

Nature Management Project Curaçao

Tropical Forestry and Nature Conservation
Bachelor Thesis

Kees Baake 2016



Managementplan



Guide



Annex



*Increase Stichting Uniek Curaçao's
autonomy in the process of developing
systematic management plans*



Velp, August 2016

Kees Baake (author)
kees.baake@gmail.com

E. Van Duijl (supervisor)
T. Van der Giessen (external supervisor)

Van Hall-Larenstein (educational institute)
Stichting Uniek Curaçao (host organisation)

Bachelor Thesis
Forest and Nature Conservation



ABSTRACT

The NGO Stichting Uniek Curaçao (SUC) wants to improve their management plans in order to acquire more responsibilities from the government. With this responsibility, SUC can create new opportunities for the management of Curaçao's wetlands of international importance which fall under the Ramsar Convention since 2012. The purpose of this thesis is, therefore, to establish a practical, systematic that can be used by Stichting Uniek Curaçao (SUC), not only as a management plan in itself but also as an example for future management plans. For this purpose, the Ramsar site of Malpais/St. Michiel, in the centre of Curaçao was chosen.

The plan starts with an extensive analysis of the Ramsar site, which forms the foundation of the management plan. This analysis consists of a geographical, stakeholder and problem analysis. First, a preliminary literature research was used to explore the geographical parameters of the Ramsar site Malpais/St. Michiel. A basic inventory supplied additional information to cross-check data from the literature research. This inventory assessed the paths, facilities and landscape characteristics. Second, the stakeholder analysis was carried out through a social research. Interviews among specific stakeholders were used to explore and evaluate relevant topics to the Ramsar site, such as legal situations, conflicts, laws & policies and transparency. And third, the problems identified during this social research were mapped in a problem tree and ordered logically.

After the analysis, the implications for the management of the Ramsar could be derived. These implications were then clustered into three objectives. Through these objectives, effectivity of the management can be assessed. These objectives are:

- *Objective 1: Number of visitors of the Ramsar site is increased*
- *Objective 2: Accountability by the governmental institutions is improved*
- *Objective 3: Sustainable management is improved.*

These objectives are achieved through the carrying out of the management activities. These activities are organised by splitting them up into four categories based on their topographical zone. These four zones are: the area around the bay of Von Pesjbaai and Vaersenbaai, the freshwater lake and its buffer zone in Malpais and the Saliña and the hypersaline lagoon in St. Michiel & a general zone. Each zone has several management topics that further help to identify the activity type. These are the same for each zone, namely: Evaluation & Monitoring; Maintenance; Rules & Regulations; Information provision and Facilities & Infrastructure.

The management activities should lead to six results that contribute toward the achievement of the main objectives:

- *The number of incidents related to illegal activities is lowered*
- *Cultural functions of the Ramsar site are improved*
- *Responsibilities of the government are divided between the relevant stakeholders*
- *A proposal for a national wetland policy is developed*
- *Environmental impact is researched*
- *The scope and quality of management activities are improved*

Ultimately, in addition to the management plan, a management guide is also supplied in the annex. Moreover, a database with geographical information and scientific reports was constructed and put on SUC's internal server. These additions provide the necessary components that SUC needs for constructing future systematic, logically structured management plans such as the example management plan included in this thesis.

ACKNOWLEDGEMENTS

This thesis has been an enormous challenge for me; it has both been a test of individuality and a test of endurance. Up until this point, I have never worked on an individual project of this scale. I have learned that working in a team definitely is much easier for and more optimal to me. However, by setting up this thesis, I cannot deny that I have learned and developed valuable new skills and gained more professional experience.

Special thanks go out to my supervisors. First, I would like to thank my external supervising, T van der Giessen, for helping me gain useful insights to structure and the working field of the organisation as well as providing useful information about the full particulars of the (distinctive) setting of Curaçao itself. Next, I would like to thank my supervisor Van Duijl of the Van Hall-Larenstein, University of Applied Sciences. E van Duijl has been a valuable help regarding ideas, perspective and thesis structure.

In addition to my supervisors, several other people have also played a role in the development of this thesis. First, G J Baake, A E A M Schipper, S Dorelijers & R van Soest for layout and design. Second, S. Lakerveld & B Meyers, both have been very helpful with the explanation of the obscure laws, policies and legislations of Curaçao. I would like to thank F Dilrosun of the Ministry of Health, Environment and Nature, who provided relevant information and documents regarding the study site.

I am also very grateful for the tremendous support my girlfriend, J Boetje, has given me throughout the whole thesis writing process!

K W Baake

Velp, July 14th, 2016

TABLE OF CONTENTS

CONTEXT	6
1 Introduction	1
1.1 Thesis objectives	2
1.2 Structure	2
2 Description Host Organization	3
2.1 Operative Range	3
2.2 Organization structure	3
2.3 Funding	4
ANALYSIS	6
3 Methodology	7
3.1 Geographical Analysis	7
3.2 Stakeholder Analysis	8
3.3 Legal Analysis	9
3.4 Problem Analysis	9
4 Geographical Analysis	11
4.1 History	12
4.2 Climate	12
4.3 Geology	14
4.4 Soil	15
4.5 Vegetation	16
4.6 Fauna	21
4.7 Ecosystem services	22
5 Stakeholder Analysis	25
5.1 End users	25
5.2 Institutions	27
5.3 Stakeholder Chord Diagram	29
6 Policies and Regulations	31
6.1 National Policies	31
6.2 International Conventions	32
7 Problem Analysis	35
7.1 Safety	35
7.2 Accountability	35
7.3 Environmental impact	36
8 Implications for management	39

8.1	Geographical Implications	39
8.2	Social implications.....	40
8.3	Legislative Implications	40
MANAGEMENT		42
9	Management Plan Objectives	43
10	Management Activities	45
10.1	Zones	46
10.2	Activities per Zone.....	47
11	Management Impact.....	55
11.1	Economic Impact.....	55
11.2	Socio-cultural impact.....	55
11.3	Ecological impact.....	56
13	Future Outlook.....	57
13.1	Monitoring and Revision.....	57
13.2	Opportunities for future development	57
14	References	59
ANNEX.....		2
Annex I	Log Frame Matrix.....	3
Annex II	Problem Tree	4
Annex III	Objective Tree.....	5
Annex IV	Interview structure.....	6
Annex V	Stakeholder description	8
Annex VI	Topographic Map	11
Annex VII	Zonation Plan Map	12
Annex VIII	Geological Map.....	13
Annex IX	Geomorphological Map	14
Annex X	Soil Map.....	14
Annex I	Vegetation Map	16
Annex II	Landscape Ecological Vegetation Map.....	17
Annex III	Recreation Map	18
Annex IV	Schedule	19
Annex V	Management Plan Guide.....	21

CONTEXT

1 INTRODUCTION

Wetlands are highly dynamic ecosystems that provide many critical ecosystem services: water purification, flood control, carbon sink and shoreline stability (Russi, et al., 2012). Wetlands also offer multiple (dynamic) habitats for flora and fauna species. Moreover, wetlands are considered to be among the most biologically diverse ecosystems on the planet (Gopal, 2009). Because wetland ecosystems are also very fragile ecosystems many wetlands have been destroyed, exploited and/or harmfully afflicted since the start of the industrial revolution (at the beginning of the 18th century). The impact on global wetlands has been so severe that the total area of wetland loss estimations ranges from 54-87% (Davidson, 2014). Therefore, the international community took several important steps toward sustainable wetland management and wetland conservation, such as the development of international treaties. The Ramsar Convention is the largest intergovernmental treaty on wetlands that “provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources”. (Matthews, 1993)

Nations that sign the Ramsar Convention can assign Ramsar status to their wetlands to conserve these wetlands. However, not every wetland qualifies as a Ramsar site; only wetlands of international importance qualify. If it meets the requirements, it gets designated as an official Ramsar site, which means that the government is now officially accountable for its sustainable management. Ramsar calls this sustainable management the wise use principle: *“the maintenance of the ecological character [of wetlands], achieved through the implementation of ecosystem approaches, within the context of sustainable development”* (Ramsar, 2014). Central to Ramsar’s wise use principle is the development of a nature management plan as it ensures the efficient application of the ecosystem approach.

A sustainable management plan that follows Ramsar’s wise use principle needs to have several features:

- It includes a natural resource inventory that is used to sustain and increase the natural resources.
- It responds to the needs and wishes of the different stakeholders.
- It identifies the current problems and (potential) obstacles
- It establishes objectives necessary to evaluate and measure future success.
- It increases the management effectivity by planning management activities and assigning responsibilities.
- It increases transparency to settle agreements and improve effective communication.

In 2012, the Ministry of Health, Environment and Nature (GMN) of Curaçao officially designated four sites as Ramsar sites (CARMABI, 2012). Even though the local research institute Carmabi and the Ministry of GMN developed basic management plans in 2014, little has changed in the actual management of the sites because the plans lacked several of the sustainable management plan features (see above) needed for the correct implementation of Ramsar’s wise use principle. Moreover, due to insufficient capacity, GMN could not carry out all activities and contracted the NGO Stichting Uniek Curaçao (SUC) to carry out basic maintenance activities. However, these sites are often too degraded to rely on basic maintenance activities as they continue to be under human pressure. Hence, active management that incorporates the ecosystem approach is strongly needed. The ecosystem approach is a crucial factor in sustainable nature management as it focuses not only on biodiversity but also on the services an ecosystem can provide for humans.

SUC is one of the few organisations on Curaçao that take an active approach toward the management of wetlands. SUC has already had much success in the privately owned Asencion wetland, which is also part of a Ramsar site. However, SUC does currently not have enough responsibilities to manage the governmentally owned Ramsar sites actively. Although SUC already has a contract with GMN, SUC should also acquire an additional management contract with the Ministry of Traffic Transport and Spatial Planning (VVRP). Therefore, SUC asked for a detailed management plan to apply for the necessary responsibilities from the VVRP Ministry. This Bachelor Thesis is the

result of that wish for such a management plan. It is the management plan of one of the Ramsar sites: The Malpais/St. Michiel wetland.

