that serve the rights of peoples to safe, healthy

and ecologically sustainable production,”(Nyéléni 2007 *Forum for Food Sovereignty*, 2007). It claims that due to the WTO and bilateral and regional free trade agreements, transnational corporations control the global food market. It argues international trade should be reduced, and what remains should be in ‘democratic control of producers and consumers’ rather than the WTO. Such alternative policies should counteract dumping, include supply management and price support, and promote family farm agriculture over agribusiness. An acceptable form would allow for trade only when domestic production is not sufficient to meet local needs and the agricultural producers also prioritize providing food for local markets with only the surplus available for export (Burnett & Murphy, 2014). Additionally, the decision-making behind such processes should be re-localized, with decisions made democratically and context-specific.

### ***A Peasant Movement in Actual Policy***

Finally, in research about a political and legal application of the concept of food sovereignty, it is integral that the theory is sufficient to form real policy, which is sometimes argued that it is not due to its nature of being more of a protest against the current framework. Patel (2009) considers human rights talk to be ‘big tent politics’ which form an umbrella movement wherein most are able to recognize their wants and needs, but there is no explicit and consistent core of ideas on which to base real action. Lee (2007) similarly criticizes the lack of reference to formal politics in the food sovereignty movement.

### ***Food sovereignty: a need for context-specific policy and law***

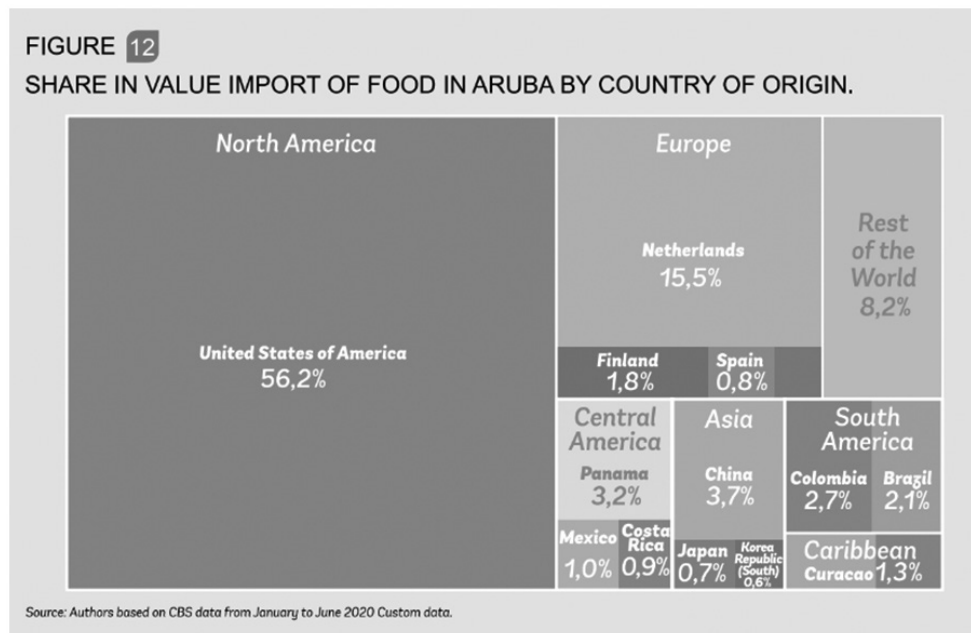
Despite the prior critiques, it can be argued that the open-endedness of food sovereignty is a strength rather than a weakness, and the purpose itself of advocating for food sovereignty-based policy. It is a part of the essence of the movement, that food policy should be context-specific

and reflect the often varying and individual needs of the community. McMichael (2014) and Pimbert (2009) argue that this diversity per place is truly the strength of food sovereignty as it advocates for democratic control by the people over the food regime and can therefore accommodate differing histories, cultures, and social and ecological contexts. Each localized area requires democratically-developed frameworks which can properly advocate for the rights of the unique area.

**Context of Aruba: how does food sovereignty look currently?**  
**National Context: Aruba**

To understand the context in which Aruban food sovereignty can be supported, there are a multitude of levels of analysis to consider including the local, the Caribbean, and small island states.

Illustrating the level of import dependence in Aruba, data from 2019 shows that locally grown fruits and vegetables constituted only 0.8% of what was imported (by monetary value) (*Advies Voedselzekerheid Op Aruba*, 2020). Contribution to GDP of combined local agriculture, fishing, and livestock was less than 0.5%. This informs the priorities of the government and local community stakeholders when making food production, consumption, and importation decisions on the island and invokes a perspective of economic diversification needs. Historically, this monoculture developed following a trajectory towards oil refinery. This drew focus away from previous self-sufficient small-scale household-based ‘cunucu’ agriculture. Additionally, physical proximity to South America, while possibly a strength for importing high quantity and quality of food, is underutilized, as illustrated below.



**Figure 1** (Mary Boyer et al., 2020)  
 ‘Share in Value Import of Food in Aruba by Country of Origin’

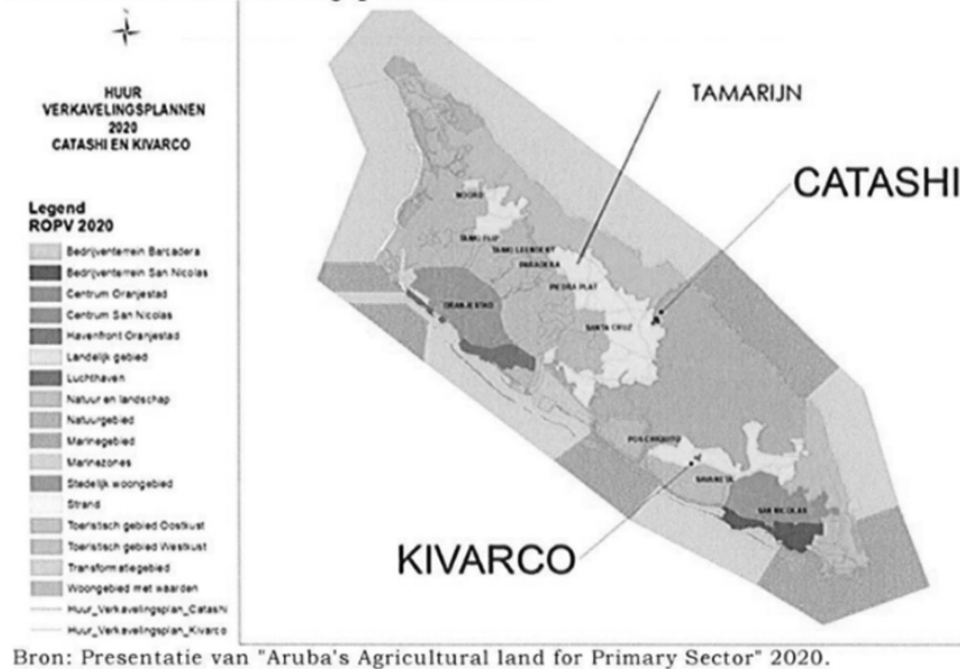
The food crisis during COVID-19 was tightly connected to the economic monoculture of tourism on Aruba. Survey results showed that eighty percent of respondents had experienced job loss or a decline in salaries, with two out of three being worried about job loss and one out of three being concerned about their ability to purchase essential goods (*Caribbean COVID-19 Food Security & Livelihoods Impact Survey*, 2020). Specifically related to the availability of food, one out of five respondents reported limited availability of fresh food/essential medicines and three out of four reported an increase in food prices. Finally, one out of ten respondents reported having no food stocks, skipping meals or eating less than usual. Data on tourism in Aruba demonstrate the crash in tourism down to zero in 2020 and the slow recuperation of the industry in 2021 reaching normal levels only in July (*Current Statistics on Performance of Tourism Industry of Aruba*, n.d.). These in combination with World Food Program data illustrate that the problem in this economic shock seemed to lie with job loss in combination with food cost increases. De Kort (2018) explains, on the basis of such information, that there is a need to diversify the Aruban economy.

Simultaneously, the tourism sector provides an opportunity for development of the agriculture sector through the ‘farm-to-fork’ concept, a component of an ‘Agri-tourism’ movement. For 3 years, Aruba had its own version of this, until COVID forced its doors closed, the ‘Goshen Sustainable Development Corporation.’ James Ocalia, from Goshen, outlines that there are three important ingredients to such an enterprise: the social, environmental, and support by economic pillars, in this case tourism (“Social Entrepreneur James Ocalia in Cooperation with HopeAruba Movement,” n.d.). Considering Aruba’s extreme dependence on tourism, such a synthesis may be the key to underpin a growing agricultural sector.

Advice from the Social and Economic Council of Aruba (SER) on food security in 2020, delves into the specifics

of various sectors of developing Aruba’s food production. Besides the economic monoculture, additional important challenges to Aruban agriculture are the dry climate, high costs for desalinated water, energy, and imported materials, access to financing, a shortage of allocated land for agriculture, bureaucracy, and knowledge of modern technology and knowledge transfer (*Advies Voedselzekerheid Op Aruba*, 2020). The commonly referred to reason for ignoring possibilities for local agriculture is a lack of land. The image below shows (in yellow) the land available for agricultural purposes. However, this is far from sufficient for feeding the entire population of Aruba. The World Bank report (2020) emphasizes that despite the essence of Aruba’s food security lying with purchasing power and disposable income for food, there must simultaneously be a local food buffer. During COVID-19, the government initiated programs to support the agricultural sector. In order to address issues of land allocation, they distributed additional plots of rental land specifically for agriculture. Additionally, an agreement with the water and energy company of Aruba (WEB), provides producers who are registered with Santa Rosa with a discount on water from 9.50AWG to 5.50AWG per cubic meter (*Advies Voedselzekerheid Op Aruba*, 2020). However, the use of gray water, from the sewage treatment plant (RWZI), is not permitted due to a lack of capacity to control the sanitation every day.

*Kaart 1. Huurverkavelingsplannen 2020.*



**Figure 2** (*Advies Voedselzekerheid Op Aruba, 2020*)  
 ‘Land Allotment Plans’

Beyond agriculture, an important food sector in Aruba is chicken (egg) farming. The egg example is one where the government has enacted policy to try and protect local production against imports. Data from SER says local egg production constitutes 15.2% of eggs consumed in Aruba. Decree AB 1989 no. GT 13 bans the import of chicken eggs into Aruba, with exceptions only in the case of insufficient local production (Landsbesluit Invoerverbod Kippeëieren, 2013). An additional import ban particular to brown eggs also aims to protect local producers, as theoretically only brown eggs are produced in Aruba, which allows them to be distinguished. The imported eggs do remain cheaper than those locally produced, likely due to high production

costs such as chicken feed (*Advies Voedselzekerheid Op Aruba, 2020*). The main challenges to the sector are price competition with imports, high costs of materials, a lack of hygiene control, high water costs (as egg producers are not eligible for the same WEB discounts as the agricultural sector), and access to financing.

Santa Rosa is an important institution when it comes to understanding the chicken egg example, due to their attempts to centralize data collection on quantities of local production. For Santa Rosa’s end goal of supporting local production insofar that ultimately Aruba no longer requires importation of fruits and vegetables (*Santa Rosa: Information, n.d.*), they have identified the registration of local production as essential. A government call (2021) for egg farmers to register at Santa Rosa so that production can be protected



against imports emphasizes this registration goal following complaints from egg farmers unable to sell their eggs. The advice from SER based on Santa Rosa's main challenges is to make registration mandatory and thereby reduce the amount of production which remains informal. Additional challenges for Santa Rosa are a capacity shortage, lack of available rental land, lack of a certification system for hygiene, and irrigation.

### *Aruba as a 'Small Island State'*

Aruba's classification as a 'small island state' provides an additional context for research to facilitate understanding of trends. Connell et al. (2020) identify the main vulnerabilities of SIDS, the results of such vulnerabilities in the global context, and what this means for governance and effective change. These vulnerabilities include: limited resources, over-dependence on trade (imports), high energy and transportation costs, scarce physical and skilled human resources, inequities in global trade, rising food prices, and underdeveloped domestic food systems. The import dependence and resulting dietary changes cause increasing 'lifestyle diseases of modernization,' non-communicable diseases like diabetes. Aruba suffers a particularly high diabetes rate of 16.24%, relative to the global average of 8.33% (Coenen, 2016). Additionally, SIDS may suffer land pressures, particularly in tourism dependent economies due to a coastal squeeze, which result in a shift away from subsistence economies. Regarding trade and the WTO, the authors argue that due to low domestic control over trade and import barriers as well power imbalances between existing and acceding members, collective action is necessary to gain access to the market and reduce vulnerability to the neoliberal system.

Several obstacles to participation and supportive governance are highly centralized governance, low access to markets, financing, knowledge networks, a gap between local knowledge and modern science, lack of political and technical support, the limited capacity of few bureaucrats, and a lack of trust among smallholder farmers, other actors,

and with formal institutions. Consequently, innovation, adaptive capacity, knowledge exchange, coordination and collective action are limited. Structures should be decentralized, research partnerships made with the community, and fostering of community relationships can help to address these challenges in SIDS.

### **Application of regional food sovereignty perspectives to the Aruban Context**

To operationalize the definition of food sovereignty for the purpose of this research, several main challenges within the food sovereignty movement are identified as key points for Aruba to address and thus to include in the field research subjects. These main factors from the food sovereignty movement on the basis of contextual research are the following:

- Prioritizing of local and national economies and markets
- Democratic control
- Needs of producers and consumers
- Rights to use and manage land/territory and water
- Collaboration and sharing of knowledge and technology
- Obstacles and support from the government

## **Results**

### **Prioritization of Local and National Economies and Markets**

When asked about motives for getting engaged in issues surrounding food; researchers, a representative from Aruba foreign affairs, and representatives of NGOs cited COVID-19 as a major driving factor for bringing food issues to the public and government's attention. Rendell de Kort, a researcher at the University of Aruba and of Cornerstone Economics states, "before COVID, it was impossible to get anyone to give food security a thought." Gabriel Marchena, a social worker at Fundacion Pa Nos Comunidad (FPNC), the food bank of Aruba, tells how the number of families

dependent on the food bank during COVID-19 jumped from 250-300 up to 5000 families.

General import dependency is repeatedly highlighted as a problem. Gregory Fung-A-Fat from 297-Farm and United Farmers Association mentions in an interview, “last week, there were no tomatoes on the island,” saying that these types of issues are a regular thing in Aruba as result of containers not coming in, and Aruba does not have the same ability to back up such a shortage with local production as other contexts such as the Netherlands does.

## **Needs of Consumers and Producers**

### ***Consumers***

Subcategories which emerged from stakeholder interviews on the needs of consumers were the role of the youth and a changing cultural mindset. Andrew Brouwer, president of MAGEC (Make Aruba a Greener Environment Club) stated clearly that local food is not something the youth thinks about. Several stakeholders did mention a changing mindset in Aruba surrounding food choices. Frank Timmen of Happyponics brings up the changing mindset towards sourcing food locally, although the purchase of fresh produce is still limited by a culture of eating warm, fried foods during the day. Jareth Vermeulen of Cunucu-297 notes a mindset shift in the opposite direction, where prior to 2018/2019, buying organic foods was a big thing, but that there has been more of a movement towards convenience foods in recent years. Regarding indigenous rights, a representative of Aruba foreign affairs says that indigenous rights are not talked about in Aruba, and they don't know if you can even call anyone in Aruba, ‘indigenous.’

### ***Producers***

Interviews conducted with stakeholders involved in both commercial and small-scale food production revealed

competition with imports, funding and investment, and support for small-scale production and NGOs as main themes. Although the lettuce farmers from 297 Farm, Cunucu Fresh, and Happyponics were not obstructed by import competition, with Greg even saying he does not do marketing because he sells it all anyways, Jareth does cite an example of where he was not able to compete with import prices. When trying to sell watermelons to stores for 10 florin which they would be able to resell for 25, he was not able to sell since imports were sold at only 7.

Regarding financing for commercial agriculture, Frank, Rudolf, Greg, and Jareth all struggle with access to funds, each one saying banks are not interested in agriculture and will not finance it. Therefore, they each either used crowdfunding, personal funds or personal loans. Rudolf mentions the government's plans to set up an ‘Agri-bank’ based on the World Bank Report, but that he has not seen this emerging yet.

## **Rights to Use and Manage Territory and Water**

On top of access to finance, the importance of land and water resources is made clear. Several farmers name limited space for agriculture as one of their challenges while Nathalie, the director of Santa Rosa says that they don't even know how much land has been given out. Frank, on the other hand, says that space is not an issue, since there is still land being distributed. On the additional space which has been rented out by the government since COVID, Rudolf explains that although he has electricity, he has been waiting for water on this new land for months. Greg also received property with no water lines or electricity, and it took 7 months to get infrastructure. He also explains that the government could take back and redistribute the agriculture rental grounds which have been undeveloped for at least 5 years, but they don't.

Concerning access to water, there are issues related to the use of gray (waste) water, wells, rainwater, and costs of water

from WEB. While water seems to be less of an issue for the hydroponics/vertical farmers, for the traditional such as Jareth, it is the biggest problem. The use of greywater is mentioned as an option by Greg and Jareth; however, the obstacle Jareth sees is that the government does not see a reason to help farmers. Greg explains how machines were bought for sterilizing the wastewater, but they were never certified. He also heard they might be fixed within a few weeks and the costs would be next to nothing for using this water. However, an issue of quality remains. Catching rainwater is seen as a difficult option by Gabriel for the household level and too expensive to set up irrigation for a normal household. Jareth mentions that dams in Arikok are possible due to the landscape able to catch rainwater, but industrialization and urbanization have gotten in the way. Greg's difficulty with the use of rainwater is that because of infrastructure, water runs onto the road and is contaminated. He says that currently only three out of the twelve dams in Aruba have good water left. Finally, Jareth makes use of an option not mentioned by others in agriculture, the re-opening of wells which were closed by WEB in the past. Additional high resource costs related to the necessity of importing all materials appear to be a concern for the sector. Greg expresses his concern for the future of chicken (egg) farmers in Aruba because of rising costs of chicken feed internationally.

### **Collaboration**

Numerous stakeholders have named collaboration and sharing of knowledge as an area they would like to see strengthened, yet name a variety of barriers.

### ***Sharing of knowledge and technology***

Knowledge on agriculture in Aruba can generally be divided into traditional knowledge and modern technological knowledge. Jareth, as a traditional farmer, does it not for commercial reasons, but for conservation of knowledge, as

a passion project. He names a 'knowledge gap' as a result of the Lago refinery shifting everyone into the oil industry. Greg's perspective aligns with this idea on limitations of traditional farming in saying that it isn't useless, but it is not suitable for the commercial level. The future of farming in Aruba lies with the technological approaches of vertical and hydroponic farming. Rudolf also states that traditional farming is too difficult and only produces in the rainy season.

Between different technological approaches, the pros and cons are weighted differently, with Frank arguing for hydroponics based on the use of natural light, and against systems like vertical farming, saying it's just new and innovative, but not necessarily suitable to the circumstances. An additional element is the importation of international technologies, which was a recurring theme in new project/fund proposals. Reasons for this included a lack of willingness among local farmers to share their methods, and greater technological advancement also suitable for the Aruban climate from places like Israel. On the small scale, Andrew also says that a more innovative MAGEC garden would be nicer and simpler to maintain, but too complicated for them to set up.

### ***United Farmers Aruba (UFA)***

UFA, according to the president of the association, Greg, is intended to represent the voice of farmers to the government, which bases everything on its members and tries to advocate for their needs. He says that along the big lines there is not much variation in what members want; however, there is a lot in approach, where particularly big and small farmers, and agriculture and chicken/pig farms differ. To Frank, however, it appears as though UFA is not doing anything, as several of their initiatives have stopped. Both Jareth, a previous board member, and Greg complain that being a part of the UFA board is a volunteer position, and as members they also pay contribution fees, so it is difficult to maintain. Rendell, as an

economist closely involved in Aruban agriculture, joined UFA as a founding member, but says that he kept not being invited back to meetings.

### **Competition**

Frank, Greg, Jareth, Clifford Rosa (chair of Stichting Rancho), Andrew, and Rendell all point out a sense of competition in Aruban agriculture. Nonetheless, they each explain that there is no competition because the market is not saturated, there is not enough production, and in Rendell's words, "The pie is so big that there is no need to worry about competition amongst each other. It's about trying to have a pie rather than not at all." When asked what the reason is for these feelings of competition, the stakeholders gave a variety of interconnected answers related to the nature of SIDS, pride and ego, resource/funding competition, distrust, and simply being excluded. Rendell says relationships are difficult because everyone already has a relationship with everyone, and Andrew also attributes feelings of competition to Aruba's size. Clifford and Greg both mention that people are concerned about having their unique ideas stolen and so they keep knowledge to themselves. Greg says that he is often told by small producers that it's easier for a 'big commercial farm' because they don't have to be as worried about their ideas being stolen and being undermined. Jareth similarly points out ego and pride not allowing collaborations to work out because people feel a disbalance in how much everyone gets out of partnerships.

Rendell goes into an economic explanation behind competition. Due to being a small island and so focused on tourism, there is little technological advancement, which means there is a high cost and perceived risk when entering the market with an untested method and competing for the same land resources. Additionally, because there is no funding from the public sector, there is a sense of protectiveness and competition around where private investments are found.

Finally, several stakeholders name a lack of even being reached out to for cooperation as a barrier. Rudolf says, "they never asked me," when asked if he is a part of the UFA, and Frank says "I'm happy to help anyone and share knowledge but it's difficult with this mindset, and people don't ask." At the NGO end, Gabriel says in reference to support from local agriculture that, "they need to approach and care."

### **Democratic Control, Government Support and Obstacles**

Besides the water discount, another frequently named way in which the government supports local agriculture is through tax exemptions. Both Frank and Jareth name the benefit of not having to pay import taxes for work-related materials, but also explain what else the government should support. As a hydroponic farmer, Frank's water usage is relatively low, and for that reason he says the government should better cater to their needs, and offer a discount on electricity for cooling. Jareth says that there should be two or three big changes to the government's support for the sector: water sourcing (gray water and rainwater), solar energy, and supporting their market by purchasing local produce and giving it to the FPNC. Within NGOs, Gabriel says that the government should see the connection between social problems and tourism development, so they should work more with social organizations.

However, Frank says as Happyponics he has no expectations anymore of the government, Jareth says, "I'm the last one the government would want to help," and, "I'm tired of saying, 'the government should,'" and Greg explains that there is a lack of will from UFA's members which makes it difficult to get things moving.

When asked about the law in Aruba banning the import of eggs, most stakeholders had not heard of it. However, Rendell, who has researched the subject, explains the link between this and Santa Rosa. During COVID, he says,

since eggs are susceptible to dumps, when there was an overproduction in the US they dumped several containers for low prices in Aruba and no stores bought locally anymore. To protect against this, the government has to know how much is locally produced. Greg, in relation to this subject says that the government is also working on a similar policy for general local production.

Several challenges were brought up when it comes to support from the government, including fragmentation, continuity, and a lack of know-how. As UFA, Greg attempts to communicate with the government about the needs of the agricultural sector; however, he has noticed that they don't communicate with each other, and when he tries to set up a meeting, half of the department representatives don't show up. Frank, Greg, and Jareth make the same point about continuity, that since the government changes every four years and knowledge and vision is lost, nothing ends up happening in the long-term. Nathalie says that Santa Rosa tries to stay independent of policy visions. Regarding knowledge, Greg has noticed that it's difficult for policy makers to understand some of the challenges they face, and they also don't ask for details, so they end up giving many statements like wanting to have a new economic pillar of agriculture, but not following through. He also says that Santa Rosa's creation of an app to facilitate registration and data collection had poor promotion, is not suitable for a large proportion of older generation stakeholders in agriculture and seems to have been largely ignored after the one week of promotion. Nathalie confirms these criticisms and names efforts for improvement such as prolonged marketing and making tutorials.

Finally, Nathalie explains Santa Rosa's hope to gain policy-making power and set up one big cooperative for everyone in agriculture, fishery, and animal husbandry. This aims to tackle problems of participation, communication, and data collection.

## Discussion

### Government Vision and Policy

The National Strategic Plan for 2019-2022 includes agriculture as one of Aruba's promising sectors, focusing specifically on local organic food production (Nos Plan, Nos Futuro, 2020). Looking to the Strategic Economic Plan more specifically, under the agricultural sector the aims are to: meet local demand for fruits and vegetables, develop health and wellness in tourism, support healthy lifestyle on Aruba, local organic food production (supported by a regulatory framework guaranteeing organic standards), collaboration with other countries for knowledge and partnerships, specializing in an export crop, and exploring the possibilities of medicinal cannabis (Economic Policy: A Strong and Resilient Economy 2019-2022, 2019). The concrete steps included for developing Aruba's primary sector are: create infrastructure, modern and technological innovative agriculture, support sustainable and circular agricultural products, develop agriculture, fisheries and husbandry into an economic pillar, create facilities for hydroponics, and make water prices more accessible. The plan also refers to the 2019-2024 investment strategy which includes further elements of encouraging local entrepreneurship, challenges of arid climate and limited space, agro-tourism possibilities, and wellness, sustainability, and organic production (Investment Strategy 2019-2024, 2019). The policy claims that the government together with Santa Rosa is educating local entrepreneurs on how to start a company and providing information on Aruba's business climate. For the actual investment it says it's aimed for local investors, but focus countries include Canada, the USA, Colombia, and Panama.

Considering the consumption and production needs expressed in the results, what stands out from these policy plans is the focus on health, organic production, and consistent references to the tourism sector.

## Main Themes and Food Sovereignty

Thematically, the interview results can be tied to the food sovereignty movement. There doesn't appear to be a clear interest in locally produced food. The interest in Aruban agriculture emerged largely because of the food crisis during COVID-19, indicating the concern was having sufficient availability of food, a matter of food security, rather than its source. This does not negate the interest in and importance of local production, as it may be necessary to protect Aruban access to food in case of external shocks due to high import dependence. However, the push for local agriculture cannot, on the basis of these interviews, be established as due to the population's inherent interest in or knowledge about local food.

On the subject of tourism, there appears to be a distinct type (younger generation) of tourists that would be interested in local food, which indicates that such tourism will be a growing sector. Stakeholders are positive about the possibilities of farm-to-fork agro-tourism, demonstrating the creativity in the use of local foods, which Beckford (2012) claims is necessary for the tourism-agriculture unification.

Price competition with imports was a preliminary concern going into the research; however, as all the hydroponic lettuce farmers indicated no struggles selling their produce, it appears to be more of a problem for traditional farmers such as Jareth and chicken egg farmers. Food sovereignty issues surrounding dumping therefore appear to not be generalizable to all production, particularly as other products are yet to reach a significant market share. Therefore, laws protecting against importation/dumping perhaps should remain product-specific as in the case of the chicken eggs.

Access to funding and resources such as land, water, electricity and import materials are all concerns expressed

by the sector and central to food sovereignty. They are constraints inherent to the small island nature of Aruba, and therefore vulnerabilities which should be tackled by the government. The need for the World Bank recommended 'Agri-Bank' model appears clear, and the concept has been developed, it is now just a matter of the government following through with their plans. Recommendations on the basis of land access issues such as reclaiming undeveloped agriculture properties and encouraging the use of technologically advanced farming may aid in increasing available land and making the most use of the limited available space. Regarding access to water, the main roadblocks appear to be the government's imposed limitations on options of using rainwater, groundwater, and gray water. Considering the government's aspirations towards a circular economy, improving access to these water sources would limit water consumption from the WEB, desalinated using fossil fuels and put it to use in a sustainable sector.

As predicted by Agarwal (2014) and Patel (2009), contradictions emerged from the discussion on collaboration, which complicate the movement's ability to support the community in its totality. First, support for both traditional and technological knowledge may have conflicting end goals, since a balance has to be reached between maximizing food productivity in limited space and preserving traditional culture and knowledge; both of which are essential to the goals of food sovereignty. Additionally, Patel's (2009) concern about the prioritization of group decisions resulting in an overpowering of smallholder voices plays out in UFA's dynamics, where by trying to account for both parties, there is a stagnation in actually being able to present a unified voice to the government. In order for both to be taken into account, there must once again be government capacity to distinguish between different needs and provide various options.

Competition as a state of mind inherent to the Aruban context emerged as a consequence of the nature of being a

small island, ego and pride, and competition over resources. Thus, solutions to this challenge require tackling the various components discussed to reduce resource competition in addition to facilitating communication and small-scale partnerships. Once the benefits of cooperatives have been established in Aruba, one of the benefits of a small network of stakeholders can kick in to facilitate the spread of such values. The lack of success thus far casts doubts on the prospect of forming one large cooperative under Santa Rosa, which would require levels of trust far beyond the current state.

Finally, many of the previous points and recommendations depend on government responsiveness and democratic control over policy. The demonstrated lack of faith in the government on top of lack of faith in each other facilitates an 'every man for himself' mindset standing in the way of developing agriculture as a 'promising sector'. Fragmentation, a lack of continuity, and lack of field-specific knowledge in the government and its initiatives indicate that possibilities of decentralization, simultaneously with increased democratic control should be explored for increased government capacity to support the identified important principles of food sovereignty. Looking specifically to Santa Rosa as an essential department, decentralization would entail strengthened relationships with the community and researchers, thus improving accessibility. One component of this is the data collection initiative, which is intended to protect the needs of producers, but according to Greg, has come across as an initiative which has not been adapted based on community response and which is not accessible for a large proportion of the older farmers in Aruba. Such initiatives should be developed in collaboration with stakeholders. For example, the laws protecting all eggs against imports, and then banning the import of brown eggs have attempted to protect local producers. However, due to a lack of data, the law has not been enforced, and it has been observed that there are white eggs produced in Aruba as well. Therefore, such laws

should be reformed based on input from local producers and used as a model to develop further supportive policy. The differentiation of local produce, as well as the organic certification encouraged in the Economic Policy (2019) are strong supporting concepts, which with contextual adaptation, might provide opportunities for future policy development. This ties well with Santa Rosa's plan to gain policy-making power, which might ensure that agriculture-related policy fits more closely with the sector's needs.

### **Food Sovereignty Needs in International Human Rights Law: an Introduction**

The in-depth analysis of international human rights law falls outside the scope of the present research; however, preliminary research on where in international human rights law the rights underpinning food sovereignty could be derived from looks to collective rights of self-determination, development, and permanent sovereignty over natural resources (McMichael, 2014). Additionally, Article 11 of the International Covenant on Economic, Social, and Cultural Rights includes under the 'right to be free from hunger,' elements of equitable relations between importing and exporting countries, improvement of production methods through technical and scientific knowledge, and efficient utilization of natural resources.

### **Limitations**

The current research is limited by the timeline of obtaining results from interviews and surveys as well as legal research. Several interviews with stakeholders from modern and traditional agriculture, fishery, animal husbandry, Santa Rosa, DEACI, the SDG commission, and local legal experts have been planned but not yet executed. Additionally, both surveys have been prepared but are either still in the process of being translated or approved for dissemination. These results will contribute to the discussion of this research quantitatively and qualitatively. Moreover, the

sample of interview subjects is limited in the sectors covered related to food. The majority of interview subjects were individuals working in agriculture rather than animal husbandry or fishery. The majority within the agricultural sector were exclusively making use of modern technology rather than traditional methods. Attempts are still being made to contact the international (LVC and IPC) and regional food sovereignty movements to gather opinions on the possibilities for Aruba's adaptation of some of the movement's principles.

## Conclusion

COVID-19 illustrated to the world the extent to which the taken for granted globalized food production and distribution system is able to come to a complete standstill. Small island states such as Aruba bear the brunt of such a collapse as a result of extreme import dependence. By problematizing the food security approach in favor of food sovereignty, problems of import dependency can be tackled through methods which evaluate the community's needs first, and develop a new framework with these needs at its heart. The research has aimed to demonstrate in what ways a food sovereignty based approach can support the protection of the rights of the community in Aruba in relation to the right to food. The focus which emerged from interviews on collaboration, competition, and democratic control aids in an understanding of how government policy can develop in order to facilitate inter-stakeholder collaboration as well provide supporting resources in order to reduce the competitive environment and encourage political participation. This approach has the potential to aid Aruba in its resilience to external shocks and avoid crises as in the pandemic.

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## **Aruba Riba: High spirits, great lessons**

I got on an airplane in January, not really knowing what to expect of the next three months of my life. Well, I did have some expectations, but they were half-hearted and dramatic: I wrote in my application that I believed I would have 'a life-changing experience' here. The reviewer told me to temper that, but I think that they were wrong. Some dramatics keep life interesting.

Over the past time, I have felt freer than ever. All the possibilities of the world hit me like a bomb, especially after staying indoors for two years. Every day was an opportunity to meet new people and do something I had never tried before. I felt inspired by all the things that I learned and all the beauty I was seeing around me. After the busyness, I was exhausted, but so freaking happy.

Of course, my main focus in this incredible program was actually doing research (with a small 'wink-wink'). As it wasn't always an easy process, I am so thankful to

all the people supporting me through it, from the survey participants to those giving me feedback, to (especially) my research partner Thizianne. I often doubted myself, my skills and my topic, but all of it came in the framework of 'look how much I am learning today!'. Positivism all the way, that I hope to have shared with those around. And to be fair, regular sunset swims with Karlijn easily put my worries into perspective, making for a true Aruban lifestyle that I can only appreciate.

This way of living came with adventures that baffle me to this day. I cannot tell you all of it (as it is not suitable for this book), but one involves riding on the back of a motorcycle in a glittery dress and another is about dancing in the Carnival's parade all night long. I have played beach tennis until I could not move one more muscle and developed a similar, life-long addiction to salsa and bachata music. For the first time ever, I have taken life one day at a time, and it felt good.

Throughout all these experience, Aruba will always be about the people for me: It is Eric's undying devotion, which will inspire me for years to come. It is Carlos' kindness. It is Michel's wisdom (Michel: wise, not old!). It is Armand's drive, Nigel's dance steps and Endy's humor. It is the love that everyone shares for this place. You guys taught me a lot about life and how I want to live it. It is also my fellow UCU-peeps: You guys are great. I like our laughing, feeling supported, the dancing until morning. I love that you entertain my wildest ideas and my strangest sleeping spots. The shapes I have taken and the ways I have grown in this place are formed by you.

Next to that, I want to thank John and the Tostaoo-team, with a special shout-out to Zeerover and the existence of Colombian avocados, for keeping me fed, and the amazing

barmen across the island for helping me unwind (never underestimate the power of a strong espresso martini).

And lastly, to Aruba, let me make you a promise that is either comforting or very scary: I will be back.

# What the future holds

## *An insight into the political and civic engagement of young Arubans in environmental action*

Lynn Smeets

### 0.0 Introduction

In recent decades, the negative impact of climate change on environments and communities all across the globe has been a prominent topic within academic, political and social debates. In January 2022, the UN's International Panel on Climate Change (2022) presented their latest report about the consequences of global warming for future generations. Their conclusions have been getting bleaker over the years: extreme regional weather circumstances and rising sea levels will greatly alter lives, hitting the economically disadvantaged and underrepresented part of the population the hardest (IPCC, 2022). With each passing year without drastic global action, halting changing temperatures becomes more expensive and difficult.

Presented with this distressing promise for their futures, young people have been prominently advocating for more awareness and action: in the worldwide Fridays for Future-strikes that took place before the COVID-19 pandemic, millions took to the streets, inspired by the young Greta Thunberg, with demands to be heard and taken seriously (Millman, 2019; Simmons, 2021). This coincides with the goals of international organizations like the UN and the World Bank that highlight the importance of empowering young people by having them participate more fundamentally in political and civic processes (World Development Report, 2007).

### 0.1 Introducing the Aruban context

Aruba, a small-island state located in the southern Caribbean, is vulnerable to the effects of a changing climate too (Simmons, 2021). Its economy thrives on American and Dutch tourists washing ashore in waves of planes. The deterioration of coral reefs and beaches due to rising temperatures is set to greatly affect the volume of these tourists, impacting economic opportunities for its inhabitants in the future (Simmons, 2021).

In Aruba too, policy makers and NGOs are conscious of the role that young people can play in society. In two recently published reports, the Aruban government highlights the importance of youth empowerment and citizen participation (*Aruba as a Model for Sustainable Development*, 2019; *Youth Empowerment*, 2019). Despite these ambitions, the view of many Aruban citizens is that the Aruban government is characterized by a lack of transparency and economic mismanagement, serving the interests of politicians and their supporters instead of the Aruban people (Alders, 2015). In this context, the public's trust in governance institutions, and the public's willingness to participate in decision-making processes is failing.

Given that young livelihoods are under threat and the political sphere is not always as accessible for change-

making, a question arises: What is the position of the youth in Aruba?

### *0.2 Introducing this project*

This research project focuses on young Arubans' role in current and future environmental action, both in the political and civic sphere. In particular, it investigates how young Arubans' perception of efficacy influences the way they engage in order to improve understanding of the barriers and drivers for civic and political participation of the youth. It therefore aims to answer the following research question:

*How does the perceived efficacy of young Arubans influence their political and civic engagement in environmental action?*

To address this question, as a preliminary publication of the larger project, this paper will firstly establish a basic understanding of the relevant concepts by reviewing existing literature on youth engagement. Then, it will introduce the concept of 'perceived efficacy', a measure of young people's feelings of their potential impact on Aruba, as a predictor for different forms of engagement within quantitative research. Based on this, the paper will move onto the actual research set-up, by explaining the survey conducted and its implementation. Finally, it will discuss expected results.

## **1.0 Literature review**

As the research done on youth engagement in politics and society is extremely broad, this part of the paper will first go into an overview of relevant definitions on youth and engagement. Then, it will elaborate on the different forms of engagement that have been identified by researchers and reported trends in youth behavior. These inform methodological and data-collection choices discussed later in the paper.

### *1.1 'Youth' as a category in political and social debates*

Within academic social and political sciences 'youth' has been defined in several ways. All definitions, however, agree that a young person is someone who is going through a transitional phase from childhood into adulthood, and that this process comes with specific socio-economic and political opportunities and challenges (Barrett & Pachi, 2019; Simmons, 2021; White, 2012). To create some order in the chaos, researchers and policy makers use different age ranges to distinguish youth from children and adults, most sticking to ranges from 14 to 24 or 15 to 25 (Lochocki, 2010). The UN employs a range of 15 to 24, UNICEF 10 to 24 and the Council of Europe steers away from a definition by age all together, stating that the transition to adulthood is a nonlinear process that is heavily influenced by cultural context (Barrett & Pachi, 2019; Narksompong & Limjirakan, 2015). After all, different hurdles could have young people independent radically earlier or later in life than age ranges suggest.

Even within the borders of the age ranges, it is recognized that youth is made up of a very diverse and complex group of people that should not be generalized too hastily (Lochocki, 2010). How young people behave, the things that interest them and the specific struggles they face are greatly influenced by context and individual personhood.

### *1.2 Youth engagement: an overview*

As youth is seen as a stage distinct from childhood and adulthood, so is youth engagement with politics and society. The term 'engagement' has different dimensions. Likewise, scholars have different views on current trends in youth engagement.

#### *1.2.1 Engagement: definitions & characteristics*

In colloquial language, engagement is used to describe a process of involvement in something. As that is not an

easily measurable definition, scholars give engagement several dimensions, based on how it impacts externalities, the behaviors it entails or the intentions it stems from. For example, Riemer, Lynes & Hickman (2013, p. 555, as in Pancer, Rose-Krasnor and Loiselle, 2002, p. 49) describe it as “the meaningful participation and sustained involvement of a young person in an activity that has a focus outside himself or herself”. Amnå (2012) argues that engagement can be summed up as “the values, beliefs, attitudes, feelings, knowledge, skills and behaviors concerned with conditions outside of the immediate environment of family and friends” (p. 613).

To make it more specific, engagement is often divided into two categories: political and civic engagement (Barrett & Pachi, 2019; Ekman & Amnå, 2012; Lochocki, 2010). *Political engagement* consists of formal and informal involvement that aims to influence governmental institutions and policy making (Barrett & Pachi, 2019; Ekman & Amnå, 2012; Lochocki, 2010; Verba, Schlozman & Brady, 1995). The particular focus of this form of engagement is mostly chosen within, not surprisingly, political science disciplines that interest themselves in the relationship between (often democratic) governments and their citizens.

On the other hand, *civic engagement* regards involvement of an individual or a collective to improve the well-being of a certain community or society (Amnå, 2012; Barrett & Pachi, 2019; Lochocki, 2010; Shaw et al., 2014). Although it can overlap with political engagement (after all, the personal is political), civic engagement distinguishes itself by behaviors that are not directed at political institutions, but at community members, community problems or individual people that play a role outside of the public sphere.

### 1.2.2 Participation & conventionality

Within the context of youth engagement, it is important to highlight a difference between being *psychologically*

engaged and *behaviorally* engaged (Barrett & Pachi, 2019): one can be interested in a civic or political topic without actually acting on that interest. To manage this dynamic, researchers use *participation* to describe the behavioral side of certain activities (Barrett & Pachi, 2019). As naturally follows, political participation then regards activities aimed at political institutions, while civic participation is aimed at community-level issues.

Political participation itself entails two modes: conventional and non-conventional. *Conventional political participation* includes voting, joining a political party or donating money (Barrett & Pachi, 2019; Schulz, 2005; Verba, Schlozman & Brady, 1995). As some of these, like voting, have a minimum age for participation, youth are institutionally excluded from them. In contrast, non-conventional political participation is open to anyone. It consists of actions that fall outside formal institutions, although they are still aimed at political issues. Examples are demonstrating, signing petitions and writing opinionated pieces on political matters (Barrett & Pachi, 2019).

### 1.2.3 Apathy & disengagement: the youth way?

One of the most prominent trends from the research literature of the two most recent decades is that youth are engaging less and less with conventional forms of political and civic participation: young people in Western democracies are showing up less to vote and are less structurally committed to civic organizations and social or religious groups (Barrett & Pachi, 2019; Lorentzen & Hustinx, 2007; Sloam, 2014). This alarm is sounding: is there a crisis in youth engagement?

In light of this trend, some scholars have said that youth might be *apathetic* to major social issues, arguing that individualization, globalization and secularization have created a shift from social ties to individual interests (Barrett & Pachi, 2019; Lorentzen & Hustinx, 2007). These scholars

hypothesized that this has made young people purposefully *disengage* from certain practices, as they do not care.

But the opposite is true: youth disengagement from conventional participatory modes does not indicate apathy. Instead, it indicates that youth are engaging in *new ways*, which young people perceive to be more effective (Barrett & Pachi, 2019). This perceived effectiveness is influenced by different factors, such as tokenism – “invited and managed forms of participation and citizenship that do not acknowledge youth as autonomous political actors” (Riemer, Lynes & Hickman 2013, p. 42) - and perceived illegitimacy of governmental institutions (Checkoway, 2011; O’Brien, Selboe & Hayward, 2018).

#### 1.2.4 *New forms of youth engagement*

The new ways of engaging with the political and civic spheres are manifold. This paper will highlight a few specific concepts that describe major trends: standby citizenship, lifestyle politics and cause-oriented actions.

The concept of *standby citizenship* (also called *monitorial citizenship* by Schudson (1999)) ties into the previously mentioned idea that people are psychologically engaged with social issues instead of behaviorally engaged (Amnå & Ekman, 2010, 2014, 2015; Barrett & Pachi, 2019). This means that people actively seek out information and share their interests with others, but only act in a participatory way when they view that to be imperative. In their study of the participation of Swedish 16-year-olds by Amnå & Ekman (2014), nearly 50% of the participants showed characteristics of standby citizenship, although it is unclear whether this finding can be generalized to other countries and cultural contexts (Barrett & Pachi, 2019).

In line with this, Norris (2004) emphasizes a shift from structural engagement with issues and organizations to a cause-oriented engagement: more than ever, youth engage

with certain causes, like environmentalism or poverty, in an episodic manner. This cause-oriented action is often not only aimed at influencing policies, but also at altering patterns of social behavior, thereby blurring the lines between the political and social sphere (Norris, 2004).

At the same time, whereas youth engage with causes rather than institutions, they also perceive their individual actions as highly politicized. This is lifestyle politics, meaning that someone adapts everyday behavior to fit certain ethical, moral or political standpoints (Bennett, 1998; De Moor, 2017; Stolle & Micheletti, 2003). This form of engagement is especially relevant in the environmentalism movement, as individuals are more and more aware of their action’s impact on the environment (De Moor, 2017).

#### 1.3 *Youth engagement within the context of a Small-Island State*

It is relevant to consider all the discussed forms, both the ‘old’ and the ‘new’, when looking at youth engagement in Aruba. Before this paper can go into the data-collection part, it is necessary to discuss how the country-specific context of Aruba might influence the way that young people engage with the political and social sphere. As a small island and a part of the Kingdom of The Netherlands in the Caribbean, Aruba has certain characteristics that distinguish it from the Western democracies that most of the previous reviewed literature is based on. These characteristics may impact how Aruban youth engage within politics and society. This research gap makes the aims of this research all the more relevant, and to facilitate that, this part of the paper will briefly go into Aruba’s political system, the country’s small size and how this might affect young people’s perceptions.

##### 1.3.1 *Aruba’s political system*

Since 1986, Aruba has *status aparte*, making it an individual country within the Kingdom of The Netherlands (Alders,



2015), a constitutional monarchy with parliamentary democracy. As in other countries in the Caribbean, Aruba's colonial history and small size has influenced its governmental functioning. According to Alders (2015), Aruba is dealing with the existence of prevailing patronage, an informal institution in which the "executive branch of government dominates the legislative branch and renders other public watchdog institutions futile" (p. 8). This gives the people in power the opportunity to act in their own interest and the interests of their supporters, instead of the public's. A lack of transparency makes it hard for individuals and civic organizations to hold government officials accountable for their actions (Alders, 2015). In the past decades, this dynamic has made the Aruban government known for economic mismanagement (Alders, 2015).

### 1.3.2 Political trust & its impact on youth engagement

In a 2013 survey conducted by De Vries (2014) in collaboration with students from the University of Aruba, less than 40% of respondents indicated that they trust Aruba's government and its institutions and only one in five respondents put faith in political parties. In light of this, it is very possible that youth in Aruba engages differently than could be expected from the existing literature. For example, when young people perceive that governmental institutions are not working in their interest or are not considering the opinions of individual and civic actors, they might decide to disengage with the political sphere and engage more with civic initiatives. Especially for environmental issues, it could well be that awareness of the importance is rather high among Aruban youth, but that they do not consider engaging with government as a way to impact social change.

## 2.0 Research approach

In order to gain a better understanding of this phenomenon, this project aims to answer its research question (*how does*

*the perceived efficacy of young Arubans influence their political and civic engagement in environmental action*) via an online questionnaire survey. A quantitative approach was chosen to provide meaningful insight into the effect of certain variables on youth engagement. The online format is easily accessible to respondents and guarantees anonymity (Bryman, 2016). As Papiamentu is the official language of Aruba and many people feel more comfortable communicating in Papiamentu than in English, the survey was offered in both languages.

### 2.1 Operationalization of the Theoretical Framework

The survey was built up by operationalizing different theoretical concepts, in part based on the discussion of literature in this paper: demographics, perceived efficacy, trust in government and political and civic engagement.