1.1 Thesis objectives

This management implements Ramsar's principles to increase the wise use of the Ramsar sites in Curaçao to mitigate the effects of future threats and conflicts. Hence, this thesis is not just for the wetland Malpais/St. Michiel, but also serves as a reference and venture point for future management plans to be written by SUC for the Ramsar wetlands of Curaçao. Consequently, the main purpose of this thesis is: "to enable the foundation to be more autonomous and systematic in carrying out all tasks needed to construct comprehensive management plans." The purpose is divided into several sub-objectives to reach this purpose. Below is an overview of the sub-objectives. In the annex is a complete overview of the project's objectives and their corresponding indicators in the form of a log frame matrix (see Annex I).

The main objectives of this thesis are:

- A) Develop a management plan
 - I. A comprehensive geographical description of the area is provided
 - II. Detailed problem and stakeholder analyses are conducted
 - III. Objectives are achieved through the implementation of management activities
 - IV. An activities schedule is provided
- B) Develop a management guide
 - I. Instructions on writing the different management chapters are given
 - II. Logical Framework Approach is explained
- C) Construct a database
 - I. Comprehensive Geodatabase is provided with all available geographical information on Curaçao
 - II. Scientific literature database is included

1.2 Structure

The plan consists of three parts: Analysis, Implementation and the Annex. The first part, analysis, consists of research methods, a detailed site description, stakeholder analysis, laws policies and regulations and a problem analysis. The next part, implementation, describes all practical steps needed to be taken to achieve the results and objectives set earlier; this section also includes relevant tables, such as a planning per management zone. The last part, the annex, contains more detailed information with several graphical representations: geological, soil and vegetation maps, and a problem and solution tree. The annex also contains a management guide that can be used to set up new management plans and that gives insight into the meta-structure of this management plan (Annex V).

2 DESCRIPTION HOST ORGANIZATION

In 1991 a group of motivated volunteers of the Tourism Awareness Program (initiated by the Development Bureau Curaçao) joined forces to establish the Uniek Curaçao Foundation. In November 1992 the foundation received its legal status and started their mission of bringing the island's nature closer to the inhabitants of Curaçao. (SUC, 2016)

2.1 Operative Range

The foundation's main focus is to acquire rights to manage areas that have a high potential for nature development. SUC achieves this by concluding contracts with terrain owners. Currently, there are over 15 areas under the management of Uniek Curaçao. Sometimes partner organisations collaborate in the management of the parks. (T. Van der Giessen, Personal Communication, March 2016)

Park Rangers visit the parks on a regular basis, not only for maintenance but also by talking to residents of the nearby located neighbourhoods. SUC talks to local residents about problems with waste dumping, pollution or vandalism is an important measure that can be taken to reinforce social structures to eradicate misbehaviour in the (near) future. Collaborating with the neighbourhood residents in addressing their problems also falls under poverty alleviation, which is one of the other important focuses. Poverty alleviation can be as simple as facilitating playgrounds for impoverished children. Rehabilitation procedures, such as cleaning of the park or other maintenance activities, are facilitated for drug addicts to help them reintegrate into society. (C. Hagenaar, Personal Communication, March 2016)

Next to nature conservation and poverty alleviation, education is another point of interest for Stichting Uniek Curaçao. During field trips, SUC speaks the importance of nature to these children. SUC also organise clean-ups for school children so that they can experience how pollution affects nature and that they help to change. The mentality of the population has to change, and this mentality change starts in childhood. The slogan 'konose bo isla' of Stichting Uniek Curaçao means 'know your own island' further illustrates the need to address island related issues to the local inhabitants, especially among its youth. (SUC, 2016)

2.2 Organization structure

The director is the main decision maker and contact with terrain owners, partners and sponsors. The director is advised by a board, consisting of a chairperson, a treasurer, a secretary and three regular members. The board meets on a monthly basis, with additional meeting when needed. The board discusses all important issues before the executive director makes a final decision. Although the executive director makes most smaller decisions directly: Theo van der Giessen. Most of the members of the board have full-time jobs and are sporadically present at the office. They are advisors rather than executives. Many have a field of expertise on which they base their advice, ranging from lobbying to quality control and field experience. (SUC, 2016)

Next to the board, there are also volunteers that are present on a structural basis. In the field, Park Rangers work on a weekly basis to check for illegal activities. Two of these Rangers operate on a daily basis and carry out core activities, such as collecting litter and plastic debris, maintaining the paths and other small management activities. A financial manager is present to check accounts and regulates budgets. SUC also offers excursions and tours where they share information on cultural-historical heritage, geology and flora and fauna. However, most volunteers and interns predominately work with the organisation on an irregular basis. Many interns come to support the company by doing field work, assisting in front office management and by writing reports. Reports vary from a whole range of subjects, including but not limited to financial advice, juridical issues, environmental protection, water & nature management, rural & social development, media and graphic design. The volunteers mainly

give tour guides, host hikes, organise and carry out clean-ups and offer technical support. (T. Van der Giessen, Personal Communication, March 2016)

The matrix below (Table 1 Responsibility Assignment Matrix. Table 1) presents an overview of all the different functions present within the organisation and their corresponding responsibilities. It is important to divide the responsibilities among the various staff members to make decisions adequately, this will aid the effective planning and implementation of the management activities.

Table 1 Responsibility Assignment Matrix.

	Perform	Accountable	Control	Suggest	Informed
Director		X	X		X
Chairman				X	X
Council members				X	X
Financial Administrator			X		
Tour operator		X			
Guide	X				
Head field work	X		X	X	
Field worker	X				
Volunteers	X				

This chart depicts all different roles and responsibilities within Stichting Uniek Curaçao according to the PACSI model (Perform, Accountable, Control, Suggest and Informed).

2.3 Funding

Stichting Uniek Curaçao is a non-governmental organisation (NGO) and therefore it needs to secure its independence. SUC only receives limited funding or subsidies from the government of Curaçao. Therefore, the organisation is mainly dependent on sponsors from charitable organisations and funders from organisations that have a sustainability ethos, such as the Triple Bottom Line's: "people, planet, profit" philosophy. The funding is often project-based and therefore the foundation is always looking for new opportunities and projects to fulfil the wishes and needs of these donors. Nevertheless, there are also structural, performance-based funders that cover the expenses of the permanent staff. Furthermore, some funds are non-monetary gifts, such as vehicles, computers, servers, office articles, pallets and other useful materials. (T. Van der Giessen, Personal Communication, March 2016)

ANALYSIS

3 METHODOLOGY

This section describes the data and methods used to construct this management plan. First, an extensive literature research was conducted to identify the different geographical and social characteristics. Literature from several sources was collected and assessed: Scientific reports, informational books, websites, newspaper articles and internal reports from the local SUC server. Second, a basic inventory was carried out to assess the state of the trails and recreation facilities. Third, social research was conducted which was both conducted in a structured and non-structured fashion. All relevant collected data has been assembled in a database on a server located on the local area network (LAN) of SUC.

3.1 Geographical Analysis

3.1.1 Basic inventory

The already present recreational routes were assessed with the use of GPS equipment. Waypoint marked all high valued recreation zones, these included important bird areas, picnic spots and waste containers. The location of overhanging trees and litter hotspots were also identified and saved as waypoints. The GPS information of the walked paths was edited in ArcGIS to smoothen edges and eliminate incorrect data such as wrong turns or inaccurate GPS readings due to signal fluctuations.

The identified routes and recreation waypoint in conjunction with the Elevation and Topographical data – described in further detail below – were used to construct the Recreation Map ([Annex III](#)).

3.1.2 Spatial data

■ Printed maps

The printed landscape ecological vegetation map (scale 1:50.000) by Beers et al. (1997) served as a basis for the Curaçao vegetation map ([Annex II](#)). The same publication also included a Soil map (scale 1:40.000) from Grontmij & Sogreah report (1968), the only published soil survey report of Curaçao. The cadastral service of Curaçao was consulted to obtain a map (1:20.000) indicating ownership boundaries ([Annex VI](#)).

All maps were scanned at 300 DPI and georeferenced in ArcGIS 10.3 with Esri's World Imagery Service that is based on TerraColor and SPOT imagery ([ESRI, 2016](#)). All georeferenced maps were then projected from the geographical coordinate system WGS84 to UTM Zone 19N.

■ Digital maps

Carmabi Research Station provided a detailed and updated digital shapefile Beets's Geological Formations map (1972). The geological dataset provided by Carmabi was used in conjunction with the information on the landscape types from the Beers publication to identify the land types to construct a geomorphological map ([Annex IX](#)). The Curaçao zoning plan was acquired from the Dutch Caribbean Biodiversity Database ([DCNA & WUR, 2016](#)), which was adapted from the original Island Development Plan ([DROV, 1995](#)). Digital topographical data, such as houses, roads, vegetation layers, was obtained from the internal server of SUC. SUC had acquired the governmental dataset from Dienst Openbare Werken's (DOW) geodatabase in 2010 to update their Curaçao Hiking Map ([T. Van der Giessen, Personal communication, April 2016](#)).

The topographical map from the DOW dataset was transformed from a geographical Lambert Conformal Conic coordinate system into the WGS 84 coordinate system by using Mugnier's (1998) datum transformation ($\Delta x = -265.766$ m, $\Delta y = 109.445$ m and $\Delta z = -360.686$ m). Afterwards, it was projected from WGS '84 to UTM Zone 19N. The coordinate systems of the geological map and the zoning plan were already projected in the UTM Zone 19N projection.

- **Satellite data**

The US Geological Survey website (USGS, 2016) was conducted to acquire high-resolution satellite raster images from the LANDSAT 8 and NASA's SRTM satellites. The LANDSAT 8 satellite was used to classify terrain characteristics and vegetation density. The SRTM satellite imagery included a 15m resolution Digital Terrain Model (DTM) that was used for further spatial analysis to identify terrain characteristics such as slope classes and flow accumulation streams.

The datasets were in the WGS '84 coordinate system and were projected to UTM Zone 19N.

3.2 Stakeholder Analysis

3.2.1 Social research

First, a brainstorm session with the director (Van Der Giessen) and a socially engaged park ranger (Ching) was organized at the SUC office to identify and describe all present stakeholders: (groups of) people who frequent the park and/or have responsibilities in relation to the Ramsar site. These specific stakeholders were classified into four stakeholder groups (Section 0), and SUC's director provided the necessary contact information. The contact with these key informants was held in both a structured method (i.e. organised meetings) and unstructured method (e.g. short telephone calls and e-mails). The school children stakeholder group was an exception; they were approached in a participatory fashion: a focus group meeting.

After the identification of all these specific stakeholders, their influence on the Ramsar site was assessed. Interviews with stakeholders were conducted to assess the relations between the stakeholders and the impact of the stakeholder on the Ramsar Site in the past. The interviews served as a basis for the evaluation of the influence of stakeholders on other stakeholders. Both negative and positive impact were taken into consideration. The valuation of this influence provides extra insight into the complex interrelations between all these specific stakeholders.

- **Interviews**

Structured

Five structured interviews with different stakeholders (Carmabi, GMN, VVRP, SUC, Tour Operator) were held in April 2016 to gain more knowledge about the area and get a better view of the needs and wishes of the different stakeholders involved and to identify their associated problems. Interviews with representatives of all different stakeholder groups included government officials, executives of organisations and park rangers (Annex IV). In-depth interviews are optimal in this case because they are a thorough technique for collecting data on individuals, individual patterns, outlooks and experiences, this gives participants a chance to speak without external pressure (Kapila & Lyon, 2006). The interviews were started by an informal, clear introduction to explain the objectives of the management plan and the potential benefits to the stakeholder(s). The framework of the interviews revolved around land use, recreation and problem identification (see Annex IV).

Unstructured

Due to time constraints, there were some difficulties in making structured interview appointments. Therefore, short telephone calls and e-mails were used in addition to the structured interviews to gain insight on unanswered questions. Contacts included Carmabi employees De Freitas & Stokkermans; Government officials Jonckers, Constantia-Kook & Dilrosun and board members Mercelina and Duvalé from SUC.

- **Focus Group**

A focus group meeting was organised with children of different primary schools during the spring holiday at an event of SUC. The goal was to identify motives for children to come to the parks/nature areas in general. A participatory ranking method was used, in which, several images of activities were placed on a surface so that they could

be rated by the (school) children. A total of 20 children within the age group 7-14 were given two numbers printed out on paper, a 1 and a 2, which they could place at the activity represented by a printed image; where 1 was first choice and 2 the second choice.

3.3 Legal Analysis

The help of an attorney in law (Meyers) and a legal intern at SUC (Lakerveld) was requested to identify all policies and regulations that apply to the management area. Older copies of legal documents were acquired in print. After 2010, several documents had been revised and were, therefore, unavailable both in print as well as online. Lakerveld and Meyers requested these legal documents at the governmental institutions. Subsequently, these legal documents were assessed and summarised to extract the relevant data for the management area (see Section 6).

3.4 Problem Analysis

Collected information from the interviews served as the basis for the problem identification. News articles from local newspapers were reviewed to investigate the identified problems further. These identified problems were logically structured into a problem tree to identify and organise their underlying causes (Annex II). The problems that SUC has a big relation to, and thus can have a high influence on, were extracted from this problem tree. These selected problems were then translated into achievable objectives (see Section 6).

4 GEOGRAPHICAL ANALYSIS

This section provides a comprehensive description of all the site characteristics. This section starts with a historical introduction to the site. Second, the geological characteristics are described in detail, as they form the fundamentals for the biotic components. Ultimately, these biotic components, i.e. vegetation and fauna, are thoroughly explored in the last paragraph of this section.

The Ramsar site Malpais/St. Michiel is a combination of several different wetland types: a hypersaline lagoon in St. Michiel; coral reefs along the coast of Vaersenbaai and Von Pesjbaai; and two seasonal freshwater lakes in Malpais. All these wetland types fulfil various ecological functions to various fauna and flora species. Four of these ecological functions fit with the Ramsar wetland criteria for international importance (Table 2). The Coral reefs form are a unique marine ecosystem; the hypersaline lagoon is an important site for the typical Caribbean Flamingo populations, and the temporal freshwater lake is vital to at least seven species of waterbirds.

Table 2 Ramsar designation criteria for Malpais/St. Michiel.

Criteria	Description
criterion 1	The wetland contains a representative, rare, or unique example of a natural or near-natural wetland type found within the appropriate biogeographic region.
criterion 2	The wetland supports vulnerable, endangered, or critically endangered species or threatened ecological communities.
criterion 4	The wetland supports plant and/or animal species at a critical stage in their life cycles or provides refuge during adverse conditions.
criterion 6	The wetland supports 1% of the individuals in a population of one species or subspecies of waterbird.

Original data from Vermij & Chamberland (2012).

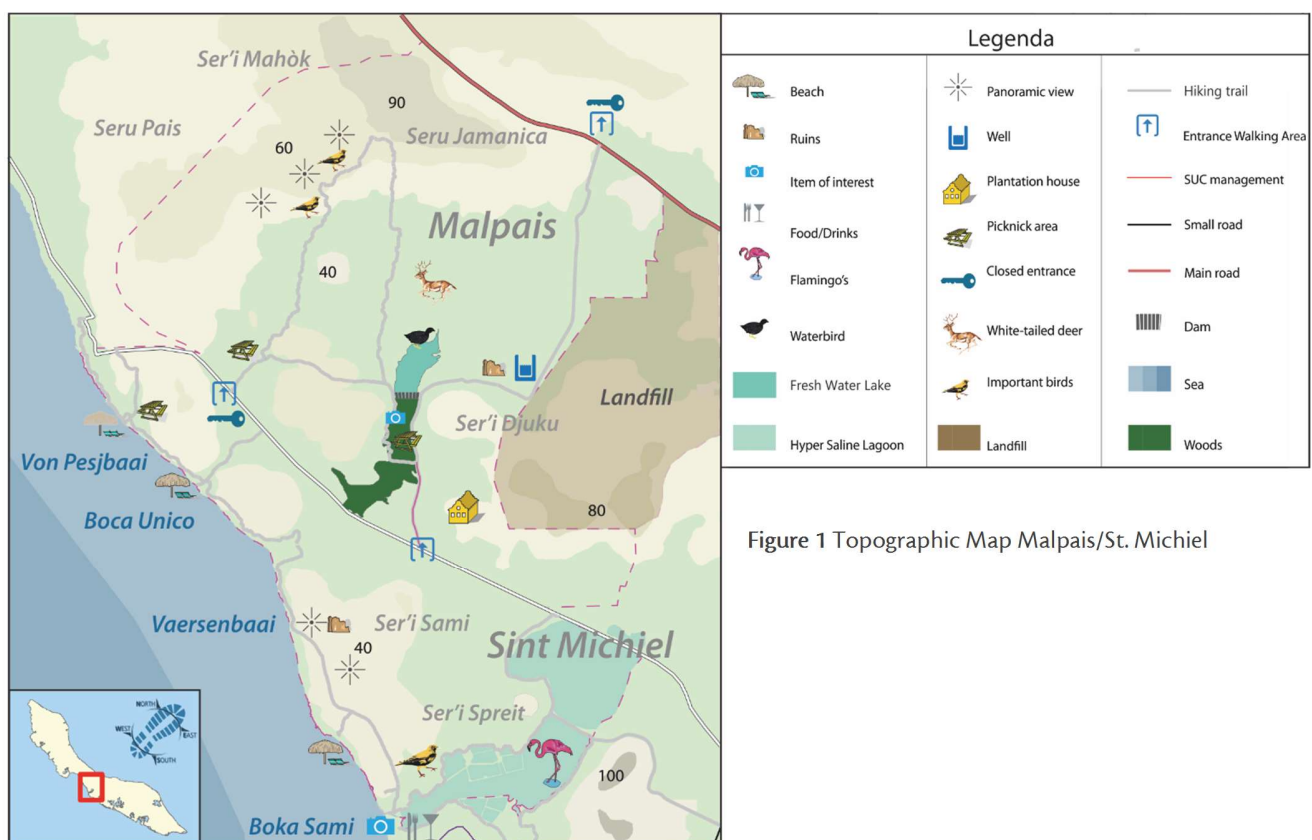


Figure 1 Topographic Map Malpais/St. Michiel

4.1 History¹

In the past, Malpais (also named Texel or Wawoe) was mainly used as a livestock plantation of around 10 square kilometres (1000 hectares) and also included the areas of Siberie, Weitje and Souax. However, due to allotment over the years, its size reduced significantly, and it got divided into several smaller plantations. Although the territory Malpais originates from the Spanish period, little information is available from that time. Most documented data, which often is about slave accounts, traces back to the 18th century when the slave trade of the Dutch West Indies Company was at its peak. In this period colonists also established the (now degraded) historical plantation villa located in the south-east. The area derives its name from the combination the Spanish words: Mal and Pais, which translate to 'bad land'. Malpais probably acquired its name because of the unsuitable conditions for agriculture in the past. Hence, it was used for cattle grazing instead. The area in the south, close to the sea is called St. Michiel and colonists exploited its hypersaline lagoon for its salt pans, but in comparison with other salt pans, the yields from these salt pans were probably relatively low.

In 1910, Royal Dutch Shell bought the area of Malpais as a buffer zone for its oil refinery. In 1960, Shell built a 30m long dam that could store rainwater in a natural basin. These dams are currently still functional and enable two seasonal lakes to exist throughout the majority of the year. Lago Dispersé, located in central Malpais, is the biggest of these two. Shell used the water from these lakes for the cleaning of the machinery, after being pumped up with a now destroyed pumping station. After the departure of Shell company from the island, they sold all their land to the government for a symbolic amount of 1 ANG. On paper, the legal land owner now is Domeinbeheer, which is part of VVRP (F. Dilrosun, Personal Communications, April 2016).