#### 2.1.1 Perceived efficacy

To encompass the individual, political and social sphere, the survey uses the term *perceived efficacy* as a predictor for political and civic engagement in environmental action. Perceived efficacy is defined as "one's general belief that his or her action can have an impact" (Barrett & Pachi, 2019; Caprara et al., 2003; Jugert et al., 2016; Schulz, 2005; Van Zomeren et al., 2010). Perceived efficacy can be divided up into three categories: internal efficacy, external efficacy and collective/group efficacy. Internal efficacy (*or self-efficacy*) regards the perception that individual actions can make a change (Barrett & Pachi, 2019; Van Zomeren et al., 2010). *External efficacy* regards the belief that political and social institutions are responsive to one's personal or citizen's demands (Barrett & Pachi, 2019; Schulz, 2005). Finally, *collective (or group) efficacy* regards the opinion that a collective can have an effect on a political situation (Barrett & Pachi, 2019; Jugert et al., 2016; Van Zomeren et al., 2010). These three measures can be used individually or combined.

### 2.1.2 *The other factors*

Alongside questions about perceived efficacy, the survey included other factors that could either mediate the level of efficacy or ones that other scholars have found to be potential influencers of engagement in environmental action (Barrett & Pachi, 2019; Schulz, 2005; Van Zomeren et al., 2010). The survey questions were divided up into a global and an Aruban scope, so that the importance of place could be tested.

For a full overview of the operationalization of these concepts into the survey questions, please take a look at table 1 to 4 in the preliminary results section.

### 2.2 *Survey implementation*

To reach as many youth as possible in three weeks, different means were employed to implement the survey. For starters, with the help of Aruban research partner Thizianne Tavarez, an Instagram page was launched to engage with young people informally. To draw eyes to the survey, Thizianne made posters that could be shared as online content. Over the course of two weeks, we started following Instagram accounts of Thizianne's friends, their extended social circle and personal accounts that were suggested by the Instagram algorithm and who fit our target group at first sight. When the survey was available, we started posting the link to the survey and asking people via Direct Messaging to fill it in.

Alongside engagement through social media, we reached out to educational institutions on the island. Before posting the survey, Thizianne made a list of relevant email addresses. We hoped that by contacting different schools, we could reach youth of different educational backgrounds. When the survey was available, these schools were emailed with a request to distribute information and a link of the survey to relevant students.

Additionally, posters with QR codes were hung up on the grounds of the University of Aruba. Lastly, we got into contact with a number of Aruban civic (often environmental) organizations and asked them to share the survey with their members.

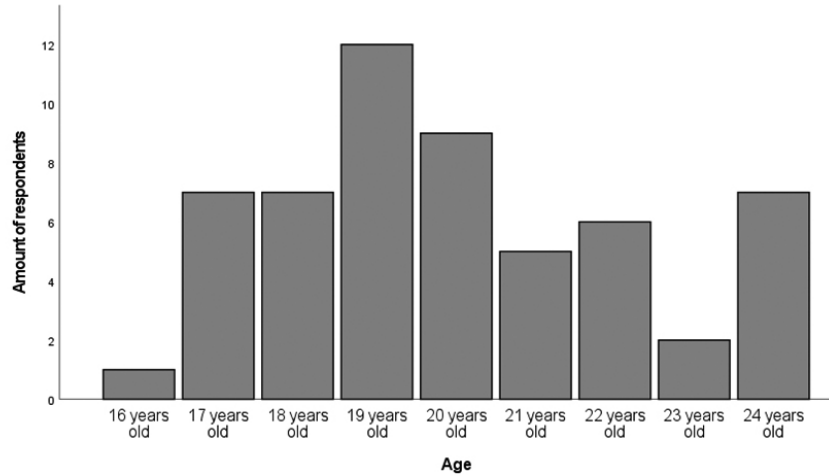
## 3.0 **Preliminary results**

As the survey is still being conducted, a full analysis of results cannot yet be provided. When there are enough responses, the survey will be closed, and the data will be imported into SPSS Statistics to run the required analyses.

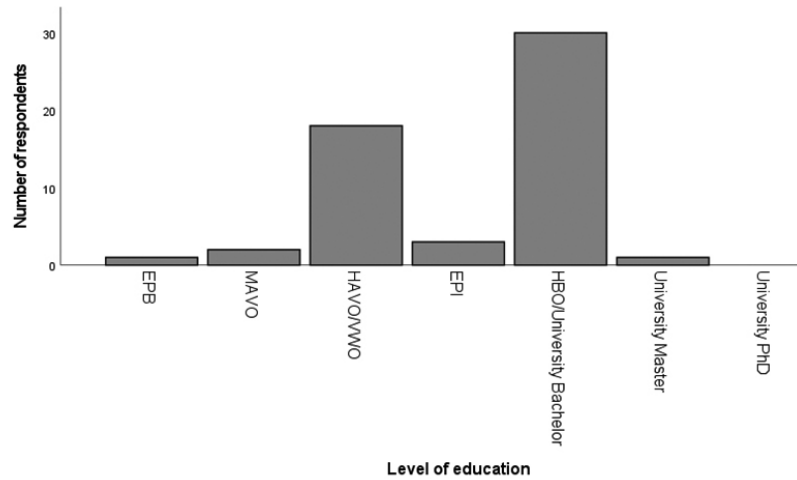
Preliminary data discussed here was imported from Qualtrics Survey into SPSS on the 30th of March. The data was analyzed descriptively. As most questions were constructed using a 5-point Likert scale (from 'strongly disagree' to 'strongly agree'), the mean answer to the questions indicate opinions shared by youth.

### 3.1 *Descriptive statistics*

In total, 55 useful responses were recorded. Figure 1 shows the age distribution. Only one respondent indicated that they are 16 years old. The distribution of other age categories is reasonably equal, with 19 years as the highest recorded age. Figure 2 shows the distribution of the type of education. The survey was mostly filled in by students enrolled in HAVO/VWO and HBO/University education. This could influence potential results, as it is known that people enrolled in these tend to be more concerned with environmental action more than other educational groups (De Moor, 2017).



*Figure 1: Age distribution of respondents*



*Figure 2: Education enrollment of respondents*

Lastly, the gender balance of the respondents is skewed: 42 women filled in the survey, compared to 12 men.

### 3.2 Youth opinion on climate change

The survey asked questions regarding climate awareness and climate distress. With 5.0 the highest possible answer, it becomes clear from the responses that the youth responding know and worry about climate change and are of the opinion that action should be undertaken. The high scores on this topic could be highly influenced by the educational background of the respondents, as university students share more awareness about environmentalism in general (Barrett & Pachi, 2019).

**Table 1** Youth opinion on climate change

<i>Survey question</i>	<i>Mean</i>
I have heard about climate change and its consequences for the future	4.51
I believe that the global climate is changing	4.65
I do NOT worry about climate change and its consequences for the future	1.51
I think Aruba will be impacted by global climate change	4.45
I think that action should be undertaken to halt global climate change	4.61
I think that the people on Aruba have a negative impact on the environment	4.06
I talk to others about my concern for the environment	3.51

### 3.3 Youth's perceived efficacy

The second section of the survey regarded youth perceived efficacy. As introduced in the research approach, this is divided into three subsections. As expected, the results show that youth score low on questions related to external efficacy, especially regarding government organizations, and higher on internal efficacy and collective efficacy. Youth perceive their individual means of helping the Aruban environment the most impactful.

**Table 2** Youth's perceived efficacy

<i>Theoretical topic</i>	<i>Survey question</i>	<i>Mean</i>
Internal efficacy	Through changing my daily routine, I can reduce the effect of global climate change	3.86
	Through my actions, I can help protect the Aruban environment	4.08
External efficacy	If I would go to a governmental official (e.g., someone in parliament, someone in a political party or a member of the Aruban cabinet) about my concerns for global climate change, they would listen	2.45
	I do NOT think that organizations on Aruba care much about what people like me think	3.63
Collective efficacy	I believe that young people, though joint effort, can reduce the negative consequences of climate change	3.94
	I think that we as young people have ways and means to protect the environment of Aruba	3.92

### 3.4 Youth's trust in government institutions

To get a better idea of what might influence the external efficacy, the survey asked for youth's opinion of their government. As was suggested in earlier discussion, governmental trust is low.

**Table 3** Trust in government institutions

<i>Survey question</i>	<i>Mean</i>
I trust that the Aruban government acts in the best interest of the Aruban people	2.49
I think that the Aruban government is often honest about what they do and why they do it	1.96

These numbers correlate (in a non-statistical manner for now) with the lower perceived external efficacy.

### 3.5 Youth's (intent for) engagement

The last part of the survey treats political and civic engagement in environmental action. On all different forms of engagement, youth scored high, which shows their willingness to participate in actions aimed at protecting the environment. Out of all forms, they indicated to agree the most with joining collective activities and the least with joining a political party.

**Table 4** Youth's (intent for) engagement

<i>Theoretical concept</i>	<i>Survey question</i>	<i>Mean</i>
Conventional political participation	I (would) vote for a political party that promised to reduce the impact of climate change on Aruba	3.94
	I (would) join a political party that concerned itself with the impact of climate change on Aruba	3.27
Non-conventional political participation	I (would) participate in a demonstration that is aimed at doing something about environmental issues	3.79
	I (would) openly share my concerns about climate change with others (through a school newspaper, social media, etc.)	3.81
Civic participation	I (would) join an organization (a group of people with a shared goal/interest) that is aimed at reducing the impact of climate change on Aruba	3.81
	I (would) join activities that are aimed at protecting the Aruban environment (think of beach clean-ups, tree-planting, etc.)	4.31
Lifestyle politics	I personally adjust my behavior to reduce my impact on my environment	3.81

Although the scoring for the joining of a political party is lowest, the results do not give any indication that low governmental trust and perceived external efficacy influence youth's willingness to participate in the political sphere. Although still preliminary, this result differs from what was initially hypothesized for this research. It would be interesting for future analysis to see how other factors might play a role in this as well.

## 4.0 Discussion & conclusion

These preliminary results are a preview of what this research might find about youth engagement in environmental action on Aruba. What becomes clear from these results are two things: at least some segments of Aruban youth are environmentally aware and concerned about the future of the planet and of their island. They want action, and they are willing to participate in that themselves, individually and collectively. Secondly, they perceive the political sphere, and especially the government, as untrustworthy. Although the results do not show that this leads to disengagement with political participation, it is relevant to consider what the lack of trust and reduced external efficacy might mean for the future of the island. And most notably, how the government can include youth in their decision-making processes surrounding environmental action to start building this layer of truth. One thing is clear, young people's will is there, all they need is a way.

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## **I landed in Aruba with many goals and ideas**

Aruba Field Research was an academic goal of mine since my first semester of UCU in 2018. I was drawn to the idea of applying the knowledge and skills I would learn at university outside of the confines of a classroom. Aruba Field Research offered the opportunity to learn in the field, and develop my geology experience.

One pandemic later, I had the fortune of indeed boarding a plane to Aruba to complete my own community-engaged/ community-based field research for thesis. I knew there would be challenges in extending my research to include the human; geology is often a discipline that discusses time in millions of years, whereas human history is only in the thousands.

I landed in Aruba with many goals and ideas. I wanted to explore the many ways humans interact with the bedrock, through hiking, farming, mining, urban development

and landfill. Upon my arrival, we had the opportunity to tour the island, see the history. It was grim at times, seeing the landfill's smoking state or learning of the thinning mangroves. It was also hopeful though, seeing the compassion and pride of Stichting Rancho looking to promote the local community. It further motivated me to make sure that whatever I produced would promote the island's truth and offer some insight in an academic field that is less explored.

I began my research along two branches, one in the National Archives of Aruba with the help of my research partner, Ethan, and another in the field photo-documenting the remains of the gold industry. I recorded my findings using more inclusive language with diagrams for support. Through this effort to invite the non-academic to access this information, my hope is to not only make geology more entertaining but also show its relevance. Aruba's gold

industry extended for almost a hundred years and had just over 1.5 tons of gold to show for it. Of course it took over 20,000 tons of ore being dug up to obtain that gold. The gold industry was a prominent economic force for the years it thrived and certainly shaped the land, both in terms of the ore excavated and the roads built for it.

To conclude, I more than enjoyed my time in Aruba, I am so grateful to the people who helped me, the stories they shared, the locations they took me to. Every hike was another perspective to explore, every family story a part of a larger weaving. Going forward, I hope to see Aruba continue to develop in the multitude of fields it is pursuing, everything from the hydroponics to the eco-tourism. Whilst there were drawbacks during my research, I leave with hope, inspired by the resilience of Aruba.

# Communicating the Geologic History of Aruba: Contextualizing Gold and Incorporating Human Activity

Maro A. Savvides

## Introduction

In the following text, the geologic events that lead to Aruba's existence will be shared. The dates are based on and conclusions drawn from multiple articles and so may at times be approximations. Various geologic concepts are introduced, but the focus will remain on Aruba and her formation, so not all concepts will be fully expanded on in comparison, simply incorporated when relevant.

This text can also serve as a starting point for those interested in familiarizing themselves with the language needed to read on in more detail academic texts concerning Aruba and the Caribbean. For more diagrams (in color), and field photography, scan the QR code.



## *Why Write?*

The ultimate focus of this text is to introduce geology to those who have an interest but not the prior knowledge. Using gold as a navigator, the text can share the basics of geology in the Caribbean and Aruban context with the hopes of being entertaining, informative and inviting for future pursuits in the field of geology.

Whilst there may not be new information recorded in this text, it is a new method of presenting this information which can in turn lead to interest and innovation. Additionally, there is a moral obligation to preserve knowledge for future generations, which can only be done to the fullest degree if as many people as possible can access said information. The history of the very Earth that people walk upon belongs to everyone.

## *Why Aruba?*

As a small island, Aruba has clear boundaries making it succinct to study and present in the limited time available. It is well-studied geologically - albeit to a lesser degree than other Caribbean islands - but the language in the publications is dense and at times inconsistent. This is a unique opportunity to rephrase decades of science into a shorter, more consumable text and make it available to the general population.

Furthermore, Aruba's gold mining history is distinct with a clear start and end. Through reports, the gold mining process has been well-recorded and preserved in the local national archive. The gold mining history is also very relevant to Aruba's own economic and cultural history as it was a driving economic factor for almost a hundred years.

Another factor to consider is the island's simplified units - or layers. The island can be summarized into three distinct units and these have been well-defined since their first recording in 1931 (Westermann, 1931) As a result, explaining the geologic processes that led to Aruba's modern-day presentation in layman's terms is reasonably attainable. It allows for a shorter introduction to broader geologic concepts such as tectonic plate theory before also using gold as an example of how geology is relevant and even entertaining.

### ***Why Gold?***

Gold has a long history in many cultures. Whether referencing golden fleece in myths or discussing the modern-day economic market, gold is everywhere. It can be studied from any discipline, from chemistry to fashion. Many people, if not most, are familiar with gold and its worth, so it would be a fair argument that using gold as an introduction to geology would capture the attention of the general populace.

Why bring anyone into the world of geology at all though? The purpose of this text is not for it to be forced into the field of education but to be available when wished for by any individual with an interest in learning more. Geology has certain preconceptions; it does not seem relevant for the everyday layman to dabble in it, not when compared to economics, politics, data analysis, etc. That said, it is also a difficult field to become interested in if not in academia; the language is erudite, the diagrams assume knowledge of implicit information, and the field is broad - spanning the entire globe.

To summarize, geology is difficult, and as a result, it is at times inaccessible to the average person. To increase interest but also to provide relevance, this text will share the geologic history of Aruba in a story-telling format using layman's terms and clear definitions supported by diagrams when necessary. The goal is to make the science that is already recorded available to any who would like to learn more.

## **Tectonics**

### ***Geologic History of Aruba***

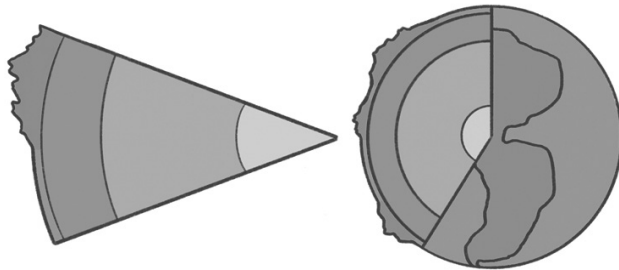
Like all good stories, the tale of Aruba's geologic history begins at the beginning, some 250Ma (millions of years ago). Whilst the development of the Caribbean tectonic plate is often stated to be some 200Ma (Boschman, van Hinsbergen, Torsvik, Spakman, & Pindell, 2014), it would be more accurate to begin with the event that led to the creation of the Caribbean plate.

### ***Tectonic Plates***

First of all, what is a tectonic plate? Tectonic plates can be divided into two types of crust: thicker, lighter continental plates, and dense and thin oceanic plates (Marshak, 2018).



These two types of plates wrap around the entire globe and form the solid crust that sits over the magma below. In this text, the focus remains on the crust and outer-mantle - the magma closest to the surface below the solid crust.

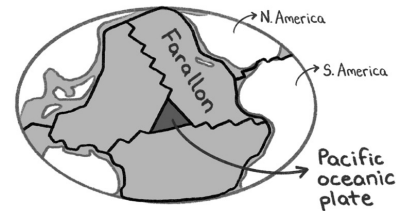


Front: Supercontinent Pangea



(no Atlantic ocean)

Back: Superocean Panthalassa



Pacific oceanic plate

The majority of the Caribbean plate is oceanic (Boschman, van Hinsbergen, Torsvik, Spakman, & Pindell, 2014), meaning it is thin and dense for the majority of its area with some regions that show continental features of thicker and lighter crust.

### **Caribbean Plate**

There is still debate over how the Caribbean plate formed, but the popular theory is that over 200Ma, the Pacific Ocean was spreading (Boschman, van Hinsbergen, Torsvik, Spakman, & Pindell, 2014), resulting in a part of the oceanic plate between the Pacific and the Americas to eventually subduct - or be thrust below - the Americas (Wright, 2011; Boschman, van Hinsbergen, Torsvik, Spakman, & Pindell, 2014; Garmon, 2017).

### **250Ma**

To take a step back and capture this more visually, take into consideration that 250Ma, the location of the modern day's Pacific Ocean was occupied by Panthalassa, a superocean covering the majority of the planet, and the supercontinent, Pangea, occupied the space where the modern Atlantic Ocean is. Incredibly, this enormous superocean plate rifted, spreading from its center, the lava flooding into this space and hardening to create a new oceanic plate, the Pacific Ocean plate. To accommodate for the expanding ocean, Panthalassa broke into multiple plates. The plate next to the Americas was the Farallon plate, and it is this plate that would one day create the Caribbean plate (Boschman L. a., 2019).

### **100Ma**

In the span of 91-88Ma (Derix, 2016a), the Farallon plate was subducted below the Americas, the magma - molten rock - below the crust escaped and flooded over part of the Farallon plate. This flooded region hardened and became the Caribbean Large Igneous Province (CLIP) (Derix, 2016a). It is during this lava flooding event that part of the flooding developed into the Aruba Lava Formation (ALF) (Hippolyte & Mann, 2009) (Van Der Lelij et al., 2010) (Derix, 2016a) in the south end of the CLIP.



Soon after this flooding event, something unusual occurred. The subducting Farallon plate underwent a subduction reversal (Van Der Lelij et al., 2010; Boschman, van Hinsbergen, Torsvik, Spakman, & Pindell, 2014; Wright, 2011), meaning it no longer went under the Americas, but rather overrode them, causing the American plates to subduct below it.

## **Stratigraphy**

### **Stratigraphy**

Anyone who has ever walked by a cliff or driven through a road that was cut into a hill may have seen distinct layers

in the bedrock. There is a variety of colors, textures and thickness to each layer. These layers could be thought of as blankets. They lie over each other and with time become wrinkled, folded, torn, and have other blankets added to the top.

To understand Aruba's stratigraphy, the very concept of stratigraphic formations must be understood first. So, what is a stratigraphic formation? Put simply it is "an interval of strata composed of a specific rock type or group of rock types that together can be traced across a fairly broad region" (Marshak, 2018). To rephrase, it is a layer of rock that extends over a large area, just like a blanket over a bed. Each blanket represents a layer of time - and stratigraphic formation. Each new blanket is placed on top representing a new layer of rock - a new formation.

Having introduced the concept of stratigraphy and stratigraphic formations, we now turn to some rules as to how the layers work. The principles addressed in this text are in accordance with the textbook *Earth: Portrait of a Planet* by Stephen Marshak. All the geologic principles are fairly intuitive. You may consider them as a cake.

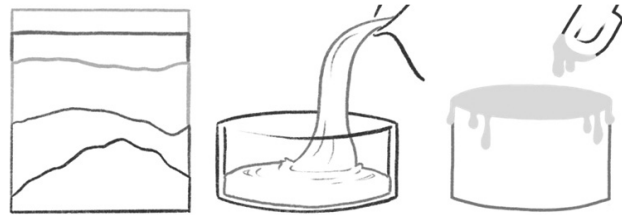
***The principle of:***

**Uniformitarianism**

All observable processes today also occurred in the past. There has been no change to physical laws since Earth's existence. If baking a carrot cake today, using carrots is necessary. When having baked a carrot cake 100 years ago, carrots were still necessary. The rules have not changed.

**Original horizontality**

Gravity applies to the layers, so that they all are laid fairly flat and evenly; sand collecting at the bottom of a lake or seabed. When pouring cake batter into a tin, it flattens to fill the bottom of the tin. If icing is poured over, that too accommodates for gravity and flattens.

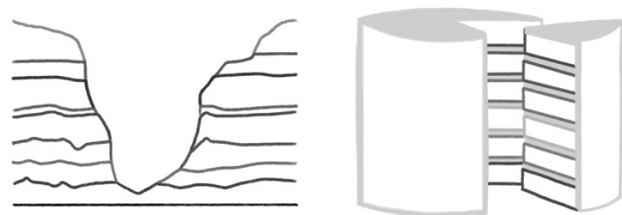


**Superposition**

Nothing can be placed on nothing, so naturally, if a rock layer forms over another layer, that would make the top layer younger. Whilst with a cake you could flip it or pick it up, the rock bed of the Earth cannot, so the top layer must have been placed over the older layer below. If making a tiered wedding cake, the top cake would be a younger stratigraphic formation than the bottom layer.

**Lateral continuity**

As an extension of the principle of original horizontality, the stratigraphic formation that is laid down must be fairly evenly distributed. Therefore, even if there is now a canyon, the layers still are in the same order and were once connected before the tear of the canyon caused them to separate. In the cake example, a slice is cut from the cake, but the layers of the cake still came from the same original stratigraphic formation.



**Cross-cutting relations**

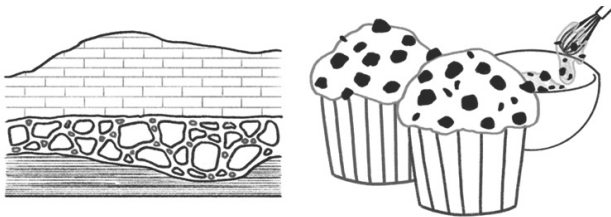
If an event such as a canyon developing occurs, then the formations that have been cut by the event are younger than the event. Again with the slice of cake, the slicing of the cake

came after the layering of the cake.

Alternatively, if a collection of formations have a line of magma that cut into them, then that magma must be younger so that it may have cut the existing layers. If a cake has three layers and then icing is forced into the middle to create a filling. That icing is cutting across the older layers, which means it is younger.

### **Inclusions**

Unlike cross-cutting relations where magma is forced to cut through existing rock, inclusions are rocks that already existed that were enveloped during the blanketing process. Any addition to the formation must be older than the stratigraphic formation that holds it, in other words, rocks carried to the base of a lake by a river, are older than the sand that will harden around them. It's simple, when baking chocolate chip muffins, the chocolate chips are the rocks carried by the river and the muffin batter is the soft mud and sand at the base of the lake that will eventually harden to hold the chocolate chips (which are the inclusions in this scenario). So if the stratigraphic formation has a rock in it, then that rock must have existed before the layer did, as the layer formed to hold the rock after.



### **Baked contacts**

In the case of a rock bed, the magma intrusion can be so hot that it will “bake” the layer it is entering. Similar to the principle of cross-cutting relations, the newer addition is younger, but in this case, it can also be identified because of the changes it causes to the layers it intrudes, just like when adding icing can make the parts of cake it touches softer or moist.

### ***Stratigraphy of Aruba***

Bringing the focus now to Aruba whilst keeping in mind the subduction reversal, Aruba has three distinct units that make up the island. In order of oldest formation to youngest, they are:

- The Aruba Lava Formation (ALF),
- A Batholith intrusion, and
- Limestone shelves. (Westermann, 1931; Van den Oever, 2000; Hippolyte & Mann, 2009)

Soon after, the aforementioned subduction reversal occurred. With the ALF hardened and part of the Caribbean plate, magma from below the plate broke through to form a batholith (Hippolyte & Mann, 2009; Van Der Lelij, et al., 2010), a bubble or pocket filled with magma trapped between layers of hard rock. This batholith sat within the ALF and hardened into solid rock.

The Caribbean plate has since continued to push through between the North American plate and the South American plate, causing Aruba to uplift - to rise above sea level. When exposed to the environment above water, the exposed bedrock began to erode - to wear away. The ALF eroded to expose the batholith within. Today the majority of the exposed ALF has eroded, with it remaining most visible in the South end of the island where Arikok Nature Reserve covers large lengths of land (Van den Oever, 2000; Hippolyte & Mann, 2009; Van Der Lelij, et al., 2010; Schmutz, 2017).

### **Gold & Archives**

Gold is a noble metal. During the times of alchemy, gold was personified as a king in artwork, the king of all metals. You could say gold was the greatest of the nobles (Habashi, 2016). Today we understand that gold is often inert – unlike salt which can dissolve easily into water, gold has very few reactants/reagents – and so it can be found in its raw state (in nuggets or flour) and is known to not tarnish, hence its popularity as jewelry. However, that is not a steadfast rule,

which is important to keep in mind when the processing of gold is presented later. Gold indeed can react in response to select reagents (Srithammavut, 2008).

Gold is precious not only for its bright luster, but also its malleable and ductile nature. Malleability references gold's ability to be hammered into thin sheets as fine as 0.1mm thickness. Gold's ductility is displayed by its ability for only 1g of it to be pulled into a wire 3km in length (Habashi, 2016). These abilities have led to gold being used in both décor and art, as well as in gold masks to honor the dead.

What was gold to Aruba though? Gold had no clear value nor played a cultural role on the island, not until a young Willem Rasmijn found a shiny rock whilst crossing a dry river – locally “rooi” – in 1824 (Did You Know, n.d.). At least that is the widely accepted line of events that is shared across the island, and thus 1824 marks the beginning of Aruba's gold rush. From 1824 until 1916, the gold was mined and milled. The owners of the rights to the gold changed hands over time (Stienstra, 1988):

1824-1830	Government
1830-1854	Free gold digging
1854-1866	Concession L. J. de Jongh
1871	Gebrs. Ricketts
1874-1879	Aruba Island Gold Mining Co.
1895-1898	Aruba Agency Co./AIGMC
1900-1908	Aruba Gold Concession/AIGMC
1909-1915	Aruba Gold Partnership

Before proceeding, there is a line from an article published in 1990 that is worth keeping in mind. Much of the archival information comes from reports between the owners of the gold mines and others whose professions surrounded the success of the gold industry. “Note: these production figures were provided for taxation purposes, who knows how much gold really left the island” (Salna, 1990). Another important note to make is that the gold on Aruba was deposited in

quartz veins across the island. Recall the geologic principle of cross-cutting relations and inclusions. The molten quartz was pushed through the existing stratigraphy of Aruba and as it was pushed upwards, gold was carried along with it, hardening into the quartz as the minerals approached the surface.

The early mining on the island fulfills the classic image of gold nuggets in riverbeds – a variation on gold panning (Habashi, 2016). The miners would break the gold ore into smaller pieces then leave them on sheets in the roois. When the seasonal rain of Aruba flooded the river, the lighter clay and rock would be washed away leaving the dense gold pieces behind (Ferguson). According to a report registered on the 15th of April 1872, 21,139 tons of ore was mined (Rule, 1872). However, according to the reports compiled by Stienstra in his 1988 work, it is estimated that only 427kg of gold was milled from those 20,000+ tons of ore. That is just over 0.002% gold to 99.997% quartz vein in the ore. This may be due to the low processing/milling efficiency that gold panning offers.

As mentioned earlier, gold is a fairly inert mineral. It does not react readily with just any addition. So, when the gold processing technique, cyanidation, was introduced, it revolutionized the gold industry. Cyanidation in Aruba was done at two locations, Balashi mill and Bushiribana mill (Derix, 2016b). The process used in Aruba required ground ore to be placed into a tub of cyanide solution, and with regular stirring, the gold would bond to the carbon instead of the quartz. This gold-rich carbon would then be burned off, leaving the gold behind. Over the years, the process has become further refined and to this day cyanidation is still used (Srithammavut, 2008).

An extra detail: slaked lime was used in cyanidation as well to make the process more efficient (extract more gold) (Srithammavut, 2008), and whilst the focus of this text is on gold, it is important to note that slaked lime was also



produced on the island for the same years that gold was mined. Slaked lime comes from the limestone shelves mentioned prior as the third unit of Aruba's stratigraphy. The limestone shelves were mined for their limestone which is burned in a kiln to extract the desired materials (Derix, 2016b; Rosa, 2022) such as slaked lime.

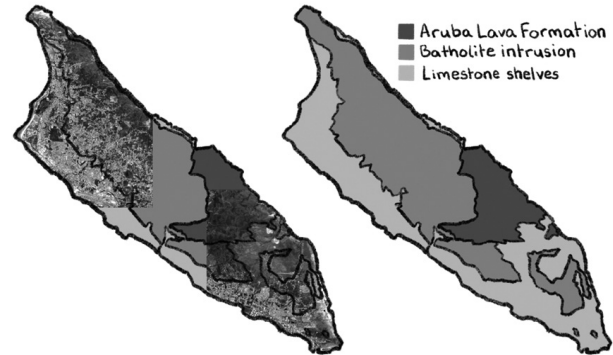
Earlier, it was stated that 427kg of gold were harvested between 1824 and 1872. The years 1874-1898 only amassed 127kg. But in the years 1900 to 1915, over 1000kg of gold was milled, a clear nod to the success cyanidation offered. This success was short-lived, as the First World War meant resources were scarce and gold mining was no longer the priority (Salna, 1990).

Now, in hindsight, was this gold rush actually successful? Of course, the first criticism is that these gold mines were often owned or reviewed by those who benefitted from the colonization of other nations, such as the Dutch or English (England, n.d.; Rule, 1872). The local population was not portrayed in an equal light, being quoted to be "obedient, and very easy to control" in a report (England, n.d.).

The environment also suffered from the cyanidation process. The waste materials (tailings/slag) that remained in the tubs after the gold was extracted scarred the surrounding area; the mangroves took almost 100 years to return to Balashi mill as seen in archival and academic tourism photos (Hutt, 1998). The rocks running between the ocean and Bushiribana mill bear scars etched into itself from the chemicals. Undoubtedly, these tailings/slag likely affected life underwater, too, when the mill was in use.

It is the Batholith and ALF that carry the veins which cross through both urban development (left map) and Arikok National Park. Keep in mind, it was not only the quartz veins that were mined, but also the limestone to support the cyanidation process. Urban development also overlaps with the limestone shelves. It would not only be nature that

would be disrupted but also the people living across the island if gold mining and milling was reintroduced.



Finally, was the gold harvested worth the effort? The quartz vein intrusions that ran for various lengths across the island were recorded by Rule in his 1872 report (Rule, 1872). Using his proposed length and width of the veins, albeit with a large grain of salt, it can be approximated that the gold mine owners were informed that there were some 1,151,399 tons of gold-bearing quartz. That makes the initial 20,000 tons less than 2% of the total ore on the island. It also means that the total gold collected over the years 1824-1915, all 1627.6kg of it, was less than 0.00002% of the total gold-bearing quartz on the island.

Which begs the moral and economic question, was mining Aruba worth it and will it ever be again? Given that its small attempts to revive the industry led to nothing of substance (Salna, 1990), it can be extrapolated that Aruba's value is not in its gold anymore but its golden beaches. Gold mining and milling is expensive and invasive. Destroying an entire ecosystem and excavating millions of years' worth of geologic history morally cannot equate to the gold that may or may not be there if trust was to be placed in reports from 1872.

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## **It was not the smoothest ride**

When I am asked about my experience in Aruba, it always brings mixed feelings. Do not get me wrong, it was a uniquely unforgettable experience that, in the end, I am glad I took part in. However, it was not an easy time. If not, the fact that I struggled through the weeks I spent there, but the fact that I, in the end, decided to leave earlier, should be an indicator that it was not the smoothest ride.

Still, through that struggle, I found amazing experiences. The moment you step out of the airport and the sudden realisation that you are in Aruba hits, everything becomes clear, and the excitement begins. Then, as the days slowly pass, you begin experiencing what the island has to offer. The enriching culture, all the café corners, the bars, discos and restaurants provided me with an incredible “tip of the iceberg” of what it means to be Aruban. The initial stiffness of the locals soon goes away as we start dancing in the middle of a sports café. As people become more and more

relaxed, they show their true selves, dancing along, having fun, and soon the whole café joins in. When we initially felt like outsiders coming to this local bar in Rancho, we ended up meeting people, dancing, and bringing some happy vibes to a starry night.

I also got to meet wonderful people whose efforts are pushing for a better island. I have always been passionate about Nature, and this program made me understand how much I want to follow ecological and conservation studies. To be able to bring stability and beauty to an environment through reforestation or simply through nature conservation is a fantastic feeling. I got a sample of that when tagging along with Ban Lanta Y Planta, a local reforestation project active on the island. As I took part in their efforts, I quickly realised that I could see myself doing this for a large part of my life. Not only that, but Arikok Park is a wonderland of natural, beautiful, but still aggressive landscapes, with

amazing views and fascinating landscapes. As I climbed the highest point and looked at the view, with the wind hitting me strong, I realised this was the spot where I wanted to do research and contribute to understanding such a complex and beautiful place.

On the other hand, Aruba gave me a struggle that I had never faced before. Being that far away, and not being able to feel at home was something hard to deal with. Now, when I look back at it, I realise how much it made me grow as a person. I learned a lot about myself, how I operate, how things affect my feelings and moods, and that was a tremendously important step for my individual development. I am genuinely grateful I went through it in the end because it made me grow in ways I was not expecting.

So when asked, would I have gone if I knew what it would bring, I would say yes! With all considered, Aruba and this program made me understand what I want for my future and how and where that can happen. Still, it was hard to give up on this opportunity halfway, as most expectations

were of Aruba being this amazing experience that everyone enjoys. It took strength that I doubted I had to step back, reevaluate and decide to return. I am grateful for the experience and grateful for everyone I met during this time. What a place!!!

# Winds of change in Aruba: A Push for Higher Biodiversity

Joao Rafael Wendrich Teixeira

## Introduction

The global expansion of our species has resulted in large scale alterations to the world's ecosystems. Our activities over the centuries have resulted in resource extraction and land occupation, accompanied by their destructive effects (Boivin et al., 2016; Csaba, 2019; IPBES, 2019). Very few places on Earth can be considered pristine, with our reach touching almost all environments. With this destruction comes species extinctions. Anthropogenic extinctions have been occurring since the beginning of human history. These first extinctions coincide with early human achievements such as our global dispersion in the late Pleistocene, the spread of agriculture in the Early Holocene and the settling of the world's islands during the Holocene. One of the most prominent examples is the disappearance of large mammals caused by human hunting and expansion (Boivin et al., 2016). Still, the most significant damage to nature occurred in the last couple of centuries (Csaba, 2019). Globalisation and the linking between all parts of the world sped up this effect, where our activities allowed for species to be moved, which profoundly altered the composition of ecosystems (Boivin et al., 2016). This destabilisation, accompanied by habitat destruction, pollution, and climate change, has resulted in the most significant number of species extinction. According to the IPBES report (2019), 75% of terrestrial environments have been severely

altered, with oceans having 66% of their environments altered by human activity. Around 1 million species are threatened with extinction, most in the upcoming decade, something unprecedented in human history (IPBES, 2019). A behaviour change has begun in the face of eradication, with conservation and restoration efforts becoming more present. These efforts hope to prevent or slow down this decrease in wildlife.

One such effort can be seen in Aruba. Aruba's long history of negative impacts on nature created the need for its restoration. One effort that attempts to restore forest biodiversity and stability is Ban Lanta Y Planta. This reforestation project aims to plant native tree species, restore biodiversity, and increase awareness. Still, it is important to understand how ecosystems naturally become biodiverse, what influences them and what can be learned from them. One factor influencing plant community is wind (Gardiner et al., 2016). This research project focuses on studying wind's possible effects on a naturally grown ecosystem in Aruba. The wind is expected to negatively affect biodiversity, resilience, and plant density, with its effects being more substantial at shorter distances from the coast. By means of a literature review complemented with field research data analyses collected in Aruba's Arikok Park, this paper aims at answering the following research question: How do the constant winds shape and affect the

natural biodiversity and resilience of a naturally grown area in Aruba, and how can this information be applied to a reforestation/conservation project initiative?

## Literature Background

One of the most destructive activities that have a significant impact is vegetation removal, mainly in the form of deforestation. Deforestation is characterised by the long-term conversion of natural forests to other forms of land use by removing vegetation cover (Csaba, 2019). Deforestation can be human-induced through direct efforts and indirect impacts, such as human-induced climate change. On the other hand, deforestation can be a natural process caused by fires, droughts, or pests (Csaba, 2019).

This loss of habitat is always accompanied by a decrease or loss of ecosystem services. Ecosystem services comprise benefits to both human society and the living beings of an ecosystem that can be obtained from the interactions and functioning of biological and physical processes in an ecosystem (Csaba, 2019). These services can have a regulating function (cooling, pest control or natural heating), providing function (water, food and medicine) or supporting function (nutrient cycling, air purification and soil formation) (Csaba, 2019). Even in the case of the forestry industry, where forests are constantly being replanted, the ecosystem services it provides are minimal compared to a naturally grown forest. These monoculture forests contain fewer species, mainly comprising one major plant species. Ecosystem services require interactions between species and the environment. This loss of biological diversity - biodiversity - in ecosystems is accompanied by the loss of services these species provide (Csaba, 2019). Habitat loss thus puts at risk the provision of essential services for our survival and the survival of all species present in each ecosystem. This land degradation – a decrease in ecosystem productivity - could lead to a destabilisation of ecosystems, and a shift in the ecosystem conditions, bringing it into a new stable state.

Each ecosystem tends to have two or more stable states. This stability is defined by the system's resistance, resilience, persistence, and (in)variability (Donohue et al., 2016; Radchuk et al., 2019). These four characteristics of stability ensure that the multidimensionality of a system is captured and considered. A stable state of an ecosystem is characterised by having the ability to maintain its system conditions when under the effect of small and slow disturbances (Cardinale et al., 2012; Donohue et al., 2016; Lenton, 2013; Radchuk et al., 2019). If the disturbance is strong enough to go over a tipping point – a point that defines the limits of 2 stable points – it will result in drastic changes to the ecosystem's biotic and abiotic conditions and structures. This crossing of a tipping point is caused by a positive feedback loop – a system interaction that continuously amplifies the initial perturbation, thus strengthening the initial disturbance (Lenton, 2013). Thus the return to the initial conditions becomes hard to achieve, even with the cessation of the disturbance, as extra effort/change is needed to return to the initial conditions (Chen et al., 2015; Donohue et al., 2016; Lenton, 2013). It is hard to determine when a system is at risk of going over a tipping point, and ecologists rely on early warnings. These consist of early changes in the system that is being disturbed and correspond to the most sensitive parts of an ecosystem. Such early warnings can be, for example, a change in vegetation cover patchiness which can occur in semi-arid environments.

According to the insurance hypothesis, ecosystem conditions, services, and properties will undergo less variation when disturbed, with a more biodiverse community of species, due to the likelihood of species containing redundant traits contributing to the same ecosystem service. Thus, the extinction of a species will not affect the provision of a service as there is a high likelihood that other species will fill that niche and continue providing said service (Loreau et al., 2021; Yachi & Loreau, 1999). This effect and redundancy contribute to the resilience of the ecosystem. By ensuring the maintenance of essential ecosystem services, the system



will be less prone to extinction and destabilisation. Thus, the higher the biodiversity in an ecosystem, the more resilience that ecosystem has, and thus the less likely it will be to shift to an alternate stable state due to natural or human disturbances (Cardinale et al., 2012; Duffy et al., 2017; Loreau et al., 2021; Rosenfeld, 2002; Yachi & Loreau, 1999).

Looking at the case of Aruba, this small island has seen much disturbance, both natural and human-induced. The current environment in Aruba is that of a semi-arid environment, with low precipitation and drought-resistant vegetation. Although this is the island's current state, the conditions appear to have been different in the past. According to soil data and the presence of fern spores, Aruba likely presented a more humid, wetter environment close to that of a tropical dry forest (van Nooren, 2008; Veerbeek, 2016). This shift seems to be caused by centuries of human impact. These factors that disturb Aruba's vegetation include overgrazing by invasive goat and donkey species, habitat fragmentation, road building and urban expansion, and off-roading and tourist activities. These disturbances put continuous pressure on these habitats, resulting in vegetation cover decrease, reducing the regeneration and recovery of tree and shrub species, increasing grass dominance, and altering plant species composition (Denters, 1979; Veerbeek, 2016). This effect, mostly seen between 1957 and 1977, resulted in a decline in species richness (Verbeek, 2016), but this is an effect still seen to this day.

A shift in behaviour has started to surface in Aruba in the last two decades. The creation of the Arikok National Park in 2000 initiated an effort to conserve and protect Aruba's natural flora and fauna. This park, which comprises 34 km<sup>2</sup>, put a brake on the urban expansion and deforestation of the area, and over the years, they have pushed for the restoration and protection of this area (Aruba National Park Foundation, n.d.). Another effort that has already been mentioned that started in the last two years is Ban Lanta Y Planta! (Trees for Aruba). In its infant stages,

this project has four clear goals: Restore the tropical dry forest landscape that once covered the island; stimulate biodiversity; fight climate change; raise awareness of the need for conservation. They are actively growing native tree saplings and planting them in selected areas. At the same time, they are ensuring a biodiverse plantation that contains not only native species but also provides essential services while creating habitats for local fauna (Trees For Aruba | Ban Lanta Y Planta!, n.d.). This project thus has the potential not only to carry out its objectives but also to increase community involvement and awareness.

Projects like Ban Lanta Y Planta are essential to reduce and revert the effects of disturbances on ecosystems. In the case of Aruba, where deforestation caused the most considerable disturbance, reforestation is a method of ecosystem restoration to reverse the degradation of ecosystems and regain the functioning of said ecosystem by increasing productivity and by ensuring the capacity of the ecosystem to support all species dependent on it (Environment, 2020). Another method of ecosystem restoration is afforestation, where trees are planted in areas where they were never present. These two methods aim to increase plant community biodiversity, if not done for wood production, which brings all the effects mentioned earlier in this paper. These reforestation projects require careful consideration, and the relevant factors influencing them need to be studied beforehand to prevent further damage to the environment (Cao et al., 2010)

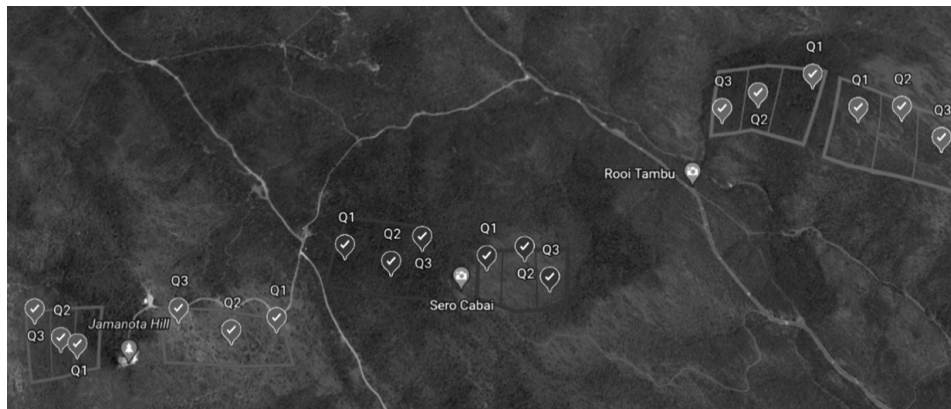
A factor that has a potentially significant effect on Aruba's vegetation cover is wind. Wind in Aruba comes from the NE/E direction, with almost constant strength all year round, with rare alterations in wind direction when major hurricane events occur in the proximity. Wind has strong altering effects on plants' physiology by causing branch and leaf damage or altering the growth and shape of trees (Du & Hesp, 2020). Wind is also known to alter the abiotic conditions by decreasing soil evaporation time and thus increasing the loss of soil humidity. This

decrease is exponential as wind speed and strength increase (Davarzani et al., 2014; Du & Hesp, 2020; Négyesi et al., 2021). Another significant effect that causes harm to plants is salt spray. Salt spray consists of transporting salt particles by wind that reaches more inland areas, causes osmotic damage, and induces plant mortality if in excess (Du & Hesp, 2020). Considering the constant wind direction, it is expected that wind salt spray occurs on the NE/E coast of Aruba, similar to Barbados, where the island's leeward side had minimal salt spray, primarily due to wave breaking action. An increased salt concentration causes reduced growth and plant reproduction, eventually leading to leaf necrosis, decreased water use efficiency, photosynthesis and stomatal conductance (Du & Hesp, 2020). The combination of salt spray and wind speed also results in asymmetrical plant growth. Areas closer to the ocean present a prostrate (at ground level) growth, with windward branches being mostly leafless. This decreases as distance to the ocean increases, with only smaller salt particles reaching more inland areas, where trees become taller.

With a better understanding of how ecosystem stability functions and what can alter this stability, the next section will go through the approach taken in this research.

## Approach

The chosen approach to answering this question consists of data collection in Arikok National Park. The fieldwork consisted of 2 steps: First, measuring biodiversity in 3 pairs of slopes, each pre-selected in advance. Each pair consists of 2 slopes, one windward (facing NE) and one leeward (facing SW). This is done to reduce variability between opposing slopes, as the slopes in each pair are measured in the same area and at similar distances from the ocean. The pairs of slopes are gradually located closer to the ocean, thus obtaining a variation in wind exposure and wind strength. Three, 10 by 10m, squares were randomly selected within each slope. These squares comprise the sampling areas, giving a total of 300 m<sup>2</sup> area sampled per slope (totalling 1800 m<sup>2</sup> of sampled area between all slopes). These quadrants were measured and delimited by markings in each corner. Inside each quadrant, all major tree, shrub and cacti species were identified, and their population was counted and noted down. Only these types of vegetation were counted, as these comprised the majority of the ground cover in the area (Oosterhuis, 2016). Another important factor is that trees and shrubs are the focus of the reforestation efforts of stakeholders.



The data was collected in 3 areas along a line parallel to the coastline, as highlighted in figure 1.

The collected data on population count was then used to calculate the slope's biodiversity using both the Shannon and Wiener index and the Simpson index. These two indexes rank each slope's biodiversity level using specific formulas (Spellerberg & Fedor, 2003).

The second stage of this research identifies and compares the presence of trait redundancy between all six slopes, with wind exposure under consideration. Firstly, all species were identified, either on the field or during the data processing stage. Then a set of traits were pre-selected, which represent major ecosystem services. These consist of nitrogen fixating capabilities, plant height, water-storing tissue, canopy size and photosynthesis method. Afterwards, using a book describing the flora of Aruba (Proosdij, 2012), each species was matched/described concerning the pre-selected traits by using the general description found in the book (or supplementary information obtained from discussions with the stakeholders). Next, each trait was defined as a binomial variable or scale value. This information was then used to calculate functional trait redundancy. This was done using formulas describing the functional diversity index and the already calculated Simpson index, with functional diversity (FD) comprising the difference between these two indexes (de Bello et al., 2007; Lepš et al., 2006). The value obtained represents the similarity in traits between the identified species.

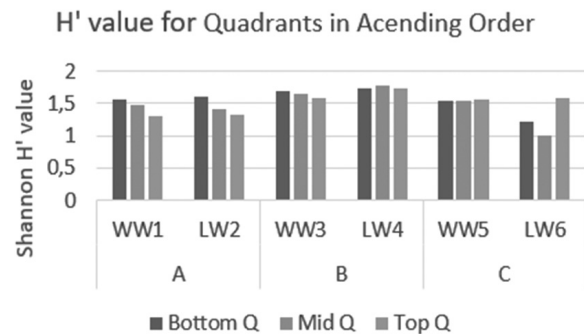
These calculations provide a view of the state of biodiversity and trait redundancy in these slopes. Furthermore, statistical analyses, using a paired-samples t-test, will be used in the future to identify if there is a significant relation between wind exposure and biodiversity level, plant density or functional redundancy. An ANOVA will also compare all slopes with the same exposure, thus comparing all windward slopes and leeward slopes. From these results, it will be possible to compare resilience between the slopes. Resilience will be higher when biodiversity and trait redundancy is high (Loreau et al., 2021; Yachi & Loreau,

1999).

## Preliminary results

Due to time constraints, the data has not been thoroughly analysed, as the statistical step of the analysis is missing. Nonetheless, the collected data was analysed using the following steps: calculating the Shannon and Simpson biodiversity index and the Functional diversity index. The data was organised by pair of slopes. Thus, the furthest from the ocean, pair A consists of slope WW1 (Windward) and LW2 (Leeward); pair B consists of slope WW3 and LW4; pair C consists of slope WW5 and LW6. Each slope comprises three quadrants organised from bottom to top (concerning its location within the slope). Because the two biodiversity indexes are similar, only the Shannon index results will be analysed.

There is an apparent decrease in  $H'$  value regarding the Shannon index results, from the bottom quadrant to the top quadrant, with pair A having the most notable change and Pair C being outside of this trend (Figure 2a). For the slope's  $H'$  value, two methods were used to obtain this: The first consisted of averaging the  $H'$  values of all three quadrants. The second consisted of calculating  $H'$ 's value with all three quadrants' data summed together. This resulted in slightly different values but a similar trend along the slopes (figure 2b).



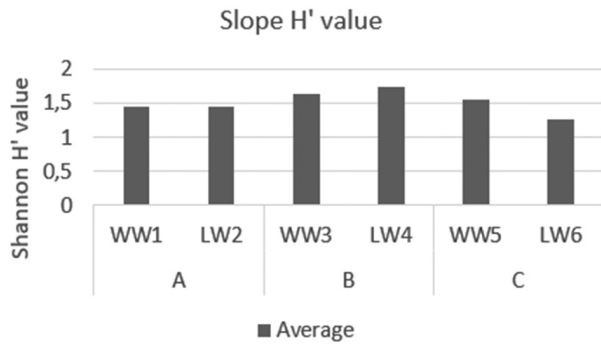
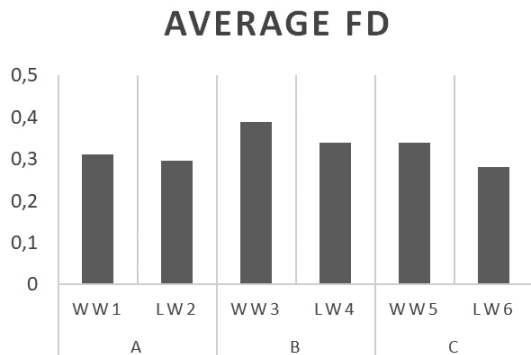
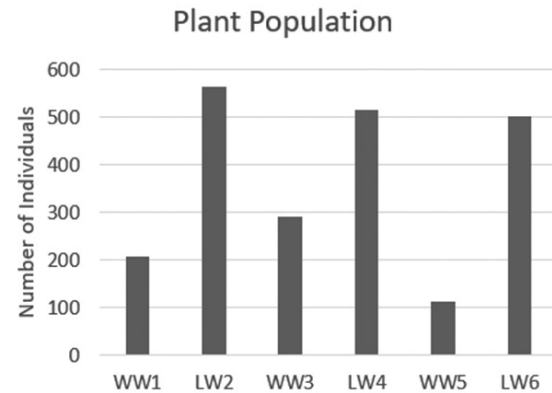
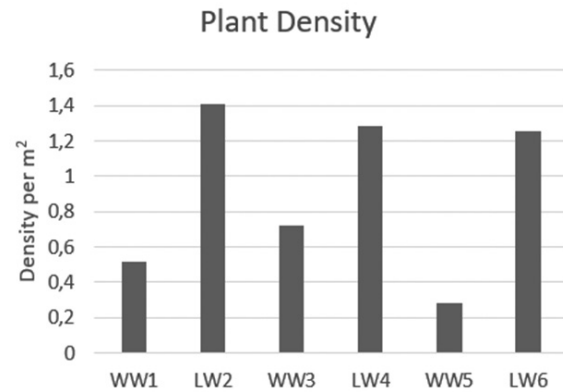


Figure 2a, b - Shannon index of all quadrants in each slope, ordered from bottom (of the hill) quadrant to top quadrant (a). Shannon index values for the slope itself, both the average from all quadrants and total value (calculated by joining all data from every three quadrants) (b)

The last index calculated, the Functional Diversity index, resulted in the values found in figure 3. The average FD value for each slope was calculated by obtaining the mean of all FD values for each chosen trait. The FD index determines how much functionally diverse a slope is. Results show that Pair B presents the higher functional diversity, with slope 6 having the lowest value and slope 3 having the highest value.

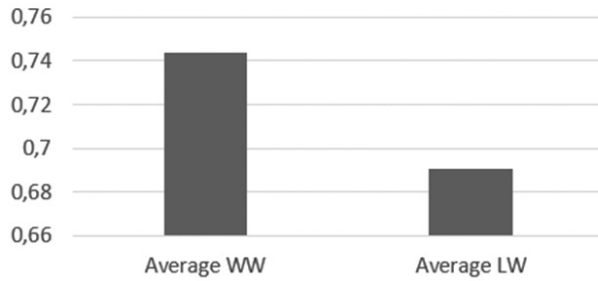


Figures 4a and 4b depict the total population data and the plant density on each slope, respectively. Plant density was calculated based on the total area sampled, which amounted to 1800 m<sup>2</sup>. Leeward (LW) slopes present a much larger population and thus density values compared to the windward (WW) slopes.

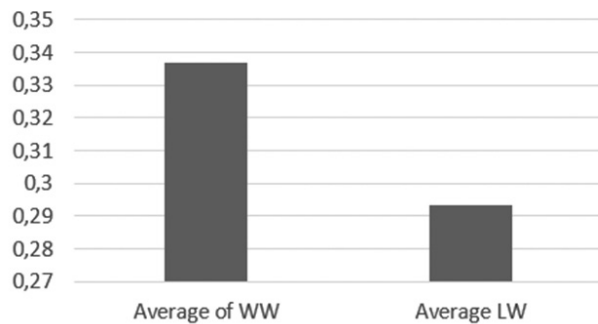


In Figures 5a, b and c, the differences between the calculated average values of the windward slopes and the leeward slopes can be found for Functional Diversity, Shannon index and Simpson index. These three graphs show a similar difference between the windward and leeward slopes in all three index values. Graph d demonstrates the values of that difference, with all values being close to each other.

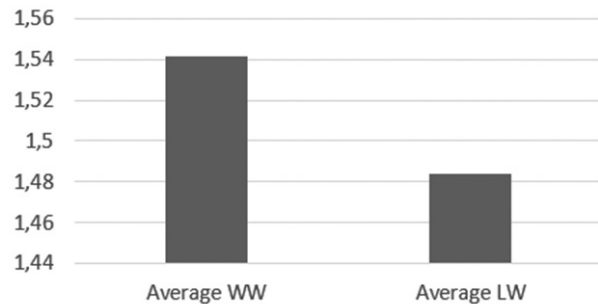
Simpson Index Average for Both Exposures



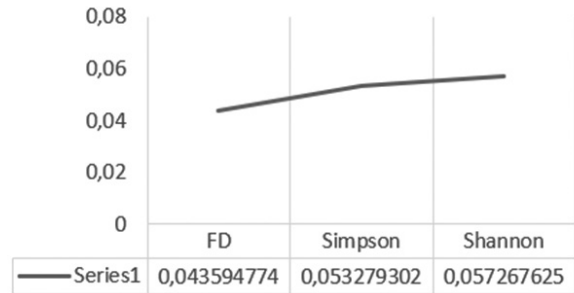
FD Average for Both Exposures



Shannon Index Average for Both Exposures



DIFFERENCES BETWEEN WW AND LW AVERAGES



## Discussion

Firstly, it is important to realise that no conclusive remarks will be made because the data analysis has not been completed. Nonetheless, remarks can be drawn from these preliminary results. Regarding the within-slope variation, and considering that it was expected that the top quadrant presented the lowest biodiversity level, only Pair A (figure 2a) seems to show an apparent decrease as elevation increases. In contrast, the other slopes show a decreasing trend as the distance to the ocean decreases. For the Simpson index, this trend is not clearly visible, which confirms that even though these two indexes both calculate biodiversity, there are variations within their calculations. In all indexes, Pair B shows the highest values, while according to the hypothesis, Pair A would be the pair with higher values. Unfortunately, due to the size of the sample and the possible presence of outliers, no conclusion can be drawn from this observation. The within-pair comparison shows that the difference between each pair's WW and LW slopes exhibit minimal variation: either the values were similar or the WW slopes had a slightly higher value. This goes against the hypothesis, as it was expected that the sheltered slopes (LW) would contain higher biodiversity and functional diversity.

Slope 6 presents an abnormality compared to the trend of the other slopes. There is considerable variation between its two quadrants, seemingly without following any elevation trend. This could be due to unknown disturbances that might have occurred in this slope, thus being an outlier, or it could also be a possible effect of the wind. No clear conclusion can be made, but it is nonetheless possible that the short distance to the ocean and the relatively higher wind speed and strength could have caused this shift in plant community composition in slope 6. The major difference between the WW and LW slopes appears in the population counts and density calculations. As seen in figure 4, all LW slopes have a much higher population count than the WW slopes. This follows the hypothesis that wind is expected to reduce the number of individual plants present, thus affecting plant composition. This effect is most potent in the exposed slopes (WW). An interesting trend appeared regarding the comparison between the WW and LW slope's average difference. This difference, seen in figure 5, appears similar between all three indexes.

From these results, a couple of remarks can be made. First, wind appears to affect population and population density clearly, but this has to be confirmed with statistical analyses. Second, wind appears to have no effect or an opposite effect on the biodiversity levels of exposed and sheltered slopes. Finally, it is important to note that there is an overall herbivore pressure in Arikok, mainly from goats; its destructive effects reach all park areas and are considered equal in strength between the sampled slopes. These goats affect the composition of the plant communities, especially when considering that the majority of plants present are those with spikes and thus could potentially be more resistant to this herbivorous pressure. Thus, goats have considerably shaped this plant community since the beginning of its recovery, 70 years ago. Nonetheless, because the pressure is deemed equal within the whole park, any differences in plant community structure between slopes have potentially different catalysts. Considering this and the

information obtained from the literature, the wind seems a likely candidate for this difference. Still, these results do not allow for conclusive remarks, as statistical analyses are required, and a more extensive scale study would be needed to confirm these ideas.

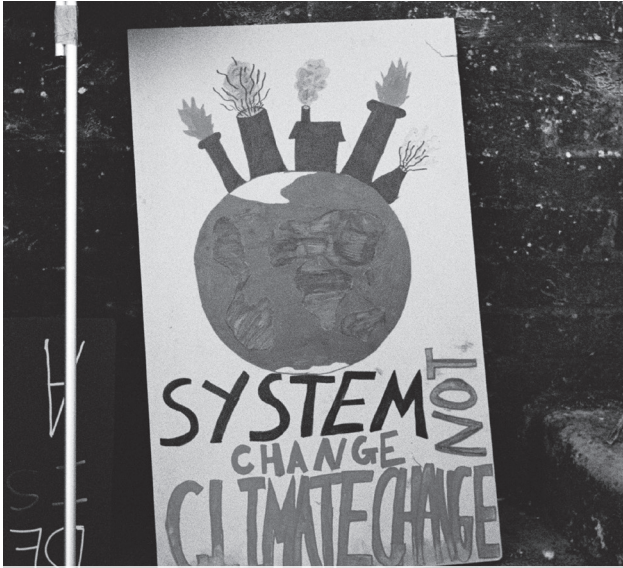
With these interpretations in mind, and considering the limitations of this research, it is clear that wind affects plant composition in Aruba. Biodiversity and the resilience of the ecosystem do not seem to be strongly affected by wind, but only with further research can this question be answered. If focused on the island's windward side, this data and information can be necessary to reforestation efforts. Here, tree planting needs to consider the reduced humidity, increased salinity and constant damage from wind. Solutions to reduce these effects are required to ensure a successful establishment of planted trees. Methods can be developed to reduce evaporation and shelter trees from wind by using artificial wind shelters or natural (such as already established trees). This would reduce the stress on the physiology of the plant, such as bending or breaking, and reduce the salinisation of the plants, as a reduction of direct contact with wind reduces the absorption of salts by leaves. All this can create conditions that potentially allow for the facilitated natural establishment of trees and shrubs, as services will begin to be present, providing needed conditions for these plants. Finally, it is also vital to consider coastal restoration. By conserving and restoring coastal and dune vegetation, wind strength and direction will be altered and become less effective at damaging inland plants. Not only that, but it will also reduce salt spray and thus ensure a less harsh wind effect.

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Tracy van der Biezen, University of Aruba

## **It feels good to do research on topics you care about**

This research project and subsequent paper as presented in this book was certainly a learning experience. Having previously done research using systematic literature review, this was only my second introduction into this topic (and my absolute first into citizen science), and yet I had decided that my thesis (and this paper as a subsection of my thesis) was the direction I wanted to take. When doing research, one finds that there are limitless unknown unknowns, the methodology went through endless revisions, there were bits and pieces that of everything couldn't make it in and considering the scope of the results that would have come with applying the project, hard choices had to be made in what would in the end form this final paper. There's a lot of difficulty in wanting to do something new and wanting to do it right, certainly I had written about the Sustainable Development Goals before, but not in this Depth and not about the indicators. In the same manner I had used PRISMA (the chosen systematic review methodology)

before and so I thought I could copy-paste it onto my existing project, adjusting where needed. Case in point: unknown unknown. In the end as a researcher I am most pleased that I got to do what I wanted and that the points I make and defend are ultimately ones I truly stand behind. I do believe this framework can be successfully applied and I find that the results it shall produce will be useful. I'm certain that further research I do on this topic will add to the total knowledge in sustainability and add in a manner that matters. In addition, I also got to bring citizen science to the forefront, research that focuses (sometimes) on democratizing science, but certainly has an air of science aimed at improved equality and equity.

What has this project taught me? It feels good to do research on topics you care about, the discourse is clearer since you've read more of it, the extra effort is put in to understand what you don't, because it's important, how dare you do anything

halfway? A second thing is that research always takes a lot more time than you think it does. Before formulating my methodology even, I had spent weeks trying to narrow the scope, changing the direction, changing the research question, changing the visualizations of the paper. There is so much to be done before even starting to research to then go into writing that It's always a realization that research, no matter how often you've done it before, takes time. Other lessons I learned are 1) that research is rewarding yet draining, 2) over half the papers you thought you'd include end up being irrelevant, and that 3) trial and error are the backbone of society. Or at least, the backbone of my research projects.

# A Scoping Framework for SIDS

## How can citizen science projects contribute to (Aruba's) SDG indicators?

Tracy van der Biezen

### Introduction

The Sustainable Development Goals (SDGs) are a set of targets set for 2030 by the United Nations (UN) for international development to proceed sustainably, created in 2015 (*Transforming Our World: The 2030 Agenda for Sustainable Development* | Department of Economic and Social Affairs, n.d.). These are, as is in the name, goals for nations to reach as an assurance that their development proceeds sustainability. These sustainable development goals are relevant to Aruba's position as a Small Island State (Sustainable Development Knowledge Platform, n.d.). Aruba has also in turn committed to being a model for sustainable development in SIDS, showing overall a dedication to research in implementing these SDGs (SustainableSIDS.Org – Online Platform of the Aruba Centre of Excellence for SIDS, n.d.).

An important part of reaching a goal is to be able to measure your distance to it, and what data is available to use for this measurement. This is what was done with Aruba's Baseline Measurement Report (SDG Commission Aruba Indicator Working Group, 2018). In this report, data collected and compiled by Aruban government institutions was used to fill the indicators, showing where the data for these indicators exists, alongside how many goals could be measured. However, looking at the report shows that for

a group of these indicators the data to fill these indicators does not exist. One way to fill this data gap is the use of citizen science, a two-pronged approach. Firstly, it puts the science in the hands of citizens who have the betterment of their nation at heart, and secondly it allows for more manpower to be committed to collecting SDG relevant data. In this research project, the issues surrounding SDG indicators, the position of SDGs on Aruba, the applicability of citizen science as well as the methodology chosen for the framework will be discussed further below.

### SDGs on Aruba

The timeline for SDGs on Aruba started in December 2016, when the SDG commission of Aruba was formally established (Algemene Rekenkamer, 2018). This commission provides strategic direction, manages the implementation of these goals alongside writing reports, reporting to the ministers, who are represented in the commission. Not all ministries are involved in sustainable development - as is proposed in the SDG roadmap - and there is no uniform approach in policy between the ministries. To remedy this, in December 2016, an indicator working group (SDG-IWG) was established to coordinate and monitor the data collection in relation to the SDGs.

The SDG-IWG consists of stakeholders from different government departments that report directly to the SDG-

commission. The IWG's main role is to coordinate and monitor the data collection and to establish the SDG indicators for Aruba. The SDG-IWG performed a baseline measurement in 2018 to establish the SDG indicators for Aruba. The baseline measurement results served as a basis for the measuring and monitoring of progress and also provided a better view on the areas that still need further attention on data collection (SDG Commission Aruba Indicator Working Group, 2018).

The SDG-IWG conducts feasibility studies for bottlenecks and/or needs for indicators on Aruba evaluating what the best methodology is for application of further research.

### **Citizen science**

Citizen science is the name for research done where volunteers conduct the data collection. It is a common approach in geographical and ecology research (Kullenberg & Kasperowski, 2016). Citizen science is known by a multitude of names including but not limited to “public participation”, “voluntary contribution” and “knowledge production”. Previous research has already shown the value of citizen science in relation to SDGs (Fraisl et al., 2020) (IEAG, 2014) (Flückiger & Seth, 2014) though it has yet to be introduced in official methodology.

Citizen science has two general views that can exist in conjunction or separately: one on hand democratization of science for the general populace and on the other productivity of traditional scientific research (Sauermaun et al., 2020). Democratization strongly focuses on having the volunteers work towards education and empowering their relationship with science, while the productivity view strongly focuses on benefits received from the data collection conducted by volunteers.

Following the productivity view as described by Sauermaun et al. (2020), Citizen science generates a lot of in-kind value where projects can (in the United States) exceed federally

funded research both in spatial and temporal extent (Theobald et al., 2015). However not many of these research projects reach scientific publication (approximately 12% in biodiversity projects), suffering from a lack of scientific rigor and public availability of the data (Theobald et al., 2015). The growing movement of citizen science however is opportune for being repurposed for policymaking and for the development of baselines where funding is limited. The idea behind employing citizen science for SDG indicators is to both empower and educate volunteers by integrating them into scientific research that they can use for their personal growth, and to allow them to collect valuable scientific data and therefore add to the productivity of their nation.

### **SDG indicators**

Aruba has a dedicated SDG commission focusing on highlighting projects that support the SDGs alongside producing publications on the state of SDGs on Aruba (Algemene Rekenkamer, 2018). The SDG commission itself is supported by governmental institutions: the SDG secretariat, the SDG advisory board and the Scientific Board for Sustainable Development (Government of Aruba, 2018). A combination of this Commission and the governmental institution came together in 2018 in order to form the baseline measurement for the SDGs in 2019.

According to the SDG baseline indicator report, there are a total of 231 unique indicators, of which some repeat leading to 247 indicators across the overall 17 goals. (SDG Indicators — SDG Indicators, n.d.) . The indicators are further classified in a tiered system alongside a letter system. The tiered system is to explain how standard or exploratory an indicator is, with Tier I indicators being the most standard and Tier II indicators being the most exploratory. Tier I indicators are conceptually clear, their methodology and standards are internationally established and available, and 50% of countries where the indicator is relevant produce the relevant data regularly. Comparatively Tier II indicators are also conceptually clear but only have

an internationally established methodology and standard, but no regularly produced data while Tier III indicators have no internationally established methodology or data, being the most exploratory indicators (SDG Commission Aruba Indicator Working Group, 2018). The letter system instead focuses on the availability, applicability, and relevance of data to these indicators. Indicators with the letter A are the only indicators for which the data is being produced, for the remaining letters B and C, these indicators do not exist. C is furthermore split into C1 and C2. For the letters B and C1, there is (some) data available for which the indicator could be produced. For B it is a simple matter that the indicator has not been produced yet, for C1 further refinement is required to produce the indicator. For the remaining letter category C2, the data to produce the indicator is unavailable. The remaining indicators that do not have one of these letters are marked as Not Applicable.

For Aruba, the issues with these indicators are varied: the baseline indicators used are not necessarily aimed at measuring a single country's progress in SDGs. Considering their global nature there are existing indicators such as "Mobilized amount of USD per year between 2020 and 2025 accountable towards \$100 billion commitment" which have no applicability to Aruba, but nonetheless cannot be counted as indicators filled in as they are not applicable. Following this it is hard to draw proper conclusions from the number of indicators that are measured without checking each of the 200 plus indicators individually for their applicability.

Another angle to approach is that these goals are conceptualized with large nations in mind, and for small island states such as Aruba equivalent indicators have to be reformulated to properly measure progress.

This is one of the issues when looking at SDG indicator measurement in small island states. Other issues include but are not limited to: the data-collection and dissemination

burden put on governmental institutions on top of their existing responsibilities, the cost of financing research into indicators and research methodology and any required modifications for indicators to be applicable for Aruba's small island scale (SDG Commission Aruba Indicator Working Group, 2018). The bottom line is that at this moment there is no outlined path forward for the data collection to formulate the lacking indicators other than new work orders from the Aruban government (or from the SDG commission) at this point in time. For this reason this paper explores the potential of the application of citizen science for data collection as described in literature, more specifically for its application in formulating SDG indicators for SIDS.

### **PRISMA and Scoping Reviews**

PRISMA is a type of systematic literature analysis where specific research papers are reviewed under an overarching theme). PRISMA was originally and currently is most used in medicine research (Tian et al., 2015), but has been applied in ecology research as well (O'dea et al., 2021), and several citizen science meta-analysis articles reviewed during the research also used PRISMA methodology (Eitzel et al., 2017; Kullenberg & Kasperowski, 2016; Wiggins et al., 2018).

PRISMA, tends to focus on a type of exposure or intervention (Tricco et al., 2016). The goal of the framework described in this paper is not to see a particular effect of any specific exposure or intervention on citizen science in SIDS but rather to identify particular patterns found in citizen science projects in SIDS. This is done in the form of a framework following the scoping PRISMA methodology. In this paper the research question posed and answered is: "What form does a framework scoping citizen science projects for SDG indicators take?"

## **Methodology**

In order to analyze existing concepts in the overarching field of citizen science in SIDS, Preferred Reporting Items

for Systematic Reviews and Meta-Analyses (PRISMA) methodology for scoping reviews was used (Tricco et al., 2018). Instead of systematic reviews, scoping reviews are conducted in areas where there are knowledge gaps, to identify and map existing knowledge, acknowledge, or identify trends, and/or as a precursor to systematic reviews (Munn et al., 2018). In this case the scoping review aims to identify trends in citizen science projects in all Small Island Developing States (SIDS). This review aims to map a body of literature with relevance to a time and location, namely the body of literature on citizen science in SIDS in the past 3 years. A protocol was formed based on Peters et al. (2020) where population, concept and context are recommended to guide inclusion criteria. In this paper the population was scientifically published citizen science projects in the last 3 years.

The cumulative inclusion criteria for the scoping review were:

- Quantitative and qualitative articles on a specific case study
- Citizen science projects where volunteers gathered the data used in publication
- Country where the citizen science project took place must be one of the 58 Small Island Developing States

Exclusion criteria included:

- Non-qualitative or quantitative articles e.g., protocols, meta-analysis, peer reviews
- Citizen science projects where the participants were the subject of the study
- Studies that included a non-SIDS nation in their study

Inclusion criteria were formed based on the research question:

- “What form does a framework scoping citizen science projects for SDG indicators take?”

Web of science was chosen for being the most recurring database found in citizen science meta-analysis in articles

analyzed for this paper. (Eitzel et al., 2017; Kullenberg & Kasperowski, 2016; Wiggins et al., 2018). The list of SIDS was pulled from the United Nations website of SDGs (Sustainable Development Knowledge Platform, n.d.) The search string used the most common terminologies used for citizen science projects as found in a meta analysis conducted by Kullenberg & Kasperowski (2016) using their original search string and the terminology found during their first snowball. Additionally the search string was added to by including synonyms alongside terminology found while previously scoping citizen science case studies. Upon inclusion, the categories in the table below were registered for each individual paper. Categories were created based on prevalent themes found in case studies, categories found to be impactful from specific research articles (both case studies and systematic reviews), and a category in relation to SIDS and SDG indicators.

These categories were formed from a literature review and selected via discussion groups and methodical testing. In order to test the selected categories and the first draft of the framework, a pilot was run using the journal “Citizen science: Theory and Practice” as a database. This journal being an open access journal focused on citizen science case studies (*Citizen Science: Theory and Practice, n.d.*). The pilot study found that when categorizing the case studies from the open access journal there were issues with ease of input, data reliability and room for error in interpretation. The issues found during the categorization led to a revision of categories, focused on streamlining future categorization and improving accuracy. A second revision happened upon receiving feedback from a second researcher leading to a framework containing the final categories as visualized in the table below. That framework could subsequently be tested, as will be explained in the next section of this paper. Categories formed from prevalent themes in case studies

Demographic data (author/research location, scale, duration of participation, quantitative or qualitative research, thematic)

<i>Facilitation for compensation</i>
<i>Overall communication and feedback</i>
<i>Category formed from existing research papers</i>
<i>Intended Outcome/Goal (Sauermaun et al., 2020)</i>
<i>Could contribute to SDG indicators (Fraisl et al., 2020)</i>
<i>Participant motivation (Wehn &amp; Almomani, 2019)</i>
<i>Change in participant motivation (Carballo-Cárdenas &amp; Tobi, 2016)</i>
<i>Self-formed categories for research question</i>
<i>SDG indicator mentioned</i>

Table 1: Categories used for the framework

## Results

### Results in testing of the framework

An initial test of the framework demonstrated that it was very common for a select number of categories to require multiple selections instead of a standardized one. This was most clear in the categories concerning communication and participant motivation to where multiple selectable approaches co-existed. Instead of one clear communication strategy or participant motivation it was more common for there to be a combination of two or three options. This was then improved upon by expanding the two of the existing categories into yes/no style categories which more clearly allowed for multiple selection underneath a new branch category. Previously the categories would have led to a single approach or option being selected, but post revision the previous options became subcategories. This led to better being able to indicate whether a particular option was found in the research article or not. The final framework contained 3 areas concerning demographic data, four areas pulled from existing research papers and a framework specific category in SDG indicator mentioned.

### Potential results from the framework

The goal of this framework is to find patterns in the existing literature in citizen science. Previous research has found that terminology is both inconsistent but important (Crain et al., 2014; Eitzel et al., 2017; Kullenberg & Kasperowski, 2016). This inconsistency and importance is both in what defines that something is citizen science as well as terminology used in citizen science projects. Citizen science has a role to play in environmental research (Theobald et al., n.d.), sustainability issues (Sauermaun et al., 2020) as well as policy and governance in the Sustainable development goals (Fraisl et al., 2020).

Should citizen science projects in SIDS display the same ability to play a role in environmental research, sustainability issues as well as policy and governance, there is monumental potential for future implementation and further integration. What will play an important role are the patterns that may or may not be discovered. Is the type of projects essential to whether it can be used for a SDG indicator? Does location matter, or whether participants received benefits or how they were recruited? Is the type of motivation experienced by the participants more dependent on the theme of the project, or the location, or the type of project it is?

## Discussion

The limitation in the potential and actual results of this framework is three-fold. Firstly, a scoping review is inherently limited, there are only so many papers that can be analyzed, a framework should be comprehensible yet comprehensive. In order to keep the framework comprehensive it was chosen to lean heavily towards participant motivation, communication strategy and SDGs. However, equally the paper could have looked at potential benefits from the project, the value of the results or negative effects from citizen science projects. Secondly, scoping reviews in the area of citizen science are in themselves somewhat

self-selective. It is only those citizen science projects that are published and (in this case) are collected in the Web of Science Scopus Core Collection that the framework is formed on and will be researched. Any citizen science projects hosted by the community for the community or otherwise by scientists who are unable to be published with such stringent criteria are not fit for this framework. In this way the view given by the results of this framework will remain lacking, particularly for SIDS countries that lack the existing scientific human resources with enough scientific rigor to publish in well-established journals. Lastly, the framework was tested on an open-source journal that contains limited research on SIDS and instead (in the same self-selection that was mentioned before) contains bigger projects found in larger nations. This was chosen in order to avoid bias in the framework itself concerning specific SIDS projects and so the framework can stand on its own. This does mean that SIDS nuances do not come forth in the framework itself and that this is instead left to the results.

Nonetheless, this framework can form a basis for research on SDG citizen science projects in several types of directions, depending on what the end goal of the research is. Much like citizen science, one of the end-goals is to have the data from which conclusions can be drawn. When applied, the framework will form an overview on how SIDS and their citizen science projects relate to one another, and to the SDGs.

Additionally results from this framework can go even further to determining how specific citizen science projects are better applied in certain nations, which participant motivation is more common, in which country to continue to create projects where this participant motivation is more common and to overall bring awareness on the benefits of citizen science both in the use for SDG indicators and overall for the country.

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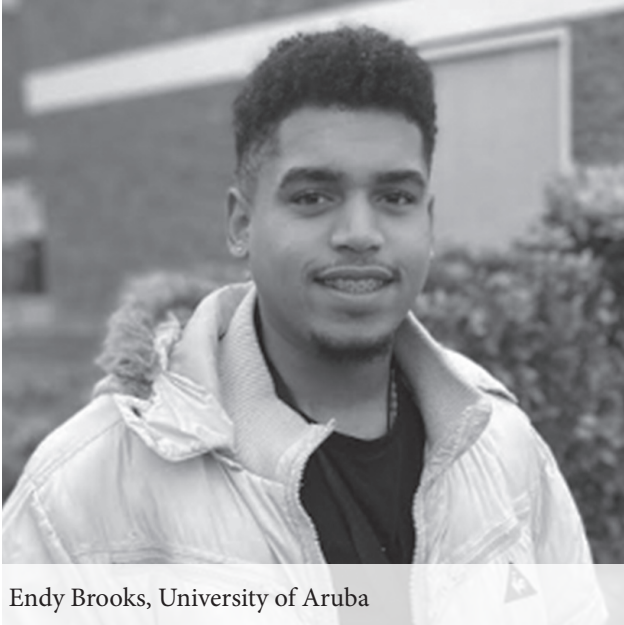
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## “Am I doing the choice”

“What will I do next”, was the first thing I asked myself after finishing high school. Sustainability did not even exist for me since then. Entering the University of Aruba, I did the Academic Foundation Year with the goal of studying Law or Finance. But even so I was looking for a different study which was more diverse, little did I know that my opportunity was coming. During a 2018 college fair I was introduced to the upcoming study called SISSTEM. After successfully finishing AFY I entered SISSTEM without knowing what to expect especially being a person not interested in science.

First week of SISSTEM was heavy, doubts started to come into my mind: “Am I doing the choice”.

Pushing through the first weeks of SISSTEM, 2 classmates and I started working together. That made me conscious on how teamwork is important for a person to succeed

in life, as a person once said, “no man is self-made”. Throughout the SISSTEM study there have been up and downs, happiness, and stress but each accomplishment was satisfactory.

In the 3rd year we had a student exchange in Belgium where we had the opportunity to explore new fields and make research on different topics. I didn’t even know I liked biodiversity conservation until then. We had fun time together as a class and had our less fun time.

Returning from Belgium it was thesis time together with UCU student from different countries, each had their own thesis research. My topic of interest was the production of Albion strawberry, in the research I had to assess the energy- and water usage for the production.

Thesis is closer with each week passing by, hope everything

goes well. Looking forward to seeing my classmates in the Master program 2023.

Sometimes we need to get out of our comfort zone to realize how capable we really are.

# SIDS vertical farming water- and energy assessment on Albion strawberry production in Aruba

Endy Brooks

## Abstract

A strong agricultural sector and food security system diversifies the economy, systematically strengthens the country's capacity, better manages risks and recovery from extrinsic and intrinsic shocks. Moreover, a strong agricultural sector also enhances climate resilience. Food safety is always material in terms of adequately nutritious, safe, and culturally relevant food produced for all in an environmentally sustainable and socially equitable manner. Agriculture currently accounts for about one third of greenhouse gas (GHG) emissions that contribute to climate change. Most of these emissions are related to techniques introduced by industrial agriculture. Vertical farming is one of the possible solutions to this GHG emissions problem. By farming upwards instead of outwards, vertical farming pursues to minimize pressure on typical agricultural land while increasing yield. In this case the vertical/indoor farming of Albion strawberry will be looked upon. The focus of this research project will be on the assessment of water – and electricity consumption using monitoring devices. With the results, carbon footprints of production can be calculated, and the calculated electricity demand will determine the investment in renewable energy (e.g., solar panels).

The main question is “what is the feasibility of farming Albion strawberries within a small island state scale as an introduction to crop diversification regarding water- & energy usage?”

## Introduction

Because of the unique set of challenges and vulnerabilities they face, small island developing states (SIDS) are recognized as a special case for sustainable development. While SIDS consist of diverse group of countries, the majority share characteristics such as small size, limited land availability, insularity, susceptibility to natural disasters, and vulnerability to global environmental and economic change processes. (Lowitt K. et.al,2015). Agriculture currently accounts for about one third of greenhouse gas (GHG) emissions that contribute to climate change. Most of these emissions are related to techniques introduced by industrial agriculture. As the new global sustainable development goals are the focus of many Governments and citizens, another shift in agriculture is seen as an important step towards mitigating climate change. According to the Food and Agriculture Organization of the United Nations (FAO), per capita arable land area will be reduced to one third of the 1970 figure by 2050. The main cause is the achievement of 9.7 billion by 2050 (UN, 2015). Climate change, declining fish stocks, soil degradation and rising costs of agro-business add to the pressure on current agricultural systems, which are already forced to significantly increase production for the growing world population (Engler N, 2021). As the world's population grows and food demand rises, agricultural production is under increased pressure to produce higher yields. Furthermore, agricultural

land may be lost due to urbanization and infrastructure development, potentially leading to farmland scarcity. This magnitude of change may necessitate the investigation of novel food production methods, as both the amount and yield achievable from conventional farming of agricultural land are limited. (Beacham A.M. et.al,2001).

Food security, identified as a priority at the Third International Conference on SIDS convened by the UN in 2014 in Samoa, is one area in which SIDS' vulnerability to global change is increasingly manifesting itself (UNDESA 2014). Environmental change has been identified as a significant contributor to SIDS-related food insecurity (Lowitt K. et.al,2015)

### **What is Food Security?**

Food security is always material in terms of adequately nutritious, safe, and culturally relevant food produced for all in an environmentally sustainable and socially equitable manner. It also means people have access to funding and the ability to make informed decisions about food choices. Food security also means that our food producers can earn a decent living wage to grow, fish, produce, process, transport, retail and provide food. Increase. At the heart of food security is access to healthy food and optimal nutrition for all. Food security depends on healthy and sustainable food systems, as access to food is closely linked to food availability. The food system includes food production, processing, distribution, marketing, procurement, and consumption (Resilience, 2015).

As stated by World Bank (2020) in Aruba food security is thought as a high degree of self-sufficiency in food production on the island. This derives foremost from the recognition that the island's natural resource endowment and land availability places limits that make production costs in most cases high compared to alternative import sources. The true basis of Aruba's food security is grounded in the ability of the population to generate income to

maintain its purchasing power while maintaining an adequate local buffer. (World Bank,2020)

A strong agricultural sector and food security system diversifies the economy, systematically strengthens the country's capacity, better manages risks and recovery from extrinsic and intrinsic shocks and provides climate resilience can be enhanced. Aruba's sustainable food security strategy is based on two pillars: commercial scale food & agriculture based on a specific set of business expansions very and efficient land and water usage. (World Bank, 2020)

### **Aruba's constraints**

Aruba's land limitation, nutrient scarcity, dependency on desalination, dependency on oil for energy production shape the basis for the opportunities to expand their food security. The near total dependence on imported food reflects the challenging production environment and cost-structure relative to more affordable food products that can be imported. (World Bank,2020)

### **Vertical farming**

With the goal of growing crop yield per unit area of land, the thought of Vertical Farming (VF) is currently gathering momentum (Agrilyst, 2017). By farming upwards instead than outwards, this approach pursues to minimize pressure on typical agricultural land, focusing on the change of traditional farming methods while increasing yield. Vertical farming encompasses a range of increase systems of one of a-kind scales, users, technologies, areas, and purposes. It is particularly suited to the cultivation of horticultural crops such as leafy greens (Beacham A.M., et.al, 2019).

Vertical farming is a new type of farming in a controlled environment with a total replacement of solar radiation with artificial lighting. In the physical layout, the plants are vertically stacked in a tower-like structure. This way, the area required to grow plants in minimized.

Most vertical farms are soilless, meaning no soil is required

for plant growth. There are 3 types of vertical farming: 1) hydroponics (a nutrient-rich water container), 2) aeroponics (spraying mist with water and nutrients to plant roots) and 3) aquaponics (combining fish farming with hydroponic). Artificial light is often used to stimulate plant growth, but it is often used in conjunction with natural sunlight. Synthetic lights can use light emitting diodes (LEDs) organic LEDs or high-pressure sodium. (Bourget C.M.,2008)

The advantage of using LED is that it is very efficient, very durable and can emit light with a specific wavelength. For an effective product, these lamps are available for about 18 hours a day. Lightweight shelves are used for effective and maximum light entry. Water requirements are also a factor to consider as the production of these systems depends on a water based nutrient system (hydroponics) rather than soil. VF requires only 5% of the water needed to grow the same number of vegetables grown in the open field. (Brin H et.al,2016). According to Ifarm (2020), for strawberries, 117.10 kWh/ month per square meter is needed. The energy demand is for equipment such as s LED-lamps, dehumidifier, controller & automation, pump, and cooling system (e.g.A/C). A strawberry plant needs between 16.4 ml to 131ml weekly. Several factors such as temperature, humidity, chemical equilibrium, photosynthetic photon flux (PPF) affects plant growth (Engler N, 2021)

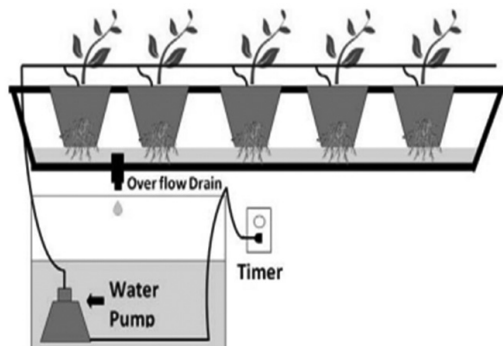


Figure 1: Aeroponics vertical farming (Birkby J.,2016)

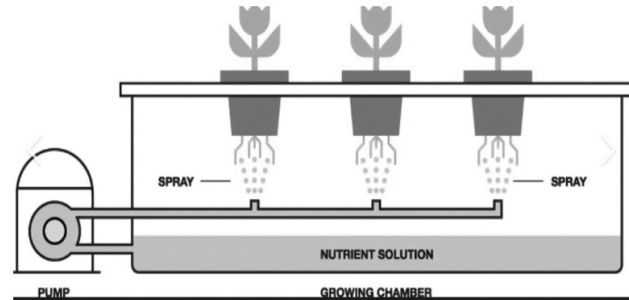


Figure 2: Hydroponic vertical farming (Birkby J.,2016)

The research done by Andrew M. Beacham A.M et al. (2019) showed that even though hydroponic yield was higher, also the energy demand was higher.

To fill the energy demand for the appliances, solar panels or solar walls and wind energy could be used.

In addition to providing more local food production in urban centers, the CEA can be used to reduce biosafety, pest and drought mitigation, year-round crop production, and transportation costs associated with conventional farming (Engler N, 2021).

### Crop choices

Crop choice in VF systems is currently limited, with most producers predominantly favoring salad leaves and other small leafy vegetables (Agrilyst, 2017). Their small size allows them to be grown in facilities such as stacked horizontal systems or cylindrical growth units where space, particularly in the vertical dimension, is at a premium. Small plant size allows a higher number of plants, and so potentially increased income, per unit area horizontally. These crops also tend to show rapid growth and a short timeframe from germination to harvest, increasing the number of crops that can be produced in a season, further maximizing profitability. (Andrew M. Beacham, Laura H. Vickers & James M. Monaghan,2019)

Strawberries are a candidate crop due to their small space requirement and they provide good nutrient value as they are rich in safe antioxidants and can provide psychological benefits as part of the diet at long-term (Gioia D. Massa; Judith B. Santini; Cary A. Mitchell, 2010).

### **Albion strawberries**

Cultivated Strawberry (*Fragaria ananassa* Duch.) “Albion” is one of the most important soft fruits in the world. It belongs to the family Rosaceae and is a cross between two wild strawberries: *fragaria virginiana* (Meadow strawberry) and *fragaria chiloensis* (Chili strawberry). It is a short, low-growing herb that propagates through runners. Strawberry cultivation gives good yields in a short period of time and is highly adaptable to different agro-climates. It is widely grown in temperate and subtropical countries under protected and open conditions with a maximum temperature of 22 Degrees Celsius to 25 Degrees Celsius (Jensen, 2008).

Represents a hydroponic growing system for strawberries. It uses advanced technology, is highly productive, conserves water and land, protects the environment, and often intensifies soil capitalization. The cultivation of greenhouse crops and achieving high yields and good quality can be done with hydroponics in saline or sodic soils, or even in informal soils with poor structure representing a significant percentage of the world’s cultivated areas. Hydroponics is a technique of growing plants in nutrient solutions (water and fertilizer) with or without the use of an artificial medium (e.g., sand, gravel, vermiculite, rock wool, peat moss, sawdust) to provide mechanical support. Energy for electric lighting is a key input to a controlled environment crop production system for strawberries (Nanhe Lal Saroj et.al.,2021).

Most strawberries are given light between 14-17 hour daily. A study done by Gioia D et.al (2010) showed that strawberries did not have any change on the fruit regardless

of the amount of light it was given. However, there was a visible amount of difference in electricity consumption based on the amount of light given.

One of the major current problems for vertical farming is the lack of scientific studies on yield potential, crop quality, energy efficiency and other parameters of VF systems. (Beacham A.M. et.al,2019).

In this paper we focus on the water- and energy assessment of the pilot indoor farming of Albion strawberry at the Santa Rosa/ University vertical farming lab. Using different data gathering tool electricity- and water usage was assessed for the implementation of solar panels as a mean to reduce dependency on unrennewable energy source. Carbon footprint was calculated based on the electricity consumption per appliance.

### **Research questions**

The main question is “what is the feasibility of farming Albion strawberries within a small island state scale as an introduction to crop diversification regarding water- & energy usage?”

#### **The sub-questions are:**

Why is vertical farming important for food security in Aruba? What is the set-up of the indoor lab at Santa-Rosa? What is the water-usage of Albion? What is the electrical consumption of Albion strawberry? How many solar panels are needed to fill in the energy demand?

What is the cost for the setup of the indoor farm (excl solar panels) and the internal rate of return? What is the possible carbon footprint of the whole production?

#### **Case study: Aruba**

This study, a collaboration between KU-Leuven and the University of Aruba, explores the possibility of indoor vertical farming on the small island of Aruba. The study investigates and optimizes the conditions for growing



seedlings in a controlled indoor farm, cultivating favorable specialized crops with short storage time to reduce import dependence. The knowledge of plant physiology, agronomy and innovative vertical farming was translated to a real-life standard to supply locally grown fruits and vegetables and make Aruba's economy and food production more sustainable.



Aruba is a constituent country of the Kingdom of the Netherlands physically located in the mid-south of the Caribbean Sea, about 29 kilometers north of the Venezuelan peninsula of Paraguaná and 80 kilometers (50 mi) northwest of Curaçao. It measures 32 kilometers long from its northwestern to its southeastern end and 10 kilometers across at its widest point. (countryreports 2022, Googlemaps 2022).

Unlike much of the Caribbean region, Aruba has a dry climate and an arid, cactus-strewn landscape. Its area is 179 km<sup>2</sup> (69.1 sq mi) and it is quite densely populated. The temperature in Aruba is measured in Celsius and is practically constant throughout the year. On average the temperature varies between the 26 and 32 degrees Celsius (climatetotravel 2020).

80% of the Electricity is provided by the company Elmar N.V. by combustion of heavy fuel oil (HFO) and the other 20% is renewable energy (windmills & solar panels). There is no freshwater present, drinkable water is provided by distillation of seawater done by the company Water & Energy Bedrijf (WEB N.V).

The research takes place in a small lab space at Santa Rosa Aruba. Santa Rosa is the Aruban department of agriculture, horticulture, and fisheries.

The room is approximately 8sq.meter, there are 4 stands consisting of 3 columns. Each column has space for 3 trays with each having 6-8 strawberry plant.  $3 \text{ trays} * 6 \text{ plants} * 3 \text{ column} * 4 \text{ stands} = 216 \text{ plants}$ .

The indoor farm is equipped with 24 mini ventilation fans, 36 LED lights and 1 Airconditioning.

## Research design and methodology

For the research design we will be looking at the appliances used for the indoor farm including the ventilation fans, LED-lights and air-conditioning. The electricity usage is recorded using an electricity monitoring device & a clamp meter. To see the difference in energy usage throughout the day, the monitor device is recorded using a camera. Each week one appliance is recorded, resulting into 4 data set per week of either ventilation fans or LED-light. We try to see the energy usage differences from morning (9:30am-9:45am) till evening (8pm) and from the evening(8pm) till around (5am). This is because the lights stay on for 16hours (4am till 8pm).

To visualize the energy usage per appliance, we record the energy usage(voltage) after every 15 minutes. After that the voltage is converted to kWh.

Water assessment will be based on literature review on Albion watering and on the currently water usage at the lab space.