4.1.1 Archeological remnants

Archaeologists discovered the Ruins of an old indigo dye extraction system in the area. Slaves used the natural dye from a plant called the Indigo shimaron (*Indigofera suffruticosa*). This indigo extraction was a very lucrative business for slave drivers because blue coloured dyes were uncommon around that time. Colonists also exploited the salina of Sint Michiel for salt extraction, the remains of these salt pans are still present. Furthermore, on top of the St. Michiel terrace lay the ruins of an old Fort. In the eighteenth century, the Dutch colonists used this fort to defend against attacks from the Spanish naval fleet.

4.2 Climate

Curaçao is a stretched, arid and mainly flat island located close to the coast of Venezuela and is part of the ABC islands. From west to east, it is around 60 kilometres long and 10km wide, with a total area of around 500 square kilometres (CIA, 2013). Due to its shape, Curaçao is always under heavy influence by water from the sea. Moreover, almost all of the precipitation falls during the rainy season that lasts for three months (Meteorological Department Curaçao, 2016).

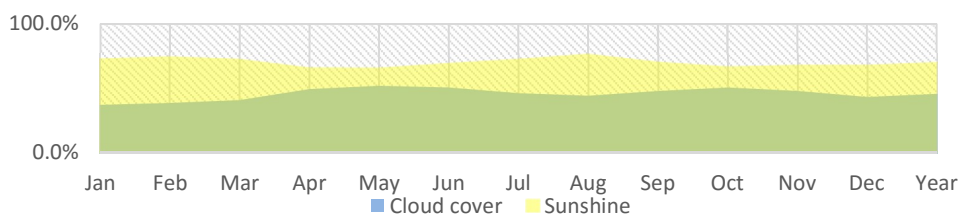


Figure 2 Monthly average percentage of cloud cover and sun hours in Curaçao (data from MDC, 2016)

¹ The information of this paragraph has been assembled through several unstructured conversations with a member from the SUC board (F. Mercelina), a park ranger (C. Hagenaar) and a tour guide (T. Ching) and may therefore contain certain historical inconsistencies. No historical information about the site was found in literature to cross-check the data on validity.

4.2.1 Climate zone

Curaçao, located at 12 degrees north of the equator, has a semi-arid climate (SAT) with both dry and wet seasons. There are no hurricanes throughout the year, as it lies outside of the hurricane belt of the Caribbean. However, some severe tropical storms come by during the rainy season. With just slight climatic characteristic differences in some of the months, the climate is relatively constant throughout the year (Taylor & Alfaro, 2005). Because the island is only small, the same weather conditions apply to all parts of the island.

4.2.2 Rainfall

The precipitation table (Figure 3Error! Reference source not found.) reflects this dry climate: Curaçao has a rainfall total of 550 mm over the year, this is almost half as much as can be expected annually over in most western European countries. However, when the rain falls it is very intense and short, hence the rains has a high impact on erosion and runoff. This high impact especially affects the steeper slopes of the many hills.

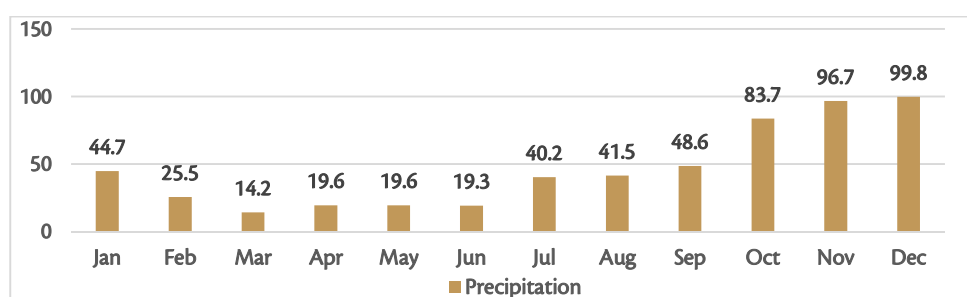


Figure 3 Monthly average precipitation (mm) in Curaçao (data from MDC, 2016)

The runoff of the mean annual precipitation is strongly affected by the evapotranspiration, up to 90% of the total precipitation (Limper, et al., 2016). The trade winds on the island are the main reason for this high evapotranspiration. Research estimates that 10% of the total precipitation consists of run-off water. Next to runoff and evapotranspiration, there are also some underground water flows that both lose and replenish water, although the leftover effect is not substantial (Pors & Nagelkerken, 1998). The wet season with its strong rains, starts in October and stops in December and is responsible for most of the annual precipitation. When looking at the nature and wildlife on the island, the dry climate becomes even more evident.

4.2.3 Temperature

Like the precipitation, the average temperature also stays constant throughout the year (Figure 4), it has an average maximum temperature of slightly over 30 degrees and an average minimum temperature of around 26 degrees (Nagelkerken & Nagelkerken, 2004). Moreover, the monthly variances in temperature are, as a rule, not more than 3 degrees. With an average temperature of 26.5, September is the coldest month; January is the hottest, with an average temperature of 29 degrees. Thus, the temperature is not highly related to the seasons. The high number of sun hours per day (Figure 2), together with the always present trade winds further balance each other creating these consistencies.

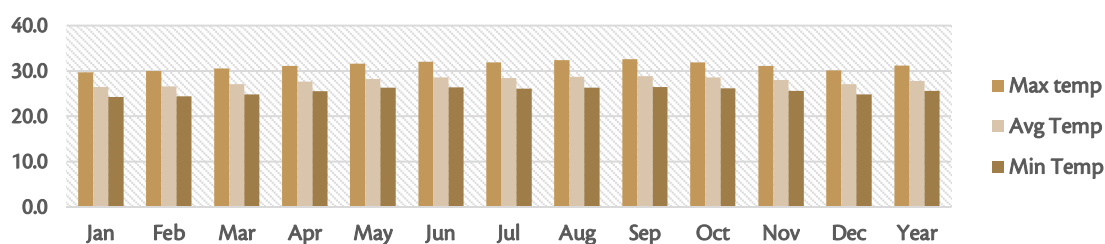


Figure 4 Monthly average, average minimum and average maximum temperature (°C) in Curaçao (data from MDC, 2016).

4.3 Geology

Geological formations are important factors for soil formation and the correlating vegetation types that form on these soils. The parent material contains varying amounts of minerals that weather, this subsequently leads to differences in soil characteristics: fertile/infertile, water holding capacity and texture. These characteristics are, in their turn, are linked to potential and natural vegetation types. Beets (1972) was the first to conduct the classification of these geological formations, Beets also composed the first geological map of Curaçao (see Annex VIII).

In the management area are three major formations. Endogenous magma processes formed two of these formations; together they make up for the largest part underneath the area. The other formation is the limestone formation, mainly concentrated around the coastline. There is also on small formation located in the mid-east, within the landfill site; it belongs to the Knip group (~2 hectares). The paragraphs below give a more detailed description of these major formations; they also include a graphical representation of the composition material of the formations (Figure 5Error! Reference source not found.). This section does not describe the Knip group as it only forms a minuscule part of the total management area.

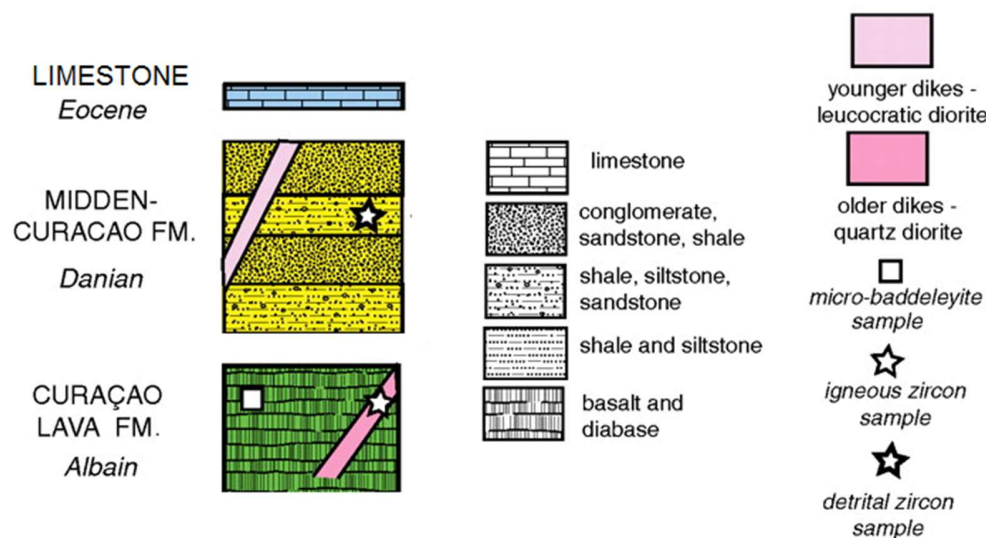


Figure 5 The compositions of all formations in chronological order, starting from top (adapted from Wright and Wild, 2010).

4.3.1 Curacao Lava Formation

Research has shown that this formation can be dated back to 90 million years ago, it stems from the Mesozoic Cretaceous period (Van Buurt et al., 2009). This formation has developed itself into a 5 km thick formation with little intrusions or sedimentation layers present within its interior, probably due to the continual eruptions in a relatively small period. Since gases have little to no opportunity to expand when the pressure difference is too large no vesicular textures that could make it brittle are present. Therefore, it is a very dense and hard formation and also forms the basis on which the other formations lay.

The formation exhibits peculiar pillow shaped forms. They are named pillow shaped because of these typical round crystallised structures present within the formation. The principal behind these pillow shapes is the difference in solidification speeds between the outside and the inside (Diebold, 2009). On the outside, rapid solidification of magma takes place because it comes into contact with the much colder sea water. On the inside, however, the heat is conserved for a much longer period, which allows crystallisation to take place.

The outcrops of the Curaçao Lava Formation are often heavily weathered, due to the presence of groundwater (James, 2007). The outer borders of the pillow shaped structure (the volcanic glass) cannot withstand

groundwater. This weathering process allows the clay to form around these structures, which cause the 'pillows' to start to loosen. Consequently, groundwater can effortlessly come into contact with these loosened parts and exacerbate the weathering even further.