Finally, the carbon footprint is also calculated using water usage and electricity as HFO is used for their production. To reduce the carbon footprint, renewable energy production is important. This can be done using solar panels. Using the electricity data usage, we can calculate the number of solar panels required for the electricity needs. The return on investment and the Internal Rate of Return (IRR) is also calculated using excel. Also, a quotation on the appliances used in the indoor farming can be done. This is based on that irrigation is manually done.

## Results

Table 1: Mini-fan Electricity consumption(kWh)

Appliance	Day #	Average voltage (V)	Ampere (A)	Active (hrs)	Average kWh
Mini fan	1	124.51	0.12	24	0.36
	2	124.92	0.12	24	0.36
	3	125.25	0.12	24	0.36
	4	124.98	0.12	24	0.36

Table 2: LED-lights Electricity consumptions

Appliance	Day #	Average Voltage (V/voltage (36 lights))	Ampere (A)	Active (hrs)	Average kWh
LED-lightslight	1	131.45			0.5 16 1.05
	2	122.5505			0.5 16 0.98
	3	122.546 122.0.5	16122.3		0.98

Appliance	Average Voltage(V)	Average Ampere(A)	Active (hrs)	kWh
A/C compressor	219	5.5	12	14.45
A/C fan motor	219	0.325	24	1.71

### LED-lights & mini fan

In the tables above the electricity consumption (expressed in kWh) is represented. Two appliances (mini ventilation fan & LED light) were recorded for 3 to 4 days, with each day having a different amount of recorded data. The mini-fans have an amperage of 0.12/0.11A and the LED-light have an amperage of 0.5A. Each camera recording had a duration

of 37 minutes to 60 minutes. Based on each individual recording, the minimum and maximum voltage is written down and the sum of these two values divided by 2 is the average voltage. For the 3-day recording, the LED lights had a minimum average electricity consumption of 124.51 V a maximum average of 125.25 V. The mini ventilation fan had a minimum average of 122.54 V and a maximum of 131.45 V. The LED lights stays on for 16 Hr/day and mini fans stay on for 24 Hr/day. Based on each individual recording, the minimum and maximum voltage were recorded. The sum of these two values divided by 2 is the average voltage (see table 1 and 2).

The A/C stays on 24hr per day. The compressor has an amperage of 5.5A and an average voltage between 208-230 v. The fan motor has average ampere of 0.325. Compressors have an average of 2 cycles of 15 minutes per hour, resulting in a 12 hour/day activity. But the fan motor stays on for 24 hours/day (see table 3). By using the equation  $P(kW) = V(V) \times I(A) / 1000$ , we can calculate the average Kw usage. We know the voltage for all 36 LED-lights, we calculate the voltage for 1 LED-light and the amps to know our kW. To calculate the kWh, the equation  $E(kWh) = P(kW) \times t(h)$  was used. The mini fans consumed an average of 0.36 kWh each day. LED-lights had a higher electricity consumption between 0.98 kWh to 1.05 kWh per day. Air conditioner consumes 16.16kWh daily.

### Expected annual electricity consumption

Table 3: Preliminary monthly electricity consumption

Appliances	Daily electricity consumption (kWh)	Monthly electricity consumption (kWh)	Yearly electricity consumption (kWh)
Mini fans	0.36	10.8	129.6
LED-lights	1.00	30	360
Airconditioning	16.16	484.8	5817.6

In table 3 an expected yearly electricity consumption is presented. It is based on a 30-day extrapolation of the daily consumption. Afterwards, the monthly electricity

consumption was multiplied by 12 (months) resulting in the annual consumption. As seen air conditioning consumes 16 times more electricity than LED-lights and 44 times more electricity than mini fans.

### CO2 footprint

Using the CO2 footprint equation for electricity: Input value (kWh/Yr) X 0.85 (Emission Factor) the annual CO2 (kg) emissions were calculated. Each appliance's annual consumption was multiplied by the emission factor of 0.85, resulting in the annual CO2e emission(kg).

Table 4: Annual CO2e footprint per appliance

Appliances	Yearly electricity consumption	CO2 footprint (kg)
Mini fans	129.6	110.16
LED-lights	360	306
Airconditioning	5817.6	4944.96

The total annual CO2 footprint of all appliances = 6264 kWh \* 0.85 = 5361.12 kg CO2e/Yr

### Conclusion

This study will allow us to calculate the feasibility of growing Albion strawberry in a controlled indoor environment. This will be done to enhance food security in Aruba as the island is dependent solely on food imports.

One way to enhance food security is by producing Aruba's own products, but due to lack of land availability, nutrient content in the soil, high electricity tariffs, import dependency is currently considered to be the norm. By using vertical farming, we can introduce new, nutritious crops into our diet. Furthermore, we gain more understanding on the different factors that help increase crop yield, especially strawberry.

To visualize the feasibility of vertical farming in SIDS, an energy and water consumption assessment must be done. This was done by recording appliances' electricity usage

throughout the day and multiplied by the amount of hour the light is on. As Aruba is dependent on desalination for water, an efficient cultivation system is important limit the carbon footprint of agriculture.

### Discussion

Water- and energy assessments may be simple depending on the complexity of the farming system. In the university lab space, no pumps are used and plants are being manually irrigated. Moreover, adding of electrical appliances may result in indirect GHG emissions. To mitigate this, the use of renewable energy is important. As air conditioning constitutes 92% of the annual electricity consumption and CO2 footprint in the lab, focus needs to be put on insulation. This can contribute to the reduction of energy needed for cooling techniques.

### Terminology

**SIDS:** Small Island Developing States (SIDS) are a group of developing countries that are small island countries which tend to share similar sustainable development challenges. These include small but growing populations, limited resources, remoteness, susceptibility to natural disasters, vulnerability to external shocks, excessive dependence on international trade, and fragile environments.

**Sustainable energy production:** Energy that is produced using the sun, wind, etc., or from crops, rather than using fuels such as oil or coal which cannot be replaced.

**Internal rate of return:** The internal rate of return or IRR is a discounting cash flow method to determine the rate of return earned by the project excluding the external factor. By IRR definition, it is the discounting rate at which the present value of all future cash flows is equal to the initial investment, that is the rate at which the company investments break even.

**Food security:** the state of having reliable access to enough affordable, nutritious food.

**Controlled environmental agriculture:** Controlled Environment Agriculture (CEA) is an advanced and intensive form of hydroponically based agriculture where plants grow within a controlled environment to optimize horticultural practices

**Percolation:** Percolation is a natural process in which surface water is gradually filtered through the soil into aquifers, but generically the word also can be used to describe the movement of a liquid through a medium

**Carbon footprint:** carbon footprint is the total greenhouse gas (GHG) emissions caused by an individual, event, organization, service, place, or product, expressed as carbon dioxide equivalent (CO<sub>2</sub>e). Greenhouse gases, including the carbon-containing gases carbon dioxide and methane.

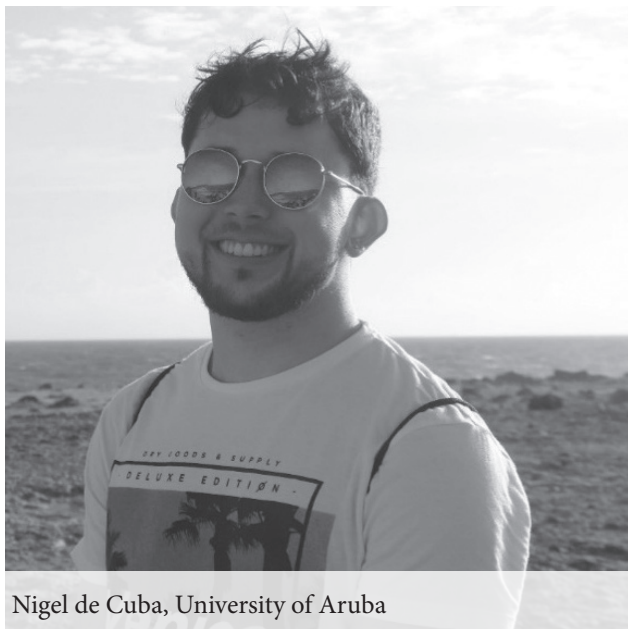
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Nigel de Cuba, University of Aruba

## **When I saw SISSTEM I knew that I had to give it a shot**

In 2018 I was about to graduate high school not knowing what to do afterwards. Fortunately, I was able to go to a college fair at the UA, where I was able to first get to know about the SISSTEM program. Throughout my whole life I enjoyed all the science courses like chemistry, physics, math, etc. So, when I saw that SISSTEM had these courses I knew that I had to give it a shot. One of the things that I was not too familiar with was the sustainability aspect of the program. The program went through various interesting topics about sustainability.

One of the very first things we did at the beginning of the program was take a bus tour around the island. On this bus tour we got to see various sustainability problems around the island. One of the most memorable one being the landfill situation.

In the 2nd semester of the first year of SISSTEM we had the

opportunity to do an energy audit at the Marinierskazerne Savaneta. It was one of the first times where we were truly able to go out in the field and use the theory that we have been learning throughout the program in a practical setting.

In the 3rd year the SISSTEM students got the opportunity to go to Leuven for an exchange semester. We were able to choose a research topic where we got to experience lab work. In my exchange in Leuven, I got to meet many people from different cultures. I learned many new things thanks to them. After the first semester ended, we went back to Aruba.

When arriving back on Aruba I was faced with new faces in the classroom. The UCU students came on exchange to work on their thesis alongside the SISSTEM students. Through the course Interdisciplinary and Multidisciplinary

approaches to sustainable development we were able to discuss over various topics regarding sustainability. It was nice working with the UCU students since they add new perspectives to some of the topics that were discussed. Besides schoolwork, there also were many fun social activities that took place. It was a nice and refreshing atmosphere with the UCU students around.

I am at the final stretch of the bachelor's program, with the thesis being one of the few things to finish.

Looking forward for the master's program.



# The challenges of implementing circularity in the flow of waste tyres on Aruba

Nigel de Cuba

## 1 Introduction

This paper aims to introduce the lifecycle of tyres, through a circular economy framework.

Due to the lack of data this paper will focus more on a theoretical approach on the results by using other research papers about other countries that have similar characteristics to Aruba's waste tyre situation. Thailand was chosen because it already has a few implementations in place when it comes to waste tyre treatment and it still has its own issues that relate to Aruba as well.

Small island developing states (SIDS) are a distinct group of developing countries that are faced with unique challenges from a material reuse perspective due to their small economies, high dependency on tourism, their small size and geographic location (UN-OHRLLS 2009). One of the common challenges SIDS face is waste management. When looking into the waste management issue on Aruba one of the most visible problems to be seen is the waste tyre situation at the landfill.

In the year 1991, there were a total of 20.236 cars in Aruba, in 2000, this number had risen to 32.801, and in 2010 there were 44.739 cars on the island. When comparing 1991 with 2000, there is an 62.1% increase of cars on the Aruban roads. From the year 2000 to 2010 there was a 36.4% increase in

cars owned by households (CBS, 2010). According to the director of the Public Works Department Croes, there were 83.000 cars in the streets in the year 2019. There can be concluded that with all these new cars coming in that there are also a lot more tyres coming in each year. Currently Aruba has no way of managing these tyres after their lifecycle ends. Waste management on Aruba in general is a very linear economy, tyres get imported to eventually end up in the landfill. Waste tyres are not inherently dangerous. Since, while they contain 0.02% copper compounds, 1% zinc compounds, 0.001% cadmium compounds, and 0.005% lead compounds by weight, the quantities are too low to be considered dangerous. However, they can become harmful to public health and the environment if they are not properly managed or disposed of. Furthermore, disease-carrying vectors, such as mosquitoes, rats, and rodents, thrive in uncontrolled waste tyre disposal grounds, especially in tropical and sub-tropical climates. Lastly, tyres are a fire hazard, and their combustion emits toxic chemicals into the air, including carbon monoxide and mono- and poly-aromatic hydrocarbons (BaselConvention, 2011). Consequently, the fact that the tyres at the Parkietenbos often get set on fire and can cause health problems to the neighbouring houses due to released toxic chemicals.

With the aim to answer the research question a material flow analysis will be applied in order to measure the flow

and accumulation of waste tyres throughout the system on Aruba. This is to find out where the majority of waste tyres are ending up in Aruba, in order to combat the negative consequences.

The research question

What are the opportunities to implementing a more circular flow to waste tyres on Aruba and what are the obstacles to this?

To operationalize the research question, the following sub questions will be addressed throughout the paper:

1. Who are the major stakeholders that play a part in the flow of waste tyres?
2. What are the stakeholders' policies towards waste management/waste tyres?
3. What is the annual import of tyres in Aruba within the past 5 years?
4. What is the flow accumulation of imported tyres till their end life-cycle
5. How does implementing a more circular flow influence the average volume annually of waste tyres at Parkietenbos?

### ***1.1 Waste Management on Aruba***

Aruba is an island located 25 km from the north coast of Venezuela and Aruba is situated on the Caribbean tectonic plate. It has a total surface area of about 180 km<sup>2</sup> with an estimated population of 120.000. There are currently 2 major waste management companies on Aruba: Ecotech and Serlimar. Ecotech has a sister company called Ecotech Freezone N.V. who treats the waste that is dropped off by Ecotech and Serlimar. Ecotech Freezone N.V. then separates the sand, glass, rocks, organics such as food waste, ferrous metals, and non-ferrous metals out of the waste stream. The remainder of the waste, which is classified as refuse derived fuel (RDF), is further compacted and bagged into, so called, envirobales which is, claimed by the director to be, non-toxic and all carbon-based. These envirobales are being

buried in a designated area in Sero Teishi. Furthermore, Aruba has only one landfill "Parkietenbos". Currently the majority of waste tyres end up here and from time to time they are sent on fire. Aruba has no waste tyre treatment options in place yet. Although Ecotech Freezone N.V. is currently shredding a few tires from a few companies and then compacting them and bagging them into envirobales..

### ***1.2 Literature Review***

#### **Global waste tyre problem**

One of the most serious solid waste concerns that many SIDS face is the disposal of waste tyres. In countries like Thailand who have a rapid urbanization rate, tyres have emerged as a new waste stream. Thailand produces 60% of its natural rubber domestically, which is used to make tyres and tubes. Tyre waste generation in Thailand has expanded dramatically in recent decades because of the country's rapid urbanization and increased automobile use. Large volumes of waste tyres are being stacked in the open environment around the country due to the lack of a specialized landfill for tyre waste disposal and a lack of specific legislation to assist proper tyre utilization. (Jacob, Kashyap, Suparat, & Visvanathan, 2014). Countries like Dominica also have many concerns regarding the waste tyre problem. An increase in vehicles, a steady flow of imported tyres and the fact that Dominica does not export waste tyres has led to an increase of waste tyres around the island. Thus, the Dominica Solid Waste Management Corporation created a stockpile of roughly 80.000 tyres (DSWMC, 2007).

#### **Concepts for sustainability**

These waste tyre problems have led national, regional, and municipal governments to promote the circular economy (CE) as a new path to economic development and sustainability. The promotion of this ambiguous and contentious idea coincides with growing worries about resource depletion, waste generation, and planetary limit overrun caused by human actions on the biosphere (Henckens, 2014). The theory of CE draws on and expands

on prior waste valorisation and greener production projects by taking a holistic approach to both production and consumption behaviors (Ellen MacArthur Foundation, 2013). While the environmental and economic problems that motivate CE may appear to be novel, the methods used to address them are more traditional or long-standing organizational practices, such as enhanced recycling targets, waste regulation, and extended producer responsibility (EPR) agreements (European Commission, 2013). Therefore, there is also a need to reflect on and assess past CE efforts and practices in order to determine their suitability and capacity to enable and address the developing societal problems highlighted in current CE debates. EPR is one such system that has been adopted collectively and voluntarily by numerous EU member states for a variety of items, including passenger car tyres (Commission, 2014). Three European countries' EPR systems were reviewed, with different policy approaches, accomplishments, and potential limitations noted. Their findings showed that having an EPR system in place does not guarantee that waste tyres are disposed of in the most environmentally friendly way possible (Winternitz, 2019). Increased material circularity is helpful in terms of resources, but not necessarily in terms of other environmental factors (Lonca, 2018). On the other hand, a circular economy is expected to promote economic growth by creating new businesses and job opportunities, saving materials' cost, dampening price volatility and improving supply security (Kalmykova, Sadagopan, & Rosado, 2017).

### **Waste tyre management practices**

There are many ways on how waste tyres are currently managed such as stock piled, landfilled, burning and pyrolysis. Tyre stocks that have been discarded are not environmentally friendly. Due to the cross-linked structure of rubbers and the inclusion of stabilizers and other chemicals, natural breakdown of discarded tyres takes a long time. Metals and various chemicals added to the rubber can cause leaching complications (Adhikari, De, &

Maiti, 2000). Tyres in landfills take up a lot of room and can last for decades. Furthermore, when entire tyres are buried, they trap air and have a tendency to move to the top of the landfills, causing the sanitary cap to crack and the sites to become more unstable (van Beukering, 2001). The use of intact discarded tyres for burning eliminates the need for costly shredding operations. To maintain emissions within regulatory standards, this type of burning requires a highly sophisticated high-temperature combustion facility, as well as equipment capable of handling and delivering tyres into the combustion chamber (Jang, 1998). Despite these requirements, due to their high heating value, "clean" combustibility, and ease of handling, turning scrap tyres into fuel is quite simple (e.g., transportation, storage) (Amari T. T., 1999). Pyrolysis of tyres is when waste tyres are broken down in the absence of oxygen producing three main products: gas, oil, and char (Galvagno, 2002). Waste tyres can also be recycled into vulcanized rubber for athletic surfaces and flooring, as a building and filling material, and as an addition for bitumen in road surfaces are the most common recycling activities. Typical tyre mechanical recycling, which uses traditional shredding, grinding, and milling processes, as well as the more rare ultrasound mechanical and baro-destructive recycling methods, are examples of recycling technologies (Silvestravibiitiñ, 2006). Countries like Dominica are already looking for alternatives for waste tyre management. The DSWMC has plans to purchase a tire shredder to begin producing waste tire crumb, a marketable product that can be sold to private contractors to use as a modifying component in rubberized asphalt (DSWMC, 2007). Most of the literature focuses on circular economy. A different approach could be if you look at the interactions between circular economy and industrial ecology.

## **2 Research Design and Methodology**

### **2.1 Theoretical Framework**

The goal of this paper is to see how the flow of tyres in Aruba can become more circular. A few concepts that

will help support this paper are: Circular economy and Industrial ecology. The goal of a circular economy is to keep products, components and materials at their highest utility and value. Circular economy is usually supported by: product redesign, reuse, recycling and refurbishing of products (Ellen MacArthur Foundation, 2013). This is a beneficial concept when looking at the flow of waste tyres in Aruba, because currently end-of-life tyres are left to gather dust at the landfill rather than being repurposed. Thus, this concept will give input on what a circular economy flow could look like and on how it can be implemented in Aruba.

Industrial ecology is based on how a natural ecological system works in nature. These natural ecological systems have this circle where organisms live and consume each other and each other's waste. This system depends on that every material is used and no materials will be lost. Same principle applies when looking at industrial ecology. Industrial ecology considers each process and looks at how waste can either be mitigated or reused (Frosch, 1992). This concept will be a good way to look at how "waste" tyres can be reduced or maybe reused in some other fashion.

Both concepts strive for overall more sustainable systems and they both deal with how the material flows throughout the chain of production and end-of-life cycle. Therefore, these two concepts will support each other very well as well

MFA, also known as Material flow analysis, follows the concept of mass conversion. Whatever has entered the system also has to leave the system, input equals output. Within a specific boundary, a system consists of a set of material flows, stocks, and processes.

In Material flow analysis processes are defined. These processes can range from storage processes, transportation processes and transformation processes. Stocks are material reservoirs (mass) within the examined system, with

kilograms as their physical unit. A stock is a component of a process that contains the mass that is stored inside it. They are important aspects of a system's metabolism and can keep the same size, or they can grow (material accumulation) or shrink (material depletion). Flows (mass per time) or fluxes (mass per time and cross section) of materials connect processes. Imports and exports are terms for flows/fluxes that traverse system boundaries. Materials entering a process are referred to as inputs, while those leaving are referred to as outputs.

Through managing the inputs and outputs of the system, the accumulation and flow of waste at the sources becomes more clear. If the problems of the systems flow and accumulation are identified early on they can be circumvented or prevented altogether (Brunner & Rechberger, 2005).

## **2.2 Data**

Two approaches will be used when gathering data:

### *Literature*

A literature study will be used in order to provide a theoretical structure to this thesis. This literature study will introduce the concept of circular economy, industrial ecology and material flow analysis on how these topics relate to the problem in this thesis.

### *Interviews*

In order to gather data on how many tyres are in the system a series of interviews are going to be conducted. Companies that deal with waste tyre management or that are relevant for this thesis were chosen. These interviews will gather qualitative data, from a very select group that deals with waste tyres.

The data that will be collected will be used in the material flow analysis in order to create this system. The STAN software will be used in order to create the MFA. The system will most likely not have all the data required since some companies will either lack the data that is needed or some companies will be unwilling to give out the data.

### 3 Expected Results & Discussion

#### Waste Tyre Replacement Rate

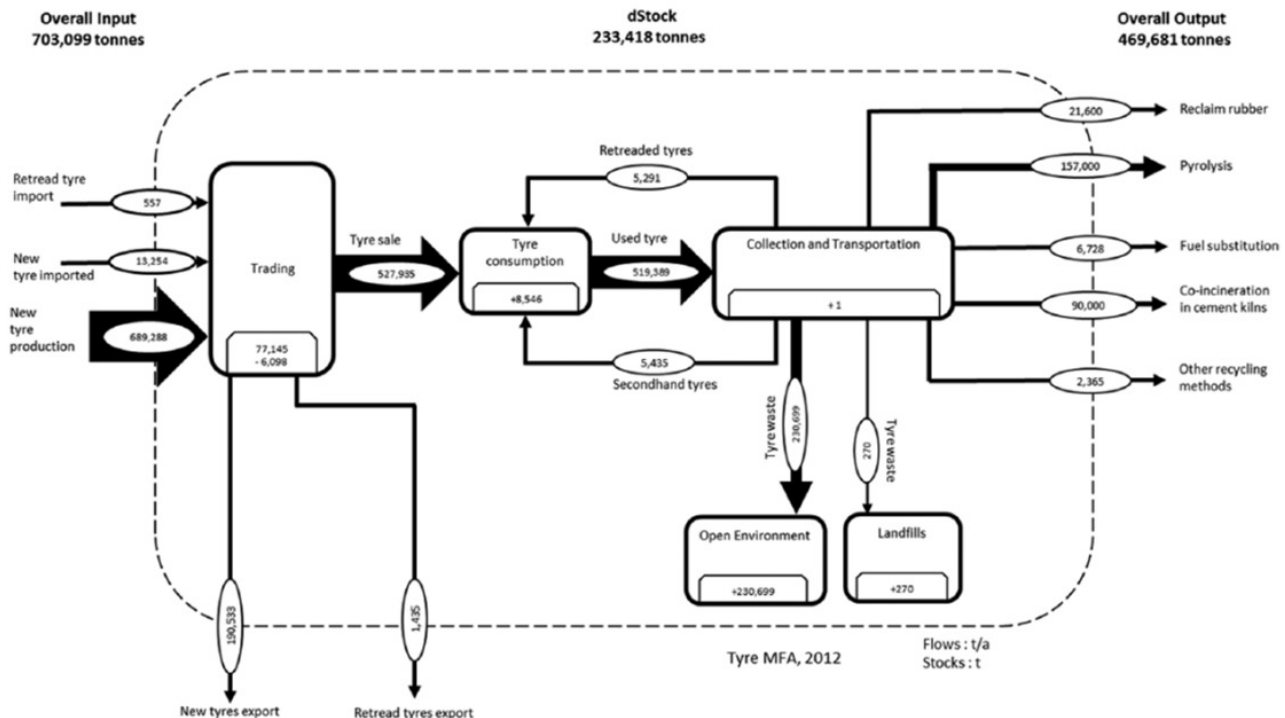
The average length of a tire's life may vary substantially across personal and commercial vehicles, between driving areas, and among vehicle classes that are employed and consumer behaviour. In Thailand for passenger automobiles and light trucks, the replacement rate was predicted to be 1.6 tyres per vehicle per year. As a result, all four tyres on a passenger car must be replaced every 2.5 years. Thailand's passenger automobile tyre replacement rate was somewhat greater than 1.1 tyre per vehicle per year (Sarkar, Chamberlain & Miller, 2011). When looking at Europe on the basis of 20000 kilometers travelled per year, an average passenger tyre replacement rate is around 0.4 tyres per vehicle per year (Giannouli, de Haan, Keller, & Samaras, 2007). Bus and

truck replacement rates were high at an 3.7 tyre per vehicle per year, presumably due to heavy loads and extended hours spent on the road every day (Jacob, Kashyap, Suparat, & Visvanathan, 2014). These numbers can be used to make a prediction on how many tyres get replaced in Aruba and then to confirm it with the MFA.

#### MFA System

This section will look at the Material flow analysis that was done in Thailand in order to look for similarities and differences on what the Material Flow Analysis for Aruba will look like.

*Figure 1. MFA of waste tyres in Thailand for the year 2012. Retrieved from (Jacob, Kashyap, Suparat, & Visvanathan, 2014)*



From Figure 1 you can see that 66.80 percent of the 703,099 tons of tyres that entered the system exited the MFA system boundary, while the remaining 33.20 percent remained within the system boundary (Jacob, Kashyap, Suparat, & Visvanathan, 2014).

From the system boundary that has been set up for the Thailand MFA you can already see a few things that the Aruba MFA will not have. For example, the MFA system of Thailand has an input for new tyre production. This input is contributing 98.04 percent of the overall input. In the case of Aruba the import of tyres will be the biggest input in the system, since Aruba currently does not produce their own tyres. Some other differences are: Thailand exports the tyres they produce, they use pyrolysis, fuel substitution, co-incineration in cement kilns and various recycling methods. As mentioned before, Aruba currently has no way of managing waste tyres. Consequently, the MFA for Aruba will likely not have these outputs. In light of these issues, the MFA for Aruba will likely see the most accumulation of waste tyres in the landfill.

### **Waste tyre treatment and disposal practices**

#### *Tyres as fuel*

Depending on the type of combustion furnace, tires can be utilized as Tire Derived Fuel (TDF) in either shredded or full form (Amari, Nickolas, & Iddo, 1999). Typical tire-derived fuel (TDF) systems for both power generating and cement kiln operations require a high input. Low annual inputs of waste tyre do not appear to be sufficient for the processed tire or TDF projects unless the island offers itself as a collector and processor of waste tires among other Caribbean island states (Sarkar, Chamberlain & Miller, 2011). Aruba will not have enough input of waste tyres for this implementation to be feasible.

#### *Resale and Retread*

The most resource-efficient technique for old tire recovery

is retreading, which saves both material and energy. Scrap tires can be recycled whole or size-reduced for civil engineering and agricultural purposes, as well as composite materials, in addition to reuse (Amari T. T., 1999). Whole-scale civil engineering uses, such as use as a building material, obstacles, or playground equipment, may be more practical for even an island like Aruba (Sarkar, Chamberlain & Miller, 2011).

#### *Destructive technology*

One of the more common destructive technologies known for waste tyre treatment is pyrolysis. Pyrolysis is another option for recovering high-temperature resources from tyres. Under an inert atmosphere, pyrolysis is the heat degradation of a material into low molecular weight compounds. Gas, oil, and char are the three main products of tire pyrolysis. The value of the solid char residue has a significant impact on the economic feasibility of tire pyrolysis (Amari T. T., 1999).

## **4 Conclusion**

This paper aimed to give an insight on the waste tyre management system on Aruba. A theoretical material flow analysis was used to study the flow and accumulation of waste tyres throughout the different system processes that were set for the MFA.

From the CBS data we can conclude that there is still an increase of cars owned by households, thus increasing the number of tyres which enter the system. The theoretical MFA was extrapolated from literature on Thailand since it had similar problems as Aruba, while already having implemented a few waste tyre treatment options. From the MFA from Thailand we can conclude that its input for the system relies heavily on tyre production within the country. While for Aruba the input would predominantly rely on the importation of tyres. Another difference between Aruba and Thailand was that Thailand already has many waste tyre

treatment practices in place. Some of these practices were a pyrolysis plant, fuel substitution, co-incineration in cement kilns and other recycling methods. Even though Thailand has all these practices in place most of the waste tyres still ended up at the open environment area. It is expected that the MFA of Aruba will have a similar outcome where most of the tyres end up in the landfill, due to lack of technological practices and lack of laws, policies and regulations around waste tyres. When considering potential technological practices for Aruba the options are limited due to Aruba's size. For example, if Aruba wanted to implement a Pyrolysis plant or a tyre as fuel (TDF) furnace it would not have enough supply of waste tyres to make these plants cost beneficial. A more feasible implementation would be the resale and retread approach. With this approach the waste tyres would be recycled into building material, obstacles and even playground equipment. This prolongs the life cycle of the tyre making it a more circular approach. This conclusion is still predominantly based on literature. When the data collection and data analyzing is complete, a more appropriate and accurate assessment of the Aruban situation can be made.

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## **If I want to see change I also have to form part of it**

Although I initially joined SISSTEM because it was the only stem related study the university of Aruba offered, I now actually enjoy it. The topics we've learned about have not always been the brightest, but they do somehow instill hope and give a sense of importance to what we are studying. I think following the SISSTEM program has forced me to 'grow up' a lot, not only by exposing me to the reality of the problems small islands face, but also by changing my mindset of expecting someone else to fix the problem and making me realize that if I want to see change I also have to form part of it.

For the first semester of our third year we had to go to Leuven to gain experience in bigger institutions and research experience. That was something entirely different for me, in hindsight if we were to go now, I would probably take a printed map of the city where I was staying to not be lost at all times. During my time in leuven I got ill and could

not attend all the courses I had signed up for. However, I still had a good time. I did my research in a big laboratory right outside of the city. This was one of the best experiences I have ever had, even though it was hard work everyday and lots of patience waiting for the chemicals to separate. I think I learned a lot from my time there, mostly thanks to my supervisor Sem. Leuven was also a great personal experience for me. It was my first time living alone and away from home. I had to be the most independent I've ever been. It was a very nice experience. I came back a totally different person from Leuven.

I chose to write my thesis about food security on Aruba because it is a topic that has always fascinated me since my first year in SISSTEM. How an island that barely produces any food is able to sustain itself and the thousands of tourists it gets per week is a fascinating topic. So when the opportunity to work with the ZonMw project presented

itself, I knew that I would be applying. While I would like to solve the food security issue on the island, that is nigh impossible, for a multitude of reasons. However, I am still confident that my research will have some type of impact. There is not much research available on the topic, not for an Aruban setting at least. It is important to create data for future researchers to have comparative data and come up with new solutions befitting of the environment then.

The UCU students were very fun and nice people. I learned some things from them, and their experience. I learned how to think more critically and not just accept everything that is told to me by professors just because a professor is saying it. It was nice as well to get classes with more people and hear their perspectives. I also learned a lot from all their thesis about sustainability problems on the island, problems that we had previously not talked about such as spatial planning.

# Food security as perceived by Aruban households

Alejandra Moreno

## Introduction

Food security was first defined in the World Food Summit in 1996, as follows “Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life.” (Food and Agriculture Organization, 2006). This definition touches upon the different dimensions of food, such as availability, access, utilization and stability. Food security often goes hand in hand with the United Nations (UN) second Sustainable Development Goal (SDG), Zero Hunger. This SDG strives to end world hunger, achieve food security and improved nutrition and promote sustainable agriculture (United Nations, n.d.). The UN hopes to eradicate hunger by promoting food security, as hunger is not only measured by the physical unavailability of food but also by the prevalence of undernourishment. Hunger had been on the decline until 2015 when the number of people suffering from hunger slowly started to increase again (United Nations, n.d.). Currently 8.9% of the world population is estimated to suffer from hunger. One of the UN’s targets to reach their goal of ending hunger is to double agricultural productivity and incomes of small-scale food producers. One of their many target groups are family farmers. Another one of the UN’s targets is to ensure sustainable food production systems and implement resilient agriculture practices that

increase productivity and production (United Nations, n.d.). The other targets include ending malnutrition, maintaining genetic diversity of the food produced and increasing international cooperation. It is clear from their targets that the UN thinks it is important to grow food more sustainably and efficiently to achieve food security and subsequently end world hunger.

However, achieving food security is not as simple as growing more food. Food security, like many sustainability issues, is a wicked problem, meaning that the more one tries to define and explain the problem, the bigger and more unclear the problem becomes. Alternatively, as one tries to solve one aspect of the problem it negatively impacts another aspect of the same problem. As previously mentioned, there are four core dimensions to food security and these dimensions constantly interact with each other.

Food security is a more complex problem for Small Island (Developing) States (SIDS) than it is for continental countries. SIDS face unique problems that continental countries do not. Firstly, as the name implies, they are islands and most SIDS are in remote locations isolated by the sea. This makes the transport of food to the islands more expensive than if it was between two neighboring countries. Aruba is an island that experiences all three of these problems. The nearest island to Aruba is Curacao, which is

nearly 108 kilometers away (DistanceBetween2, n.d.), and the nearest landmass is the Venezuelan peninsula that is 24 kilometers away. In the past the relatively short distance to Venezuela meant fresh fruits and vegetables at a reasonable price. However, due to the political instability in Venezuela in recent years, fewer and fewer ships with food have been coming to Aruba. In 2020 after the COVID-19 lockdown ended and the prime minister of Aruba opened the borders for all countries, except for Venezuela. This resulted in the island having to import all its food imports from countries farther away, causing a rise in prices. Secondly, SIDS have limited space resources; therefore, less space to grow crops in a traditional way. Aruba is also a very small island, only 180 km<sup>2</sup>. A big part of the island has already been covered by urban sprawl. Aruba no longer has enough land available where farms could be developed. Even when small farms are opened, they face other problems typical of small islands. Lastly, almost a third of SIDS are located in the Caribbean making them vulnerable to yearly tropical storms (United Nations, n.d.). Aruba is fortunate enough to be geographically south of the hurricane belt, a spot where hurricanes and tropical storms do not affect it as harshly as the neighboring islands. However, that does not mean it is not affected at all. There have been times recorded in the past when the island suffered damages from hurricane and tropical storms (Boyer, et al., 2020). Moreover, Aruba faces some problems that other islands do not encounter, such as not having any source of fresh water, its soil top layer not being adequate to grow plants on, an arid climate prone to droughts and being heavily dependent on oil for water and energy production.

All these problems would together make it difficult for Aruba to claim it has any type of food security. However, despite all those factors Aruba has proven to have a resilient food network. This is due to the island's high GDP per capita. Aruba's biggest economic pillar is tourism, 84.3% of jobs on the island are related to its tourism industry (Boyer, et al., 2020). Perhaps ironically, another factor that has

contributed to food security is the inefficiency of shipping companies. During the COVID-19 pandemic the island was on complete lockdown and, no container ships with food were coming to the island. Despite fears that there would be an immediate food shortage, that was not the case at all. The inefficiency of shipping companies meant that they had silos full of food, originally designated for the hotels, to supply the island. In addition, the island's high GDP as previously mentioned meant that most households could still afford the higher prices and access food. While it is positive that Aruba has proven to have a somewhat resilient food network, it is a network that is highly exposed to external shocks, such as increases in oil prices, increase in food prices in other countries and changes in tourism patterns. This is why it is important to find ways to make Aruba's food security more resilient and less dependent on the outside market. This research paper hopes to contribute toward achieving this goal.

## Research question

The main research question is: How has the Aruban population reacted to their food security being threatened during the pandemic? The sub questions are as follows:

- 1) Have households felt their access to food threatened during the pandemic?
  1. Did they fear scarcity?
  2. Did their diet have to change?
    - (due to prices or unavailability, health)
  3. Was it difficult to keep up with the increase in prices?
- 2) How has the pandemic affected food access for different community groups?
- 3) What are households doing to ensure their continued access to food?

## Research objectives

This research will be part of a bigger project : the ZonMW Project Covid-19, Food security and economic diversity in

Curacao, Aruba and Sint Maarten. The goal of this research is to assess the impact the COVID-19 pandemic has had on Aruban households and their food security. In addition this research will help create a database for future researchers who want information about Aruba, written with the island's context in mind. The research objectives are the following:

- 1) Assess the impact the COVID-19 pandemic has had on households and how they have perceived it
- 2) To determine ways to make Aruba less dependent on food imports

## Relevance of the study

During the COVID-19 lockdown in March 2020 80% of Aruban households reported to have lost jobs and food prices increased worldwide (Boyer , et al., 2020). These two factors together are clearly cause for concern regarding the food security of the island. Since then, unemployment has gone down; however, food prices have steadily kept rising. This, paired with the fact that the minimum wage on Aruba has stayed the same since January 2020, before the pandemic lockdown (Overheid Aruba, 2020). This research is relevant because it will look for ways to help the island become less dependent on food imports. It is also part of a bigger project that will assess how Aruba was affected by the COVID-19 pandemic from multiple dimensions.

## Methodology

### Research design

The design of this research will be a mixture of basic and applied research (UTEP, n.d.). For my part this research is driven by my curiosity on how the food ends up on the plates of an island that does not even produce 5% of its own food and by my incessant need for new knowledge. It is also to create data for future SISSTEM students to have a foundation to build on for future research projects. On the

other hand, this research has value to the ZonMW project group as the data gathered will hopefully help them answer any questions they have about the link between households and food security during the COVID-19 pandemic. Data will be gathered through the means of a survey, interviews and existing literature.

### Selection of Respondents

Since the goal of the research is to assess households, the target group of the survey are adults that have been living on the island since before the pandemic. Subgroups inside the target groups are different types of households and different age groups. The goal is for the survey to have between 350 and 400 respondents, this should be a good representation of the households on the island. Interviews will be conducted with people already growing food on the island and with stakeholders involved in the food market.

### Expected results

I expect the survey answers to reflect the following:

- 1) It is still mainly women who do the grocery shopping for the households. I expect to see this because, worldwide, women are still the ones expected to take on most of the household responsibilities (Germano, 2019).
- 2) Households have had to slightly change their diets compared to before the pandemic. This is expected because food prices keep increasing on the island and the minimum wage has stayed the same since before the pandemic. However, I would like to emphasize that I only expect a small shift in diet. This is due to Aruba's relatively high GDP per capita (Boyer , et al., 2020).
- 3) The households that have felt their food security most affected by the pandemic are the low-income nuclear family households. I expect to see this due to the previously mentioned unchanging minimum wage. That minimum wage was established on a pre-pandemic cost of life basis. Not only have food prices gone up on the island, but the cost of life in general has become more

expensive.

- 4) Not many people have grown fruit, vegetable or edible plants during the pandemic. During the pandemic lockdown, many people took up gardening as a hobby (Aratani, 2021). However, I do not expect to find that the majority have grown edible plants as opposed to decorative plants. This assumption is due to observation and exchanging pandemic stories with peers.
- 5) Physical access to food has stayed the same; however, economic access has become more difficult. I expect to see this in view of the fact that no food shortages have been reported on the island and when one enters a supermarket it is fully stocked. This means that physical access to food is still possible. Economical access might be more difficult due to previously mentioned reasons.
- 6) Households do not necessarily fear food scarcity, but they also think that the GoA could better guarantee their food security. I do not expect households to fear food scarcity. As was shown during the lockdown, there is no reason to fear this, since it did not when it was expected. However, I do think households expect more from the GoA, because people always expect their government to take care of everything and do not want to take action themselves. I also think that it could stem from feelings of distrust towards the government, since previous administration have proven themselves to be untrustworthy.
- 7) The elderly were disproportionately affected by the pandemic. Most elderly people have specific dietary needs. The old age pension on Aruba is based on their salary from their working years. The general old age pension on Aruba, handled by SVB Aruba, is 1157 florins per month for a single person or 1948 florins per month for a couple, which amounts to 974 florins each per month (SVB Aruba, n.d.). Both of these pensions are below the current minimum wage.
- 8) Households do not grow more food because they do not have the time, knowledge or money. Due to Aruba's weather and soil conditions plants do not grow as efficiently in Aruba as they do in other countries. The soil needs to be 'fixed' with potting soil, and it can take multiple bags to make a small area arable. Bags of potting soil on Aruba are relatively expensive; one of the cheaper 40-liter bags can cost 17.99 florin per bag (Kooyman Aruba, n.d.). It does not often rain on Aruba, 450 mm/year, and there are no other fresh water sources other than tap water. This means that unless the household has a pump system that reuses waste water, all the plants will use fresh tap water, which can be costly. The water tariff for households on Aruba starts at 4,55/m<sup>3</sup> florin, for the first six cubic meters; the tariff gets progressively higher the more cubic meters are used. There is, however, a special farming, horticulture and husbandries tariff, but one needs a special permit and it does not apply to households (WEB Aruba, n.d.). Growing non-tropical or non-indigenous plants on Aruba requires additional knowledge that not all households might have. However, that knowledge is readily available at Santa Rosa. Even though this knowledge is available, not everyone has the time to go to Santa Rosa and get the lessons.
- 9) Households do not have sufficient space to grow as many plants as they would like. Aruba is already heavily urbanized and does not have much space left for its citizens to build houses on, much less for farms to be developed. This means that the only available space for households to grow plants would be their own backyards (Boyer, et al., 2020). In 2010, the average plot size was 600 m<sup>2</sup> and the average built upon area was 100 m<sup>2</sup> (Derix, 2016). That would leave yard spaces of around 500 m<sup>2</sup>. On average, tropical trees need 5 to 10 meters of space each to fully grow (Slaven, 2017).
- 10) Households do not have much control over the amount or types of food they consume. I expect this as I expect households to be bound by their economical access to food, which as previously mentioned is becoming more difficult to secure. This also goes hand in hand with my expectation that households might have had to slightly shift their diets to be able to keep up with the increasing

food prices. I also expect households to be bound by the food available at the supermarkets. Most supermarkets on the island carry the same products, at slightly varying prices. 80% of the food imports on Aruba come from either North America or Europe, this is due to the fact that while supermarkets cater to Arubans they also have to cater to tourists.

- 11) Households do not incorporate much technology into their gardens. I do not expect many households to have more than a simple irrigation system or a waste water pump system in use. I do not expect it mainly due to the fact other garden systems do not get as much advertisement or are as well-known as irrigation systems and wastewater pumps. I also expect it to reflect that people have misconceptions about other garden gadgets such as hydroponic systems, for example, that they are too expensive for households. While expensive hydroponic systems do exist and are used, they are not the only ones that are available. High tech hydroponic systems are mainly used in farms that aim to produce high yields of products. Such high-tech systems can cost tens of thousands of dollars (Pure Greens, n.d.). There are, however, also middle tech and low-tech systems that are more suitable for household use. These systems have a price range from 50 to 1000 dollars. Beside the initial cost of the system itself, there are recurring maintenance costs that depend on the type of system being used. Recovery systems are less expensive than non-recovery systems because they reuse the water instead of constantly having to use new water, and as previously mentioned water on Aruba is relatively expensive. Therefore, a non-recovery system would be too costly on Aruba. The size of the system also influences the initial cost price. Bigger systems, which are most costly, are more suitable for farms whereas smaller systems, which have a lower cost, are more suitable for households and hobby projects. Another factor that raises the price of hydroponic systems is how much control you would like to have over the system. If

you control factors like the temperature, water pressure and humidity this will make the system more expensive. Electricity use is another recurring cost of the hydroponic system that depends on the size and type of the system. A bigger system will naturally use more electricity than a smaller system. And a recovery system will use more electricity than a non-recovery system. In this case, one would simply have to weigh the cost of electricity versus the cost of water to determine which one is less costly. The nutrients that need to be added to the water are another cost to take into consideration. Most crops need multiple nutrients that are sold separately. The nutrient cost is also dependent on the size of the system. A bigger system that holds more water will need more nutrients to get the same concentration as a smaller system. And lastly, a big factor that influences the cost of hydroponic systems is the types of plants that will be put into the systems. Systems where the nutrient water is shared in between crops require that only crops with the same nutrient necessity can be placed in the system. To diversify the crops you would need multiple systems.

## Literature review

Based on a World Bank study for the government of Aruba, *Building Resilience in Aruba's Food Security During the Pandemic and Beyond*, 76% of their respondents perceived that food prices had increased in 2020. The Central Bureau of Statistics in Aruba has not released any information yet on the increase of food prices since the beginning of the pandemic, thus making the previously mentioned research my only source for this information in addition to my own observations as an Aruban citizen. The same report shows that food prices on Aruba had been going down prior to March 2020, since there had already been a spike around December 2019. The spike in March 2020 was not an isolated event as world wide food prices spiked due to the pandemic and the consequences thereof.

A preliminary suggestion to help improve food security on the island would be to have more efficient husbandries. One possibility would be the farming of naked neck chickens. Naked neck chickens are an indigenous breed of chicken in Bangladesh that have no or little feathers on their neck. Bangladesh has a similar climate to Aruba, so the chickens would not have to adapt too much to the climate. In Bangladesh, the naked neck chickens are preferred due to the tenderness of the meat and the better taste (Islam & Nishibori, 2009). The advantage that naked neck chickens have over regular broiler chickens is that they are better adapted to hot climates. Naked neck chickens also use less energy than broiler chickens in growing feathers; thus they use that energy to grow bigger. The feed-to-growth ratio for naked neck chickens is lower than for broiler chickens (Islam & Nishibori, 2009); thus, they need less food to grow bigger. Naked neck chickens also lay bigger and more eggs in warm stressful climates compared to full feathered chickens. In 2002 a scientist tried inserting the genes of the naked neck chicken in a broiler chicken to grow a fully naked chicken. According to the scientist, this chicken would be more efficient than a regular broiler chicken because it would not use energy to grow feathers and thus grow bigger. At the time, people opposed the research saying it was unethical. They also claimed that due to the bird having no feathers it had less equilibrium than its feathered counterparts and that it had trouble mating. No other research has come out on this topic since 2002.

Another preliminary suggestion that could help improve food security on the island is the use of juncao technology. Juncao is a type of hybrid grass developed by Chinese scientists, which means 'fungus grass'. The whole plant has different uses in ecological management (Feifan, n.d.). Juncao technology is unlike traditional ways of growing fungi, as it does not rely on wood as a source for cultivation (Gandhi, 2021). Instead, with Juncao technology, the juncao grass is used as the source for cultivating the fungi. Fungi are very nutritional. The UN's Food and Agriculture

Organization has mentioned Juncao technology as one of the methods that could help alleviate hunger and help reach SDG 2. It is worth doing more research on this and seeing if it could be applicable in an Aruban setting.

So far, I am unsure of what households are doing regarding their food security; however, they are not the only stakeholders that play a role in this issue. In recent years, there have been many start-up companies in the food sector. Currently we can enjoy locally-grown lettuces, mushrooms, small cucumbers, green beans, strawberries, peanuts and dragon fruits. These companies use different technologies to grow their crops more efficiently despite all the natural setbacks.

## **Preliminary conclusion**

While Aruba has many limitations to grow its own food and challenges to its food security, it also has many opportunities. There are ways to make the island less dependent on outside sources for its food, thus making the prices more stable. Most of all, I hope my goal of creating data for future researchers is fulfilled.