4.3.2 Midden Curaçao Formation

This formation probably came into existence 65 million years ago, at a time where endogenous processes formed pronounced elevation differences on the ocean floor (Van Buurt et al., 2009). These elevation fluctuations on the sea bottom enabled the Midden Curaçao formation to develop. The sedimentary layers of sandstone and shale characterise the formation.

In the Midden Curaçao Formation, gravel, sand and clay first became deposited on the slopes of the higher elevated parts of the ocean floor. Tectonic plate movements could, therefore, easily destabilise these texture deposits. On the lowest parts, the heavier gravel settled, then sand and at last the light clay particles. This process repeated itself in manifold until it hardened under the increasing pressure. In this process, shale turbidites could develop between the layers of sandstone (Noguera et al., 2009). Shale turbidites are sediments that are not transported and deposited by traction and frictional flows, but by density flows instead. These density flows exist due to the rapid changes in flow velocity and variations in pressure because which cause the solid materials to enter an intermediary state where they behave as liquids, but still are non-liquid.

4.3.3 Limestones (Seroe Domi Formation)

Limestones are the youngest formation and consist of the terrace landforms. Most of Curaçao's terraces are not older than 2 million years old, the geological period that these shapes formed are called Pleistocene and Holocene, both are in the Quaternary Period (Fouke, et al., 1996). The development of these structures is a combination of two factors: Tectonics and climate change.

Tectonics that started during the period the Midden Curaçao pushed Curaçao further up and are continue to press the island further up until this day. This land elevation causes the underwater coral reefs that are around the island to dry out and become part of the island. The alterations of interglacial and glacial periods drastically enhance this effect. During the glacial the sea level lowers and during the interglacial the water rises again, the differences in seawater level could range up to tens of meters (Focke, 1978). Consequently, many of the island's terraces formed, the highest ones formed 2 million years ago. The middle-high terraces formed approximately 500.000 years ago and the low terraces formed 30.000 years ago.

4.4 Soil

Soils often correlate with vegetation characteristics. Therefore, it is helpful to get an overview of the different soil types in the management area as soil types will have implications for future landscape designs.

The Grontmij & Sogreah report (1968) – the only soil classification study conducted on Curaçao – divides the soil types into three main groups: Soils on limestone, soils on diabase and the colluvial and alluvial soils as soils form on top of these geological formations. The soil map in the annex shows all soil types that are present in the management area per soil group (Annex X).

4.4.1 Soils on limestone

The soils on limestone formations classify as highly porous, shallow and frequently saline. Their drainage system is different from the non-calcareous formations (De Vries, 2000). Most of these soils are located toward the coast, as can be seen on the soil map (Annex X). The soil types that occur in the study area are rocky and erosional terraces and have shallow profiles with a loamy structure.

Calcification often takes place in these soils, a process that frequently occurs in semi-arid climates because evapotranspiration exceeds precipitation (Gunal & Ransom, 2006). The evaporation causes the dissolved salts present in

the groundwater to accumulate in the top soil. It is most typical for the soils on the limestone formations (because of the high calcium carbonate content), but also occurs – albeit to a lesser extent – on the surface of the other formations.

4.4.2 Soils on diabase

The soils on the Curaçao Lava Formation comprise a significant land cover and are predominantly formed on the undulating landscape as can be seen on the Geomorphological map ([Annex IX](#)). They range from 0.1 to 0.4m thick, which is considered to be very shallow according to the FAO classification. Consequently, these soils classify as Leptosols ([FAO, 2015](#)). In the Ramsar site, these soils also occur around the drainage basins, or ‘roois’.

The brownish-red colour and the sandy, pebbly texture can be attributed to the heavy weather on the surface of these soils, as weathered basalt rocks often display a brownish- red colour because they contain much kaolinite and hematite and only limited montmorillonite content ([De Vries, 2000](#)). In contrast, when they appear as black soils, frequently found in depressions and roois in the landscape, montmorillonite is the dominant mineral, and the minor minerals are kaolinite and hematite. Moreover, these black soils are less influenced by leaching and weathering than the red soils caused by their lower permeability due to the high montmorillonite content ([Beckmann, et al., 1974](#)).

The soils on the Curaçao Lava Formation share many characteristics with the soils laying on the Midden Curaçao Formation (also diabase), these soils are often light to yellow-brown in colour, shallow and consist of fragmented rocks like gravel and stones.

4.4.3 Colluvial and alluvial soils

The most interesting part of the Ramsar site are the colluvial and alluvial soils that are very light textured and have a high water holding capacity. These alluvial and colluvial soils, indicated on the soil map with a green colour ([Annex X](#)), can be found in and around the drainage basins – also called ‘roois’ locally. Since a large area percentage of these soils become temporarily flooded during the rainy season, the soil forming processes are optimal. This results in soils that are much deeper than the other soil types and are either clayey or loamy in texture ([De Vries, 2000](#)). This difference in texture enables plants to grow much more easily, as water can be absorbed efficiently. Hence, a unique green vegetation is present on these soils, in combination with much larger trees than the rest of the area.

Some of these soils would be classified in the FAO taxonomy as Vertisols according to Breteler ([1981](#)), because they often display typical deep cracks in the ground when they dry out. In the Ramsar site, these typical Vertisols occur mainly around the salt pans.

4.5 Vegetation

Stoffers extensively researched the vegetation on Curaçao in the early 20th century. Most of Stoffers’s research focused on plant communities, which he published throughout various monographs between 1950 and 1960. In the late 1990s, Stoffers research was used to complete the first vegetation map of Curaçao, which was created and conducted by Beers et al ([1997](#)). They clustered Stoffer’s plant communities to form new vegetation types and then combined these vegetation types into landscape ecological vegetation units. These units are the same units used on the landscape vegetation map of Malpais/St. Michiel in the Annex ([see Annex II](#)).

Due to time constraints, a vegetation type (instead of a landscape vegetation and vegetation class) map of Malpais/St. Michiel is absent. However, to provide information on species and stand characteristics ([see tables below](#)), the vegetation types (that follow the synoptic tables from the Beers publication) occurring in the area and their corresponding descriptions have been included below.

This section first organises the vegetation classes per landscape type. These classes are further divided into landscape ecological vegetation units, which are subsequently divided into vegetation types. There are four different landscape types with six distinct vegetation classes, listed as:

- Undulating landscape vegetation
 - Mixed evergreen-deciduous Acacia shrublands with succulents
 - Sclerophyllous evergreen woodland
- Terrace vegetation
 - Sclerophyllous woodland and hemisclerophyllous evergreen woodland
 - Mixed evergreen-deciduous thorn woodland
 - Sclerophyllous evergreen woodland
- Salina vegetation
 - Pavement vegetation
 - Tidally flooded perennial forb vegetation
- Escarpment vegetation
 - Sclerophyllous woodland and hemisclerophyllous evergreen woodland

4.5.1 Undulating landscape vegetation

- **Mixed evergreen-deciduous Acacia shrublands with succulents**

- Acacia tortuosa* - *Prosopis* landscape**

- The *Acacia tortuosa* – *Prosopis* landscape is the largest represented vegetation class of the management area. As can be seen on the map (see Annex II), the vegetation class starts from the road and ends just before the beginning of the escarpments in the north. It can be subdivided into two vegetation types:

- *Acacia tortuosa*-*Croton flavens* type (API1)
 - *Acacia tortuosa*-*Prosopis juliflora* type (API2)

These types are very similar in appearance; often impenetrable, thorny and woody and dominated by *A. tortuosa*. However, the API2 type is often found on soils with more moisture content, which is indicated by the differentiating species *P. juliflora*. Furthermore, the API1 type has a better-developed undergrowth, and therefore it also has more species abundance than type API2. The often occurring presence of *Lemairreocereus griseus* in the API1 type indicates that the land was formerly used for agricultural purposes.

- Croton* - *Acacia glauca* landscape**

- Around Mount Pleasant, located in the central right of the management area, the *Croton*-*Acacia glauca* landscape can be found. It can be subdivided into two vegetation types:

- *Acacia tortuosa*-*Acacia glauca* type (CAI1)
 - *Croton flavens*-*Opuntia wentiana* type (CAI2)

The main difference between the two vegetation types is the tree layer density: type CAI1 has a much denser tree layer than the CAI2 type. The CAI1 type is predominantly represented by *A. tortuosa* trees; the CAI2 type is represented by more variable species. The shrub layer of both types is predominantly represented by *Croton flavens* shrubs. What is typical of the CAI2 layer, is the presence of *Aristida adscencionis* in the herb layer next to the dominant *Opuntia wentiana*. In contrast, the CAI1 layer the herb layer is almost completely represented by *Opuntia wentiana*.

- **Sclerophyllous evergreen woodland**

- **Hippomane rooi landscape**

This vegetation class is represented by only one vegetation type: The *Hippomane Mancinella-Opuntia wentiana* type (H10/BAe1). The tree layer is almost a pure *Hippomane mancinella* stand. The understory is very open, mainly represented by *Opuntia wentiana* with some seedlings of various species that germinate in the litter, but often do not make it past the first phase.

Table 3 Overview of the dominant species in the undulating landscape

Dominant species (layer)	Differentiating species	Layers	Height (m)	Species (#)	Cover (%)	pH
Acacia tortuosa - Prosopis landscape						
Acacia tortuosa - Prosopis juliflora type						
Acacia tortuosa (tree)	N/A	Multi-layered	0.4 - 4	4-29	25-90	6
Cordia curassavica (shrub)						
Croton flavens (shrub)						
Jatropha gossypifolia (shrub)						
Opuntia wentiana (herb)						
Prosopis juliflora-Opuntia wentiana type						
Acacia tortuosa (tree)	Prosopis juliflora (tree)	Tree layer	1.5-3	10-17	45-90	5
Cereus repandus (tree)	Capparis odoratissima	Herb layer (sparse)				
Opuntia wentiana (herb)	(tree)					
Cyperus confertus (herb)						
Croton - Acacia glauca landscape						
Acacia Tortuosa - Acacia glauca type						
Croton flavens (shrub)	Randia aculeata (tree)	Tree layer (sparse)	0.4-4	6-22	10-70	6.5
Opuntia wentiana (herb)	Phyllanthus botryanthus (tree)	Shrub layer				
	Bursera spp. (tree)	Herb layer				
Croton flavens-Opuntia wentiana type						
Acacia tortuosa (tree)	N/A	Multi-layered	1-2.5	9-23	30-75	6
Acacia glauca (shrub)						
Croton flavens (shrub)						
Hippomane rooi landscape						
Hippomane Mancinella-Opuntia wentiana type						
Hippomane Mancinella (tree)	N/A	Tree layer	1.5 - 15	3 - 38	40 - 100	7
Opuntia wentiana (herb)		Herb layer (sparse)				

4.5.2 Terrace vegetation

- **Sclerophyllous woodland and hemisclerophyllous evergreen woodland**

- **Coccoloba - Erithalis terrace**

Around the salina the Coccoloba-Erithalis terrace can be found in small patches. These patches often occur on very hard limestone rocks where roots grow into the eroded holes. It exists only out of the Coccoloba swartzii-Erithalis fruticosa type (CEt0). It is a relatively well-developed vegetation with a wide range of species. Only the herb layer cover is relatively sparse. Two evergreen species are differentiating species, namely *Erithalis fruticosa* and *Antirhea acutata*.

- **Mixed evergreen-deciduous thorn woodland**

- **Croton - Acacia tortuosa terrace**

A large part of the higher terraces in the northeast of the management area belongs to the Croton - Acacia tortuosa terrace. Also in the area of Vaersenbaai, this landscape vegetation is largely represented. The vegetation

only has one type, namely the *Acacia tortuosa*-*Croton flavens* type (APt1), which also occurs on the undulating landscapes as AP1 and has been mentioned above. The vegetation is characterised by relatively dense, mostly impenetrable, thorny low trees of *A. tortuosa*. The difference between the type AP1 that occurs on terraces is the over-dominancy of *A. tortuosa* trees over the other occurring species in the tree layer.

Haematoxylon - Bourreria terrace

The Haematoxylon-Bourreria terraces can be found on the St. Michiel Saliña and close to the coastlines of Von Pesjbaai and Boca Uniko, and it occurs mainly on the most eroded terraces that are slightly dipping. The vegetation is predominantly of the Haematoxylon Brasileto type (HBt0) with a relatively dense tree cover. This type can have large fluctuations in species composition, but in the tree layer *Haematoxylon brasiletto* and in the shrub layer *Croton flavens* are very dominant. In the shrub layer, *Lantana camara* is also often well-represented.

■ **Sclerophyllous evergreen woodland**

Haematoxylon - Rhynchosia terrace

The Haematoxylon-Rhynchosia terraces are located at Boca Sami, bordering the St. Michiel hypersaline lagoon in the south. It is predominantly of the *Aristida Adscensionis*-*Tephrosia Cinera* type (HRt0). The sparse and low herb layer in combination with scattered large trees (mainly *Acacia tortuosa*) is characteristic of this vegetation type. The herb layer is dominated by *Aristida adscensionis* and *Tephrosia cinera*.

Table 4 Overview of the dominant species in the terrace vegetation

Dominant species (layer)	Differentiating species	Layers	Height (m)	Species (#)	Cover (%)	pH
Coccoloba - Erithalis terrace						
Coccoloba swartzii-Erithalis fruticosa type						
Coccoloba swartzii (tree)	Erithalis fruticosa (tree)	Tree layer	0.7 -3	12-29	20-70	7.5
Haematoxylon brasiletto (tree)	Antirhea acutata (tree)	Shrub layer				
Cordia curassavica (shrub)		Herb layer				
Croton flavens (shrub)		(sparse)				
Jatropha gossypiiifolia (shrub)						
Lantana camara (shrub)						
Croton - Acacia tortuosa terrace						
Acacia tortuosa-Croton flavens type						
Acacia tortuosa (tree)	N/A	Multi-layered	0.4 - 4	4-29	25-90	6
Cordia curassavica (shrub)						
Croton flavens (shrub)						
Jatropha gossypiiifolia (shrub)						
Opuntia wentiana (herb)						
Haematoxylon - Bourreria terrace						
Haematoxylon Brasileto type						
Haematoxylon brasiletto (tree)	N/A	Tree layer	0.7 - 4	9-40	15-95	6/7.5
Croton flavens (shrub)		Shrub layer				
Lantana camara (shrub)						
Haematoxylon - Rhynchosia terrace						
Aristidia Adscensionis – Tephrosia Cinera type						
Aristida adscencionis (herb)	Polygala monticola (herb)	Shrub layer	0.1 - 1	?	10-60	7/8
Tephrosia cinera (herb)						

4.5.3 **Saliña vegetation**

■ **Pavement vegetation**

Conocarpus saliña

On drier places north of the St. Michiel hypersaline lagoon, just before Mount Pleasant, the *Conocarpus salina* can be found. Its vegetation type consists solely out of the *Conocarpus erecta* - *Hippomane mancinella* type (Cs0). *Conocarpus erecta* and *Hippomane mancinella* are quite common, especially in and around the gullies (roois). Depending on the wind, the *Hippomane mancinella* trees can reach heights of up to 8 meters, but the cover will always be low (<60%). The undergrowth is very sparse, mainly consisting of *Sporobolus pyramidatus* and *Sesuvium portulacastrum*, often with only a few tree seedlings. The vegetation type can locally have up to 17 species, but more often the species composition is very limited (<5 species).

▪ Tidally flooded perennial forb vegetation

Sesuvium salina

The *Sesuvium salina*s occur in the lower central part of the salt flats around the St. Michiel hypersaline lagoon. Directly around the lagoon, it can form a dense vegetation of the *Sesuvium Portulacastrum-Heliotropium curassavicum* type (Ss0). Its appearance is characterised by a flat, and mainly barren land and the vegetation only grows on the land that temporarily floods. Its cover can vary highly, up to 90%, although this not often the case. The species *Salicornia perennis*, *Batis maritima* and *Sporobolus virginicus* are also regularly present but never dominant.

Table 5 Overview of the dominant species in the *salina* vegetation

Dominant species (layer)	Differentiating species	Layers	Height (m)	Species (#)	Cover (%)	pH
Conocarpus salina						
Conocarpus erecta - Hippomane mancinella type						
Conocarpus erecta (tree)	N/A	Tree layer	1.5-8	1-17	25-60	8
Hippomane mancinella (tree)						
Sesuvium salina						
Sesuvium Portulacastrum-Heliotropium curassavicum type						
Sesuvium portulacastrum (herb)	Heliotropium curassavicum (herb)	Herb layer	0.05-0.8	1-7	15-90	8

4.5.4 Escarpment vegetation

▪ Sclerophyllous woodland and hemisclerophyllous evergreen woodland

Bouyeria - Acacia tortuosa escarpment

This is the most variable landscape vegetation class in the management area and occurs only on the steep escarpments in the north-west of Malpais and in small parts in the transition zones of terraces and *salinas* on the west of the hypersaline lagoon of St. Michiel. It is a complex between interweaving vegetation types and is, therefore, unique. However, two vegetation types are more dominant than the others.

- *Hippomane Mancinella-Opuntia wentiana* type (BAe1/ H10)
- *Bouyeria succulenta-Phyllanthus botryanthus* type (BAe2)

The BAe1 type is completely similar to the H10 type that occurs on the undulating landscapes. The tree layer is almost a pure *Hippomane mancinella* stand. The understory is very open, mainly represented by *Opuntia wentiana* with some seedlings of various species that germinate in the litter, but often do not make it past the first phase.

The BAe2 type is a moderately dense multi-layered vegetation, with the dominance of *Bouyeria succulenta* and *Phyllanthus botryanthus* in the tree layer. Nonetheless, many other species may be present in the tree layer, such as *Randia aculeata*, *Caesalpinia coriaria*, *Acacia tortuosa*, *Bursera bonariensis* and *B. tomentosa*. The lower shrub layer

is very variable and represented by *Croton flavens*, *Cordia globosa* and *Tournefortia volubilis*. *Opuntia wentiana* is the dominant species in the herb layer.

Table 6 Overview of the dominant species in the escarpment vegetation

Dominant species (layer)	Differentiating species	Layers	Height (m)	Species (#)	Cover (%)	pH
Bourreria - Acacia tortuosa escarpment						
Hippomane Mancinella-Opuntia wentiana type						
Hippomane Mancinella (tree)	N/A	Tree layer	1.5 - 15	3 - 38	40 - 100	7
Opuntia wentiana (herb)		Herb layer (sparse)				
Bourreria succulenta-Phyllanthus botryanthus type						
Bourreria succulenta (tree)	N/A	Multi-layered	1.5 - 6	9 - 40	25 - 85	6/7
Phyllanthus botryanthus (tree)						
Opuntia wentiana (herb)						

4.6 Fauna

This section describes most fauna species that give the site a high ecological value. Most of these species, especially the bird species, are related highly to the Ramsar criteria and are thus essential for the status of the site. This section has been subdivided into three categories:

- Birds
- Mammals
- Fish.

4.6.1 Important birds

The freshwater lakes in Malpais support a population ranging from 200 to 400 Caribbean coots (*Fulica caribaea*); the Caribbean coot also breeds (Table 7) around these freshwater lakes (Vermij & Chamberland, 2012). However, the conservation status of the Caribbean coot has been a reason for dispute. Despite efforts of other scientists, IUCN lumps the species with the American coot (*F. Americana*) and now has the status of least importance (Nijman, 2010). This can undermine the breeding range of the Caribbean coot.

The hypersaline lagoon in St. Michiel supports a significant fraction of the Caribbean population of the Common tern (*Sterna hirundo*). Debrot and Wells state that at least 15 pairs of nesting Common terns are present in the area every year (Debrot & Wells, 2008). The nesting terns are located on the far west side of the lagoon, away from the most intensive disturbance related to recreational activities (Vermij & Chamberland, 2012). The saline lagoon of Sint Michiel also represents an important foraging area for the Caribbean flamingo (*Phoenicopterus ruber*), especially during the dry season when the larger wetlands of Venezuela run dry (Vermij & Chamberland, 2012).