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Armand Kelly, University of Aruba

## **Always looking at the betterment of People, Planet and Prosperity**

In 2017 I began my journey into fatherhood. In 2018 I came back to Aruba from the Netherlands, and in 2019 I decided to go back to school. I had to choose between studying to be a Math Teacher or SISSTEM. I had to choose between a passion I have for Education, or a passion I have for Science and Engineering. I said to myself “there is more than one road to Rome.” If I was meant to be a teacher, then I will do it through SISSTEM. Something new, filled with opportunities, but also mysteries.

Starting SISSTEM I didn’t even know what sustainability was or what it meant. When I was shown what was happening in my own country, it opened my eyes and broke my heart. I couldn’t imagine that there was a waste problem happening in front of me. An Energy problem that peoples are mindlessly consuming and a food and water problem that has the potential to crush a population with the simplest global cracks. I feared for the wellbeing of my

country, but also for the future of my daughter. What kind of world will she experience during her lifetime? Am I to just sit back and let things play out or be part of the change, part of the solutions? From the first day to where I am now in SISSTEM I gained so much knowledge and experience. I have even gotten the chance to share and do so much. I got the chance to make a difference. And I am proud and thankful for it.

I have gone to Europe as part of the SISSTEM study and then Europe came to us through the UCU students. Fresh minds, different backgrounds, and disciplines. It was something new and delighting to experience. Through the Interdisciplinary and Multidisciplinary approach to Sustainable Development we worked together to try and come up with solutions to wicked problems. At times where questions would sound so simple, you can find yourself getting easily lost in a 30-minute discussion without any

answers. But these discussions are what sharpens the mind. Entering debate, everybody aiming at a different goal but always looking at the betterment of People, Planet and Prosperity.

# Electrification of airside equipment at Reina Beatrix Airport Aruba

Armand Kelly

## Abstract

Before an airplane arrives at an airport there is already equipment on board that is emitting greenhouse gasses, setting up in preparation for the aircraft. Aruba airport has the ambition to go towards a zero-emission airside. So, how can this be done? Going through documents and using observation, an inventory of all the equipment that are used for a single aircraft will be made. Once you know what you have, it is easier to understand what needs to be changed and what the new energy demand is for the equipment. Once the demand is understood, the technology to generate and store energy and charge this equipment is researched. Recommendations will be proposed considering factors such as airport operations, maintenance, complexity, economical as well as the environmental impact by implementing new technology.

## Introduction

Sustainability has become a trending topic in many present discussions. Sustainability in general is a broad term and in the aviation industry this becomes even a complex term. Currently, the aviation industry contributes to around 2% of total emissions (Hannah Ritchie, 2022). However, forecasts expect that this number will rise to 27% by the 2050 (Roz Ripdock, 2016). So, what should we understand under

sustainable aviation? Alternative fuels for aircrafts, such as electric, biofuel, hydrogen? Yes, but unfortunately with current technology it seems that overseas electrical travel is a couple decades far from being possible (Snow, 2021). But what about for short hauls, such as for small island states? Can interisland electrical airplane travel be possible? How can islands be able to benefit from an electrical island-hopping airplane? Norway, which is a mountainous country has promised to make all its short haul flights electric by 2040 (Snow, 2021).

The discussions on alternative fuel and sustainable aircrafts are ample. But what about the airports? What are they doing to make the aviation industry more sustainable? According to Schiphol.nl “Schiphol’s aim is to be a circular and energy-positive airport in 2050.” Schiphol airport has already invested millions in technology with already most of its Ground Servicing Equipment (GSE) being swapped to electric (Schiphol Royal Schiphol group, 2022). So, then what can small islands do to better prepare for the transition towards electrical aviation? Aruba, Bonaire, Curacao, Saba, St. Maarten, and St. Eustatius, form the Dutch Caribbean Cooperation of Airports (DCCA) (Aruba Airport Authority N.V, 2021) and are preparing to set the stage to answer these questions, leading the way into an unexplored area in sustainable island solutions. Increasing awareness among the community that Aruba Airport is going towards electric.

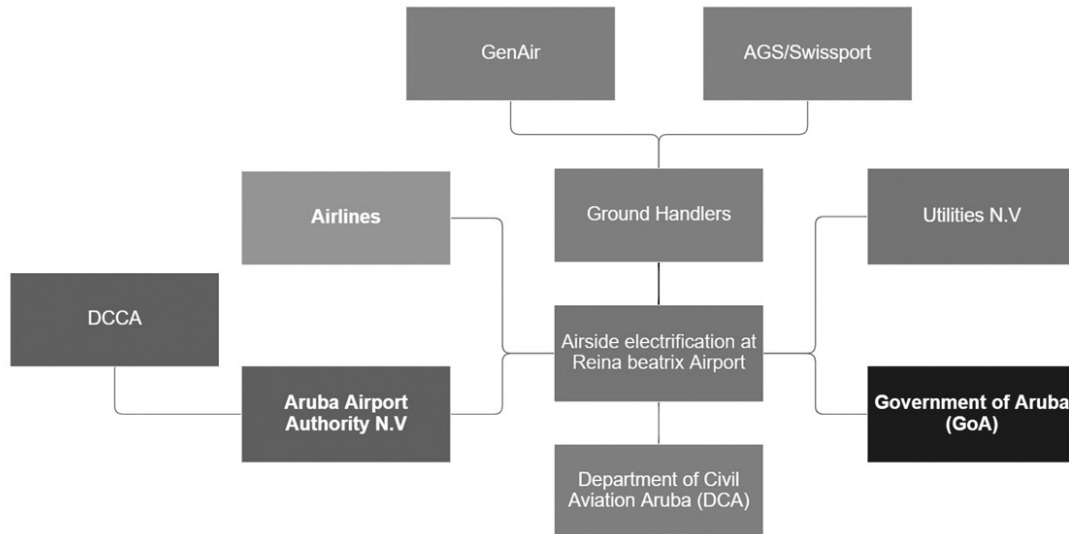
The aspects that are most frequently discussed in sustainable solutions for small island states social, economic, and environmental (Mori et. al., 2014) (Meddeb, 2020). With islands having a fragile ecosystem, environment aspect would focus on reduction on the impacts done to the environment. Social aspects which set focus on the betterment of the community/population of the island. Economical, which focus on the financial prosperity and stability of the country. These 3 aspects are also applicable to an airport, but with a slight modification. Safety, reliability, and efficiency are all terms that fall under operations. If at anytime operations is in jeopardy, there will be losses to the airport. Either in revenues from passengers, claims from airlines or even fines from governing bodies.

To understand how to change a system one does not look at only a part of the system and change it without influencing the entire system. Airports are complex by itself (Vogel, 2019). Understanding the different terminology (North Carolina Dare County, 2022) and workings of an airport, the different parts of an airport (Anupaju, 2022) and different equipment (JSI, 2022) that is used at an airport is

a challenge. having stricter rules and regulation compared to the world on the outside, different safety, and security compliances (FAA, 2022) that the airport needs to take into consideration before implementing changes on the apron.

This research aims to widen the scope to understand what the needs are of the different stakeholders to make DCCA's vision a reality. Operations at an airport need to stay as close to 100% as possible. Inefficiency for an airport would be time lost which equates to loss of revenues for an airline/airport. The ground handlers, which are the ones that purchases and operates the equipment that provide the aircraft with support. They too also contribute to inefficiencies in operations since if their equipment is enough or is unable to support an aircraft this would become a major inefficiency. For this reason, it is of importance to take all these aspects into account to implement sustainable solutions at Reina Beatrix Airport. For the convenience of the reader, in figure 1 a stakeholder map can be seen of the different stakeholders that will have to be considered before implementations are made.

*Figure 1 initial stakeholder map - airside electrification*



## Problem Statement

Tourism is one of the critical economical pillars for the island of Aruba. In 2019 Aruba Airport Authority N.V (AAA) processed a total of 1.2 million passengers while in the year of 2021 AAA processed 761 thousand passengers (Government of Aruba, 2021). In 2020 Coronavirus (Covid) shook the world and Aruba was not an exception. Covid has led to AAA losing employees and eventually restructuring the organization. One of the changes that came with reorganization was that sustainability was introduced as one of the 4 strategic pillars. What this meant was that AAA would have an ambition to work towards being one of the most sustainable airports in the Caribbean. “We aim to become the first airport in the Caribbean and hopefully the first in the world to be Green Globe Certified paving the way as a leader in sustainable operation and management of our airport”— CEO Aruba Airport Authority N.V. Joost Meijs.

On April 28, 2021, the Caribbean Airports within the Kingdom of the Netherlands signed a cooperation agreement. Within the statement found on the Aruba Airport website (Aruba Airport Authority N.V, 2021):

“DCCA’s objective is to improve the general quality of each individual airport by facilitating mutual assistance and efficient exchange of information, transfer of knowledge, sharing of expertise with the goal of achieving economies of scale on seven key elements including but not limited to innovation, sustainability, regulations, safety and security, health challenges for Airports, emergency assistance/ response, economical sustainable, stable and affordable air connections and maintenance, infrastructure and project management.” (Para. 2)

On January 26, 2022, it was announced they will be organizing the first international “Sustainable Air Transportation Event” in Aruba in November 2022. With

the added information that DCCA is working on a road map leading to “An affordable sustainable (electrical) and stable air connectivity network between the islands.” Together with other Airports in the Dutch Caribbean, AUA has the ambition to make air transportation and ground operations more sustainable. AUA needs to prepare for this as it currently lacks knowledge, expertise, and infrastructure for this.

## Research objectives

1. Calculate energy demand increase with eventual conversion of electrical GSEs and electrical aircrafts.
2. Clarify what the environmental impacts are of the different Ground Support Equipment (GSE)
3. Identify which equipment would be most beneficial to be replaced to minimize environmental and operational impacts
4. Identify the opportunities for suitable power production and storage and distribution locations.
5. Determine which environmental factors need to be taken into consideration for eventual charging stations.

## Research question

To meet the objective, a research question was proposed. And sub questions were derived from the research question, it is assumed that the researcher will be able to reach an informed conclusion.

What changes need to be implemented at AAA to distribute energy for electrical Ground Support Equipment as well as electric aircrafts?

### Sub questions

1. What is the overall load needed and how does it vary in time?
2. What should be the equipment that should be converted first?
3. What safeguard measures are needed to ensure

continuous operations?

4. What type of preventative maintenance measurements need to be taken to ensure longevity of the equipment?
5. What are the suitable locations for electric GSE parking areas considering for future expansions?
6. Which generation technologies and auxiliary equipment is most suitable?

## Literature review

This research is centered around electrification of airside equipment at Queen Beatrix International Airport of Aruba. To understand how to electrify the equipment, it must first be understood what kind of equipment is being used to service an aircraft, and what are the emissions associated with this. Literature review includes the gathering of already existing knowledge relating to a particular topic or problem. This also includes finding existing methods to gain data and perform analysis.

A Focus on the production of renewable energy at the Airport site (ICAO, 2020) describes possibilities in producing energy in airport. The International Civil Aviation Organization (ICAO) has published many documents that includes, security, safety, as well as environmental standards for airports. These documents incorporate the operations aspect when considering sustainable solutions.

A Simplified Approach to Estimate EV Charging Demand in Urban Area: An Italian Case Study (Paolo Lazzeroni, 2021) case study can be a framework to calculating EV demand. Calculating EV demand might be a tedious and complicated task due to the unpredictability of charging. However, what might be complicated for the automation industry, might be simple for the aviation industry where everything runs on a schedule.

Optimal location of electric vehicle charging station and its impact on distribution network: A review (Ahmad et. al,

2022) factors to consider with regards to electric vehicles and charging stations. Aruba has a harsh environment. Scorching sun that is blasting everything with radiation, saltpetre in the air that corrodes materials, wind and dust that clogs and jams moving parts.

### Ground Support Equipment (GSE)

According to (TRONAIR, 2022) GSE is a term used in aviation that refers to equipment that are typically used to service an aircraft between landing and takeoff. This equipment is usually found on the apron (where aircraft movements take place). The Main purpose of GSE's is to support aircraft operations while on the ground.

In Figure 2 the usual set up of a B 737 can be visualized. The list of GSE includes:

#### Ground Power Unit

- Galley service truck (catering)
- Bulk cargo/baggage loader
- Bulk cargo/baggage train (carts)
- Fueling truck
- Potable water truck
- Cabin cleaning truck/stairs
- Lavatory service truck
- Air conditioning
- Passenger bridge



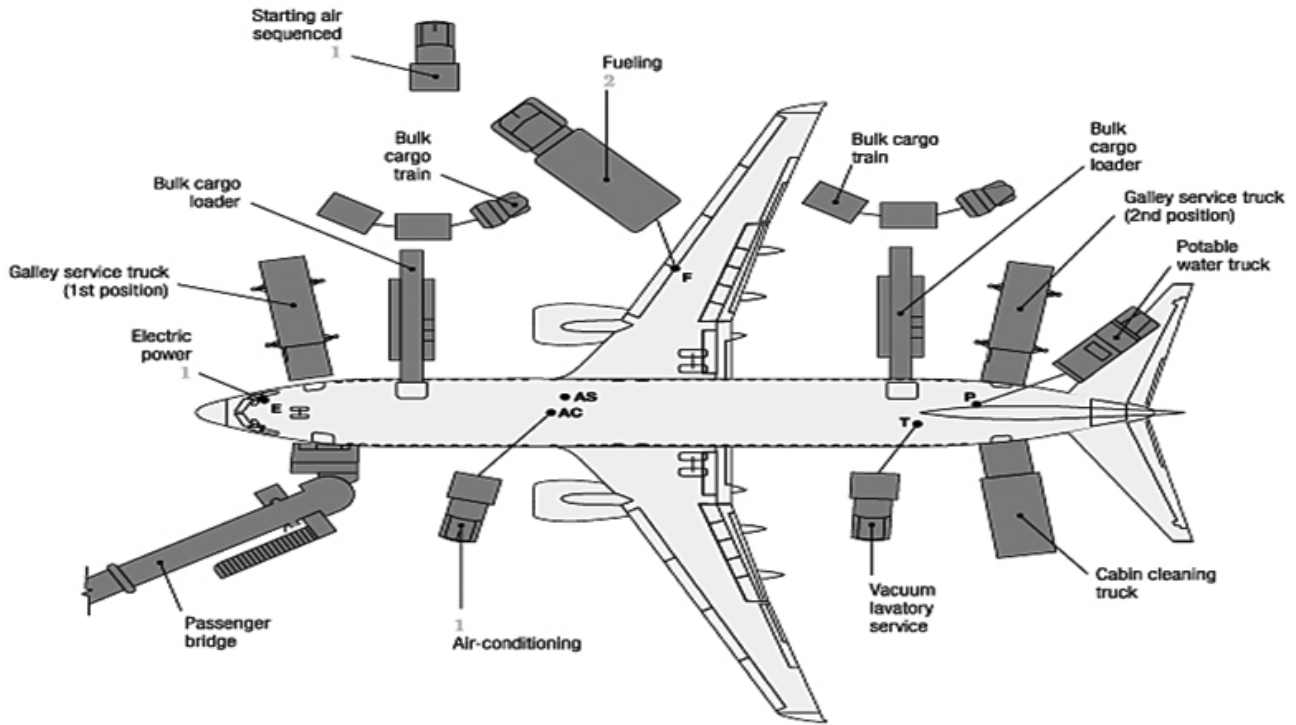


Figure 2 Boeing 737 Servicing Arrangement - [https://www.boeing.com/commercial/aeromagazine/articles/qtr\\_4\\_08/article\\_04\\_2.html](https://www.boeing.com/commercial/aeromagazine/articles/qtr_4_08/article_04_2.html)

### Ground operations equipment emissions

Identifying the impact of Beirut Airport's activities on local air quality - Part I: Emissions inventory of NO<sub>2</sub> and VOCs, (Mokalled et al., 2018) calculated emissions of all equipment involved in Green house Gas (GHG) emissions such as Carbon Dioxide (CO<sub>2</sub>). According to the research, the operations equipment was split into 5 categories. Namely, aircraft main engines, auxiliary power unit, aircraft ground support equipment, airport static sources e.g. fuel tanks, and other sources. The results of this research were that the Landing to Take Off (LTO) of an aircraft is the dominant

contribution to airport emissions, followed by Aircraft Auxiliary Power Unit, then Ground Support Equipment.

### Theoretical Framework

The Theoretical framework in figure 3 will set a specific viewpoint for the research and focus on finding relevant data for the different aspects of the framework. There are the Economic Viability, Operational Efficiency, Natural Resource Conservation and Social Responsibility (EONS). This framework also has a purpose to better understand the symbiotic interactions of airport processes.

**AIRPORT SUSTAINABILITY PLANNING**

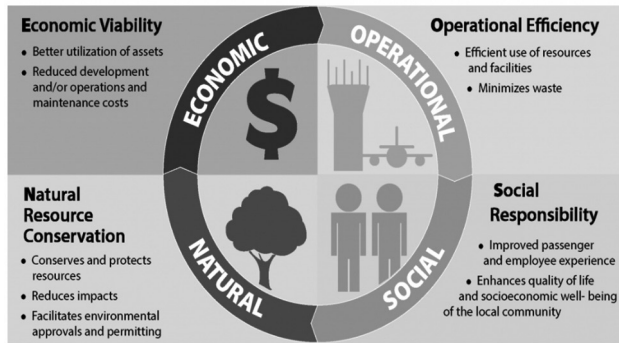
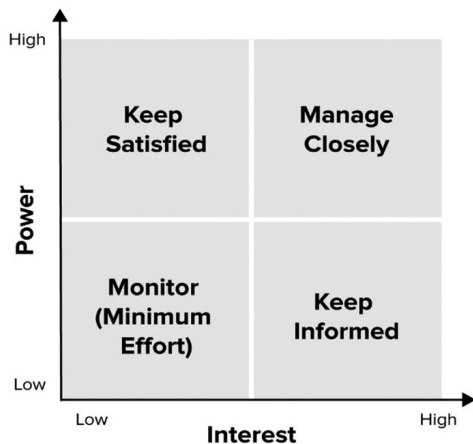


Figure 3 Sustainability Framework for Airports - <https://coffmanassociates.com/aviation-industry/what-we-do-airport-sustainability-planning/>

In Graph 1 the power and interest grid can be seen. This graph can be used to identify the hierarchical structure of stakeholder communication. In airport operations, where communication is crucial, this graph can be used as a tool to keep all identified stakeholders informed according to their need-to-know positions.



Graph 1 The power and interest grid

## Methodology

Methodology describes the system of methods that will be done during a study or research.

This chapter describes the steps that are taken throughout the research. The chapter starts with an explanation of the design method and the sample size that is chosen. The methodology chapter continues with information on how the data is collected during the observations and the interviews, following how the collected data is analyzed. The chapter is completed with the feasibility of the research and the limitations encountered throughout the entire research.

### Design method

For this research qualitative and quantitative analysis will be used. Qualitative analysis will be used to gain understanding, opinions and motivations from interviews and site visits. These will lead to develop ideas, hypotheses and may lead to quantitative research. Observations of GSE movements under the aircraft will done and interviews will be held with different stakeholders such as ground handlers and Aruba airport workers for example. Quantitative research is a method used to examine relationships and describe variables, performing different calculations and understand which variables affect outcomes.

### Sample size

**Observations:** The population size for this research is set to a minimum of 25 samples. This is to observe if there is a change in the difference of GSE used for a difference in aircraft type such as a Boeing 737 and Airbus 320, but also to check if there is a difference based on Ground handlers, mainly GenAir and AGS/Swissport. Observations are expected to be done on a less busy day of the week as well as on a Saturday which is considered the busiest.

**Interviews:** The planned interviews are to be held with:

- the fleet manager of the two ground handlers.

- Electrical engineer of Aruba Airport.
- Safety officer of Aruba Airport
- NACO engineer.
- WEB Engineer
- ELMAR Engineer

## Expected results

In the past, electrical GSE's were introduced by GenAir at Reina Beatrix Airport, however it was unsuccessful, an expected outcome from an interview with GenAir would be to better understand why this was not successful and perhaps gain a "lessons learned" paragraph from it.

It is assumed that different aircraft types such as the B737 and A320 uses different equipment. It is also assumed that the different ground handlers might use a different amount of equipment or maybe is even more efficient than the other. It was understood that due to airport's reorganization in the year 2020, a lot of information was lost due to projects not being digitally documented. As well as having staff responsible for certain projects not on the workforce anymore.

Netherlands Airport Consultant (NACO) have been in various projects with different airports. NACO might be able to provide insight, opinions, or views as to how it would be possible to facilitate a change towards an Electric Airside.

WEB and Elmar might have technologies used to self-produce and store energy that could provide viable information for AAA. They might also have an idea how to ensure that there is a stable supply of energy for the different GSE's when an eventual change takes place.

## Discussion

### Orientation

In the aviation industry there is currently a set of artificial barriers for academics.

Before research can be done, a researcher must first get a background check by a governmental instance. Once this is completed and nothing suspicious came out of the investigation, a researcher can gain access to sensitive areas and documents. Assessments and studies done at an airport are considered sensitive information, this means that the public will not have access to properly gain data from research done in the past.

Learning Airport abbreviations and terminology could be compared to learning a new language. Something that is developed the more it is used. Aviation language is complex and depending where in the airport you are, the abbreviations might be the same but with different meaning. This creates a problem in data collection. A stressful situation for a researcher to be able to adapt to the language of the industry.

An airport needs to comply with standards. These standards are set in place to ensure human safety. This also means that complexity of solutions is increased. Where usually in the hotel industry biggest aspects to consider are Social, Environmental and Economical, the airport introduces a 4th one which is Operational. Understanding the symbiotic relationship between aspects, how one affects the other is also time consuming.

### Potential outcomes

AAA has set a requirement to the ground handlers to go electric by the time the new Baggage Handling System (BHS) is introduced. This sets pressure on the ground handlers and sets the priority for the baggage tractors since this equipment is the one that will mainly gain access to the BHS.

Retrofitting existing equipment (Martynyuk, 2022) might be a good challenge for students to experiment, however due to the urgency, new equipment needs to be ordered. Also, enough of it to ensure a constant operations flow. This

new equipment might have to be standardized to ensure that Aruba Airport can be provide for the needs of the equipment. Otherwise, this might increase the complexity.

Implementing e-GSE's will increase electrical demands this also means that energy consumption of Aruba Airport will be increased, this has a direct influence on the monthly electricity bill that Aruba Airport receives. To reduce the energy consumed from ELMAR's grid, it is advised to investigate possibilities for own power generation. Currently there is a limitation as to how much solar panels is allowed to be placed on a property according to ELMAR's solar panel Policy (ELMAR N.V, 2020).

Energy production is much easier to tackle compared to energy storage. Currently, energy storage technology is costly. but it should be researched if this is also the case for Aruba. If energy storage is much more possible for Aruba than it is for a larger airport such as Schiphol.

### **Preliminary Recommendations**

Airports are complex places. For people that are not in the industry it can be hard to comprehend the way everything works, and to know where and what to look for. This does not mean it is impossible. Specialists in an area can meet halfway to speed up the orientation phase, to reach a better understanding of solutions at the airport. Airports should be more willing to release assessments for the public to make the industry more accessible for academics in hopes to propose more sustainable solutions.

Airports need to take regulations as well as different aspects into account making it a wicked problem to find sustainable solutions. Aviation industry needs to lean towards more sustainable solutions to better ensure the reliability of connecting countries, especially countries that needs it the most such as the island of Aruba.

While it may be a difficult task to implement changes in the

sky. Airports can take the lead and start from the ground up.

### **Preliminary conclusions**

Although operations play a crucial part in solutions, sustainability remains at the center if the leadership has that mindset. This promotes engagement in finding Sustainable Solutions first and figure out the rest later. While leadership vision is a driving factor in sustainability, realistically there are many challenges that have yet to be explored when introducing electric equipment on the apron especially in a harsh environment such as that of Aruba. Energy production, storage and distribution can hinder the entire operations of an airport if proper planning is not done. Sustainable technology has increased in efficiency and decreased in price over the years, but that only comes through investment in the technology. And although electric flying might seem like a faraway solution to the emission problem that airplanes cause, it can only be possible by investing in the technology and creating the possibility to do so. In the aviation industry it might be easy to think of electric planes, but this is just part of a system. There are other parts that need to be looked at, such as the GSEs. Although a small part of the system, the outcome might be bigger than expected. While there may be a long list of challenges and aspects to consider, this necessary change is not impossible, and is something that should be researched and analyzed.

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## **Experiencing something that would deeply change me as a researcher and a person**

It's quite surreal for me to look back on the journey I've had since attending the first info session at the UCU bar. Back then, I felt a mixture of intimidated and amazed by the extensive work the UAUCU alumni had put into their projects in such a short span of time. But after my two months here, I know this is not only possible, but maybe even not that difficult, at least in the way I thought it would be.

I imagined "doing" research to be so much more stressful and confusing, and in many ways it is. Doing 1-2 interviews every day of the week means you'll be bombarded by so many opinions and stories that you lose sight your research. But people's excitement in telling their stories is also what made me more enthusiastic about my research.

Before I applied to UAUCU, I took a course in qualitative research where I learned for the first time about the

responsibilities of researchers to communities under research. Research abroad in Aruba would give me a chance to put what I'd learned into practice. But this was much easier said than done. I think my process was much more of a guided muddling along, where I tried out a few things until I felt I got it right. I initially tried to involve myself in as many activities as possible, but I soon realised that for the sake of myself and others, quality over quantity is the better option. Thankfully, on the days I was overwhelmed, I was so grateful to be surrounded by a group of people who knew what I was going through and knew just what to say to support me.

In my first weeks here (and even now) I wasn't really able comprehend that I was actually in Aruba, experiencing something that would deeply change me as a researcher and a person. I think I understand now why some people say it's difficult to feel change when you're in it. One of my UCU

classmates said “Islands, they just do something to you”. Though this was said in humour, this has struck a chord with me. I don’t think I’ve felt this happily overwhelmed and overstimulated in my life. Academically, I feel a lot of what I’ve learned has been turned upside down; theories aren’t universal, and context matters. I think learning to wrap my head around this has been one of the most interesting experiences in my journey as a researcher.

But beyond this, I’ve made memories with amazing people who have allowed me to step comfortably out of my comfort zone. Thank you, Eric, and Jocelyn, for the insightful courses you ran. I don’t think I would have been adequately prepared without them. And thank you to the UAUCU group who supported me; for those gentle nudges forward and helping me learn so much about myself. I will cherish my time here in Aruba and the people I spent it with.



# Fostering community stewardship: The role of sense of place in participation in environmental initiatives

Rachel Nel

## 1. Introduction

Small island states in the Caribbean are recognized as some of the most vulnerable to climate change, and the region is predicted to be one of the earliest and most severely impacted (Rhiney, 2015). But the Caribbean is not alone in this vulnerability. Ecosystems around the world are changing, threatening the livelihoods of humans and non-humans alike. Not only are places changing physically – their inhabitants are changing too. Populations are increasingly mobile, urban, and connected to other places. These changes to habitats and homes are significantly changing people's relationship with place, and future 'sense of place' is unlikely to resemble that of today (Wilbanks, 2015).

On a global scale, regulation and market-based approaches have been used to slow temperature rises, and the changing of places, and the rate at which they are moving is regarded by many as too slow. These approaches are only one piece of the puzzle. Resource-use and overconsumption are not "[...] solely motivated by economic self-interest or fear of punishment." (Chapin & Knapp, 2015). A combination of other factors, in addition to regulation and market-based approaches, is suggested as more effective to accelerate the pace that is needed to address the urgent and pressing climate and environmental challenges that humanity faces. Actively fostering 'sense of place' has been suggested as

another important piece of this puzzle, to inspire people to take up action and responsibility for the good of humanity and the planet (Chapin & Knapp, 2015; MacGillivray & Franklin, 2015).

A 'sense of place' can be defined as the associations and meanings attached to a place, by individual or group relationships (Jorgensen & Stedman, 2001). Place, individuals, and society are deeply intertwined and shape one another (Parkhill et al., 2015). Climate change is driven by dominant Western philosophies and relationships with place, which disconnect human and environmental concerns. The choices of individuals and communities facilitate the making of sustainable places, but their motivation to do so is influenced by their connection to place and personal relationships, amongst other factors (Acedo et al., 2019). It could be argued that a stronger connection to place, or a stronger sense of place could lead to a stronger desire to protect it from the effects of climate change. Scholars like Yuval-Davis (2006) argue that when place is 'under threat', for example from urban development or climate change, individuals' tend to become more attached to previous versions of that place and articulate their belonging and claim to those previous versions of place. Although perceptions of attachment to and dependence on place are often stronger in people living in threatened places, their level of attachment does

not always predict their motivation to engage in protective behaviours (Anton, 2016). This is supported by Chapin and Knapp (2015), who argue that sense of place best predicts actions of stewardship in more homogenous communities, where associations and meanings of a place are shared.

The anthropogenic and global nature of climate change call for new approaches to reframe relationships with place. Chapin and Knapp (2015) argue that a type of 'environmental citizenship' arising from attachment to place could be complementary to global-level regulations. Participation in environmental initiatives may form part of this environmental citizenship. Community-based initiatives that rely on volunteers are increasingly fulfilling the tasks of governments desiring to cut back costs (Harvey et al. 2001). Local initiatives that build resilience to climate change, and mitigate environmental damage are ever more important to achieving climate goals and are well-placed to foster pro-environmental behaviour and relationships of stewardship (Chapin III & Knapp, 2015; Enamul Haque, Mukhopadhyay, Nepal, & Shammin, 2022). Stronger attachments to place have a positive, but moderate effect on place-protective behaviours (Anton, 2016; Daryanto & Song, 2021). However, as Devin-Wright (2009) argues these place-protective behaviours are not always 'pro-environmental' in nature. Despite public support for transitions to renewable energy, windfarms have often been met with NIMBYism (Not In My Backyard), or place-protective attitudes by local initiatives leading to the delay or abandonment renewable energy projects (Devin-Wright, 2009). In this way, local initiatives play an important role in shaping narratives about place, how it should be protected, and what, or who puts the place under threat. These narratives can also be exclusionary, aligning to the experiences and 'sense of place' of only some within the community. For this reason, it is important to investigate the narratives constructed by individuals within environmental initiatives, whether these are similar across different environmental groups and how these narratives could exclude different experiences of place.

But how well does sense of place provide the foundation for collective pro-environmental action? Can it be used to explain the linkages between people's experience of place, and their actions? And what are the implications of care - not only one's own 'place' - but also an 'outwardlookingness' and responsibility for far away and future places? Does this foster resilient networks of just collective action, or does it privilege certain groups, while alienating others or undermining local needs?

This research will address some of these knowledge gaps, by investigating the role of sense of place in motivating participation in environmental initiatives. Research will be conducted in the context of Aruba. The research question is as follows: *What is the role of sense of place in motivating residents of Aruba to participate in environmental initiatives?*

This broader research question will be tackled through four sub-questions:

1. *What are the narratives that participants of environmental initiatives construct about Aruba as a place?*
2. *In what ways do participants of environmental initiatives form their identity around Aruba?*
3. *In what ways does Aruba as a place, and activities of environmental initiative satisfy the participants livelihood and leisure?*
4. *What are locally contextualised enabling factors and barriers for participation in environmental initiatives in Aruba and how do these interact?*

Sense of place is a concept that can be easily understood, as it is based on emotional connections to place. The formation and breaking down of these bonds is something many people can relate to. In this way, this research could provide lessons on inclusionary practices in environmental initiatives. The ultimate intention of this research is to contribute an understanding of how to inspire shifts to more climate and nature-friendly practices.

### 1.1 Context of Aruba

Aruba is a small but highly diverse and multicultural community. Increases in mobility over the past decades and a shift to an economy based on tourism has meant the island's population grew significantly between 1990 and the mid-2000s, from approximately 60,000 to 100,000 residents (World Bank). Population growth has slowed in past decades, with levels of emigration similar to those of immigration. Aruba is a popular destination for immigration from neighbouring countries with weaker economies and high levels of political unrest. By 2010, first generation migrants composed approximately a third of Aruba's current population (Aruba Demographics). Urban development, and changes in lifestyle and population composition has likely meant that residents relationships with place have changed significantly in the past decades. Relph (1976) and Tuan (1977) would view this mobility as a threat to Aruba's uniqueness and identity.

Before the COVID-19 pandemic, Aruba received over 2 million tourists annually (Central Bureau of Statistics, 2021). This is substantial, considering the size of Aruba's population of around 110,000 - 18 tourists per island resident (Central Bureau of Statistics, 2021). For human geographers, these increases in mobility and mass tourism would put place under threat, as there are increasingly fewer places shaped to the needs of residents, or places where they can feel 'at home' (Potter, Barker, Klak, and Conway 2015). The Aruba Tourism Authority (ATA) recognises this tension, calling for a greater visibility of 'Aruban DNA' on the island, to promote more sustainable development of tourism, with decreased social and environmental impact (Aruba Tourism Authority, 2017). As Potter et al. (2015) describes, the Caribbean region is "[...] a resource to be produced and consumed "on vacation" so tourists can feel 'at home.'" (p.406). Tourism has consequences for the island's people, scenery, sights, behaviour, especially in places where spaces are constructed for the tourist to be socially comfortable, and where the tourist's social power and status are not challenged

(Potter et al. 2015, p.427). The standardisation of Aruba's beachfronts as a tourist destinations could lead to what Relph (1976) terms 'placelessness', a weakening of identity of place, and the loss of the possibilities of unique experiences of individuals. This leads to the weaken of attachments to place, which some theorise would lead to lowered motivation to protect that place (Tuan, 1977; Vaske & Kobrin, 2001). While development for tourism is leading to the loss of 'uniqueness' of place, it is also placing increasing pressure on Aruba's ecosystems. Over- and mass tourism, together with the effects of climate change, create new and urgent ecological issues and exacerbate existing ones.

However, would a stronger 'place DNA' as ATA terms it, or a stronger attachment to place, allow for a more sustainable model of tourism, and the development of relationships of care for the environment?

The answer to this is complex, mobility, migration and mixing of cultures and identity in Aruba need not be viewed as a threat to 'stronger' place attachments but can also be viewed as processes creating relational responsibility, and attachments to multiple places. For Ardoin (2014), "Perceiving one's place at a larger-than-local scale may facilitate understanding of how an individual action may combine with others to create broader change [...]" (p. 435). Exploring the commodification and 'placelessness' of the Caribbean may be useful to conceptualise the effects of globalisation, tourism, and climate change in the region. However, it is also important to consider the resilience, agency and smaller scale actions taken by residents to preserve the island's uniqueness and combat problems of climate change and environmental destruction.

Despite its small size, Aruba has a number of environmental initiatives addressing various problems of sustainability and environmental destruction. The initiative Plastic Beach Party attempts to tackle the problem of plastic waste by setting up the only recycling service on the island. Other

initiatives focus on marine matters: Scubblebubbles on coral restoration and Tuturgaruba on turtle conservation, Caribbean Lionfish Alliance on the invasive lionfish populations that have a significant negative impact on native reef ecosystems and fishing. Fundacommandeursbaai works to protect and conserve the nature along the coasts and bays along the southwestern coasts of the island, focussing on coral and mangrove ecosystems. Ban Lanta Y Planta acts to restore Aruba's ecosystems on land, through planting native trees, which have become increasingly endangered due to urban development, pollution, and invasive species. Other organisations such as EcoLiving Aruba and Aruba Birdlife Conservation work to protect native bee and bird populations on the island. Make Aruba Green Environment Club, or MAGEC, represents the voice of the youth on matters of climate change, and assists with the activities of several of the above-mentioned initiatives.

Many of these initiatives are represented, and stand as a united front, in Climate Action Aruba, which aims to urge the Aruban government to act on climate change and the loss of nature. As of December 2021, Climate Action has met monthly with the Minister of Nature to discuss this. Despite increased interest from the Aruban government in the island's environmental NGOs and pursuing environmental policy, several initiatives continue to face problems with funding, finding enough volunteers, or volunteers with suitable schedules and skills for particular projects.

Many of these organisations rely on volunteers to manage and carry out their activities. As Measham and Barnett (2008) note, environmental volunteer groups are becoming increasingly important, as many are “[...] conducting many of the tasks that were previously the responsibility of governments or fulfilling the role of low-cost service providers for state-run programs [...]” (p. 538). The role of local environmental initiatives on small island states is thus essential, considering the lowered capacity of governments and the necessity of monitoring the wellbeing of vulnerable ecosystems.

In addition, volunteer groups play a role in creating deeper societal, or mindset shifts. Measham and Barnett (2008) describe how volunteering is a constructive way for volunteers to bond with nature and the environments around them, giving volunteers a sense of purpose and strengthening attachments to place. As Ardoin (2014); Buta et al. (2014) and Vaske and Kobrin (2001) suggest, encouraging these types of attachments to place motivate relationships of care, and stewardship between people and their environments. The strengthening of attachments may be particularly prominent in places like Aruba, where the effects of ‘taking action’ may be more visible due to the island's small scale (Ardoin, 2014; Hay, 2006). Even though their actions may seem small scale, environmental initiatives play an important role in shaping place in small island states.

### **1.2 Theory: Sense of place**

The concept of ‘place’ is one of the oldest and most central themes of human geography and has several contested definitions (Cresswell, 2009). Place can be a locale or location of any scale and is generally understood to be a space which has been given meaning by a certain subject (Gregory, Johnston, Pratt, Watts, & Whatmore, 2011). Gregory and others (2011) highlight that these meanings also arise through change, whether it be human (e.g., economic processes) or physical or environmental factors (e.g. built environment, weather). The rise of humanistic geography in the 1970s challenged previous essentialising conceptions of place, and posited that place is subjectively experienced (Ley, 1981). As Tuan (1977) describes, these experiences of place, ‘sense of place’, are basic components of human experience.

For humanistic geographers, these experiences of place were often understood as positive: ‘sense of place’ was seen as the “affection, attachment and even ‘love of place’” (Gregory et al., 2011). This approach to place was used by geographers like Tuan (1977) who focused on place as

'security' and Relph (1976) who explored the concept of 'rootedness' and 'authenticity of place'. Relph (1976) argued that attachment to place, and rootedness were more likely to form in individuals that lived in one place for longer periods of time. For Relph (1976), industrialisation and the increased mobility of populations in previous implied that individuals were becoming increasingly 'placeless', losing their sense of place, and hence their care for place. For (Relph, 1976) and other humanist geographers, place, or people's home, and their sense of belonging were under threat from the forces of globalisation. Feminist and critical geographers of the 1980s however, critiqued this 'idealist' conception of place, and sense of place, and considered how power relations impacted individual's experiences of place (Gregory et al., 2011).

For Massey (1991), focusing on place as 'home' seems to require the drawing of boundaries, and the creation of insiders and outsiders. As Cresswell (2009) notes, home as place can reinforce asymmetrical power relations. Different groups experience place differently, according to their privilege and social location (race, gender, class, ability, sexuality). Regarding 'sense of place' as something achieved through strong attachments ignores how places and their associated meanings exclude marginalised groups. Massey's (1991) 'global sense of place' takes the social locations of marginalised groups into account. For Massey (1991), places are not only constructed of meanings and attachments, but also constructed from "[...] constellation[s] of social relations meeting and weaving together at a particular locus." (p. 7). Thus, places do not have one homogenous identity based on a singular internalised history that excludes marginalised groups, but are constituted of their people, their social relations, and connections to other places (Massey, 1991). This makes mobility less a threat, and more a commodity; places are defined by their connections to other places (Massey, 1991). Massey's ideas have had a strong influence on sense of place research, encouraging a relational notion of place

which considers the marginalisation of places and people across multiple scales. As Cresswell (2009) and Darling (2009) observe, Massey's ideas are less an opposition to previous definitions of place. Rather, it is an expansion of operationalisations of sense of place, aligning the concept to the several realities and consequences of globalisation.

Recent sense of place research (e.g., Chapin and Knapp 2015, Di Masso et al. 2019) suggests that sense of place in a mobile world allows for commitment to several places at once. As Di Masso et al. (2019) explains, it is common for individuals to maintain "[...] meaningful connections with family, local traditions, nature, and one's self-identity." (p. 127). For Chapin and Knapp (2015), commitment to multiple places provides an opportunity for local to global stewardship, or vice versa. Sense of place may provide the basis to navigate and communicate urgent global problems like climate change and environmental destruction, the effects of which are caused and felt by different groups.

People's attachment to the environment around them, and their 'sense of place' has in recent years been investigated as an explanatory factor for pro-environmental behaviours (Junot, Paquet, & Fenouillet, 2018). Despite this, a significant positive or negative relationship between the two has not been established, possibly due to different operationalisations of place attachment and pro-environmental behaviour in different cultural contexts (Daryanto & Song, 2021; Masterson, Enqvist, Stedman, & Tengö, 2019).

Recent research defines sense of place as having three broader dimensions: place attachment, place dependence and place identity (Acedo, Painho, and Casteleyn 2017; Chapin and Knapp 2015; Jorgensen and Stedman 2001; Mulvaney et al. 2020). Place attachment is generally defined as the positive connections individuals or groups have to their environment (Jorgensen & Stedman, 2001). These connections reflect a variety of factors: relationships,

memories, aesthetics. Attachment to place is stronger in individuals who have visited a place often or stayed in a place for longer periods of time (Mulvaney et al., 2020). For Raymond, Kytta, and Stedman (2017), however, focussing on place attachment as a process that occurs over longer periods of time ignores the ways in which “[...] *immediately perceived and sensory dimensions* of sight, smell, hearing, taste, and touch (i.e., aspects of sensory experience) contribute to overall place meaning.” (p.5).

Place dependence can be described as the degree to which individuals believe that a place ‘underpins their behaviour’, or how well a place allows individuals to perform certain activities (Jorgensen & Stedman, 2001). An example of this is a beach that provides the perfect waves for a certain water sport, or a place with the perfect environment to grow a certain type of plant. Place dependence is usually encompassed in the question: “What can I do in this place that I can’t do in other places?” (Mulvaney et al., 2020). Mulvaney et al. (2020) explain place identity as the ‘emotional counterpart’ to place dependence, where a person is dependent on a certain place for constructing their identity. An example of this could be a person calling themselves a “beach person” or a “hiking person”, where they associate a part of their identity with a place. Allen, Cochrane, Henry, Massey, and Sarre (2012) argue that these identities are not only constructed from relationships with the physical environment, but from highly complex webs of social relations, which are internal and external to the region, and stretch nationally and internationally.

## 2. Methods & approaches

Qualitative methods are well suited for the aims of this research, as experiences of place are complex, and can be nonlinear and emergent, making it difficult to predict or quantify numerically (Manzo, 2019). As Tuan (1977) explains, people have different knowledge about places: a cab driver learns to find their way through a city, while

a geographer studies it conceptually. But both may have intimate experiences of that place through touch, smell, taste, hearing, memory, which may be difficult to express in predetermined answers. Interviews with open-ended questions will allow individuals to express their unique and similar connections to Aruba as a place. However, a limitation of this could be that interviewees may sometimes struggle to put their experiences of place into words.

Myers (2021) research on residents of Vieques, Puerto Rico highlights that it is important to not to generalise findings in place-research. Rather than aiming to discover a universalising representation, Myers (2021) emphasises documenting and understanding people’s experiences of specific places at specific times. Massey (1991) describes how places are ‘constellations of social relations’. In this way, participants of this study provide ‘snapshots’ of the ways in which individuals are attached to, dependent on and form their identity around Aruba. Tentative, rather than general conclusions may therefore be drawn about individuals’ experiences of place and their motivation to take pro-environmental action. Myers (2021) argues that by investigating these narratives of taking action, research attempts to recast participants as actors with agency in shaping their place, rather than victims to larger global forces of climate change, globalisation or tourism.

### 2.1 Operationalizing sub-research questions

As described in the review of literature in Section 1.2, sense of place is assessed through the dimensions of: place attachment, place identity and place dependence (Table 1). These dimensions are used to guide interview questions, and saturate data during coding. They are also placed in context by collecting basic information about age, educational background, time lived in Aruba, etc. This is because individual experience of place does not exist separate from broader socio-cultural values and socioeconomic constraints (Mulvaney et al. 2019). As Proshanky and others describe (1983), place identity is ultimately also a

substructure of a more global self-identification. Interview questions therefore combine this basic information, with more open-ended questions that capture the specificities of individual relationship with place.

Sub-research question	Dimensions
<p><b>Place attachment</b>  <i>RQ1: What are the narratives participants of environmental initiatives construct about Aruba as a place?</i></p>	<ul style="list-style-type: none"> <li>- Aruba as home</li> <li>- Connection to Aruba 'socially'</li> <li>- Connection to Aruba nature</li> <li>- Threats to Aruba</li> <li>- Time lived in Aruba or abroad</li> <li>- Connection to other places</li> </ul>
<p><b>Place identity</b>  <i>RQ2: In what ways does Aruba as a place, and environmental initiative form a part of participants' identities?</i></p>	<ul style="list-style-type: none"> <li>- Feeling of 'being Aruban'</li> <li>- Social circle within initiative or outside of initiative</li> <li>- Friends and family perception of activity in initiative</li> <li>- Activities of NGO as identity</li> <li>- Natural environment in Aruba as identity</li> </ul>
<p><b>Place dependence</b>  <i>RQ3: In what ways does Aruba as a place, and activities of environmental initiative satisfy the participants livelihood and leisure?</i></p>	<ul style="list-style-type: none"> <li>- Satisfaction with Aruba</li> <li>- Place allowing for personal growth</li> <li>- Perceptions of climate change</li> <li>- Willingness to move abroad</li> </ul>
<p><b>Contextual factors</b>  <i>RQ4: What are locally contextualised enabling factors and barriers for participation in Aruba and how do these interact?</i></p>	<ul style="list-style-type: none"> <li>- Time available</li> <li>- Access to transport</li> <li>- Socioeconomic status</li> <li>- Education</li> <li>- Gender</li> <li>- 'Local' or 'non-local'</li> </ul>

**Table 1:** Dimensions of Sense of Place operationalised in the context of this study

## 2.2 Data Collection

### 2.2.1 Interviews and sampling

Twelve in-depth interviews with volunteers and organisers of environmental initiatives were conducted. Almost all interviews were conducted face-to-face, apart from one conducted over the phone. The face-to-face interviews were recorded with a mobile phone and took place in informal settings, for example, in a café, the university campus, or at the participant's home. All participants were asked to sign a form of consent shortly before the interview to inform them of the ways in which their words would be used and to commit the researcher to representing their words accurately. Interviews were conducted in English, and although all interviewees had an excellent command of the English language, it was neither the mother tongue of most participants, nor the language most spoken during their daily lives (Papiamentu, Dutch). This may have influenced participants' ability to express the nuances of their connection to place. It is particularly important to note the settings in which these languages are used: Dutch is used in more official, formal settings such as in schools, government, and policymaking; English is primarily used to communicate with tourists and Papiamentu is used in most other contexts for everyday communication. These different settings may affect the ways in which participants communicate in these languages. As Myers (2021) points out, language adds an additional element of power in the researcher-participant dynamic. This was mitigated by presenting participants with the opportunity to review the ways in which they were quoted, and the analysis drawn from their words.

Cresswell (2009) describes how qualitative place research which focussed on strength of attachments to place “[...] developed a rich idea of place as experienced, felt [and] sensed [...]” (p. 5). However, for Cresswell (2009), and other prominent geographers such as Harvey (2002), this overlooked how power is implicated in constructing, reproducing these contested meanings of place. By mapping the meanings, identities and practices of place,

authors inadvertently constructed “[...] normative places where it is possible to be either ‘in place’ or ‘out of place.’” (p. 5). A diverse sample is needed to obtain wide ranging perspectives which nuance this misleading binary. In this study, a snowball technique was used to identify participants for interviews. Participants were asked to pinpoint specific people with similar or different views and experiences of living in Aruba, and volunteering or organising for an environmental initiative. To ensure diversity of the interview sample, the sample was compared to population tables from census data from 2020 (Central Bureau of Statistics). Factors such as age, gender, education level, time lived in and outside Aruba, position within the environmental initiative and length of time participating in initiative were considered in sampling. This partially limited bias and allowed several different experiences of place to be compared.