Table 7 Commonly observed waterbird species and their breeding behaviour around the seasonal freshwater lakes in Malpais.

Species	Breeding Behaviour
Green Heron	Breeds all year round
Caribbean Coot	All year round, peak during April
White-cheeked pintail	Peak in March
Common moorhen	During the rainy season
Pied-billed grebe	Only breeds after a period of extensive rainfall
Black-Bellied Whistling Duck	Doesn't breed on Curaçao.
Brown booby	Doesn't breed on Curaçao

From Voous's book (1983) on Antillean birds

The scrubland is important for the endemic Caribbean elaenia (*Elaenia martinica*) and the Bare-eyed pigeon (*Patagioenas corensis*) that only occurs in the northern parts of South America. The Bare-eyes pigeons have a population of 600. The population is located on the lower side of the Malpais dam. This area also supports more than 160 Brown-throated parakeets (*Aratinga pertinax*). (Debrot & Wells, 2008)

The limestone cliffs are important nesting areas for the rare endemic Curaçao Barn Owl (*Tyto alba*) (Debrot, et al. 2001). The Yellow-billed Cuckoo (*Coccyzus americanus*) and the Scaly-napped Pigeon (*Patagioenas squamosa*) are also common in this area (GMN, 2014).

4.6.2 Mammals

Around the freshwater lakes, the endemic White-tailed deer (*Odocoileus virginianus curassavicus*) population resides. The current population size on Curaçao is estimated at a few hundred animals, of which most are living in Christoffelpark (GMN, 2014). An aerial survey conducted in 1983 estimated the Malpais subpopulation at approximately 20-30 animals (Vermij & Chamberland, 2012). The catchment basin is on the few sources of freshwater for the deer of Malpais and therefore plays a critical role in their survival (Debrot & De Freitas, 1991).

The basic field inventory showed that the area also has a high local Cotton-tail hare (*Floridensis nigronuchalis nigronuchalis*) population, especially in and around the scrubland. The Cotton-tail hare is an endemic species to Curaçao.

The high limestone terraces offer holes and cracks where bats. The seasonal lake attracts many insects and thus is a good foraging site for the bats, and it suggested that they even might control the abundance of certain pests such as mosquitoes (Petit, 1996). Some bats also fulfil important pollination functions for several species of cacti (Petit, 1995).

4.6.3 Fish

Although the lake almost completely dries up in the dry season, there are always fish present. Currently, it is not clear whether these fish survive all year round or get deposited by the migratory waterbirds that visit the area. Little to no research has been done to assess the different type of fish species and their population. What is known, however, is that the most important fish is the restricted-range freshwater Molly fish (*Poecilia vandepolli*)

4.7 Ecosystem services

Every ecosystem has important values for humans because every ecosystem offers a whole range of useful services. This section gives an overview of the ecosystem services present within the wetland. This section divides the services into the standard groups (conform Gómez-Baggethun, et al. 2009):

- Regulating services
- Provisioning services
- Cultural services
- Supporting services

4.7.1 Regulating services

Water management

The dam at the freshwater lake lets the basin Lago Dispersé slowly fill. The undulating landscape in Malpais leads rainwater to the basin, which prevents damage caused by seasonal flooding. The Boca at St. Michiel stabilises the influence of the tides. The opening to the sea is very small and the lagoon is very shallow, this decreases the energy of the waves and distributes the water evenly. The forest around the Lago Dispersé has another important function: Stabilising the groundwater table. The roots of the trees hold water effectively as the trees try to distribute this water evenly throughout the dry season. Furthermore, the coral reefs along the coastline offer protection

against storms and erosion, because of their wave energy reducing factor (Moberg & Folke, 1999). The capacity of coral reefs to disperse wave energy also creates and regulates lagoons, e.g. St. Michiel lagoon (Ogden, 1988, as cited in Moberg et Folke, 1999).

Climate

Throughout Curaçao there are not many forested areas, only a few patches of forest still exist on the island and in Malpais there is a large patch of forest present. The trees are important in regulating both microclimates and macro climate. The trees can enrich positive environmental variables by decreasing solar radiation from heating surfaces, cooling the air by evapotranspiration, and reducing wind speed (Georgie & Zafiriadis, 2006). Tree patches also form a contribution to macro climate as the trees around the Lago Dispersé in Malpais are likely to store high amounts of carbon because they are hardwood species. However, throughout the rest of the area, there are mainly scrubs and small trees.

4.7.2 Provisioning

Freshwater

The freshwater lake provides water for many bird species and also for the white-tailed deer. It used to be a source of water used to clean the machinery of the shell refinery.

Charcoal

Several trees do not survive due to the long dry period. Therefore, the large dead tree branches in the area can be collected and used for charcoal burning. The revenue obtained from this charcoal can be used to cover the costs.

4.7.3 Cultural

Education

SUC often facilitates activities for school children; often done in an educative way. The Ramsar site offers a unique opportunity for children to learn about many different aspects. These aspects include both natural and cultural aspects. Natural aspects include the unique vegetation, water regulation and fauna and the environmental impact of littering. Cultural aspects include an old fortress and other heritage of the colonial area such as old slave remnants.

Aesthetic

The aesthetic ecosystem service is defined by the sensory experiences an individual undergoes while in nature. These experiences can range from the smell of vegetation to the sight of a big tree. These are primary reasons visitors use as a motive to visit a nature area or park. Although the aesthetic service is intangible, it is thus very important for the use of the Ramsar site. Moreover, the aesthetic value is very changeable as an understanding of an area can increase certain aspects, e.g. a wetland might look unpleasant to observant who do not see the functions it fulfils.

Recreation

With the success of the previous Curaçao Hiking Guide, the hiking tourism has been increasing in Curaçao. This is evident from the successful trade of this guide. This means that more hikers come and visit the areas. Since the designation of the area as a Ramsar site, the area offers an interesting choice for hikers and other visitors, such as mountain bikers and campers. However, with the current problems the recreation is restricted.

4.7.4 Supporting

Biodiversity and habitats

The several available habitats in the Ramsar site offer refuge sites for important and rare species. The St. Michiel salina in combination with the seasonal freshwater lake of Malpais is a unique combination that offers a diverse

mosaic of habitat types that are used by several species. For waterbirds, this mosaic is important as many also breed here.

Soil formation

Although soil formation is a long-term process, it can be very important to support new forest areas. If the soil develops, it can hold rainfall better, and vegetation has the opportunity to be more successful. Therefore, more forest will develop.

5 STAKEHOLDER ANALYSIS

Four identified stakeholder groups have a relation to the Ramsar Site: local residents, tourists, organisations and the government. These four stakeholder groups consist of different subclasses; these are called the specific stakeholders (see Figure 6).

The following paragraphs describe the major stakeholder groups and their most prominent specific stakeholders; the annex contains a description of all identified specific stakeholders (Annex V). This stakeholder analysis also includes a graphical representation of the interrelations between the most prominent stakeholders in the form of an influence Chord Diagram (Figure 7).

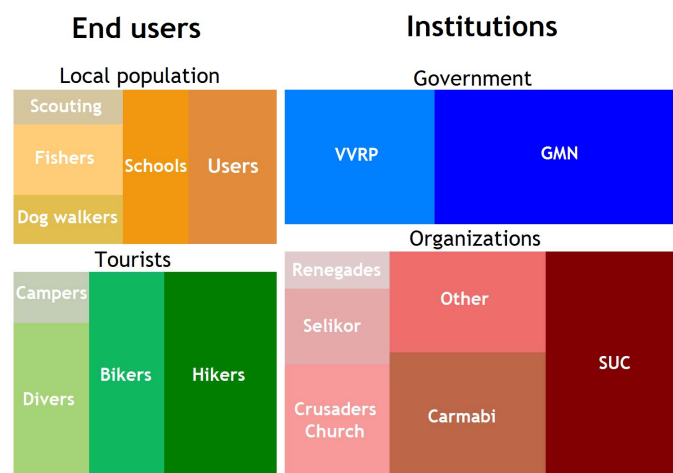


Figure 6 Treemap of stakeholder groups. Subdivisions of the major stakeholder groups into the specific stakeholders. Area size is proportional to the importance of the specific stakeholder.

5.1 End users

5.1.1 Local population

SUC's mission states that local residents are the most central group to SUC, it, therefore, forms a distinct stakeholder group. Users, schools and fishers are key stakeholders in this group. This group has an emphasis on schools/children because SUC hosts several projects for children because they form the next generation of Curaçao. Although various children are members of the scouts, collaboration with the scouts has not been very active in the last couple of years (T. Ching, Personal communication, April 2016).

▪ (Illegitimate) Users

Poverty in Curaçao is often related to opportunistic delinquencies and therefore robberies sometimes take place, especially vehicle burglary is a frequently reported issue (T. Ching, Personal communication, April 2016). Other criminal activities that take place within the area: Poaching, vandalism, waste dumping, (illegal) land claims and drug deals. Waste dumping is not limited to household waste, some visitors also dump dead dogs in crates or boxes. Not only is this a visually dissatisfying sight, but it also causes a penetrating odour due to the rotting process. Due to illegal activities, other stakeholders can feel threatened and unsafe and therefore this group has the biggest (negative) impact on the other stakeholders.

- **Schools**

SUC invites schools on a regular basis to visit the nature areas so a tour guide can teach the children about nature and its importance. Children form an important group because they are part of the future population. Hence, if SUC includes children in their management activities (e.g. organised clean-ups) they can positively transform the mentality of the future population.

5.1.2 Tourists

SUC relies heavily on the touristic sector because tourists allow them to carry out their projects. For example, many foreign volunteers come to the island to help conserve nature and spread awareness. Moreover, from revenue made from the sale of tours and products such as the Curaçao Hiking Map, the parks are maintained. Hence, SUC needs to take the needs and wishes of these tourists into consideration.²

As can be seen in the Chord Diagram (Figure 7), SUC does not have much influence on bikers and divers. Therefore, the relation to this group should be improved.