Participants who had lived in Aruba and taken part in environmental movements for longer periods of time were able to point out initiatives with a smaller social media presence, who were not contacted during initial calls for participants. Groups and participants difficult to reach on the social media front also added diverse perspectives to the study.

In addition, five organisations were contacted and one to three organisers and volunteers per organisation were interviewed. Larger scale events organised by these organisations were also attended, and conversations and observations used as background, or contextual information for analysis. Reflection and analysis of positionalities of the researcher and participants is of high importance in place research. However, due to the small size of the resident community in Aruba, and the personal, and potentially sensitive information given by participants, all interviews and conversations for this paper have been kept anonymous. For this reason, particular words or phrases within quotes which are revealing of participants' identities will also be removed.



### **2.2.2 Grounded Theory**

A grounded theory approach was used in this study, where successive rounds of interviews were conducted. In this approach, research and data collection is non-linear, where data collection is used to inform and refine previous steps in the research process. Questions in initial interviews are open-ended, covering a wide range of topics. This allows for unexpected, locally contextualised experiences of place to emerge. This is critical to not only focus on participant's identity and emotional connections to place, but also the ways in which they feel excluded, and exclude others. Following these initial interviews, questions or topics explored were refined, focussing on specific aspects and themes emerging from previous interviews. In this way, common themes from initial rounds of interviews are used to inform and guide future interviews. These allowed points made in previous interviews to be verified, and allowed themes not necessarily found in literature to be explored in greater depth.

### **2.3 Preliminary Data analysis**

Interviews were recorded and partially transcribed with the consent of participants. Transcripts were qualitatively analysed through coding. Codes are certain labels assigned to specific words or phrases from interviews. A form of open coding was performed, where common themes across the interviews were identified through a review of the transcripts and interview recordings. Certain themes were identified through presence in literature, while others were emergent. The themes identified are illustrated and discussed in section 3 below.

### **2.4 Positionality statement**

I am a white twenty-two-years old woman, studying human geography and politics. I was born in South Africa. I grew up in a smaller town, with a nature reserve behind my house where I used to hike often. Both of my parents worked in nature conservation and taught me much about the gifts of nature, and environmental destruction from

a young age. I was privileged to have the time, resources, and support from my family to occasionally volunteer in sustainability or environmental initiatives throughout my youth. Sustainability has always been a part of my studies, and over the past year I have been reflecting on how I position myself in relation to 'nature'.

My positionality is something that is reflected in every page of the research, particularly in qualitative analysis, where findings are produced from my interpretations. As Mann and Kelley (1997) state, "[...] all knowledge is affected by the social conditions under which it is produced and [it is] grounded in both the social location and social biography of the observer and the observed." It is therefore critical to actively reflect on my positionality as a researcher and observer. By being reflexive and considering my positionality at every step of the research process, I hope to produce research that enables different forms of knowledge and fairly represents the realities and voices of the participants of the study.

## **3. Preliminary Results & Discussion**

To position the experiences and narratives presented here, recall the main research question of this paper: What role does sense of place play in motivating individuals to participate in environmental initiatives? This section describes participants' 'sense of place' in terms of their attachments to Aruba, their dependence on Aruba as a place, and their identity. The connections of these dimensions of sense of place are then compared to participant's motivations for participating in the environmental initiative.

### ***Narratives of attachment and connection to nature***

Several participants (12, 8, 7) noted their attachment to nature in Aruba. For some, these connections came from time spent in nature during their childhood, while others only became interested in spending time in nature later in

their lives. Participant 12, who grew up on Aruba, reported that their interest in working with nature came from their closeness with nature as a child.

“[...] I lived more in, we call it the ‘countryside’, but really close to the park (Arikok). And my grandmother always involved me in growing plants and crops, and going fishing to feed the family. She had goats and sheep. [...] It reminded me of my love for nature in childhood and my connection to nature back then. I then see Aruba [now] [...]” – Participant 12

For Participant 12, volunteer work is a way to connect with their past and relive memories of how nature used to be. Connections to nature from childhood help to form stronger attachments to place (Chawla, 1992). As Chawla (2020) describes, these attachments and connections can continue into adulthood, and motivate environmental citizenry. Participant 12’s attachment to nature in Aruba comes from the way they practiced using the land when they were younger. Their protection of Aruba today comes from these attachments to previous place meanings of living and being in nature.

Participant 8 also reflects on Aruba’s changing landscape, and the emotional effects this has on people within the environmental movement.

“A lot of us, especially those that work in conservation, have a strong connection to the land here. [...] like it hurts us to see nature being torn down for a condominium, a hotel or a cinema. Like we already have five, six cinemas, we don’t need more.” – Participant 8

Urban development is thus seen as a threat to Aruba’s landscape. For Participant 8, nature is of higher value and increasing development is seen as unnecessary. The use of words like ‘hurt’ shows the strength of attachment to Aruba’s physical landscape. However, it also reflects the participant’s belief that people outside of environmental conservation movements feel differently. While people in environmental movements see the physical landscape as ‘place’ which they attach meaning to, real estate brokers, developers and

investors see it as ‘space’ to be filled. Participant 8 identifies with people who work in conservation, viewing Aruba’s coasts as a place of meaning. In this way, a shared sense of loss motivates participants in environmental initiatives to engage in conservation activities.

Many participants noted that the environmental movement tended to have a disproportionate number of ‘internationals’ or ‘immigrants’ relative to local Arubans. Locals involved were noted to have lived or studied outside of Aruba for a time. All participants described a generally positive perception of environmental initiatives from the public. However, some, such as Participant 7, noted that there were some tensions due to the lack of involvement of local people.

“They have their own culture, and it’s good to have your own culture, especially inland, you know to keep that [going]. But you know when you have immigrants coming in and trying to change stuff, maybe it’s a resistance to that, more than towards the movement [...]” – Participant 7

For Participant 7, members of environmental initiatives would change place as they saw fit. Due to their different cultural backgrounds from local people, what they imagined as beneficial for the island, may not always align with the ideas of local people. Participant 9 also highlighted this, describing the perceptions of older generations on environmental initiatives.

“[...] Although the colonial mindset is less here than in Curacao, it’s still seen, especially by the older generation as these Dutch people telling us what to do with nature. Or these Dutch people telling us to stop fishing. Or to stop driving UTVs on the dunes [...]” – Participant 9

Participant 9 noted how enforcement or restrictive activities of environmental initiatives are sometimes likened to the island’s colonial history under the rule of the Netherlands. Participant 1 commented on how this affected participation in environmental initiatives.

“A lot of times when I talk to people, which I find very

off-putting, is that Dutch people are the only ones that care about the environment. Like Aruban people don't care about the environment, are not aware about environmental issues. [...] And I think when you go into a group, and it's mainly just Dutch people, you feel a lot less welcome. They're like 'Oh, an Arubian!', like you're some type of exotic animal. 'You care about the environment, and you're a local! Wow!' And that happens a lot in groups where there's a lot of Dutch people. And we do have that whole colonial complex. And you get into that, and there's Dutch people telling you that you don't care about your island, you don't feel as welcome. Even if it's not coming from a bad place. Because there are stereotypes." - Participant 1

In this way, historical narratives about Aruba are still prevalent in the way people experience place in the present. For Participants 1 and 9, histories and legacies of colonialism make environmental movements less welcoming to local people, especially if potential volunteers worry that they will be tokenised within the initiative.

### *Place as contested*

Just as ideas on how to shape place do not always match, neither do ideas on how to protect place. Participants 1, 10 and 11 described how environment preservation and cultural heritage played an important role in the resistance against the construction of the Alto Vista wind park on the island.

"[...] if it's controversial, it's in the news. Like, for example, they wanted to set up a new wind park on the island. And everyone on the island heard about it. [...] People didn't want it though [...] they thought it would be ugly. They started protesting against it, and they even went to court." - Participant 11

Participant 11 described how a community group took organised action against the construction of windmills, as they wanted to preserve the 'aesthetics' of Alto Vista as a place. This shows strong connection to place and indicates a

strong identification with place amongst people not involved in environmental initiatives. Despite this, ideas on how to protect Alto Vista and its surrounding communities and natural environment diverged. For groups and individuals against the construction of the windmills protection of the environment leaving it as is, or untouched. However, others looked to the future of Aruba, and supported the wind park, as it was the 'best place' for renewable wind energy on the island (Participants 1, 10). Devine-Wright (2009), argues that place-protective actions are not always 'pro-environmental' in nature, due to different interests and investments in and attachment to place. Participant 1 argued that accessible, and easy-to-understand research on these issues would help to bring groups together, by showing that interests in preserving the environment can be aligned. The different senses of how place should be, and how it should be managed may lead some to feel that their voices and opinions are excluded from environmental initiatives. This may in turn have consequences for participation in environmental initiatives.

Despite strong attachment to place and identity associated with nature on the island that have formed over long periods of time, the island is fluid, with constant immigration and emigration. Participant 8 describes how this has affected the makeup of their initiative's volunteers.

"But the island is also like that [no long-term volunteers].

Many people come and go, and come and go. That's just how the island is." - Participant 8

As Participant 8 explains, the organisation regularly receives volunteers who only intend to live in Aruba for a few months or years at a time. For scholars such as Relph (1976) and Tuan (1977), who view sense of place as developing over longer periods of time, these volunteers would be motivated less by their 'sense of place' in Aruba and rather by other factors. However, insights from Raymond et al. (2017) suggest that these volunteers may develop 'sense of place' faster from their immediate sensory perceptions of place. Darling (2009) and Massey (1991) also point to the

relational responsibilities of these volunteers, where their attachments to multiple places also drive their responsibility to protect their current place.

### *Time lived abroad*

Experiences of other places, and leaving Aruba for a time, were important to many participants. For Participant 12, time abroad allowed them to realise the state of environmental problems on the island.

“[...] especially with that gap in time, where I lived abroad then came back. There is a big difference. I have seen the development in the countryside with the roads, we call it the *mundi*, a lot of it went so fast, without so much respect for nature [...]” – Participant 12

Participant 12 describes how removing themselves from processes of change, allowed them to reflect and better recognise changes once they returned. This aligns with findings by Ardoin (2014) in a study in the Galapagos islands. According to Ardoin (2014), individuals with a larger scale sense of place, or connections to other places, were significantly more likely to take action to protect the environment. For Ardoin (2014), this was likely due to how time away from ‘home’ facilitates understanding broader change, and how individual actions fit into it. Participant 1 was offered a more critical perspective on the consequences of environmentally conscious individuals’ time abroad.

“[...] There is a general narrative that Arubans don’t care, and that the only people that do care about it are tourists. And in my experience, that’s not true. And a lot of the time the people that go to the Netherlands for a time then come back, have this air of superiority, and look down at locals, and seem way more critical of local people.” – Participant 1

Participant 1 agreed that time abroad gave individuals space to reflect on and realised the environmental problems Aruba faces. However, they also argue it gives individuals a sense of ‘superiority’. In this way, the multiple place identities of individuals who have lived abroad may push local people

away from environmental movements, but attract others who have lived abroad and have similar attachments or identifications with Aruba.

## **4. Preliminary conclusions**

This paper addressed the question of the role of sense of place in participation in environmental initiatives by exploring the dimensions of place attachment, place identity and place dependence. The role of sense of place in participation in environmental initiatives was shown to be complex. The participants reported strong attachments and identification with place, but the dimension of place dependence needs to be further explored in order to determine its relationship to participation. Several participants also noted strong attachments to place in individuals who were not involved in environmental initiatives. As participants noted, there is care for the environment both amongst volunteers and people who are not involved in volunteering. This suggests that attachments to the natural environment could be a bridging concept, or an area in which these different groups can find common ground. This may in turn encourage higher levels of involvement in environmental initiatives.

Climate change, environmental destruction and development activities mean that place will change, and actions to protect place will likely increase. Place-protective actions, like those around the proposed windfarm, need to be guided by environmental initiatives to ensure that protecting place contributes to nature conservation and climate resilience rather than obstructing these. Facilitating dialogue and engaging with cultural and environmental arguments to protect place may be a way to foster relationships of stewardship and motivate more people with strong attachments to Aruba to take action.

One of the main limitations of this research is that it does not include perspectives of people who do not participate in environmental initiatives. The interviews from this

study showed that attachment to and dependence on place played a role in their motivation to participate. However, it may well be the case that some people who have strong attachments to place do not participate in environmental initiatives. Future research should further look into why such people do not participate.

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## **It will never go like you planned it to**

As I am sitting on our little orange porch, trying to get rid of residue on my probe, with first a toothbrush, later with harder measures, a knife, I am just contemplating is it really worth it? I could also just be sitting in Utrecht now, reading a few papers and writing a literature review instead of fighting with equipment. But then I look around me, look at the coke can rolling around between the cars, see the pink sky in the background and realise: no, I would not like to be anywhere else. With the sea, corals, and turtles just a few minutes away. With the amazing people, this island has to offer. Our stay here has been extraordinary. I could have not wished for a better opportunity than to write my thesis on this beautiful little rock in the Caribbean. It has been a journey, firstly, switching the research approach, then when I was finally wanting to start suddenly finding out that my equipment was not feeling like working. So, I started taking measurements, and suddenly Klara had to deal with toxic green water being stored in our fridge for days (or potentially

weeks) on end. But in the end: it worked out. Shocos were seen while taking measurements; Josi and I even ended our research with a little free mud-foot spa in the Spanish lagoon. The island has taught me so much, not only regarding research (it will never go like you planned it to, but in the end, it will work differently), but I will also be taking so many personal things from the island. Everyone I have met here has been so open, approachable, flexible, and open to conversation. From the different Salsa partners to the people asking me what I was doing when seeing me with my probe in the water, to the people that have been willing to talk to me about the wetlands I was researching. So, no. I would not have changed this programme for the world. Because Aruba, with all its challenges, and problems, has proven to me that it is a resilient, beautiful, and strong island, with people willing to give their all to make it better. Therefore, I would like to thank a few of them also here personally (a more extensive thank you can be found at the end of my paper).

A very big shoutout is going out to Josianne Vrolijk, thank you for your great help in taking measurements, saving the pH pen countless times, with no fear of falling in. Thank you to the SISSTEM students who have been so welcoming and told us all about their island. Showing us around at beach tennis, organising great barbecues, and joining us in our Salsa adventures. Also, a big thanks to Klara. Without you, this journey would have been a lot more boring and lonelier. You always made me laugh, hugged me, even when I was sticky, and let me annoy you like the true big sister you are. Also many thanks to Eric Mijts, Carlos Rodriguez, Tobia de Scisciolo, and Jocelyn Ballantyne, who made all of this possible, with their work, guidance, and help.

# Measuring the water

## *Comparing wetlands on the island of Aruba to determine influences of wastewater effluents on the water quality of the Bubali wetland area.*

Sophia Klaussner

### **Abstract:**

Man-made wetlands have been used as filtering systems for wastewater for several decades. Aruba is also making use of this concept at the wetland area of Bubali that is being fed by a wastewater treatment plant. The aim of this research was to determine whether water quality indicators are the same throughout the entire wetland or whether they are different throughout depending on the distance to the inflowing water source. The measured values of Bubali were then compared to values of the Spanish lagoon and a Salina at the North of the island to see whether Bubali exhibits different water quality from other wetlands on the island.

### **1 Introduction**

Wetlands can appear in numerous ways, with each type providing many ecological advantages. They are usually unique ecosystems, hosting diverse flora, fauna and other species (Bhowmik, 2020). Furthermore wetlands offer important ecosystem services like maintaining freshwater quality or nutrient conservation (Bhowmik, 2020). This is why constructed wetlands have been used for treatment of effluents ever since early experiments in the 1950s (Vymazal, 2010). As wetlands remove nutrients from effluents, play an important role in carbon sequestration, and improve the water quality overall, they are perfect for filtering pre-

treated water, also called grey water, before it is released into other sensitive aquatic environments like oceans or rivers (Bhowmik, 2020; Vymazal, 2010). However, there are limits to the capacity of wetlands to take up nutrients (US EPA, 2001). If there are too many nutrients coming into the ecosystem even healthy wetlands will reach their carrying capacity, cross a tipping point and start deteriorating. In these cases, the nutrients then act as pollutants. Pollutants, however, are not only limited to an overflow of nutrients but can also be other substances that adversely affect an ecosystem. Other examples for pollution can be oil, or heavy metals.

#### **1.1 Problem Description**

The Bubali wetland on the island of Aruba is mainly being fed by the adjacent wastewater treatment plants effluents (Overheid, 2018). Still, it serves as a breeding ground for many migratory birds and is one of the most biodiverse areas on the island. Conversations with the local population revealed that the Bubali wastewater treatment plant is known for often having to clean more sewage than its capacity allows. This, supposedly, results in water being discharged into the wetland that has not undergone a full treatment. The aim of this research is therefore to find out, how water quality on Bubali is in general, whether it is different throughout the wetland and how its values compare to two other, reportedly healthy, ecosystems on

the island, that do not receive wastewater discharge. This is being measured with basic water quality measurements. For this, the author and Josianne Vrolijk over 100 samples were taken at the site of Bubali in a several weeks long research process, and later compared to other wetlands on the island of Aruba. This research could give an indication of how well the ecosystem performs as well as whether it is showing signs of deterioration.

## **1.2 Research Question**

For this the following research question has been posed: What is the status of basic water quality parameters in the Bubali wetland and how do they compare to other wetlands on the island of Aruba?

## **1.3 Literature Review**

Water quality depends on many different factors and has different indicators. Temperature, pH, dissolved oxygen, electrical conductivity, salinity, nitrogen, and total dissolved solids have been identified as good indicators and are used in this study to compare the water measurements (Michaud, 1991; US EPA, 2013b, 2013c, 2013e, 2013d, 2015; Water Science School, 2018b).

### ***1.3.1 The role of pH in water quality***

The pH is a measurement of how many hydrogen molecules are available within a substance (Michaud, 1991). Generally speaking, the higher the pH value, the less hydrogen molecules are available for bonding. The pH value of a waterbody therefore determines the solubility and biological availability of chemical constituents like nutrients, and affects how much of certain nutrients can be used by aquatic life (Michaud, 1991). It furthermore also affects toxicity of particular chemical constituents, like metals, as they tend to be more soluble at lower pH. Therefore, they also become more toxic at lower pH values (Bhateria & Jain, 2016; Michaud, 1991). In general, in warm, productive and potentially eutrophic lakes pH usually ranges between 7.5 and 8.5 (Michaud, 1991).

### ***1.3.1.1 What influences pH levels?***

During the day pH often is higher than during night hours as photosynthesis uses up hydrogen molecules, while respiration and decomposition processes lower the pH value, by freeing up hydrogen molecules (Michaud, 1991). Usually, water bodies possess a pH buffering capacity, which results in pH levels remaining relatively stable around values between 6.5 and 8.5 on the pH scale (Michaud, 1991).

### ***1.3.1.2 Expected impact of pollution***

Pollution often causes higher productivity (further discussed in other sections), which results in an increase of pH as allowed by the buffering capacity of a lake (Michaud, 1991). While small pH changes do not have a direct influence on aquatic life, they start a chain reaction to a positive feedback loop. The small increases influence the availability and solubility of several chemicals in the aquatic body and may increase productivity in the lake even further. This results in a greater oxygen demand (further explained in the Dissolved Oxygen section), and a bigger risk of an hypoxic environment (Michaud, 1991). The research question regarding pH is therefore: What are the pH values in Bubali and how do they change in spatial distribution and in relation to comparison sites?

### ***1.3.2 The role of temperature in water quality***

Water temperature has a major influence on biological activity and determines the types of organisms that live in aquatic environments as water species such as fish, insects and plankton have a preferred temperature range (Bhateria & Jain, 2016; Michaud, 1991; Water Science School, 2018b). The temperature of the water also determines rates of chemical reactions, its oxygen content, rates of photosynthesis, and the sensitivity of organisms to toxic wastes, parasites and diseases (Bhateria & Jain, 2016; Michaud, 1991).

### ***1.3.2.1 What influences water temperature?***

Natural processes like seasonality and day-night rhythm

influence the water temperature and cause variations (Michaud, 1991). During the day, water heats up, while at night there is a cooling process. Furthermore, there can also be differences in temperature within an aquatic body when it is deeper than 2-4 m (Michaud, 1991; Water Science School, 2018b). Water temperature is furthermore also influenced by the water body's inflow and speed with which the water moves through the wetland (Michaud, 1991).

### **1.3.2.2 Expected Impact of Pollution**

Discharged water often has a different water temperature than naturally occurring water bodies, as the water temperature is being changed by mechanical, chemical, or environmental processes (Michaud, 1991). Usually, discharge flowing into a water body is warmer than the natural waterbody, but the opposite can also be the case. If temperature pollution is happening, it is changing the water temperature of a waterbody, therefore also changing all other natural characteristics connected to it, while also changing water temperature from natural conditions (Michaud, 1991). It is therefore important for this water quality indicator to find comparable waterbodies, to determine what the naturally occurring temperature is. Therefore, the temperature specific sub-question is: What is the temperature in Bubali and how does it change in spatial distribution and in relation to comparison sites?

### **1.3.3 The role of Dissolved Oxygen in water quality**

Aquatic ecosystems like fish and plants require oxygen to live and reproduce (Wilson, 2010). In aquatic environments, however, most organisms are unable to reach atmospheric oxygen at the surface, therefore they are dependent on oxygen being dissolved in the water, the dissolved oxygen (DO) (Michaud, 1991). If levels of DO fall under a certain threshold several organisms cannot survive and die off (Wilson, 2010). Exemplary concentrations for sustaining life can be seen in Table 1.

DO concentration (mg/L)	Organism	Effect
< 3.0	Salmonids	Death
1-2	Catfish	Reduced food intake; as juveniles: death
1.3-2.5	Rainbow trout (Yearlings)	Death (LC50)

*Table 1: Minimum DO concentrations for sustaining life of several aquatic species. LC50 is the concentration at which 50% of the organisms die. Adapted from Wilson (2010).*

However, low DO does not necessarily mean that no organisms can survive in the water. Certain species are well adapted to low oxygen environments, or can physiologically acclimate to them, however, these adaptations usually require a long-term exposure to low, sublethal DO levels (Wilson, 2010). When an ecosystem deteriorates, however, it is usually a rapid process that does not take the time an ecosystem needs to adapt to low oxygen environments (Michaud, 1991). Oxygen is furthermore also important for different chemical processes within water (Michaud, 1991). DO levels of healthy ponds are usually around 10mg/L, while DO levels below 6mg/L can begin to have detrimental effects on pond life (Swistock et al., 2006). If DO concentrations reach levels of less than 2-3mg/L the water is considered to be hypoxic (US EPA, 2015). Anoxic are waters or regions within water that contain less than 0.2 mg/L of DO (Cheasepeake Bay, n.d.). Those areas are also often called dead zones, because most animals cannot survive there (Cheasepeake Bay, n.d.; US EPA, 2013a, 2015). Overall, DO gives a good indication of water quality as it gives a direct indication of an aquatic resource's ability to support aquatic life (US EPA, 2013b).

### **1.3.3.1 What influences dissolved oxygen concentrations?**

DO concentrations are dependent on different factors like temperature and salinity. The colder the water, the more

oxygen can be dissolved within it, while more saline waters can hold less oxygen (Michaud, 1991; Wilson, 2010). Most oxygen enters water bodies by transfer from the atmosphere. This process happens at the surface, through wind movements or the chemical reaction of diffusion (Wilson, 2010). However, a small but nevertheless important amount of oxygen is also contributed to the water during daylight hours through photosynthesis. However, most if not all of this oxygen produced this way is consumed during respiration and decomposition throughout all 24 hours of the day (Michaud, 1991; Wilson, 2010). This can lead to variations in concentration of DO throughout the day.

### ***1.3.3.2 Expected impact of pollution***

When a water body is polluted by organic matter, like sewage, or nutrients, pollution causes a drop in average DO, as oxygen is being used in the decomposition processes (Michaud, 1991). If organic matter is formed within a lake, e.g., by algae growth, it first also produces oxygen within the water through photosynthesis. However, when getting the overhand, algae will block other aquatic plants from sunlight, causing them to die, and, during their decomposition, causing the overall oxygen demand to rise, resulting in a drop of available DO (US EPA, 2013a). This leads to dangerously low levels of DO.

To answer the research question regarding DO, the following research question has been posed: What are the DO values in Bubali and how do they change in spatial distribution and in relation to comparison sites?

### ***1.3.4 The role of electrical conductivity in water quality***

Electrical conductivity (EC) is the measure of how well an electrical current can pass through water (US EPA, 2013c). Conductivity is a useful general measure of water quality, as each water body tends to have a relatively constant range of conductivity that does not change significantly (Bhateria & Jain, 2016; Chesswatch, n.d.; US EPA, 2013c). Once a baseline conductivity range has been established,

significant changes can be used as an indicator for pollution (Chesswatch, n.d.; US EPA, 2013c).

Expected values of EC depend on several factors, but an approximation of expected values can be done. Expected values can be seen in Table 2, based on Fondriest Environmental (2014).

Water Source	Expected uS/cm
Tap Water	50-800 uS/cm
Potable Water	30-1500 uS/cm
Freshwater Streams	100-2000 uS/cm
Industrial Wastewater	10 000 uS/cm
Sea Water	55 000 uS/cm

*Table 2: Approximate expected EC values for different Water Sources. Based on (Fondriest Environmental, 2014).*

### ***1.3.4.1 What influences Electrical Conductivity?***

The higher the salinity of a body of water, the higher its electrical conductivity as dissolved salts and other inorganic chemicals conduct electrical current (Fondriest Environmental, 2014; US EPA, 2013c). Conductivity is furthermore influenced by temperature: the warmer a waterbody is, the better its electricity flow (Chesswatch, n.d.; Fondriest Environmental, 2014). With every 1°C increase, conductivity levels can increase by up to 2-4% (Fondriest Environmental, 2014). If there is an incoming water flow, it can also alter conductivity levels by mixing waters with different EC levels (Fondriest Environmental, 2014). The geology of a location can also change the EC, as solved minerals in the water can increase EC (Fondriest Environmental, 2014).

### ***1.3.4.2 Expected impact of pollution on EC***

A sudden increase or decrease in conductivity in a water body can be an indicator for pollution (US EPA, 2013c). Most often pollution results in an increase, as a sewage

leak e.g. will increase conductivity due to the additional chloride, phosphate and nitrate ions (Bhateria & Jain, 2016; Fondriest Environmental, 2014). However, an oil spill or the addition of other organic compounds often decreases conductivity, as these elements do not break down into electrically carrying ions, therefore decreasing the overall EC by insulating electrical currents (US EPA, 2013c).

To answer the overall research question an EC specific one has been created: What are the EC values in Bubali and how do they change in spatial distribution and in relation to comparison sites?

### **1.3.5 The role of Salinity in water quality**

Closely related to EC is salinity (SAL). This is defined as the dissolved salt content of a body of water (US EPA, 2013e). It determines many aspects of the chemistry of natural waters and the biological processes within them, as well as influencing physical characteristics of water such as density and heat capacity (US EPA, 2013e). As salts can be toxic to freshwater plants and animals it is important to monitor salinity levels within freshwater areas.

Depending on the SAL, water is often classified into different categories. These can be seen in table 3:

Salinity Status	Salinity in parts per trillion (ppt)	Type of waterbody
Fresh	0-1 ppt	Ponds, lakes, rivers, streams
Brackish	1-30 ppt	Estuaries, mangrove swamps, brackish seas and lake, brackish swamps
Saline	30-50 ppt	Sea water, salt lakes
Brine	>50 ppt	Brine pools

*Table 3: How water is classified depending on its salinity. Free after (Nassau Boces, n.d.).*

#### **1.3.5.1 What influences SAL?**

Small amounts of salt are evaporated from oceans and carried in rain clouds which deposit them across the landscape with rainfall. This is especially the case in coastal environments (Western Australian Government, n.d.). Landscapes' features can flush that salt into water bodies through weathering (Western Australian Government, n.d.). Consequently, in dry areas, there is a build-up of salts as there is relatively little water flushing it away (Fondriest Environmental, 2014; Western Australian Government, n.d.).

#### **1.3.5.2 Expected impact of pollution on SAL**

Changing SAL levels are not necessarily an indication for any specific pollution, but rather show the general pollution with salts, that can come from a multitude of sources (US EPA, 2013e). If levels of salinity are high, ecosystems can often not adapt to it in an adequate timespan as they are usually only adapted to a certain salinity level (US EPA, 2013e). Rising salinity levels can therefore, indicate a threat to the ecosystem. To answer the research question in regard to SAL the following sub-question has been created: What are salinity values in Bubali, how do they change in spatial distribution and in relation to comparison sites?

#### **1.3.6 The role of Nitrogen in water quality**

Nitrogen is a critical nutrient that is necessary for all life forms. It can occur in aquatic bodies in several forms, like ammonia (NH<sub>3</sub>), nitrates (NO<sub>3</sub>) and nitrites (NO<sub>2</sub>) (US EPA, 2013d). However, in big quantities it can stimulate algal blooms within water bodies, which in turn lead to a drop in DO, and overall endangered ecological health (US EPA, 2013d; Water Science School, 2018a). Measuring nitrogen in water bodies is therefore useful, as it can provide insights on whether a waterbody could be at risk from this process.

**1.3.6.1 What influences Nitrogen?**

Nitrate can enter water from the atmosphere by diffusion processes and rainwater. In addition, it can be formed in water bodies by the oxidation of various nitrogen forms. However, these processes are usually relatively balanced and result in very little unbound nitrate, as it is usually taken up immediately by ecological processes (LAWA, 2021; Water Science School, 2018a).

**1.3.6.2 Expected impact of pollution on Nitrogen levels**

Pollution usually causes rises in Nitrogen levels, in the form of nitrite (NO<sub>2</sub>), nitrate (NO<sub>3</sub>) and ammonia (NH<sub>3</sub>) (Lenntech, n.d.; Water Science School, 2018a). To answer the overall research question, a Nitrogen specific research question has been formulated: What are the values of Nitrate and Nitrite in Bubali and how do they change in spatial distribution and in relation to comparison sites?

**1.3.7 The role of Total Dissolved Solids in water quality**

Total Dissolved Solids (TDS) combines the sum of all ion particles that are smaller than 2 microns. It usually includes all electrolytes that make up salinity concentrations, as well as other compounds like dissolved organic matter (Bhateria & Jain, 2016; Fondriest Environmental, 2014). Depending on ionic properties, excessive total dissolved solids can produce toxic effects on fish and their eggs, as well as other aquatic organisms (Fondriest Environmental, 2014). TDS values in lakes and streams are typically found to be in the range of 50 to 250 mg/L, while in areas of hard water or high salinity TDS values might be as high as 500 mg/L (Bhateria & Jain, 2016). In the United States, water with TDS levels above 500 mg/L are not recommended for consumption, while values above 1,500 to 2,600 mg/L are considered problematic for irrigation of some crops (Harter, 2003).

**1.3.7.1 What influences TDS?**

TDS and salinity are related, as an increase in salinity also automatically results in a higher TDS (Bhateria & Jain, 2016; Fondriest Environmental, 2014; Water Research Center,

n.d.). However, an increase in TDS does not necessarily mean an increase in salinity, but may also include organic solvents as well as salt ions (Fondriest Environmental, 2014).

**1.3.7.2 Expected impact of pollution on TDS**

Pollution in general is expected to cause a rise in TDS, as more ions are present in the water, especially following pollution with nutrients (Harter, 2003). To answer the overall research question, a TDS specific sub-question has been formulated: What are the TDS values in Bubali and how do they change in spatial distribution and in relation to comparison sites?

**1.4 Study Area**

The island of Aruba is located about 30 km north of Venezuela's north coast. The island has an area of about 195 km<sup>2</sup> and is located in the Southern Caribbean Dry Zone, that is known for its tropical steppe and arid hot climate (Departamento Meteorologico Aruba, n.d.; UNESCO, 2010; Visit Aruba, n.d.). The discernible dry season is running from February to June, while the rainy season starts in September and lasts until January (Departamento Meteorologico Aruba, n.d.). The temperature on the island varies little throughout the year, in the period of 1991-2020 the average annual temperature was 28.4°C ranging from 27.0°C to 29.6°C in the coldest and warmest month respectively (Meteorologische Dienst Aruba, 2020). There is an average annual precipitation of 451mm (≈ 1.2mm/day) on the island while daily evapotranspiration rates are about 6.8mm/day (Halewijn et al., 1992; Higler & van Halewyn, 1991; Meteo Curaçao, n.d.; Meteorologische Dienst Aruba, 2020). Evapotranspiration rates are therefore more than six times that of the precipitation.

**1.4.1 Description of Measurement sites**

The main study area, Bubali (also known as the Bubali Bird Sanctuary) is a wetland area in the Northeast of the island of Aruba, located within the tourist area of Palm Beach. The



former salina is used as a disposal basin for the adjacent wastewater treatment plant since 1972 (Higler & van Halewyn, 1991) and has an approximate size of about 45 hectares. Approximately 85% of the inflow in the pond is the effluent of the wastewater treatment plant, the remaining 15% of the water are stemming from precipitation (Higler & van Halewyn, 1991). Evapotranspiration on Aruba is on average more than six times the rate of precipitation, which causes all freshwater wetlands, with the exception of Bubali, to dry out during dry season (Meteo Curaçao, n.d.). Bubali does not dry out, as its inflow from the wastewater treatment plant is constant enough to make up for water lost through evapotranspiration.

At Bubali wetland the sampling was conducted with two different approaches: the first approach was from the shore, reaching an arm length into the water at different locations. Additionally, five of the measurements were also taken from a boat in the middle of the wetland, at location 1 (see figure 1).

Two other measurement areas are being used as comparison areas for the water quality values measured in Bubali. The larger comparison site is the Spanish lagoon. This is a brackish wetland area that is located approximately 10 km southeast of Oranjestad, with a surface area of about 70 hectares and a tidal inlet of 2 km (Houtsma, 2017). Its main water sources are precipitation and the sea resulting in its brackish properties (FPNA, 2018; Houtsma, 2017).

The second comparison site is a small salina in the north of the island, located in direct proximity to the Fisherman's Huts Beach (coordinates: 12°35'10.0"N 70°02'35.2"W). Its main water source is unclear, but the local population assumes that the water comes mainly from the nearby sea as well as from some precipitation. The surface area varies throughout the seasons but is approximately 2.6 hectares. The water is suspected to be salty however, this was not fully determinable. The measurements were taken from the western side of the salina.

## 2 Methodology

### 2.1 How was water measured?

The water was measured with three different devices. A water probe was used that measured dissolved oxygen (DO), electrical conductivity (EC), total dissolved solids (TDS) and salinity (SAL) as well as saving location and time and date of the measurement. A pH pen was used to measure the pH of the water. Colour testing strips were used to show approximate levels of nitrate, nitrite, Hardness, chlorine, and alkaline.

#### 2.1.1 Probe

The values of BAR, DO, EC, TDS, and SAL were measured by inserting the probe into the water until fully submerged; then lightly waving it to create sufficient waterflow for the oxygen sensors. For areas with insufficient water depth for vertical insertion the probe was inserted horizontally and lightly waved to create the necessary waterflow. For accurate readings, the pH pen's tip was fully submerged. Due to equipment failure the pH could not always be measured. When this was the case, a sample was taken in small containers at the site of measurement, by submerging the container until filled up. After the collection the samples were cooled, until the equipment was available. This was the case for locations 1-5. After the arrival of the equipment the sample's pH was measured with the pH pen. This was the case after 10 and 17 days. Every 10 probe sites, or once at every location an aquarium testing strip for nitrate, nitrite, and chlorine levels was also used.

#### 2.1.2 Sample Sites

Sample sites were selected by distance from the inflow of the treated wastewater as well as reachability of the shoreline or water location by boat. The selection of the sites aimed to show a big variability of distance from the treated wastewater inflow, to determine whether the site was able to improve water quality before discharge. Therefore, several areas were selected by availability and accessibility

on foot. After identification of the location the area was sampled by taking measurements within it. When made possible by area the measurements were taken every 20 or 10 steps depending on the size of the area. When the area did not allow for this due to issues of accessibility or lack

of space, several measurements were taken in at least two-foot lengths distance of each other. This was done to ensure consistent results and an overall picture of the water quality in the sample area as well as to make sure that results were not due to single outliers at one specific sample location.

*Figure 1: The locations of all measurements.*





**2.1.2.1 Location 1 (Bubali)**

The location is in the middle of the main site of Bubali. Water depths of approximately 70 cm with open water. Areas that were overgrown with vegetation were not measured. The values here were measured from a boat. For measurements five spots were chosen. One relatively close to the inflow, two in the middle of the water area, and two to the sides. The measurements were taken off the side of the boat.

**2.1.2.2 Location 2 (Bubali)**

A little arm that is going off the main site of Bubali with water depths around 30-50cm. Measurements here were taken by the usual method of measuring from the shoreline reaching an armlength into the water.

**2.1.2.3 Location 3 and 4 (Bubali)**

These are two small lake structures separated from the main Bubali wetland by a big road. Underneath the road however, there seems to be a connection, as there are no other water sources to the area and the puddles have water all year round. The areas are characterised by low water depth of less than 30cm, and a muddy bottom. They are surrounded by some vegetation on the side of the big road, bordered by a smaller road on the opposite side of the big road, and small vegetation on the other ends.

**2.1.2.4 Location 5 (Bubali)**

A small accessible area at the North-end of Bubali. Next to a street, vegetated with trees and shaded. The accessible water area is only small, and the water is shallow with water depth lower than 40 cm.

**2.1.2.5 Location 6,7, 8 and 9 (Bubali)**

The outflow of the Bubali wetland to the ocean. Bubali is separated from the outflow by several cement walls, with small holes, that even out the water levels. Measurements were taken on both sides of the cement walls (locations 6 and 7) as well as until the effluent meets the sea (locations 8 and 9). The water depth varied in between the different walls. The

closer we got to the sea, the lower the water levels became. At the end water levels barely reached 10cm, while at the beginning of the walls, water levels were at least 50-70cm. The location separation by number was done after each wall.

**2.1.2.6 Location 10 (Bubali)**

Along the side shore of main Bubali. Water depth is greater than 50cm, with a muddy bottom. Small vegetation occurs on the side; however, the site remains accessible by foot. The water was measured with an armlength distance from shore.

**2.1.2.7 Location 11 (Salina)**

The previously mentioned small salina in the North of the island. Measurements here were taken along the South-Eastern shoreline with 10 steps in between measurements. The Salina's water depth was less than 30cm.

**2.1.2.6 Location 12 (Bubali)**

The effluent of main Bubali to a smaller wetland area. Connected by a small inflow that is going under a street. At the end of the inflow, it opens into a densely vegetated area. Measurements were taken all along the inflow into the smaller wetland and at the beginning of the wetland. No further measurements within the smaller wetland were possible due to physical obstruction by dense vegetation.

**2.1.2.7 Location 13 and 14 (Bubali)**

These locations are two measurement sites at the side of the road, across from measurement locations 3 and 4. The locations are part of the main body of Bubali with a water depth greater than 50cm. The area was lightly vegetated with some water plants and water lilies.

**2.1.2.8 Location 15 and 16 (Spanish Lagoon)**

As a comparison site the Spanish lagoon, a brackish wetland area was chosen. The site is an important resting place for birds and other wildlife. It is one of the most biodiverse areas on the island of Aruba (FPNA, 2018). It was, therefore

considered as a healthy comparison site with healthy water values. The wetland is reaching approximately 1.5km inland from the leeward coast of the island as a band. Measurements here were taken by wading in the shallow waters surrounded by the mangroves in the North of the area. The other measurements were taken from the top of a small car and pedestrian bridge located closer to the sea inlet of the Spanish lagoon (coordinates: 12°28'25.4"N 69°58'31.2"W).

## 2.2 Statistical Analysis

Statistical analyses were conducted with SPSS to compare values across sites and to see whether there was a correlation within Bubali and in between the different wetlands. First descriptive statistics were analysed with Median and Mean values as well as the Standard Deviation. Then values were analysed to find correlations between them, for this the Spearman's rho testing was used. Furthermore, a Whitney-U test was used to determine whether there is a comparison between Bubali and the comparison sites. Afterwards, a Kruskal-Wallis test was used in order to determine whether there was a significant difference in between the measurement sites within Bubali. Later in the research a post-Hoc test will be conducted to determine how big of an effect there is by location on the various parameters.

## 3 Preliminary Results

This section only contains preliminary results as there was not enough time to run a full analysis of the collected data before the end of this programme.

### 3.1 Descriptive Statistics

Overall, 132 measurements were taken at 16 different locations. Of the 132 measurements 109 were performed at Bubali and the remaining 23 were taken at the Salina and the Spanish lagoon. Due to equipment failure or non-availability of the equipment not all parameters could be measured at each of the 132 measurement sites. There were 101 valid measurements performed for pH (Median= 8.1,

Minimum= 6.8, Maximum= 8.9). For temperature and DO concentrations 132 valid measurements were taken (M= 28.13, SD= 2.46; M= 4.98 mg/L, SD= 3.11). If only looked at DO concentrations in Bubali M = 5.13 with SD = 3.38. EC and TDS had 131 valid measurements each (M= 17884, SD= 38707; M= 11624, SD= 25159). When analysing TDS separately within Bubali values changed M = 1514, SD = 1958, while the comparison sites had values of M = 59096, SD = 29396. Salinity had 122 valid measurements (M= 5.49, SD= 12.50), while nitrate and nitrite each had 24 valid measurements (M= 1.7, SD= 5.6; M= 0.8, SD = 1.3). For nitrite measurements between Bubali and the comparison sites differed as MBubali = 0.9, SD = 1.4 and MComparisonSite = 0.0, SD = 0.0.

### 3.2 Correlation analysis

Spearman's rank correlation was computed to assess the relationships between all measured independent water quality measures.

- Temperature was significantly correlated to pH (rs= .539, p < .001, N = 101) DO (rs= .621, p < .001, N = 132), EC (rs= .330, p < .001, N = 131), and TDS (rs= .331, p < .001, N = 131).
- pH was in addition to Temperature also significantly correlated to DO (rs= .606, p < .001, N = 101), EC (rs= .237, p = .018, N = 100), and TDS (rs= .237, p < .005, N = 100).
- EC was in addition to Temperature and pH positively correlated to TDS (rs= 1.0, p < .001, N = 131), Sal (rs= .997, p < .001, N = 122), and nitrite (rs= .563, p < .005, N = 24).
- DO mg/L was in addition to Temperature, and pH positively correlated to Chlorine (rs= .439, p < .005, N = 24).
- Salinity was other than with EC correlated with TDS (rs= .997, p < .001, N = 122) and nitrite (rs= -.556, p = .005, N = 24).
- TDS was other than to Temperature, and pH correlated with salinity and nitrite (rs= -.556, p = .005, N = 24).

To compare means between Bubali and the other sites the Man-Whitney-U test was used. The test indicated that there was a statistical significant difference between Bubali and Non-Bubali measurements for Temperature ( $U(\text{NBubali} = 109, \text{NNon-Bubali} = 23) = 438.5, z = -4.89, p < .001$ ), for pH ( $U(\text{NBubali} = 78, \text{NNon-Bubali} = 23) = 279.5, z = -5.0, p < .001$ ), for EC ( $U(\text{NBubali} = 108, \text{NNon-Bubali} = 23) = 0.0, z = -7.5, p < .001$ ), for TDS ( $U(\text{NBubali} = 108, \text{NNon-Bubali} = 23) = 0.0, z = -7.5, p < .001$ ), and for salinity ( $U(\text{NBubali} = 108, \text{NNon-Bubali} = 14) = 0.0, z = -6.09, p < .001$ ).

A Kruskal-Wallis test was used to determine whether there is an effect of location on the different water quality values.

### 3.3 Results of sub-questions

#### 3.3.1 pH

A Kruskal-Wallis test showed that the measurement location significantly affects pH values with  $H(14) = 79.19, p < .001$ . A Dunn's post-hoc test has not been conducted yet but will be conducted in the future. Another Kruskal-Wallis test was conducted, this found that location within Bubali also significantly affects pH values ( $H(11) = 55.1, p < .001$ ).

#### 3.3.2 DO

A Kruskal-Wallis test showed that the measurement location significantly affects DO values with  $H(15) = 95.99, p < .001$ . Another Kruskal-Wallis test was conducted, this found that location within Bubali also significantly affects DO values ( $H(12) = 76.2, p < .001$ ).

#### 3.3.3 Temperature

A Kruskal-Wallis test showed that the measurement location significantly affects water temperature  $H(15) = 111.9, p < .001$ . Another Kruskal-Wallis test was conducted, this found that location within Bubali also significantly affects temperature ( $H(12) = 88.4, p < .001$ ).

#### 3.3.4 Salinity

A Kruskal-Wallis test showed that the measurement

location significantly affects SAL with  $H(14) = 109.83, p < .001$ . Another Kruskal-Wallis test was conducted, this found that location within Bubali also significantly affects pH values ( $H(12) = 92.8, p < .001$ ).

#### 3.3.5 TDS

A Kruskal-Wallis test showed that the measurement location significantly affects TDS with ( $H(15) = 120.40, p < .001$ ). Another Kruskal-Wallis test was conducted, this found that location within Bubali also significantly affects TDS values ( $H(12) = 93.0, p < .001$ ).

#### 3.3.6 EC

A Kruskal-Wallis test showed that the measurement location significantly affects EC with  $H(15) = 120.36, p < .001$ . Another Kruskal-Wallis test was conducted, this found that location within Bubali also significantly affects EC values ( $H(12) = 93.0, p < .001$ ).

#### 3.3.7 Nitrate and Nitrite

A Kruskal-Wallis test showed that the measurement location significantly affects nitrate with  $H(13) = 23.0, p = .042$ . Another Kruskal-Wallis test was conducted, this found that location within Bubali also significantly affects nitrate values ( $H(10) = 20.0, p = .029$ ). However, another Kruskal-Wallis test did not show any significant effect of measurement location on nitrite with  $H(13) = 17.13, p = .194$ . There was also no effect of location on nitrite within Bubali itself ( $H(10) = 14.1, p = .169$ ).

## 4 Preliminary Discussion

This section only contains a preliminary discussion as there was not enough time to run a full analysis of the collected data before the end of this programme, therefore a full interpretation of the data was not possible either.

### 4.1 Limitations

The pH pen was only available for measurements after

a part of the measurements were already finished. This meant that water probes had to be stored in the fridge until their pH could be measured. This could have potentially affected their pH values, by e.g., changing their chemical composition through decay of organisms that were still present in the water. Furthermore, comparison sites were saltier than the original site, hence while this is expected to change several values like EC, SAL, and TDS, it could also have unexpected influences on some of the other parameters that this study does not account for. The low water depth at some of the measurement sites could also have influenced the measurements, as the light movements of the water probe might have stirred up some of the sedimentary layer at the bottom of the waterbody, which would have caused the measurements of TDS to be distorted. Due to an equipment failure the salt content at the salina could not be measured. This, therefore, gives no clear indication on how salty the water is. However, with the assumption of the water having similar levels to the Spanish lagoon, comparisons can still provide a insights.

#### **4.2 Discussion of Results**

Some of the observed correlations were to be expected as the values are directly related to each other. These include the positive relationship between EC, Sal, TDS. As these values are all measured by the electrical conductivity in the water, it is logical that these values are correlated, as they also are related. What is interesting to observe is that the concentration of nitrite is also positively correlated to these three values. This could be an indication that in areas on Aruba with high values of EC, salinity and TDS there also is pollution with nitrite. In addition, nitrite was only found in the Bubali area, but not in the two comparison systems.

Interestingly, there is no statistically significant difference between the comparison sites and Bubali for DO. As both comparison sites are significantly higher in salt content, the DO value would be expected to be significantly different between the sites. As this is not the case it could

indicate that the DO content of the water at Bubali is at a generally low level. The mean DO of 5.1mg/L also suggests this. While this is generally not to be considered hypoxic, it is important to consider that all measurements were conducted during the day, when DO values are generally higher due to photosynthesis. This suggests that during the night Bubali may experience hypoxic conditions. This can be threatening for the ecosystem and could be caused by overnutrification of the ecosystem.

Another hint for pollution within Bubali could be the measured TDS concentrations. As previously discussed, concentrations of over 1000 mg/L of TDS are considered as alarming in water bodies that are not saline. The mean within Bubali lies higher than this, however with much variability. While this might be caused by an outlier at 14000, the general values at Bubali often lie above 1000, while remaining in a similar range within one location. This could be an indication for point pollution, that influences levels more or less depending on the distance from the pollution.

Another interesting observation made was that the Spanish Lagoon seems to be hypersaline in the inland measurement location.

#### **4.3 Discussion of sub-questions**

All sub-questions relating the different water quality parameters returned statistically significant results between locations, with the exception of nitrite. While parts of the difference in values between Bubali and the comparison sites might be explained by some of the differences in salinity, the difference in location within Bubali itself also shows a significant influence on values. This could potentially mean that there is a point pollution within Bubali, as the values differ significantly. The difference could therefore be stemming from the fact that the ecosystem buffers the pollution in areas with less pollution, that are further away from the point of pollution. In close proximity however, the

ecosystem might be overwhelmed and overnutrified and unable to buffer anymore, therefore, showing more extreme values of pollution. However, with the results of this study no definitive conclusion, whether there is a point pollution can be drawn. Further research should be done into the water quality of Bubali to determine this. A long-term study comparing the values to found baseline values would be interesting here, as well as investigations into Bacteria and other indicators of pollution.

## 5 Conclusion

This study investigated the effects of the wetland area of Bubali on basic water quality parameters of treated wastewater effluents and how they compare to other wetlands on the island. It found that there is a significant difference between different areas within the wetland of Bubali of basic water quality parameters, except for nitrite. It, furthermore, also found significant differences between Bubali and other wetlands on the island. These effects could follow from a point pollution source within Bubali, but the results are not conclusive. Future research could replicate this study long-term to see the development of values, also to develop an early warning system for a deteriorating ecosystems, when values move too far from the baseline values established in this report.

## 6 Acknowledgements

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## **It gave me a glimpse of what I want to do in the future**

The three months in Aruba were spent at the BTA sipping beach tennis juice barefoot and making connections that made me feel at home. This was truly the start of my journey in Aruba.

Before coming to Aruba, I had a goal set in mind: I will swim everyday (ocean mostly, but pool included). Although I did not succeed to do this as regularly as I would have liked I did pretty well. But most importantly, I remembered why I had set that goal. I have grown up with a passion for swimming but during Covid in the Netherlands, I had no way to go swimming, except in the freezing water of the Krommerijn river. I'd forgotten how being outside, moving around, and having new adventures energized me and gave me confidence. In Aruba, not only could I do things that I could not do back home, like swimming, kitesurfing, beach tennis and spending sunsets at the beach, I was also able to engage my curiosity. It allowed me to explore and adapt

to a new place by myself which allowed me to grow as an individual.

Before coming to Aruba, I was scared to do research on my own. I thought that I would not get anywhere. But I have come a long way, and learned things that I could have never achieved without this program. It gave me incredible confidence to conduct my research and not second guess myself. It allowed me to get out of my comfort zone and made me grow so much as a researcher. And even though it might still be scary, it gave me a glimpse of what I want to do in the future.

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# **Breathing Unevenly:**

## **Community Response to Environmental Injustice**

### *A case study of Aruba's Landfill and the Parkietenbos community*

Laura Mathieu

#### **1. Introduction**

When you fly into Aruba expecting clear turquoise water and perfect yellow sand, what you don't see are the tons of garbage overflowing into the sea right near the airport. The Parkietenbos landfill is not only an eyesore to visiting tourists, it has a deeply rooted impact on the community living around it. Although many of us do not bother to think about where the waste we create goes once we 'take out' the trash, it is one of the largest issues in our time. In our consumer-driven world, where it is difficult to find food not packaged in plastic, 2.12 billion tons of waste are dumped globally per year (Barua & al., 2021). As our world is filling up with trash, we will have to find a way to store it all. This problem is especially evident in small island states (SIS). Limited space, limited recycling, limited resale alternatives, and the repercussions waste has on the local ecosystem are just a few of the challenges that are amplified when islands are smaller, densely inhabited, and tourist-dependent (Camilleri, al., 2018). Trucks, treatment facilities, and hazardous dumping contribute to continuous disturbance of the local environment, affecting communities and causing damage to terrestrial and marine ecosystems.

On Aruba in particular, the bulk of waste is dumped in Parkietenbos, a landfill on the island's south side, without

further processing capabilities. The landfill is perpetually on fire due to sudden combustion, and when the wind turns, toxic fumes fill the lungs of the residents of the Parkietenbos neighborhood right next door. The government's promises to address the problems associated with the landfill have been left unfulfilled, and little effective action has been taken to solve this persistent issue.

There has been limited research on the impact of the landfill, and as was observed by a neighborhood resident, if the people "don't have the data, we cannot pressure the government to do anything" (I-CS-5). Without data, the matter appears to have little urgency. This research thus aims to document qualitatively the experienced effects of the landfill on health, society and environment. Exploring this under-researched aspect of Aruba allows for a more holistic understanding of the impact of the landfill and can raise awareness about power relations within the waste management sector. Since the general population bears the brunt of environmental consequences and deterioration, community participation in development initiatives is critical (UNEP, 1972). Even qualitative research provides greater information on community vulnerabilities, effects, and adaptive capabilities, yielding better knowledge about existing gaps and constraints, and potential for strengthening marginalized communities (Lese, 2017). Better understanding of the impact of the landfill makes

it possible for communities to feel more included in the politics of the landfill and therefore, strengthen a sense of community and agency. Through interviews with residents, policy-makers, government officials and NGOs, this study sheds light on the environmental injustices that occur in the Parkietenbos community and the responses to these. It also seeks to explore these injustices through a political, historical lens and contextualize them within the community.

### 1.1 Field of study

Political anthropology looks at community characteristics through a political lens, concentrating on issues such as socioeconomic inequality, institutional processes, and political change. This makes context, method, and scale all major determinants in political anthropology (Subramanian, 2012). Political anthropology focuses on the main concepts of political science, but it additionally incorporates social, cultural and informal political processes. Usually, political anthropologists view their research sites as relational and dynamic, rather than as enduringly different from mainstream perspectives (Subramanian, 2012). This allows us to question normative notions about what constitutes “politics.”

### 1.2 Waste Management on Aruba:

Aruba generates 130 to 150 kilotons of solid waste each year, according to estimates (RFI, 2018). Currently, there are two main companies for waste collection and processing: Serlimar and Ecotech. Serlimar is a semi-private company charged with the management of the Parkietenbos landfill as well as some household collection. Ecotech takes care of most of the processing of the household and commercial waste by first separating metals and cardboards, and then compressing the rest of the waste into RDF bails. These bails are plastified and then transported into a designated area to be buried. Even though Ecotech does some sort of recycling, it is estimated that only around 2.4 percent of household waste was recycled as of early 2018 (Feenstra &

al., 2020). The remainder of the waste that cannot be treated is dumped in Parkietenbos, a landfill on the island’s south side known as ‘the dump,’ which was built in 1954. This waste entering the landfill is almost completely unsorted. With the island’s population and tourism industry booming, the landfill exponentially grows. According to Serlimar, Parkietenbos would close around 2011 since the landfill had reached capacity in 2006. Then, in 2018, it was predicted by the Government of Aruba that the landfill was predicted to reach its full capacity in two years if its present development rates continued. However, still today, the Parkietenbos dump is open and growing. Tragically, the dump has grown to cover around 18 hectares and now stands at a height of approximately 42 meters, looming over its residents (Loosveld, 2015). Due to illegal trash disposal, the landfill’s borders have become more difficult to identify, as it progressively expands towards the sea and farther into the mangroves (Loosveld, 2015).

## 2. Conceptual framework

### 2.1 Environmental justice

Environmental threats often pose particular risks to certain individuals, groups or communities. This results in disproportionate burdens or environmental benefits for certain demographics. The concept of environmental justice demands that ‘all people and communities deserve equal protection from environmental and public health laws and regulations’ (Brulle, 2006). The Environmental Protection Agency (2021) defines environmental justice as:

*[t]he fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Fair treatment means that no population, due to policy or economic disempowerment, is forced to bear a disproportionate share of the negative human health or environmental impacts of pollution or environmental*

*consequences resulting from industrial, municipal, and commercial operations or the execution of federal, state, local and tribal programs and policies. (p. 1)*

The environmental justice literature encompasses a wide spectrum of environmental dangers, opportunities, and resources, ranging from landfills to mineral extraction, lead in paint to land reforms. In this context, justice becomes inherently political, and politics entails debate, conflicting viewpoints, and active efforts to influence and/or manipulate others (Walker, 2012). This makes environmental justice essential and deserving of attention as part of present political discourse. Focusing on environmental justice allows investigation of key aspects of how people think, reason, and behave in connection to environmental issues (Walker, 2012). Environmental justice is a field that focuses on the distribution of environmental burdens, notably different kinds of pollution, given their adverse impact on human health. The field has long recognized that imbalances in exposure to pollution levels should be avoided, and has urged governments and organizations to address environmental inequities via policies, management and decision making (Walker, 2012).

The First National People of Color Environmental Leadership Summit, which took place in 1991 in the United States, established and operationalized the notion of environmental justice via 17 principles (Mohai et al., 2009). The rights were declared by these main notions: “to be free from ecological destruction”; to be “free from any form of discrimination or bias”; the “right to clean air, land, water, and food”; the “right to political, economic, cultural and environmental self-determination of all peoples”; and the right “to a safe and healthy work environment.” (Mohai et al., 2009). The aim of this summit and its corresponding 17 principles were to create an “international movement that would fight the destruction of land and communities” (Mohai et al., 2009). They were developed to assist communities to network with, organize and relate to the government and NGOs.

## **2.2 Environmental injustice**

In many parts of the world people of color and poorer communities are more likely to live near environmentally hazardous facilities, and thus, more likely to bear the burden of exposure to toxins. (Brulle, 2006). This inequity in dealing with the burden of environmental impacts can be referred to as environmental injustice. Environmental hazards are physical circumstances that have a measurable and limited geographic range that negatively impact human health or environmental sustainability (Rich, al. 1995). These dangers can cause acute or chronic or acute health problems for the people exposed to them (Goldman, 1991; Schweitzer, 1991). Poor air quality or pollution can cause immediate, acute respiratory diseases. Contamination of groundwater via seepage from buried hazardous wastes, or the emission of harmful air pollutants from a chemical plant are examples of factors that can cause chronic illness (Rich, al. 1995). Mohai et al. (2009) looked at how environmental injustices arise, and explored how economic, socio-political, and racial discrimination can all be significant factors. Economic factors become relevant when businesses adopt cost-effective measures to increase revenues. To maximize profits businesses seek the cheapest properties as locations for their facilities.. However, such low-cost areas frequently intersect in some ways with poor and marginalized communities (Roncucci, 2019).

The second set of factors in environmental injustices are socio-political. These factors relate to how decision makers choose to place damaging operations near communities with little influence and power to protest. One case study illustrating this made it clear that decision makers “would not insert an incinerator close to an area where communities are more likely to have resources to create an opposition and have strong political representation” (Mohai et al., 2009)

## **2.3 Pellow’s theoretical framework and the three facets of Environmental Justice**

Just as the notion of justice has developed and evolved over

time, so has the concept of environmental justice, which now includes three aspects: “fair distribution of environmental resources, cultural recognition and political participation” (Schlosberg, 2003). The idea of fair distribution links back to the ideas concerning the distribution of risk of exposure to environmental hazards. Secondly, since the lack of social and political recognition of marginalized populations is very often the root cause of environmental injustices, recognition became a core element of environmental justice (Roncucci, 2019). Finally, Frazer presented a new aspect of justice, one that speaks to a greater requirement for public engagement in policy making.

These three dimensions that describe environmental justice are intrinsically linked, discussions about environmental justice need to consider each aspect in the context of the others. Thus, scholars like Pellow (2004) developed conceptual frameworks for environmental justice that consider all three dimensions of justice. Environmental justice was operationalized in Pellow’s framework through four different pillars. The first entails the socio-historical dynamics that led to the uneven distribution of health and environmental hazards, in addition to the most recent assessments and decisions on these issues. It is crucial to understand environmental injustices not as isolated events, but rather as systematic, historical and social phenomena. The second pillar involves the role of different stakeholders, as well as their interaction, affiliation and the conflicts that exist between them. The third pillar is an understanding of the implications of social inequality on various stakeholders. This entails looking at examples of institutionalized, environmental, and societal discrimination, as well as class disparities, political hierarchies, and any other inequalities that may determine power relations and shape interactions. Frequently, the interactions between stakeholders can become dictated by the social roles that they play, where those that have been disenfranchised are easily silenced, while the system is designed to protect those that have more power. Lastly, the fourth pillar is agency, which refers

to the ability of groups confronted with environmental inequities to influence the results of conflicts (Pellow, 2004). Evaluating each of these aspects would provide a comprehensive picture of the environmental and socioeconomic concerns that local communities confront when facing environmental injustices.

#### **2.4 Community Response to environmental injustices**

When environmental injustice occurs, there tend to be different political reactions. These reactions or lack thereof from those in power can be disempowering for both people and communities, as existing structures for collective, grassroots action are typically unable to adequately respond to the environmental dangers. However, these injustices do not always leave an entire community disempowered, it rather allows for various versions of empowerment to rise, whether individual or whole communities. Zimmerman (2000) defines an empowered community as: “one that initiates efforts to improve the community, responds to threats to quality of life, and provides opportunities for citizen participation.” However, most scholarly research on the topic of community response to environmental injustices shows that there tends to be a lack of empowerment in those affected communities. There are nevertheless gaps in the research regarding the reasons and factors preventing mobilization in communities facing contamination or other environmental threats (Stephen, et al. 2004). Rich (1995) studied some of the responses of a community in the US to environmental injustice. His conclusions were that when industry and/or government refuse to disclose information/data with the public or denies that a problem exists, the community comes to distrust the institution in charge and circumstances get much worse (Rich, 1995). Citizens feel abandoned if their government fails to acknowledge their concerns or when technical specialists are utilized to undermine environmental concerns (Rich, 1995). Distrust arises as these institutions are supposed to protect citizen’s interests. Dissatisfaction also increases when governments encourage individuals to engage time and effort in complex



processes that have little chance of changing the outcome, (Reich,1991). Additionally, neighborly relationships are sometimes affected by disputes about how to tackle the issue. Some studies found that friendships and other relationships with people outside of the afflicted community may be severed because those who are not impacted by the hazard are unaware of the troubles it causes for its ‘victims’. Additionally, this may even wrongly stigmatize entire communities as a result of their environmental issues and lead to further marginalization within the society (Rich, 1995). Finally, officials and decision makers in charge of managing local environmental threats play a role in adding to the feeling of disempowerment. This is because solutions typically include large sums of money, complicated legal difficulties, and contentious political debate. All these factors result in officials generally taking their time to analyze these ‘wicked problems’. Governmental restrictions, recalcitrant companies, and the courts may hamper local efforts to resolve the problem. These failures may cause citizens to feel helpless, both individually and collectively. Defining the interests of government officials handling environmental hazards can be complicated. They have to balance preserving their own jobs and handling the growing problems they face with fixed, and often shrinking, budgets. Budget cuts are frequently the consequence of industry lobbying efforts to reduce the efficacy of regulatory bodies (Zavestoski, 2004), permitting companies to continue doing business as usual while avoiding having to invest in more sustainable operations.

### 3. Methodology

The methodology used in this paper is standpoint theory. “Standpoint” refers to a person’s view of the world, which is generally based on their position and viewpoints (Borland, 2020). Standpoint theory is a feminist theoretical perspective that claims knowledge systems are rooted in social position and determined by power relations. Implementing this framework allows for a holistic understanding of collective

identity and is well-facilitated by discourse analysis. The most critical part of this theory is that personal experiences in social groups shape a person’s worldview (Borland, 2020). Standpoint theory argues that people at the top of social hierarchies are prone to losing sight of actual human relationships and the true nature of social reality, and hence overlook key concerns about the social and natural world (Borland, 2020). These hierarchies of knowledge production (eg. science, religion...) pave the way to policies, governance, education, and overall structures of our current world (Allen, 1996). Through this theory, my research will aim to identify epistemologies that put an emphasis on the community’s expertise. Standpoint theory will allow certain stories to stand out, when sometimes structures render these invisible.

To use this theory, community based approaches are most beneficial. This involved interviewing stakeholders from the University of Aruba, local government officials/politicians, local and international NGOs, and residents who are impacted by the landfill. Frequently, development programs are exclusive and limited in scope. A participative method is more inclusive, comprehensive, and representative. More specifically, it would be useful to have discussions and focus groups with the local population to identify the scope of waste management in the local context, and its impacts. This is why I incorporated a multi-stakeholder collaboration: it allowed for a broad multidisciplinary perspective on the subject.

This research consists of interviews conducted with anthropological tools. There are three types of stakeholders that I focused on for this research. My first focal point was the community of Parkietenbos. I carried out through door to door interviews to shed light on the experiences of the broader community in relation to the landfill. The main focus was to understand each household’s perception of the threat(s), their empowerment or lack thereof, and finally, their ideas on solutions to mitigate these threats. A

total of 21 households were interviewed around the area of the landfill of Parkietenbos. Each of the households were roughly placed on a map by the respondent to create a qualitative risk assessment map (see fig. 1). As the issue was found to be highly politicized, I interviewed government officials to comprehend their stance on the matter. In order to form a holistic perspective, the research involved members of civil society, including members of different companies, journalists and NGOs. All key stakeholders were guaranteed anonymity, hence the table below shows the codes and affiliations of the responders. The code-arranging format has been derived from Bultrini (2017) and van Bets et al.(2016).

Coding	Interviews
I-C 1-21 (see fig. 1)	Parkietenbos Households
I-GO 1-5	Government officials - Department of Nature & Environment (DNM) - Former politician - Bureau of statistics - Financial advisor - Member of parliament
I-CS 1-7	Civil society - Ecotech employees (2) - Worker at Serlimar - Journalist - Rainbow Warriors Core Foundation - Professor at University of Aruba (2)

It is important to note that throughout the interviews I strived to remain unbiased and neutral, stressing that the interviews were solely for research purposes, with no underlying agenda, political or otherwise. Nevertheless, it is important to add that the results of the interviews must be nuanced, and identify some limitations. I am an outsider who came into the community and island with limited grasp

of the context of the island. Since I do not speak the local languages and am a foreigner, this might have influenced the answers of the respondents. However, my research partner Kailey Campos, a local Aruban resident and student at UA, assisted me with initiating social interaction and translating when needed. I believe that this assisted me greatly in establishing contact and trust. Regardless, it is important to express my position within the society to contextualize the research and its outcomes.



Figure 1. Map of the Parkietenbos Area. This figure shows the households interviewed in the neighborhood. They are represented with numbered blue pins. The Parkietenbos landfill is indicated in red and the Ecotech facilities in green.

## 4. Results

### 4.1 Environmental Injustices at ‘The Dump’

This section focuses on conceptualizing the definition of environmental justice/injustice in the Aruban context. Despite the fact that several official reports, including one from the Pan American Health Organization (PAHO) in 2018, expressed that the landfill has reached maximum capacity and poses a risk to local residents in addition to recommending that it should be closed immediately. However, the local authorities have ignored this report

and continue to dump Aruba's waste in the landfill, past its capacity, causing the trash to overflow in the direction of the sea (page. 39). Aruba is a member of numerous international human rights treaties, including the UN Treaty on Civil and Political rights and the European Human Rights Treaty (I-C-19). These agreements require governments to protect all human rights, including the right to life, a healthy environment, and health protection. This is however not the case, since results from my research have shown that both the environment and the health of the community is put at risk. A former Curaçaoan legislator, wrote on his blog about the landfill of Aruba that "the government must realize that suffocating independent human rights monitoring is intolerable. It's clear that this government aims to muzzle people who are calling for change both at home and abroad" (Rosario, 2018) This can be described as an environmental injustice on its own since one of the main rights is access to information about health and environment.

#### 4.2 Socio-Historical Dynamics

For years, residents have complained about smoke nuisance, hazardous gasses, and pollution at the already congested dump site, endangering the public health and the environment. The Parkietenbos Foundation was founded to tackle these issues around 2002. This foundation comprises a group of local people who wanted to raise awareness about the problems of the dump through campaigns. When flames erupted at the dump site again in early July 2018, the Foundation stepped in to help. However, after the Parkietenbos Foundation's unsuccessful attempts, a local citizen decided to build a court case against the state.

Aside from its social impacts, "the landfill does not have facilities for the reduction of undesirable environmental impact." On February 8, 2018, a "request for information" (RFI) was issued by the government. This was mainly for the decontamination of the landfill and for ways to have more sustainable waste processing options. Their main

goals are stated on the the first pages of the report:

*"In view of the protection of public health and conservation of the environment and in order to keep pace with evolving international standards and best practices, the Government of Aruba has established the objective to transition from its current solid waste management system to sustainable and sanitary waste management that entails a complete process from the waste sources to the recovery of valuable products and environmentally friendly treatment of the remaining waste. In connection herewith, the Government of Aruba is actively seeking for possible solutions to achieve a combination of sanitary landfilling together with other waste management methods, which are more in line with a circular economy and international standards." (RFI, 2018)*

Even though the RFI was written in 2018, the government still did not sign the environmental treaties that are required to be signed in accordance with the EU regulations (Stichting Parkietenbos, 2022). There are limited policies about waste management (I-GO-1), and almost no laws in place to control the landfill (Caceres, 2015). The main problem is that the responsibility for the harm of the environment or the community is spread too thin, therefore the people should demand accountability.

The participants discussed some of the promises and solutions presented by the government. In 2009, for example, the American business Bouldin & Lawson presented the project "WastAway." This 28 million florins equipment had to turn garbage into "fluff," which would be subsequently used as organic matter for compost. The facility, however, was never fully operational and was closed in 2011. There has been some speculation that the machine was sabotaged, as well as speculation about who was behind this sabotage (I-GO-1, 2, 3, 4; I-CS-3, 6). The reasons for the sabotage will be discussed further below. On the landfill, a small incinerator is also present, however its size cannot allow all

the garbage to be burned there. Rather this installation is used as a sewage treatment plant.

### 4.3 Life around ‘The Dump’

*“It is time to recognize that those who pollute or destroy the natural environment are not just committing a crime against nature, but are violating human rights as well”*

- (Dimitriou & al., 2011).

#### ***Health and nuisances in the Community***

Members of the community who were interviewed expressed that in the vicinity of the landfill and Ecotech treatment plant, their quality of life has deteriorated drastically. Half of the residents interviewed reported facing family health problems, from cancer, to asthma, allergies, to persistent migraines and more. Additionally, 17 households out of 19 confirmed that the landfill was affecting the neighborhood’s health. A school teacher in the neighborhood reported that sometimes kids would have the same symptoms at the same time, and the school checked where they were from, more often than not they were from Parkietenbos. He explains further that this comes to show that these symptoms or diseases are unlikely to be all genetic, since these kids were from different families.

In addition, the main nuisances that were reported were air pollution, smell, noise pollution, extreme amounts of flies, mosquitoes and dogs. According to people living on the windward side of the landfill (I-C-2, 5, 7, 6, 9, 15), the main problem is smoke, to the point that some respondents can distinguish between burns by the smells they were experiencing: “the smell of the smoke differs between the cadavers, the medical waste, and the tires” (I-C-2). Regularly, about once every month, misty smoke would come into the house, but the bigger fires happen “three times a year” and often, “we get the black smoke from the tires” (I-C-6). Many of the respondents have been forced to leave their houses due

to the smoke and pollution in the air. These experiences have tainted the lives of those around the dump as evacuations became more frequent. Many respondents have been worried about the lives of their children and the lasting impact “thick and heavy air that passes through the AC” can have on their newborn babies (I-C-8).

The dump has been expressed to be a nuisance for the residents, but respondents from the neighborhood living at 4, 1 and 12 care about something else entirely. They all expressed that since the Ecotech plant was installed they have not been able to eat outside in their garden, a routine that was integral for social or familial gatherings. This is attributed to the odor, which has gotten so severe that residents can’t even open their windows since the smell is so overpowering. (I-C-12, 1). In addition, the flies and mosquitoes are overwhelming as they fester and multiply in the runoff from the plant (I-C-1).

#### ***Environmental Concerns***

Almost all the stakeholders interviewed also expressed concern about the environment, mainly soil, water, and land contamination. The landfill contains high levels of asbestos, which is a proven health hazard (I-CS-3). The landfill was found to be substantially polluted with heavy metals and polychlorinated biphenyls (PCBs) in 1996, but not much has been done so far. Additionally, there is speculation that radioactive waste was dumped at the landfill (I-CS-6, 5 and I-C-10), however, there is no documentation to support this claim. This lack of information has been a recurring theme. A recurring problem is the reluctance of industry and/or the government to research these issues and disclose information. There has been a consistent lack of transparency from authoritative bodies which has led to inaction.

#### ***Solutions presented by the community***

When asked about what solutions they had for the situation

at the landfill, people in the community responded that they are trying to close the Parkietenbos landfill. They believe that unless all operations are ceased, their situation will not get better. Even though most respondents would be glad if the landfill closed, they acknowledge the fact that the garbage has to go somewhere. Every household interviewed agreed that a plan was required before the dump closed, but disagreements arose about what the plans should be. Some wanted to build an incinerator and burn everything, some wanted to focus on recycling, some wanted to export all the waste, and some wanted to mine the current landfill. The residents were aware of some potential solutions, however some of them are financially non-feasible (I-CS-4).

### ***Solutions presented by the government***

A solution was put in place one year ago by the government was to put a flag in front of some of the houses of the neighborhood, to tell when the wind would carry some of the smoke. If the flag was down or blowing at a certain angle, the fires on the landfill would have to halt. However, while we were at the landfill Kailey said that “the flag is down, which means they stopped burning... But it still smells like something is burning.” Most residents agreed that the solution was clearly inadequate for the problems the landfill was causing.

Currently, as part of a new project to close Aruba’s landfill, a new waste management system has been proposed and implemented by the government. This plan, dubbed ‘trash to cash,’ has been introduced by Ursell Arends, the new Ministry of Nature. The main goals are to map out different companies that can work with the different waste streams the island produces. There are eight waste streams that have been identified; plastic waste, tires, glass, construction materials, metals, hazardous waste, pallets & woods, and finally garden waste. However, this initiative sparked a lot of contention among the many stakeholders. The reactions mostly being “Trash to Cash is a waste of time, it’s just

another attempt for reports that are already there” (I-CS-5). (I-C-4, I-C-8, I-CS-1, I-CS-2) agreed that this new initiative was just to buy time, rather than taking actions.

### **4.5 Stakeholder Interactions**

To portray a nuanced and holistic depiction, this section outlines the stakeholders involved in the Parkietenbos landfill, focusing particularly on the relationships, affiliations, and/or tensions that exist amongst them. The types of stakeholders that have been identified as a result of the data gathered are: the local community surrounding the landfill, non-governmental organizations (Eg. Stichting Parkietenbos), government officials (Eg. parliament, ministers, DNM), and finally private companies (Eg. EcoTech, Serlimar).

It is important to note that all the parties interviewed acknowledged problems caused by the landfill to differing degrees. However, their perspectives differed about what these problems were and how to solve them. Stichting Parkietenbos was founded about 20 years ago. A member of the organization expressed that the intention behind starting Stichting Parkietenbos was that “the community didn’t want to tolerate the hazards of the dump anymore”. The foundation spoke up about these hazards to the government in hopes of closing the landfill, however, to no avail.

The website of *Directie Natuur en Milieu* (Division Nature and Environment), DNM, a division of the Aruban government, displays its main objectives, which are “Preparing, designing, implementing and evaluating policy that leads to a sustainable, healthy living environment for people and nature in Aruba” (Overheid, 2022). The fields that concern DNM include: waste, air quality, and hazardous substances. Although the DNM has a department in charge of researching and monitoring the environment, its research is for policy-making, not for knowledge per se. This research is inextricably linked to the political agenda

and biases of the party in power. There have been few policies made on the subject of waste management or the landfill in Aruba, and there are no laws allowing private companies to operate unencumbered by regulation on waste management. A participant from the DNM said they believe that “the problem isn’t a technical one, but rather a cultural one,” meaning that the problem comes from the mentality of the people that consume a lot.

The interviews revealed a lot of mistrust within the Parkietenbos community, especially towards the government. Many of the households interviewed indicated that the neighborhood couldn’t trust that anything would be done about the landfill because of previous unsuccessful attempts at proposed solutions and unfulfilled political campaign promises. One resident explained, “the last 10 years, there was a lot to do with the dump, but only promises, just for the votes. Now, no one comes.” (I-C-14). It was apparent that most of the households in the neighborhood shared the same sentiment, “what they say is like wishful thinking, we find it hard to believe them” (I-C-4). This cynicism was also expressed towards neighbors in the community itself. For example, there were conflicting opinions on whether the landfill had health effects on some of the people. When asked about this, a respondent stated that “if the other people in the neighborhood have health issues, it isn’t because of the dump, it’s because of their lifestyles.” (I-C-15).

#### **4. 6 The different faces of resistance**

When confronted with environmental injustice, residents of the Parkietenbos community show a range of reactions. Some residents were extremely pessimistic about any solutions that could be found for the landfill. One interviewee stated that even though she would want the landfill to close, she states that “I will die with the landfill still there” (I-C-1). Residents feel powerless as a result of the many failed attempts, both individually and collectively: “it’s not worth it to fight, nothing will get done” (I-C-14).

People in the neighborhood have tried to speak out about the topic, whether it be through neighborhood talks, court cases, petitions, discussions and more, however, “the neighborhood is fed up with complaining” (I-C-2). As discussed already, local environmental threats can be disempowering since residents have little or no influence over the repercussions, and must rely on others to make decisions about their future. The sort of disempowerment overall is not expressed through anger at the situation, rather through distrust and hopelessness. Others were still somewhat hopeful that solutions could be found, “angry is not in my vocabulary, solutions is what we need” (I-C-8).

On the other hand, some residents are stating that they will “keep on fighting” (I-C-7) until the landfill closes. There have been instances of families suing the government or Ecotech because of health issues attributed to the landfill (I-C-19, 12). An interviewed emphasized the fact that protests as a form of activism have been found to be very low in Aruba, and this could be because of cultural reasons (I-C-10). However, some residents mentioned that they would want to join if there was a protest (I-C-5, 7, 19, 12). Stitching Parkietenbos actively continues to lobby for the landfill’s closure, despite the fact that previous attempts have failed. The wife of one of the members of the board kept asking him “why do you keep meeting with Stichting Parkietenbos, nothing is happening?” (I-C-8). However, the member indicated that this problem was too important to him, and that he would continue to press until the matter was rectified. (I-C-8).

#### **4.7 Power plays & social Inequality: A politicized space.**

*“Here, everything is politics. They are really powerful” (I-C-7).*

It is important to realize that there is not one person or entity to blame for the issue of the landfill, rather “the damages are years and years of negligence” (I-GO-4). People blame the government for not resolving this issue, but it is imperative

to recognize that the problem is structural, not technical. In other words, the reasons solutions “fail is either too much politics, lack of money or not putting it as a priority” (I-GO-5). Politics has become so intertwined with the situation that each party is just playing against each other like a “football match” (I-GO-3). For a problem like that at the landfill, this tension prevents finding solutions, since each new government, there is no continuity with the last, so all projects are stopped and/or sabotaged (I-C-4, I-GO-1, 2, 4, I-CS-3). The lack of continuity between the subsequent governments makes long-term solutions extremely difficult. This is exacerbated by the fact that each new political party will promise to address the issue; however, because the next party will not continue the projects, these promises cannot be kept. This leads to short-term remedies for long-term issues, which are ineffective time after time.

It is difficult to define the interests of government officials dealing with environmental injustice. They must strike a balance between keeping their own positions and dealing with the mounting difficulties they encounter while working with fixed or rapidly diminishing budgets. Often, their job security is at stake, because “if you go against the government, they can push right back” (I-GO-2,5; I-C-8). This is explained further through a stakeholder who wanted to collaborate to create a biodiversity program with the DNM, however “civil servants in Aruba disregard and don’t collaborate so they cannot be accused of going against the current government” (I-CS-5). A former politician explained that when government officials are too critical, the minister “calls them back”, or warns them. He stated that this is why he “lost faith in the government, and I was in it” (I-GO-2). A civil servant and a current parliament member stated that “the tensions dealing with waste, is extremely stressful” (I-CS-1, I-GO-5).

The political dimension connects extremely well to the underlying issue of the lack of transparency. A member of the Bureau of statistics stressed that little research has

been done into the issues related to the landfill as the issue is “too political” (I-GO-3). Air sampling was done 20 years ago, but these reports are not publicly available for political reasons. We are unable to obtain information on pollution levels, which is unacceptable; all residents should have access to such data concerning hazards to their health (I-C- (1-19)). In addition, a worker at the landfill expressed that they signed a non-disclosure agreement that prevents her from revealing information about the dump (I-CS-3). These issues have appeared to be “too political” when it comes to protecting the interests of those in power or who have authority. When asked why health and environmental research is not being conducted, some people would state that “your motives are seen as political ones” (I-CS-5, I-GO-4). This indicates that when research is conducted, the results can often be misused against the opposing party (I-GO-4). The idea that parties are affiliated with the research itself, indicates the ways the problems and parties are viewed. Additionally, if there are revelations about the dangers of a landfill, the community might sue the government. However, to be able to come up with a viable solution, the government needs to do research and make these documents public (I-CS-5).

## 5. Discussion

### 5.1 The landfill in the realm of politics

*“Tourists are human, we are not” - (I-C-7)*

Through conducting interviews with members of the community, it is apparent that the government and the private parties involved are not addressing the serious hazards in the landfill. That being said, former members of the ministry expressed that much work was going into mitigating the needs of the people and those of the private companies. They said that, “the people say we do nothing, but it’s not that simple, we couldn’t sleep, we talked about it [the landfill] until 11 pm. And then woke up at 5 with

problems at Serlimar” (I-GO-5). This demonstrates that the issue is multifaceted, and that policymakers are grappling with it.

The landfill has become a site of political contestation. Although it seems easy to point fingers at those in authority, they are not the ones solely responsible for the situation. Furthermore, it is integral to note that individuals are mostly not to blame. Through conducting interviews with members of various agencies, it has become apparent that the problem is deep rooted in the system inside which it operates. The system of functioning is not conducive to change when those who stand to benefit most from change are disempowered and unable to collectively advocate their cause.

Many of those that were interviewed felt very little confidence in the government in many ways, and especially about whether they would find a solution to the landfill. This mistrust is translated into them ascribing much of the blame on the officials. The skepticism persists to consequent governments even when new plans are made to close the landfill. This is exemplified through the new initiative ‘Trash to Cash’. Furthermore, while the government claims that the landfill will close in December 2022, practically all parties doubt that this will actually happen. However, through interviews with members of the ministry it is understood that the system within which many of these solutions are to be fixed is rigid and catered to those with influence. Meaning that, it is the system that is at fault, not the authorities.

Interview results make it clear that the community of Parkietenbos are faced with multiple environmental injustices. Additionally, the community has a disproportionate number of health issues in comparison to the rest of the island, including no access to clean air, water, or land, and no environmental political self-determination. This paper depicted the Parkietenbos community’s

reactions to environmental injustices. By documenting the experiences and stories of some households in Parkietenbos, I hope to take a step toward restoring environmental justice in this community, by rendering certain stories to stand out, when sometimes structures render them invisible.

As the community that lives around the landfill is being affected disproportionately, an important way to mitigate these solutions is to give more of a voice to the community. NGOs like Stichting Parkietenbos are an integral channel to bridge the gap between the people living at the landfill and those with decision making power and the private companies. In addition, giving members of the community a space to express their grievances and a means by which they can have more decision making power, or even just a say in the matter can help each party come up with holistic solutions. Since this issue is extremely contentious and nuanced, and in the absence of an outright answer, it is critically important to provide a voice to those affected.



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Michel Frank, University of Aruba

## What was I thinking?!

About to turn 50 years old and going back to school. What was I thinking?! Sitting in the benches again doing a full time study, shoulder to shoulder with fellow students the age of my children was kind of awkward. But what an exciting and educative roller coaster ride it has been. After 2 years in the SISSTEM program I could finally say, I got this, and I can and will finish it. Third year now and after an exciting and with a successful exchange to KU Leuven in the pocket, I am in the final semester stretch. Surprisingly the SISSTEM class, consisting of only 6 students, suddenly was teamed up with a big group of UCU students from diverse country origins with strong opinions and outspoken characters, who came to Aruba to do their thesis research. This was a pleasant alternation to the regular classes combined with afterschool social happenings like bus and boat trips, BBQ outing, beach tennis and many more.

SISSTEM has been an eyeopener for me on so many

different sustainability oriented topics. Energy, waste, resilience, food security and the list goes on. Especially waste and Aruba's waste problem has been handled in detail during various courses and this really caught my attention. For this reason, I chose to do my thesis research on a waste related problem, which is the plastic waste problem in Aruba. The fascinating part is that the research will be done also on citizen science through which data will be collected with the use of digital tools.

I am looking forward to graduate in a few months. It has not been easy to work and study fulltime and it is time now for the pay of with an engineering diploma and sustainability specialist title.

Sisstem MSc, here I come!

The Peppermaster.



# Citizen Science as a Tool to Fill the Plastic Waste Data Gap in Aruba

Michel Frank

## Abstract

SIDS are vulnerable to plastics pollution. They are constantly dealing with plastic debris that washes ashore from other places as well as plastic waste that they generate themselves, in addition to plastic waste produced for and left behind by tourists. This research paper is about tracking the plastic waste generated by tourists in Aruba and at the airport, through citizen science with the use of a digital tool that will be developed on the basis of the input of this study. The data gathered will give us insights of the types of plastics used as well as the policies that major tourist oriented institutions, like the Aruba Airport Authority, the Aruba Tourism Authority and the Aruba SDG Committee, are implementing on the road to 2030 with regards to the United Nations Sustainable Development Goals on plastic waste reduction and recycling.

## 1. Introduction

### 1.1 Problem Statement

Small Island Developing States (SIDS) distinguish themselves in social, economic, and environmental traits, such as high population density, relative isolation, limited geographical space, and a scarcity of financial resources. (Sevold, 2020) The capacity of SIDS to safely manage waste and other polluting materials is under great pressure due

to different factors varying from growing populations, increasing socio-economic and infrastructural development and constantly growing amounts of imported goods. On average, SIDS habitants accumulate 2.3 kg of waste per day, which is 48% more than the Organization for Economic Co-operation and Development (OECD) reported average (UNEP,2022). Much of this waste comes from the tourism sector, with increasing peaks of waste production related to seasonal changes (IISD, 2019). Over 100.000 tons of waste is being collected in Aruba annually (Cáceres, 2018) of which, according to the average composition of waste for SIDS, an astonishing 16% is plastic (UNEP, 2022). These numbers however are not exactly known for Aruba and this lack of data is a problem for tackling waste streams. SIDS like Aruba are particularly vulnerable to plastic pollution. On the one hand, the islands have to deal with plastic debris that washes ashore from other places, as well as with plastic waste they generate themselves in combination with the plastic waste produced by visitors. For Aruba who deals with a great number of tourists annually, this is a great problem. The Aruba Airport is the location for the fieldwork for this research as they also deal with a big plastic waste problem.

### 1.2 Research questions

The research question for this study is defined as follows: What are the specifications to be used for the development of a digital plastic waste data collection tool to be used by tourists?

Sub questions that my research will be based on are the following:

- How can the data collection tool be most engaging through citizen science?
- What could be the interest and or motivation for tourists to use such a tool?
- What is plastic use-to-waste behavior among tourists during their stay and at the airport?
- What are the types of plastics that are most prevalent in Aruban waste?

### 1.3 Context

In this paper, I present a case study conducted in Aruba, an autonomous country within the Kingdom of the Netherlands, located in the southern Caribbean. According to the latest Central Bureau of Statistics data in 2021, Aruba has 107,457 inhabitants with a relatively high population density of 593 people per Km<sup>2</sup>. Aruba is one of the most visited islands in the Caribbean with a total of 1,951,000 overnight and single day visitors in 2019 (Lopez, 2022). A high population density and a high number of tourists are the main factors for profuse waste generation and the cause for the enormous waste problem the island is currently facing. Considering that the local landfill is practically full, and the collected waste is being buried in another location in an unsustainable manner, waste is an urgent economic, political and social problem on the island. (Cáceres, 2018)

With this research project I assist my thesis supervisor PhD candidate Alba de Augustin Camacho on her PhD thesis which is about “Citizen science for plastic waste data collection for Small Island Developing States”, with the aim to bridge technology and society to mitigate plastic pollution.

### 1.4 Literature review

The research on literature was based on the 3 keywords of my main question, which are, citizen science, digital tools and plastic waste. Citizen science involves the public in

collecting quantities of data over a certain period of time across an environmental habitat or in a specific location. Citizen science (CS) projects have been very successful in contributing to scientific knowledge, and simultaneously participants also learn about the topic, object or species that they were observing and also experience how scientific research is managed and executed (Bonney & et al, 2009). CS also is a way of democratizing science by providing the necessary tools to concerned communities to create and record data in order to influence policies on environment, health or any other issue that affects the community. (Kullenberg & Kasperowski, 2016). Although hundreds of CS applications exist, there is a lack of detailed analysis of the needs and requirements of volunteers participating in order for the research to be beneficial but also enjoyable. (Skarlatidou & et al, 2019) CS, however, is not so common in Aruba. Past projects include the national bird count in 2011 (Derix & et al, 2013) and a quite extensive project, sponsored by the UNESCO Participation Programme, which monitors vegetation on land, ocean temperature and acidification, and three SDG indicators, (science.brenchies, 2020). When it comes to the environment, SIDS have a scarcity of resources to collect solid and representative data using conventional techniques. The science.brenchies project focused also on SDG progress in Aruba by using CS as an available method and low cost approach to assist in the progress monitoring. (Sevold, 2020) In this study, I work with tourists as the citizens in CS. I focus on all the above mentioned criteria on how to make the CS project at the airport most engaging and fun but especially beneficial for the stakeholders.

During the covid period, many research organizations that had traditional data collection as part of their activities, had no other choice but to either wait or cancel their projects, or to embrace technology and utilize the many options on the internet for digital data collection. Because of this transition, many new software and apps became available because of the covid restriction measures (Pollicy, 2020). What is digital data collection (DDC) and why is it

important? DDC uses standard technology such as smartphones, tablets, personal digital assistants (PDA) and/or other digital devices. DDC facilitates data collection, entry, and analysis in an efficient, faster and more accurate way than the traditional paper-based method. Online data quality can be ensured, and online data collection is time saving and cost effective. DDC enables easy monitoring and analyzing of large datasets. (Pollicy, 2020) DDC works with digital forms which can be paper based forms in an electronic version and electronic devices like smartphones and tablets, to fill these out. There are numerous tools that support the design of these forms such as Kobotool Box, ODK, Survey Monkey, Survey Gizmo, Survey CTO, Google forms and many more. (Pollicy, 2020) There are many factors to consider when choosing the tools or software like for example the data needs, the digital literacy of the respondents, research budget and number of surveys needed. But it is also important to choose a tool that easily interacts with other tools for data analysis, data storage and data management, to guarantee an overall smooth research process. (Pollicy, 2020)

To understand plastic waste, we first need to understand plastics, Plastics are categorized in seven different types. The two most common types of plastic waste are Polyethylene Terephthalate (PET) which is a lightweight, strong and usually transparent type of plastic and is mostly used in food and beverage packaging but also in fabrics and ropes in the form of polyester. (Hardin, 2021) Another type of plastic is Polyethylene, which is the most common plastic in the world, but it is again categorized into three types: High-Density (HDPE), Low-Density (LDPE) and Linear Low-Density (LLDPE). High-Density Polyethylene is strong, and it is resistant to chemicals and moisture, which makes it ideal for e.g. milk cartons, detergent containers, pipes and building materials but also for example for toys and park benches. LDPE is a softer and clear plastic used for sandwich bags and plastic cups and LLDPE, in comparison to LDPE, is used for thinner sheets for e.g., stretch wrap (Hardin,

2021). Then there is Polyvinyl Chloride (PVC or Vinyl), mostly used in construction and medical applications. Polystyrene (PS or Styrofoam) is also well known for its use as take-out food packaging. (Hardin, 2021)

Worldwide, governments are becoming more supportive of programs aimed at reducing the use of all these different types of plastics that eventually end up as waste and cause undesirable pollution. Unfortunately, these attempts are mostly motivated by personal political interest. However, there is a critical need to minimize the most common sources of plastic pollution, especially in SIDS. The Maldives introduced the plastic Drawdown tool which explores plastic waste and leakage over a period of 10 years. It is especially designed for a data poor and budget constraint environment, which are both typical for most SIDS, and rapidly assesses government decision making on the plastic waste issue (Royle, 2022).

Aruba is taking important steps when it comes to initiatives to reduce plastic use and waste. In 2019 the government of Aruba announced the ban on imports, sale and free distribution of a list of products that are destined for single use and that are made of plastic or polystyrene. The products include plastic bags, cups, stirrers, straws and polystyrene cups, plates and food boxes for takeout food. The law came into effect on 1 July 2020 and simultaneously also banned the release of balloons into the air and the use of plastic confetti (ELAW, 2020). This has been a milestone in the road to sustainability especially concerning the plastic, so called, t-shirt bags, which often end up in the oceans with all negative consequences for marine wildlife. Single-use plastics account for 40% of all produced plastics and although many of these goods are used for a short time only, they can exist for hundreds of years in the environment (Parker, 2019). But banning single use plastics in Aruba did only solve a part of the local plastic waste problem. This research project will further contribute to the reduction of plastic waste by tracking the use of plastic packaging.

## 2. Research design and methodology

### 2.1 Theoretical Framework

This paper is focused on plastic waste generated by tourists and the research is done through citizen science by means of a digital tool which is aimed to be used to collect data on plastic use and waste by tourists. Tourists at Aruba's Int'l Airport are targeted to be part of the project and are invited to join in a survey after their stay in Aruba.

Aruba Airport Authority plays an important role in this research as one of their aims is to become more sustainable and tackle the plastic waste issue at the airport itself. According to their first Annual Corporate Social Responsibility Report, AAA realigned its purpose by adjusting strategies and created a new vision for the future, "to become one of the most sustainable, safe and future proof Airports of the Latin America and Caribbean region, providing a trusted workplace, modern airport facilities and excellent customer service which reflects Aruban hospitality, contributing to a prosperous future for Aruba" (AAA, 2022). Recently AAA has succeeded to drastically lower its paper use to an almost completely paperless company, and similar aspirations exist to reduce the plastic use and to promote plastic waste recycling. First exploratory conversations have taken place in July 2021 with the Plastic Beach Party Foundation for the options of setting up separation and recycling of plastic waste for repurposing of plastic waste materials. Plastic Beach Party is an Aruban crowdsource/community driven foundation that develops recycling initiatives. The plastic that is picked up or delivered by the local community is being used by Plastic Beach Party to create new products to be used commercially. (science.brenchie, 2020) Apparently, there are still some operational obstacles in this process, but AAA is working hard to introduce plastic separation in 2022 (AAA, 2022). The aim is that data gathered through this research will contribute to further decision making on the plastic waste issue at the airport.

Another institution that will form part in this research is Aruba Tourism Authority (ATA) who is already taking a unique approach with a variety of sustainable tourism concepts and activities to address climate change. Aruba will most likely see lower rainfall, increased temperatures and a rising sea level over the coming years, but ATA is committed to make the island resilient through implementation of innovative sustainability policies (Bedsonline, 2022). One of the newest applications of ATA towards their sustainable tourism efforts is called the 'Aruba Promise'. This is a manifesto, originally known as the Palau Pledge, which tourists can sign online by pledging their respect for Aruba's nature and culture and to contribute to preserving these for future generations. The promises can be made through [www.aruba.com/us/aruba-promise](http://www.aruba.com/us/aruba-promise). The Palau Pledge can be found at [www.palaupledge.com](http://www.palaupledge.com).

The ultimate goal of the different stakeholders, mentioned above, in my research with regards to plastics, is:

1. to lower the import of products with excessive plastic packaging;
2. to lower the use of products in plastic packaging, like for example sodas and soft drinks and thus lower plastic waste quantities;
3. to contribute to a circular economy by putting plastic waste up for recycling.

The outcome of the scheduled interviews with representatives of the partners will reveal details on their contribution and cooperation towards the research.

### 2.2 Data Collection

AAA supports the use of their premises to conduct most of the fieldwork to be done for this study. Aruba visitors will be approached and be requested to participate in a survey while they are in the waiting hall prior to boarding. A written survey, that will take approximately 5 minutes to fill out, will be handed out personally to the passengers. Usually, the average time for a passenger required to be at the gate prior to boarding is 40 minutes, which gives the



participants plenty of time to fill out the questionnaire. Before passing the last checkpoint upon boarding, participants are given the opportunity to drop the filled out paper survey in a designated box. The survey questions are still to be defined but will contain basic questions on country of origin and demographics, as well as on the plastic use by the participants while in Aruba and at the airport and how they dispose of it. Apart from that questions will be asked in the survey about their willingness for voluntary future use of a digital tool to gather data on plastic use and the disposal of it. Questions will be close ended with multiple choice or ranking pre-populated answers for the participant to choose from. Surveys will be distributed to passengers from flights to different destinations and the aim is to receive approximately 300 filled out questionnaires to ensure sufficient sample size for more accurate results.

An interview will be requested with a manager in charge of sustainability at AAA to gather more in depth understanding on AAA's goals and policies towards further airport sustainability and specifically on plastic waste reduction and the progress of reaching those goals. Details of the interview will also entail exchange of information on setting up a plan on future use of the digital tool for the tourists that will be developed.

The manager in charge of sustainable tourism at ATA will also be requested for an interview. This interview will entail inquiries on their progress towards planned goals and policies towards a sustainable Aruba 2030 and specifically on their aims to reduce tourists generated (plastic) waste in Aruba and how they are already involving the tourists in that process. The inquiry will also include if ATA is interested to participate with future use of the to be designed digital tool for plastic waste data collection.

Further requests for an interview will be to the manager in charge of operation at Plastic Beach Party to gather detailed information on their daily operation processes and to get

further insight of the current plastic waste problem in Aruba. Inquiries will also include their goals on education and awareness of the general public as well as their goals to stimulate plastic waste recycling in Aruba.

The next person on the list for an interview is an Aruba SDG committee representative. In 2016 Aruba SDG committee was established and through the committee, the government of Aruba is working on effectively implementing the UN SDGs by adapting them to a national context. This will be done through the National Strategic Plan (NSP), *Nos Plan, Nos Futuro*, which is based on the SDGs and was prepared in January 2020 for the period of 2020-2022, forming part of the long term master plan towards 2030 (DEACI, 2022). This medium term plan has been developed with the participation of Export Working Groups (EXWGs) representing the public and the private sector, NGOs and academic institutions. The NSP 2020-2022 strategy document consists of nine different very elaborated programs on topics varying from energy, wellbeing, youth empowerment and more. Program 3, titled *Natural Resource Management* and focuses among on Environmental Impact Assessment setting standards and legislation for waste management practices. Program 6, titled *Sustainable Tourism*, goes into great detail on how to strategically manage Aruba's tourism in a sustainable manner aligned with cultural values, economic goals, preservation of nature, desires of the people and the needs of the visitors themselves. Questions in the interview will be mainly on the progress towards the NSP and the 2030 SD goals with regards to waste in Aruba.

Data collection with regards to the digital tool will mostly be done through a study of different existing tools that are being used to collect data, especially on waste or plastic waste. Future data collection on the airport grounds will be beneficial as there is free internet for the participants meaning that smart mobile phones can be used to collect the desired data on plastic waste. Different types of apps with different

suitability and different functionalities are available and can be installed for data collection. Some of these can even work offline. Redcap, Open Data Kit and Teamscope are a few of the best available according to the online Ultimate Guide to Mobile Data Collection. Literature research on waste data collection will also be conducted as well as on how the use of the data collection tool can be most engaging for use. And finally, an interview will be conducted with one or two IT persons on collecting information on digital tools, apps and software developing requirements for plastic waste data collection. One of these persons is the developer of the Aruba Health App. This highly efficient app was created during the covid period to assist travelers with covid test related issues and guide them smoothly through the arrival and departure processes. All interviews conducted with the participants will be recorded for later analysis.

Citizen science is a very essential and fascinating tool that is being used in my research. As tourists will be using the digital tool, literature research is very essential to thoroughly understand how to stimulate voluntary participation in the use of the tool and on how to satisfy the needs and requirements of the participants. This information will also be collected through the survey distributed to travelers at AAA to identify the interest and or motivation to use such a digital tool. One manner to attract passengers to participate in the future digital survey is by means of posters strategically placed throughout the airport, explaining the purpose of the project and with traceable QR codes that will direct the respondents to the digital survey.

### **2.3 Data Analysis**

The survey with closed end inquiries is designed to generate data that is easily quantified and coded. It also enables us to divide respondents into groups based on the choices they make and thus allows easy comparison between groups. Different survey analysis software exist such as NVivo, Thematic Analysis Software, SPSS and Excel. The ideal tool will still need to be determined according to the amount

of data gathered and the amount of time scheduled for the project. The most crucial aspect is that the tool is dependable and provides rapid and easy analysis from which valuable conclusions can be drawn (Frampton, 2020). Currently I am inclined to use excel to enter the to be gathered data for analyzing as it gives the option to convert the results into graphs for easy visualization.

Interview analysis can be a bit more complicated, but a proper qualitative data analysis is important for the validity of the results of this study. The steps to be taken start with familiarization with the data and a form of transcript is required. After that, codes are applied to the transcript which in a process of systematically categorizing excerpts, which are brief descriptions of what is said. The next step is to search for patterns in the codes or identify themes which require a broader interpretation of the codes. After refining and naming the themes a final report on the interview can be drawn up reflecting accurately the opinion of the participants. (Mortensen, 2021)

## **3. Results**

The expected results of this research should answer the research questions. The study will allow for the presentation of specifications on how to most efficiently develop a digital tool to collect data from citizens on plastic waste, in a fun, friendly and engaging way. This can also be existing software that can be purchased for the project. A plastic waste data collection tool will also be available at AAA to be used by visitors to Aruba. Solid and rich insights will be developed on plastic use and waste behavior of tourists while in Aruba and at the airport.

## **4. Discussion**

Compared to other Caribbean SIDS, Aruba is already on the pioneering front when it comes to plastic use regulation. This research is focused on the plastic use by tourists and

the development of a digital tool for plastic waste tracking, a tool that can be used by locals as well to gather data on their plastic use to waste. By having access to this data, decision makers can take the necessary decisions towards new policies on imports of products that are made of plastic or products that are packaged in excessive or unnecessary plastic. In this manner, this project puts another important step towards plastic waste reduction.

Eventually the digital tool or software can be adapted to collect data on other types of waste. Paper and paper products form a large part of Municipal Household Waste (MSW) but also glass, metal and especially organic waste can be better traced, controlled and recycled if accurate data on the people's behavior towards the specific waste can be collected and made available.

With this research project I assist my thesis supervisor PhD candidate Alba de Augustin Camacho on her PhD thesis which is about "Citizen science for plastic waste data collection for Small Island Developing States", with the aim to bridge technology and society to mitigate plastic pollution. If the digital tool proves to be effective, it can be outsourced to other Caribbean SIDS. Ultimately all islands have common goals on becoming more sustainable and aim to close the waste data gap and lower their plastic imports, consumption and waste.

## 5. Conclusion

A research of this scope would be much more energy intensive and time consuming if it was not for public participation, citizen science offers a solution for that. Participation in any form of citizen science should be encouraged, as an inhabitant of your own country or as a visitor to a foreign destination. It helps people contribute to the collection of data on environmental problems or even on biodiversity challenges, in that manner, narrowing or even closing the data gap.

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Daniel Balutowski, University College Utrecht

## Sun, sand, and sargassum!

Sun, sand, and sargassum! The 10 weeks I spent on the island were a perfect blend of meaningful work and a social life that made up for covid times. Between conducting fieldwork, flying to Bonaire, and learning GIS, I had a great time going diving, playing beach tennis, and making friends at bars on the beach! What a life. It hardly felt like work when I enjoyed what I was doing every day.

Special thanks to everyone who made Aruba such a wonderful learning experience. To Eric, for fostering our curiosity and supporting us all since day one of the program. I drew a lot of inspiration from the way you do things. To Sabine, for involving me in Bonaire's sargassum situation and helping me further connect to my research. To Jair, for offering all your support and commitment to help make my pilot project possible. To Joelyne, for working with me on this research and connecting me with invaluable people. To Henrik and Jeroen, thanks for believing in me since day one

and making this trip about more than just my thesis. And to all my friends who embarked on this same journey, along with those friends who I made here in Aruba – thanks for all the memories and lack there of, stay real.

Cheers to Aruba and all the people who make it a special place.

I'll come back, mark my word.



# Brown Tides: Assessing the Past, Present, & Future State of Sargassum in Aruba Through a Mixed Methods Approach

Daniel Balutowski

*Please scan this QR code to see the many supporting visuals and important figures that, due to spatial limitations, could not be included within the text.*



*(FIGURE 1 & 2)*

Major concentrations of Sargassum have long been thought to be limited to the Sargasso Sea. However, the 21st century has seen a rapid change in circulation dynamics with unprecedented amounts recorded throughout the Caribbean and West Africa. Studies conducted prior to 2011 to track the movement of Sargassum in the Atlantic estimated that an average of one million tons could be found in the Atlantic per year (Laffoley et al., 2011). In 2018, this estimate was found to be closer to 20 million tons (Lindeman et al., 2021). While scientists aren't certain of the cause behind this shift, more recent studies conducted using satellite imagery and geotagged drift buoys indicate that the origins of recent influxes can instead be traced to the equatorial Atlantic in the North Equatorial Recirculation Region (NERR) (Ardron et al., 2011; Franks et al., 2016). The research conducted by Franks et al. in 2011 was followed up in 2016 with additional evidence that a new circulation flow and breeding ground for Sargassum had formed between the West African and Eastern South American coasts.

*(FIGURE 3)*

The emergence of the NERR has had an enormous impact on both the amounts of Sargassum in circulation and its impacts on the Caribbean. While little data exists regarding

## 1. INTRO

Pelagic Sargassum is an understudied yet wildly important species of floating brown macroalgae native to the Sargasso Sea in the western Atlantic. More than 145 invertebrate species, 127 species of fish, and many bird species make use of this floating ecosystem as a shelter, breeding ground, and feeding area (Laffoley et al., 2011). At the end of its lifecycle, Sargassum is also eventually dragged below the surface where it sinks to the deep sea, providing benthic communities with an estimated 10% of their energy input while also acting as a global carbon sink (Delgado et al., 2020; Gouvêa et al., 2020; Laffoley et al., 2011).

the precise nutrient differences between the sargasso sea and the NERR, studies indicate that iron and phosphate blown in from the African coast mixed with excess runoff from the South American coasts are the main drivers behind the explosion of Sargassum growth in the Caribbean (Franks et al., 2016; Lindeman et al., 2021; Ody et al., 2019). In fact, higher nutrient waters allow Sargassum to double in biomass every 11 days, nearly five times faster than in lower nutrient waters which better reflect that of the Sargasso Sea (Franks et al., 2016). After the Sargassum spends time fragmenting in the neritic waters, large amounts are transported north and will circulate around the Caribbean. During this journey, much of the floating Sargassum will inevitably end up on Caribbean shorelines. While Caribbean islands have always experienced small amounts of Sargassum washing up on beaches, the recent amounts have turned this native species into an invasive threat. Some estimates reported 10,000 tons of Sargassum washing up on beaches per day during the 2015 Caribbean inundation with accumulations up to 3 meters thick in heavily hit areas (Cox et al., 2019; J. Milledge & Harvey, 2016).

(FIGURE 4)

It's almost unthinkable how such an established system could turn into a widespread problem. However, since 2011, its proliferation in growth has indeed turned Sargassum into an environmental and economic disaster, having even been described as "the single greatest threat" in the Caribbean by the UWI Vice-Chancellor Sir Hilary Beckles (Cox et al., 2019; J. J. Milledge et al., 2020). While it may seem that more Sargassum would lead to larger offshore ecosystems and more carbon sequestration, its growth has instead induced many social, environmental, and economical concerns.

### 1.1 ENVIRONMENTAL IMPACTS

Upon reaching shore, Sargassum will accumulate in large amounts and immediately begin decomposing, creating similar problems to that of widespread algal blooms. For

example, it will block light from penetrating to the sea floor where photosynthetic organisms rely on natural sunlight for their functioning. It will also accumulate and create anoxic environments, using all the available oxygen in the water which suffocates underwater fauna. Eutrophication will follow as high levels of nutrients are introduced into the nearshore systems. These aspects become especially troublesome when Sargassum inundates vulnerable ecosystems such as mangroves, seagrass beds, and coral reefs, as less than 20% of species in these systems can survive a prolonged state of hypoxia (Lindeman et al., 2021). Beaches are also heavily disrupted, both from the natural and anthropogenic impacts associated with Sargassum beaching. While small amounts of Sargassum are good for nearshore fertilization and sand stabilization which both prevent erosion, large amounts of decomposing Sargassum deliver high concentrations of inorganic arsenic to the beaches which is harmful to all surrounding life (Devault et al., 2021). In a 2014 study conducted in Martinique, Devault et al. tracked and analyzed a Sargassum patch of 34,000m<sup>3</sup> for arsenic content when it reached shore and calculated it delivered over 210kg of arsenic to the exposed shoreline in just a few days. Applying these values to other influxes would mean that many islands receive several tons of this notoriously toxic metalloid on their coasts and beaches each year. Many Caribbean shores are also important grounds for turtle nesting sites. When Sargassum piles up on beaches it covers turtle nests and creates unsurmountable barriers for turtle hatchlings to climb, dramatically decreasing their chances of survival. Additionally, when tourist beaches experience large Sargassum pileup, intensive removal methods using heavy machinery are often utilized to keep the beaches clean. This process is very invasive as it enhances erosion and may crush turtle nesting sites if not carefully monitored.

### 1.2 ECONOMIC IMPACTS

The Caribbean is one of the most tourism dependent areas in the world and is thus highly susceptible to external factors



that may disrupt economic activity. Areas that experience large inundations of Sargassum on important tourism beaches are faced with the difficult task of carrying out cleanup operations. In places like Guadeloupe, Barbados, Punta Cana, or the along the Yucatan, Sargassum regularly accumulates in such amounts that it cuts off water access to those onshore. Fishermen cannot leave the harbor because their boats are surrounded by layers of Sargassum, tourists cannot swim or enjoy their time on the beach, and nearshore business operations are similarly stunned. The mayor of Quintana Roo estimated that in the 2017-2018 season, Sargassum alone led to a 35% decline in tourism (Gray et al., 2021). In Punta Cana, where tourism contributes around \$2 billion to the GDP of the Dominican Republic annually, the 25% decline in tourism seen in 2018 equated to approximately \$500 million in losses for just one season (Gray et al., 2021). Cleanup costs are also prohibitively expensive and require specialized machinery that has yet to be developed at scale. A single hotel in Quintana Roo spends an average of \$54,000 per month on Sargassum removal while the US government spends \$3.5 million to keep 32 miles of beaches along Galveston Island in Texas clear of the seaweed (Gray et al., 2021; J. J. Milledge et al., 2020).

Unfortunately, there are many obstacles that make utilizing Sargassum especially difficult and unattractive. From the unpredictability of its supply to the unfavorable chemical composition of the biomass, very few valorization pathways and Sargassum derived products exist which could incentivize a cost effective and scalable solution (Oxenford et al., 2021).

### 1.3 SOCIAL IMPACTS

Alongside the multitude of economic impacts, Sargassum accumulation and decomposition also has various social implications. The quality of life for coastal residents and the livelihoods of many who depend on coastal activity are in jeopardy throughout the Sargassum influx season. Some islands which take Sargassum off the beach to landfills

reported a lack of space in disposal sites and resorted to dumping overflowing amounts on the properties of nearby homeowners (Oxenford et al., 2021). Sargassum also has major health implications as it releases hydrogen sulfide during its decomposition process. While tourists are constantly on the move and have a high turnover rate, local residents and cleanup workers who are exposed to this toxic gas on a regular basis have been found to experience higher rates of various respiratory, cardiovascular, and neurological health problems (Saldarriaga-Hernandez et al., 2020). Between January and August of 2018, hydrogen sulfide related complications totaled to 11,402 cases between the islands of Guadeloupe and Martinique alone (Devault et al., 2021).

## 2. RELEVANCE

Not all parts of the Caribbean have experienced the recent surge of Sargassum equally. From differences in geophysical positioning to the surrounding currents and wind directions, each island may have vastly different experiences with Sargassum inundations. When looking for island specific Sargassum data and possible addressal strategies, there is a clear knowledge gap as most research has been conducted over a larger scope of the entire Caribbean region. Focusing on a smaller subset of the Caribbean islands may offer a unique perspective and understanding of Sargassum dynamics and related impacts at a more local scale. In this paper, I will explore such dynamics through the lens of Aruba in comparison to nearby Curaçao and Bonaire (henceforth referred to as the ABC islands) which make up part of the Lower Dutch Antilles. The ABC islands are a prime example of a cluster of islands which receive highly varied amounts of Sargassum despite their proximity.

Being positioned in succession above Venezuela at the edge of the Guiana Current, Bonaire is the first of the three islands to receive any influx of Sargassum, followed by Curaçao and Aruba, respectively. This can be attributed to the established

currents and trade winds that push Sargassum down this trajectory (Putman et al., 2018). In addition to the various amounts the three islands receive, associated impacts of Sargassum beaching are also felt differently due to the locations of both sensitive ecosystems and tourism areas. In March of 2018, Bonaire experienced their largest influx to date which completely covered the entire windward coastline and filled the Lagun, Washikemba, and Lac Sorobon Bays (DCNA, 2019). This killed thousands of fish and resulted in the die-off of critical seagrass patches and several hectares of mangroves. In the same month, Boka Ascension in Curaçao was so full of Sargassum that water in the bay was barely visible, leading to similar devastating ecological impacts. Contrarily, no abnormal Sargassum influx was recorded on the Aruban coasts during that time (DCNA, 2019).

*(FIGURE 5)*

Nonetheless, Sargassum does still make its way to Aruban shores with published reports confirming beaching events and through locals acknowledging its presence and limited impacts (Gibbs & Thijzen, 2018). The marine park management plan completed in 2019 has also identified Sargassum as a threat that needs more research, monitoring, and possible addressal strategies put in place (Parke Marino Aruba et al., 2020). Given how susceptible small island states are to major environmental and economic disruptions, Sargassum should be taken seriously, and adequate funding should be allocated to mitigation and removal resources as to minimize impacts.

Many islands that are experiencing the burden of Sargassum use various detection platforms to predict when and where Sargassum may land. Several such platforms including the Satellite Based Sargassum Watch System (SaWS) from the University of South Florida, the Experimental Weekly Sargassum Inundation Report from the National Oceanic and Atmospheric Association (NOAA), and the Sargassum Outlook Bulletin from the University of the West Indies

provide free and open access reports to Sargassum detection on a weekly basis (Sargassum Information Hub, 2022). Unfortunately, the data from the SaWS require a specialist to interpret while the others only release information from the past week, making future predictions impossible. Instead, more specialized paid software platforms such as the SAMtool offered by the satellite company CLS can be used. With this tool, Sargassum can be detected and monitored in real time, and drift models can be applied to predict the trajectory of Sargassum up to five days in advance (Datastore, 2022). However, not all who are interested in such a detection tool are willing or able to pay the monthly fee of \$2000+ for access. Instead, some are looking towards using Geographic Information Systems (GIS) to make their own predictions using the same free and open-source satellites that the SAMTool uses. This is an especially interesting option for islands that receive highly varied amounts of Sargassum throughout the season and thus have less incentive for 24/7 monitoring. For this reason, I will use both the SAMtool for which I have received demo access for, and GIS images to show how both approaches can be useful in the context of the ABC islands.

### 3. RESEARCH QUESTIONS

My thesis aims to contribute to the local understanding of Sargassum and to provide a recommendation for an effective addressal strategy to minimize future impacts. To do so, several questions must be answered sequentially.

- **RQ 1 :** How do Sargassum influxes differ between the ABC islands and how can these differences be explained?
- **RQ 2 :** How can GIS be used to visualize Sargassum accumulation on the ABC coastlines?
- **RQ 3 :** What are the implications of future beaching scenarios on the Aruban coastal environment and tourism sector?
- **RQ 4 :** What are the alternative strategies to addressing Sargassum in Aruba?

## 4. RESEARCH METHODS

Making assumptions on the various impacts of Sargassum would only be useful if accumulation amounts can be quantified and comparisons with sensitive ecosystem locations can be visualized. A combination of qualitative and quantitative research approaches has been utilized to gather the necessary data needed to address my research questions.

First, I conducted interviews with various relevant stakeholders including fishermen, managers from the National Parks of both Aruba and Bonaire, and government officials from several departments in Aruba. In combination with information on ocean current charts and my understanding from relevant literature, these interviews supported my answer to the first research question regarding the differing Sargassum influxes between the ABC islands. They also contributed to my understanding of environmental implications, oceanographic trends that affect Sargassum circulation, and government protocols regarding Sargassum cleanup. Together, this interview process built upon my assumptions regarding the severity of Sargassum impacts while also touching upon the differences in management techniques among the islands, setting the baseline for my fourth question regarding alternative addressal strategies.

A clear next step was to apply the knowledge I gathered through my literature review and interviews to map out both sensitive ecosystem locations and heavily impacted Sargassum areas using GIS. Gathering this information and applying it through GIS answered my second question on Sargassum visualization and will highlight the areas of interest for my third question regarding influx implications. Several studies using remote sensing techniques combined with validation fieldwork have already been conducted to map out the distribution of coral reefs, seagrasses, and mangroves around the ABC islands. For example, the

LANDSAT\_MANGROVE\_FORESTS dataset maps out global mangrove forest distribution and can be used to identify and accordingly classify areas with mangrove cover across the ABC islands. While no comparable datasets exist for coral reef and seagrass distribution, a 2017 reef classification study from Wageningen utilized hyperspectral imaging with combined in situ verification to map out coral reefs in Bonaire (Mucher et al., 2017). Another reef assessment report conducted by the Waitt Institute in 2017 through marine surveys provides information on the reef distribution and state of coral reefs in Curaçao (Waitt, 2017). Information on seagrass locations in Bonaire and Curaçao indicated that seagrass beds are often interconnected with mangroves and show similar distribution, as seen within Bonaire's Lac Bay (Beek, 8). Both systems in Aruba are clearly defined through the 2019 Aruban Coral Reef Baseline Report.

Together, these various resources build a comprehensive picture of the distribution of critical ecosystems which can be used to explain and further predict the environmental impact Sargassum may have on the ABC islands. Another critical aspect to understanding potential impacts of Sargassum looks at where human activity takes place on the islands. While the capitals are each located on the leeward sides, Aruba has almost no activity on the windward side due to strong waves, currents, and lack of access to beaches. Both Bonaire and Curaçao have more visited regions of the windward coast making Sargassum influxes more impactful on human and economic activity.

The next step for comparison came from using satellite imagery to visualize Sargassum beaching events. Many studies utilized the Moderate Resolution Imaging Spectroradiometer (MODIS) with the alternative floating algae index (FAFI) for good resolution and robust image interpretation options (Cuevas et al., 2018; Hu et al., 2015; Wang & Hu, 2016). Others have also validated the use of the more recent Sentinel 2 satellite platform with its Multi

Spectral Imaging (MSI) sensor for detecting Sargassum. While both are utilized within the CLS platform, the Sentinel data is free, open access, and offers up to a 10m spatial resolution depending on the band used. With various research papers pointing to its potential, Sentinel data could be a very interesting option for use in small island states like Aruba where funding is not as readily available. For this reason, I used the Sentinel 2 platform to gather images showing Sargassum accumulation along the ABC coastlines.

I focus on 2 bays per island that have been identified as key impact areas, namely Lac Bay and Lagoon in Bonaire, Boka Ascension and Sint Joris Bay in Curaçao, and Boca Prins and Boca Grande in Aruba. Using the combination of Visible and Near Infrared (8), Green (3), and Blue (2) bands, effective imaging contrast between water and Sargassum can be achieved (Tjong, 2020). Contrast between mangroves and accumulated Sargassum is less distinguishable but still possible based on differences between pre and post influx images.

(FIGURE 6)

I then compared the satellite images I gathered from 2022 to that of the SAMtool output from the same dates to verify my findings. Several ground truthing observations gathered via photographs will be used for selected dates as an additional visualization method. Using this data will allow me to extrapolate future possible beaching scenarios and associated environmental and economic impacts.

With few effective addressal strategies in place, I have built upon a novel alternative disposal method designed by Luke Gray in his MIT master's thesis as a proposed addressal strategy to answer my fourth research question (Gray et al., 2021). This approach utilizes nearshore floating barriers to prevent Sargassum from reaching shore and recommends collecting it from the barriers and sinking it in the deep sea using large pumps. After working closely

with Luke and his team at Sargassum Ocean Sequestration (SOS Carbon) in Punta Cana, I believe it's worth exploring an alternative sinking system that bypasses the need for any pumps. Therefore, during my fieldwork period, I modeled, constructed, and launched a prototype showing the feasibility of a sinking by weight prototype. This pilot has been funded by Sink-It, an innovative company looking to transform the carbon market by funding and developing carbon negative projects. A 3-D computer aided design (CAD) model of the prototype was outsourced by a professional modeler, materials were gathered from hardware stores, and the pilot was conducted with the help of a local Aruban fisherman. Recommendations for a sinking location will be identified using bathymetry maps and current charts.

## 5. RESULTS

### 5.1 INTERVIEWS

I conducted interviews with various stakeholders including fisherman, national park managers, and government officials. Each interview contextualized the state of Sargassum on the respective island where the interviewee was from.

Fernando Eduardo, a generational Aruban fisherman explained that Sargassum is really an afterthought when compared to the impact tourism has had on those from his line of work. He explained that Aruba receives very little Sargassum, nowhere near enough to be a nuisance for fishermen. In fact, the smaller Sargassum patches that can be found offshore are beneficial to fishermen as they attract all types of large fish and are generally very productive areas. Eduardo explained that if Sargassum does wash up on Aruban shores, its only on the windward coast where fisherman rarely go due to the rough conditions and large waves. Additionally, he mentioned that currents occasionally change direction such that Sargassum may wash up on the leeward side. However, fishermen rarely go out at that time

because, interestingly enough, fish behavior changes along with the current leading to much lower catches.

Talking with Roderick Westerbeek, a fisherman from Bonaire, it was clear that his feelings towards Sargassum were much different than Fernando's. Roderick and his fishing crew operate on the northern edge of Lac Bay, one of Bonaire's most impacted areas. They use a method of surface trawling in which a large net is dragged behind a boat to catch fish. When Sargassum patches inundate the whole bay, the nets clog with seaweed and removing it wastes time and effort. Sometimes, the Sargassum comes in such amounts that it surrounds their boats, making the exit and entrance from their dock much harder as the motors get caught in the seaweed. Luckily, Sargassum hasn't stunned their entire fishing operation and is still just seen as a major nuisance that can be dealt with through enough effort.

A similar trend in attitude towards Sargassum could be seen through the park managers I spoke with in Aruba and Bonaire. Sietske van der Wal, a marine park manager from the Aruba National Park Foundation (FPNA) confirmed that Sargassum is not regarded as a critical issue in Aruba due to the minimal amounts that land on the Aruban coast. She explained that while Sargassum does wash up in small quantities in nearly every 'boca' or inlet on the windward side of the island, the protocols in place call for letting nature take its course. Most often, the sea will drag deposited Sargassum from the beaches back into the water. In cases where it remains on the beach for several days, some workers may be sent to 'rake and spread' the Sargassum further back on the beach to speed up decomposition and ameliorate the beach sediment. Sietske explained that beach erosion is one of the biggest problems on the windward coast, and the limited amounts of Sargassum that Aruba receives may counteract the erosion process. Sietske is also closely connected to the Aruban turtle organization TurtugAruba which deals with protecting Aruba's sea turtles and their nesting sites. She assured me that there

is clear communication regarding nesting site locations with the DOW, the organization in Aruba that handles Sargassum cleanup.

Sabine Engel, a marine biologist involved with Bonaire's Mangrove Maniacs and STINAPA, has had a more direct relationship with Sargassum over the years. She explained that Bonaire annually gets inundated with overwhelming amounts of Sargassum which has a profound effect on the neighboring ecosystems and wildlife. Lac Bay, located on the windward side directly in line with the wind and current directions is particularly vulnerable. Sabine cited that it's home to over 280ha of mangroves and is a very important seagrass area that attracts all types of fauna. Sargassum is a direct threat to these sensitive ecosystems, piling up in amounts that at times, can reach 2 meters. This leads to large hypoxic oxygen areas that kill all surrounding flora and fauna including seagrasses, mangroves, and various types of fish and crab species. All this matter decomposes and releases large amounts of methane and hydrogen sulfide, to the extent that workers and volunteers can sometimes no longer conduct Sargassum removal due to the toxic concentrations of this nauseating gas. Unfortunately, animals aren't limited by safety protocols. Many species including Bonaire's flamingo feed on the decaying fauna and get profoundly sick from ingesting excess amounts of sulfur. Neither the government nor the volunteers have enough resources and manpower to stop this invasion, but efforts have been made to set up booms to strategically direct Sargassum away from ecologically sensitive areas. Sentinel data and monitoring systems like CLS are checked daily by members from STINAPA, but even the best detection methods can't prepare islands like Bonaire for incoming Sargassum when the influx overpowers the capabilities of cleanup operations.

As part of my research, I was able to fly from Aruba to Bonaire for several days after it was hit by a large Sargassum influx. Thanks to Sabine, I was able to see first-hand the

impacts of Sargassum pileups and cleanup operations. It became clear just how toxic Sargassum could become upon reaching the coast, especially when inundating seagrass beds and mangrove systems. Areas that saw large scale seaweed decomposition were accompanied by dead marine fauna, destroyed mangroves, and an absolutely horrid smell. While at Punta Calbas within Lac Bay, I discussed with a government commissioned Sargassum truck driver what specific heavy machinery is used to clean various areas. From custom excavator buckets to landfill dumping costs, it became clear that conducting a Sargassum cleanup is not only a toxic task, but also an expensive one. The driver mentioned that after the last influx, 10-15 truckloads were being taken from this location every day for the 23 days that cleanup operations lasted. From a receipt I was shown, an average cost per dump would equal to around \$120 at \$9 per ton of waste and 12,500 kg per truckload. Multiplied over multiple areas and costs quickly add up to over \$7,500 per day before factoring in the cost of workers and materials. The loss in revenue from ecosystem services is estimated to be much more substantial.

(FIGURE 7)

Another important perspective comes from the government officials and policy makers relevant to Sargassum work. Gisbert Boekhoudt, director of the Dircie Natuur en Milieu (DNM) in Aruba was especially helpful in relaying information on the severity of the state of Sargassum and the procedures in place for its cleanup and disposal. Gisbert made it clear that Sargassum in Aruba was seen as a “concern but not a threat”. Compared to Bonaire which receives a regular substantial influx requiring cleanup, Aruba is only severely impacted an average of once a year. Confirming what Sietske explained, Gisbert clarified that Sargassum sometimes washes up on the windward shores, but cleanup would only ever be organized along the tourist beaches on the leeward coast. If Sargassum approaches from this side, the real danger lies within people’s panic as many mistake

the patch for an oil spill. Hotel managers promptly request aid in removal to prevent any negative responses from the tourists. When I asked Gisbert about his thoughts on Aruba making use of a Sargassum specific satellite detection software, I was informed that the SAMtool was used over a trial period several years ago. However, it wasn’t used as often as they thought because of communication via social media in Bonaire and Curaçao. Indeed, since Bonaire will always be the first in line to receive incoming Sargassum, their posts on social media regarding the severity of the impact already give the successive islands a heads up. While this method is not very accurate, Gisbert explains that it’s been dependable enough to make paying for detection software unnecessary.

I also had the pleasure of speaking with Marlon Croes, the director at Public Works Aruba (DOW), who guided me through the Sargassum cleanup and disposal process. When the DOW receives notice about a Sargassum influx, they first send personnel to do a scouting and assessment of the situation followed by an evaluation of precautionary measures. They decide if the amount should be left alone, cleaned up by hand, or if heavy machinery will be needed. Next, they consult with TurtugAruba regarding any possible interference with nesting sites and, if all is cleared, equipment is gathered and contractors, truck drivers, loaders, and rakers are sent to perform the cleanup. The next part of the process involves the disposal site. Rather than taking the Sargassum to the landfill, Marlon explained that any truckload of Sargassum is taken to an old quarry site where it will be sun dried and buried with sand to quench the smell. While this is a straightforward option, it requires several work-intensive steps and has the negative side effects of producing hydrogen sulfide and methane alongside arsenic leaching.

## 5.2 GIS IMAGERY

### 5.2.1 SENSITIVE ECOSYSTEMS

To understand what kind of effects Sargassum may have on the ABC mangrove and reef areas, I first had to visualize their

spatial distribution. Mangrove distribution could be easily identified using the LANDSAT\_MANGROVE\_FORESTS dataset through Google Earth Engine. Comparing the three islands, the main mangrove areas in Bonaire and Curaçao are much more susceptible as they are on the windward side of the island, whereas the Aruban mangroves are sheltered on the leeward side. Additionally, the Aruban mangroves are more dispersed across several coastal locations which increases their resilience against any particular Sargassum event.

(FIGURE 8)

Mapping out coral reefs wasn't done using GIS in this study but was instead gathered from various coral surveys conducted in the last 5 years. The complexity of data collection and interpretation based on hyperspectral airplane imaging and marine surveys made using these studies essential for the visualization of coral reef distribution.

(FIGURE 9, 10, 11)

Based on these three coral studies, it's clear that the leeward side of each island generally supports more diverse nearshore ecosystems including corals and seagrasses. In Aruba, the entire windward side is classified as coral reef, but no verification was conducted on this side so the actual data is unclear. Both Sietske and several local divers confirmed coral reef presence, but the extent is unknown. Curaçao has fewer coral reefs around the developed area of Willemstad and along the windward coast while some of the greatest areas of coral cover lie in the southeastern tip where Sargassum is likely to accumulate. Bonaire, being described as a 'divers paradise' has extensive coral cover around the entire island. Similar to Aruba, no data was collected on the windward side north of Lac Bay, but locals confirm extensive coral all around the island.

### 5.2.2 SARGASSUM

Once the distribution of sensitive ecosystems was clear, sentinel data could be used to identify where sargassum was landing in comparison. Sargassum accumulation was visualized for individual days that were reported to have experienced significant influxes. Dates were obtained from news reports in Bonaire and a total time of 2 and 4 days were added for the same influx to reach Curaçao and Aruba, respectively, according to Sietske and Gisbert. Using a false color composite overlay combined with a reference image, Sargassum could be identified as red patches in the water, with much clearer contrast in the open water.

(FIGURE 12)

**6th March 2018:** Despite reports of a large influx, satellite images could only be taken from March 4th and 9th due to the 5-day revisiting interval, so it was difficult to capture images from the peak influx between the initial landing and cleanup time. Sargassum can mainly be identified in Bonaire's Lagun, Curaçao's Boca Ascension, and a small amount washed up on the tip of Aruba's Boca Grandi. Cloud cover limited observations for Boca Prins.

(FIGURE 13)

**18th May 2019:** Again, reports confirmed a large influx in Bonaire, but sentinel imagery provided limited evidence. A small amount could be seen in Lac Bay and Boca Ascension, while no Sargassum could be seen in Aruba.

(FIGURE 14)

**26th February 2022:** Towards the end of my fieldwork period, Sargassum began washing up on certain Aruban beaches. While I had ground proof of the Sargassum influx along the windward shore, it still covered too insignificant of an area to be detected by the sentinel satellite. On the other hand, if Sargassum had washed up on Aruban shores,

I hypothesized that Bonaire and Curaçao had received much larger amounts. Indeed, it appeared that more Sargassum had been detected on this date than in the largest recorded influxes from previous years.

(FIGURE 15)

For the next 3 weeks, I continued monitoring the influx and as additional verification, I used the SAMtool to track Sargassum movement. During this period, Aruba continued to receive Sargassum, especially in the bocas oriented to the southeast.

(FIGURE 16)

No cleanup efforts were made in Aruba and following the last influx, much of the Sargassum had already dried up and been blown away inshore or had been taken up by the waves and brought back out into the sea. However, Bonaire received incomparable amounts in Lac Bay, Lagun, and virtually all along the windward shoreline. Both government and volunteer cleanup efforts lasted 23 days with still more Sargassum to be cleaned up. On the 18th of March 2022, I flew down to Bonaire with the intention of volunteering with Sargassum cleanup. Even though the patches looked small from an arial view, on the ground they were expansive and incredibly dense as the Sargassum compresses with time and added force. Among the Sargassum were dead marine life and mangroves, accompanied by a nauseating smell that proved difficult to get accustomed to.

(FIGURE 17)

### 5.3 DISPOSAL METHOD – SINKING PILOT

The Sargassum problem is in dire need of a solution and islands like Aruba and Bonaire both need a cleanup method that minimizes impact and costs. Luke Gray developed a novel offshore disposal method that involves sinking the collected Sargassum to the deep sea. This process minimizes beach impact as no heavy machinery is needed to transport

the Sargassum onshore, eliminates landfill dumping costs and arsenic leaching, and cuts methane and hydrogen sulfide emissions. However, this sinking method involves using pumps costing upwards of 150k each. Hereby I propose a low-cost alternative method that utilizes the same principles as the pump system but instead sinks the Sargassum with a net and weight system. Instead of loading the Sargassum into the pump, it can be loaded into a large net, sunk to depth, and retracted back to the vessel leaving the Sargassum behind to sink to depth.

(FIGURE 18)

As a proof of concept, I gathered the materials needed to perform a pilot and with the help of Jair Britten, a local spearfisherman, farmer, and maritime specialist, we gathered Sargassum and tested the sinking method using his boat near Aruba's Spanish Lagoon. Special thanks to University of Aruba student Jolene Wever for making this connection happen.

(FIGURE 19 & 20)

The pilot proved to be moderately successful as the hand stitched part of the net gave way under the weight of the whole system. This meant the mechanism that held the net open no longer functioned as the net was retracted back to the surface, leading to the Sargassum getting stuck and only half escaping the net. Additionally, the Sargassum itself was still buoyant at only 5 meters which won't be the case at scale with deep sinking. Limited time, money, and resources made a full sinking pilot unfeasible, but the results show promise and should be succeeded by a 130m second stage trial.

## 6. DISCUSSION

Compared to previous studies utilizing GIS for Sargassum identification, my experience using the widely recommended



sentinel platform was far from perfect. It was very difficult to discern Sargassum from the mangroves which made my initial goal of creating an accurate supervised classification model incredibly challenging given my timeframe and lack of previous GIS experience. However, it still proved useful to manually find individual influx dates and examine how well the satellite imagery captured the state of Sargassum at that time. Fortunately, the information I obtained from the interview process proved to be very valuable for my research. Not only did I verify my findings through a local lens, I also gathered local knowledge and made connections I would have otherwise missed. This also validated just how much of a research gap there is within studies examining the state of Sargassum within the context of individual islands. In the case of Aruba, even though there may not be much Sargassum historically, annual influxes fluctuate, and currents may periodically overturn leading to a shift in Sargassum dynamics. If Aruba experiences a serious Sargassum period, it's good that information exists regarding the effects it may have on both sides of the island and how it can be dealt with in a sustainable manner.

With this said, answers to my research questions can add to this local understanding and future addressal framework.

- **RQ 1 :** Through literature, various interviews, satellite image collections, and in situ observations, it's very clear that Bonaire receives the largest amount of Sargassum and highest frequency of influxes followed by Curaçao and Bonaire. This can be explained through positioning of the islands in succession along the route of the established winds and currents.
- **RQ 2 :** GIS can sometimes be used to identify offshore Sargassum patches to give an estimate as to the severity of an incoming influx. Currently, each free and open access platform has different limitations with tradeoffs in the spatial or temporal domain, and many are susceptible to compromising factors like cloud cover.
- **RQ 3 :** With the limited amount and low frequency of

Sargassum influx in Aruba, coupled with the absence of mangroves and seagrasses, Sargassum is not expected to be a major environmental threat in the coming years. Strong currents are likely to push out any Sargassum that sinks to the coral reefs on the windward side. Tourism is strictly located on the leeward side of the island where Sargassum influxes occur even less frequently so minimal impact is expected. Largest tourism effects may be experienced over single beaching events for a very short temporal scale.

### 6.1 POSSIBLE ADDRESSAL STRATEGIES

Looking into possible addressal strategies, it's important to have an overview of what is currently being done with Sargassum around the Caribbean as to see what could be applied to the Aruban context. A wonderful compilation of Sargassum projects can be found in the Sargassum Uses Guide produced by Anne Desrochers from the center of resource management and environmental studies (CERMES) of the University of the West Indies. From crop production and bioenergy to bioplastics and pharmaceutical products, this report highlights all Sargassum derived products, local entrepreneurs work, and ongoing research in the field (Desrochers et al., 2020). One particular use case surrounding anaerobic digestion for bioenergy applications has been identified to hold a lot of potential. Anaerobic digestion, especially when combined with a hydrothermal pretreatment step, can capture the methane released by decomposing Sargassum (Desrochers et al., 2020; J. Milledge & Harvey, 2016; Thompson et al., 2020). It requires little pretreatment, is more forgiving with various amounts and conditions, and could be done by individuals in their backyard or at an industrial scale. Several other papers also address the many challenges and limitations such as the unpredictability of supply, intensive processing steps, high costs and regulatory issues that ultimately lead to the failure of many Sargassum centered projects (J. Milledge & Harvey, 2016; Oxenford et al., 2021; Saldarriaga-Hernandez et al., 2020).

Alternatively, Gray's sinking proposal creates value in a different way than Sargassum derived products. Rather than making a physical product, sinking Sargassum contributes to carbon negative climate efforts by avoiding any emissions that would be produced by decomposition or any transformation process.

*(FIGURE 21)*

- **RQ 4 :** Due to the unfavorable chemical composition of the biomass, limited use cases are applicable at scale in a Small Island State. Thus, a sustainable collection and disposal strategy must be employed to minimize impacts, especially in islands that are regularly being overwhelmed by Sargassum. The sink by weight method may be an interesting option for islands that experience highly irregular influxes.

## 6.2 PROPOSED FUTURE FRAMEWORK

Marlon Croes from the DOW expressed interest in the described sinking by weight disposal strategy, explaining that if a more sustainable disposal method could be developed, it would be tested within the next Sargassum cleanup effort. Indeed, sinking the Sargassum will limit the impact heavy machinery use has on beaches, prevent arsenic leaching into the ground, and will lead to greenhouse gas emission avoidance. With a reallocation of human and physical resources from a bulldozer and dump truck to a barge and crane system, only an investment in a dedicated sinking net would be necessary to modify the disposal method.

Based on ocean currents and depth charts, a proposed sinking location has been identified as shown in figure 22. Depths should surpass 200m to ensure permanent disposal, and optimal sinking depth is at around 500m to ensure minimal nearshore impact of the sinking process.

*(FIGURE 22)*

## 7. CONCLUSIONS AND RECOMMENDATIONS

Sargassum has proved to be a major nuisance throughout the Caribbean in the past decade. With the change in Sargassum dynamics being linked to a myriad of global problems including ocean warming and eutrophication, there is little hope for remediation at the source meaning efforts to minimize impact will instead be carried out reactively. Each island will experience the effect of Sargassum inundations in various ways, depending on their positioning in line with ocean currents and trade winds that will inevitably push Sargassum onto their shores. The ABC islands provide a great example of how island positioning in combination with sensitive ecosystems and tourist locations affect how severely an island will react to Sargassum. Bonaire, with its extensive mangrove systems on the windward side and being first in line to receive an influx heading along the South American coast, will face much larger quantities that result in extensive damage. Aruba is much more fortunate being third in line to receive an influx, and having it predominantly wash up on the rocky and uninhabited windward side.

These differences in conditions call for tailored monitoring and cleanup efforts. In Bonaire it is essential to invest in top-of-the-line Sargassum prediction software and expensive floating barriers to guide Sargassum away from sensitive ecosystems. Unfortunately, islands like Bonaire don't have adequate resources or capital to pay for software subscriptions, materials, labor and dumping costs. Nor can they afford to have their sensitive areas destroyed as the ecosystem services and biodiversity maintained by these areas are invaluable. Aruba can get away with using social media to monitor if Bonaire or Curaçao had received any influx. If something is detected, anyone could utilize the free sentinel platform and create a false color composite as I did in my research to identify the patches and give the DNM or DOW a notice.

An effective addressal strategy suitable for all islands has yet to be created given how recent of a phenomenon destructive Sargassum influxes are. While many are working on ways to make value out of this biomass through chemical extraction, biofuel conversion, or as fertilizers, many variables stand in the way and complicate the process. The alternative sink by weight design I tested during my fieldwork period could be considered as an alternative disposal strategy to eliminate several issues that come with land-based disposal. While more research and validation must be done regarding the design and proposed disposal site, I believe this is a good starting point and at least a partial answer to the ongoing Sargassum problem.

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