- **Hikers**

SUC has had success selling their renowned Curaçao Hiking Map and gained a large revenue of the vending of these maps. Hiking routes were not well-known before the construction of this map and therefore hikers form a valuable asset for SUC. Consequently, they form the largest subgroup of the Tourist stakeholder group. However, a large part of this group's composition is of foreign origin. SUC wants to increase the percentage of local residents representing this stakeholder. Currently, the local population has little to no experience in this type of recreation and still needs to 'learn' how to hike (T. Van der Giessen, Personal communication, April 2016).

- **Mountain bikers**

The Ramsar site is also popular among mountain bikers. These bikers visit the area by car and unload their bicycles at the entrance to ride through the area because there are no cycling roads in Curaçao. SUC has not established official mountain bike routes. Hence, the bikers often combine several hiking trails to navigate through the area. Furthermore, mountain bike events are hosted annually in Curaçao where larger groups of bikers meet to race each other competitively. These events have a negative environmental impact because they are not well-regulated.

- **Divers**

Divers are a potentially growing stakeholder within the tourist group. Although Vaersenbaai and Von Pesjbaai offer healthy coastlines for divers with clear water and a large coral reef, divers do not form a significant part of the tourist stakeholder group. The reason is that there is no diving school located within a close distance to the Von Pesjbaai and the hard to reach coastline – due to the installed boom barrier at the entrance. Currently, most divers are visiting the coastline of these bays either individually or in small groups. Both local residents and foreign tourists fall under this group and thus overlap. Foreigners still form the majority of divers in the area.

² Take into account that the group tourists has a large overlap with the local residents group, as local residents can also be tourists.

Table 8 Overview of needs and effects on End Users

Main Stakeholder	Interests What is important to the stakeholder?	Impact How much does the management project impact them? (negative/positive)	Contribute How could the stakeholder contribute to the project?	Strategy How could SUC improve the behaviour of the stakeholder?
<i>Illegitimate users</i>	<ul style="list-style-type: none"> ▪ Dumping ▪ Poaching ▪ Land claims 	High (-)	By ceasing their illegal activities	<ul style="list-style-type: none"> ▪ More security ▪ Increase social control ▪ Place more regulation signs
<i>Schools</i>	<ul style="list-style-type: none"> ▪ Learn about nature ▪ Field experience 	Medium (+)	By increasing awareness nature, conservation support will increase	<ul style="list-style-type: none"> ▪ Develop educational programs for field excursions
<i>Hikers</i>	<ul style="list-style-type: none"> ▪ Clean and well-maintained paths and routes ▪ Information about the hiking routes ▪ Safety 	High (+)	By recreating responsibly and help to remove litter from others	<ul style="list-style-type: none"> ▪ Provide information about nature/hiking routes ▪ Keeping area clean ▪ Informing them about responsible hiking
<i>Mountain bikers</i>	<ul style="list-style-type: none"> ▪ Clean and well-maintained paths and routes ▪ Safety 	High (+)	By staying on the trails and mitigate harmful impact	<ul style="list-style-type: none"> ▪ Informing them about responsible biking ▪ Keeping area clean
<i>Divers</i>	<ul style="list-style-type: none"> ▪ Accessibility ▪ Safety ▪ Healthy coral reef 	Medium (+)	By following the sustainable diving guidelines (e.g. not touching the coral, no 'souvenirs', proper equipment)	<ul style="list-style-type: none"> ▪ Place sustainable diving information signs ▪ Inform and engage local dive schools

5.2 Institutions

5.2.1 Government

The government have two important responsibilities regarding nature conservation: Law and enforcement. Different ministries regulate nature conservation in Curaçao: The nature policies and designation of Ramsar sites is the responsibility of GMN; the Ministry of Traffic, Transport and Spatial Planning (VVRP) is responsible for land ownership and gives out development permits. The section on policies and regulations ([Section 6](#)), gives a more detailed description of the different laws that apply to nature conservation areas, such as the Ramsar site Malpais/St. Michiel.

- **Ministry of Health, Environment and Nature (GMN)**

The Ministry of Health, Environment and Nature (GMN) is the official body responsible for the management of the Ramsar site. Unfortunately, they do not have the capacity to implement the policies and guidelines to secure or improve the wise use of a Ramsar site. Consequently, GMN contracts other organisations to carry out the management activities for them – e.g. SUC, Carmabi. Furthermore, even though GMN has the responsibility for the sustainable management of the wetland, they are not the legal owners of the area. The Ministry of Traffic, Transport and Spatial Planning (VVRP) is. This legal ownership turns out to be a major limitation in the effective management of the site ([see Section 7](#)).

- **Ministry of Traffic, Transport and Spatial Planning (VVRP)**

VVRP is the ministry that has the customary land ownership. Before the eighties, the multinational Royal Dutch Shell company was the legal landowner of the area. After the departure of Shell company from the island, they sold all their land to the government for a symbolic amount of 1 ANG. On paper, the legal land owner now is Domeinbeheer, which is part of VVRP. The governmental service Spatial Planning and Development (ROP) falls under the VVRP ministry and is the official body for responsible law enforcement.

5.2.2 Organizations

As can be seen on the Ramsar area overview map ([Annex VII](#)), a large part of the site falls within the management of SUC. SUC has the biggest overlap with all the other stakeholders within the Ramsar site and has taken responsibility by keeping the area clean and visitable for over 15 years. Several other organisations also fall into this group, such as tour operators and other NGOs.

- **Stichting Uniek Curaçao**

SUC has the biggest overlap with all stakeholders. Foremost, SUC has a maintenance contract with GMN to manage the area. Important regular activities are keeping the area clean and maintaining the paths. Irregular activities mainly include placing facilities, such as recycling bins, picnic tables and stairs, and the restoration of facilities destroyed by vandals and/or storms. SUC is also a central organ in the hosting of tours and events.

- **Carmabi**

Carmabi, established in 1955, is a research station located in the North-West of the island. Carmabi has had a major role in the designation of the Ramsar site Malpais/St Michiel because they assisted in the collection of the necessary data necessary for its recognition as Ramsar site (([CARMABI, 2012](#)). Carmabi primarily has an advisory responsibility regarding nature management ([P. Stokkermans, Personal Communication, May 2016](#)). Their broad network also offers many valuable contacts.

- **Selikor**

Selikor is the organisation that runs the landfill (in operation since 1985) in the north-west of Malpais. It is the island's biggest waste management organisation. Selikor has an enormous impact on the Ramsar site: throughout Malpais the sounds of the trucks that dispose of their waste are very noticeable, and smoke plumes from the incineration process are clearly visible. These factors disturb the recreational experience and impact the fauna present in the area.

- **Crusaders Church**

The Crusader's Church is a church located in the south-east of Malpais. It forms a community of religious members and has been in the area before Royal Dutch Shell's land donation. During the Shell period, the owner of the church had a contract with Shell for a small part of Malpais. When Shell sold their land to the government, the contract was automatically destroyed. However, the church still sees this previously contracted land as their property up to this day and has written a master plan to transform the area into an agricultural land because of the moist soil conditions ([Constansia-Kook, 2014](#)). This masterplan is in direct contraposition with its designation as a nature conservation site in 1995.

Table 9 Overview of needs and effects on Institutions

Main Stakeholder	Interests What is important to the stakeholder?	Impact How much does the management project impact them? (negative/positive)	Contribute How could the stakeholder contribute to the project?	Strategy How could SUC improve the behaviour of the stakeholder?
<i>GMN</i>	<ul style="list-style-type: none"> Improve sustainable nature management Improve nature policies and regulations 	Medium (+)	<ul style="list-style-type: none"> Increase budget for nature conservation Increase monitor capacity Adopt policies and regulations in correspondence with the Ramsar guidelines 	<ul style="list-style-type: none"> Improve contact with the minister to increase awareness and gain support for nature management Develop and renew management contracts
<i>VVRP</i>	<ul style="list-style-type: none"> Enforce current laws and regulations Spatial Planning and land ownership 	Low (+/-)	<ul style="list-style-type: none"> Provide more cooperation with GMN and nature organisations Increase transparency to demonstrate objectivity 	<ul style="list-style-type: none"> Demonstrate the urgency and relevance of active nature management within the area (e.g. management plan, media exposure) Increase nature lobby for spatial planning
<i>Carmabi</i>	<ul style="list-style-type: none"> Increase research opportunities Increase (governmental) support for sustainable nature 	High (+)	<ul style="list-style-type: none"> Carry out environmental assessments Monitor several bio-indicators Lobby with the Government 	<ul style="list-style-type: none"> Invite and engage them to conduct research Improve contact and raise awareness
<i>Selikor</i>	<ul style="list-style-type: none"> Waste management Profitability 	High (-) ¹	<ul style="list-style-type: none"> Offer to transport and manage waste the nature area Build sound blocking screens/walls 	<ul style="list-style-type: none"> Increase corporate responsibility (e.g. address situation in local newspaper)
<i>Crusaders Church</i>	<ul style="list-style-type: none"> Exploit the area for agricultural use Decrease visitors around their proclaimed land 	High (-) ²	<ul style="list-style-type: none"> Cooperate with the new management plan Cease with violent behaviour toward visitors 	<ul style="list-style-type: none"> Increase communication by identifying wishes and needs Assign an advisory role by listening to their wishes and needs

¹ If an environmental impact assessment indicates pollution from the Selikor Facility, the pressure on Selikor will increase.

² Agricultural exploitations are in direct contradiction with the spatial planning map as established by the EOP (see Section 6).

5.3 Stakeholder Chord Diagram

It is important to identify the influences between the different stakeholders so that (future) conflicts can be resolved or avoided. These influences often provide meaningful insights and can provide a proper perspective on how to tackle the problems. The chord diagram below maps out these influences (see Figure 7).

A white ribbon indicates that the segment stakeholder is *influenced by* a different stakeholder (corresponding to the chord colour); coloured ribbons indicate the segment stakeholder has an *influence on* other stakeholders (corresponding to the ribbon colour). The chord thickness indicates the degree of influence, thus showing both negative as well as positive influence.

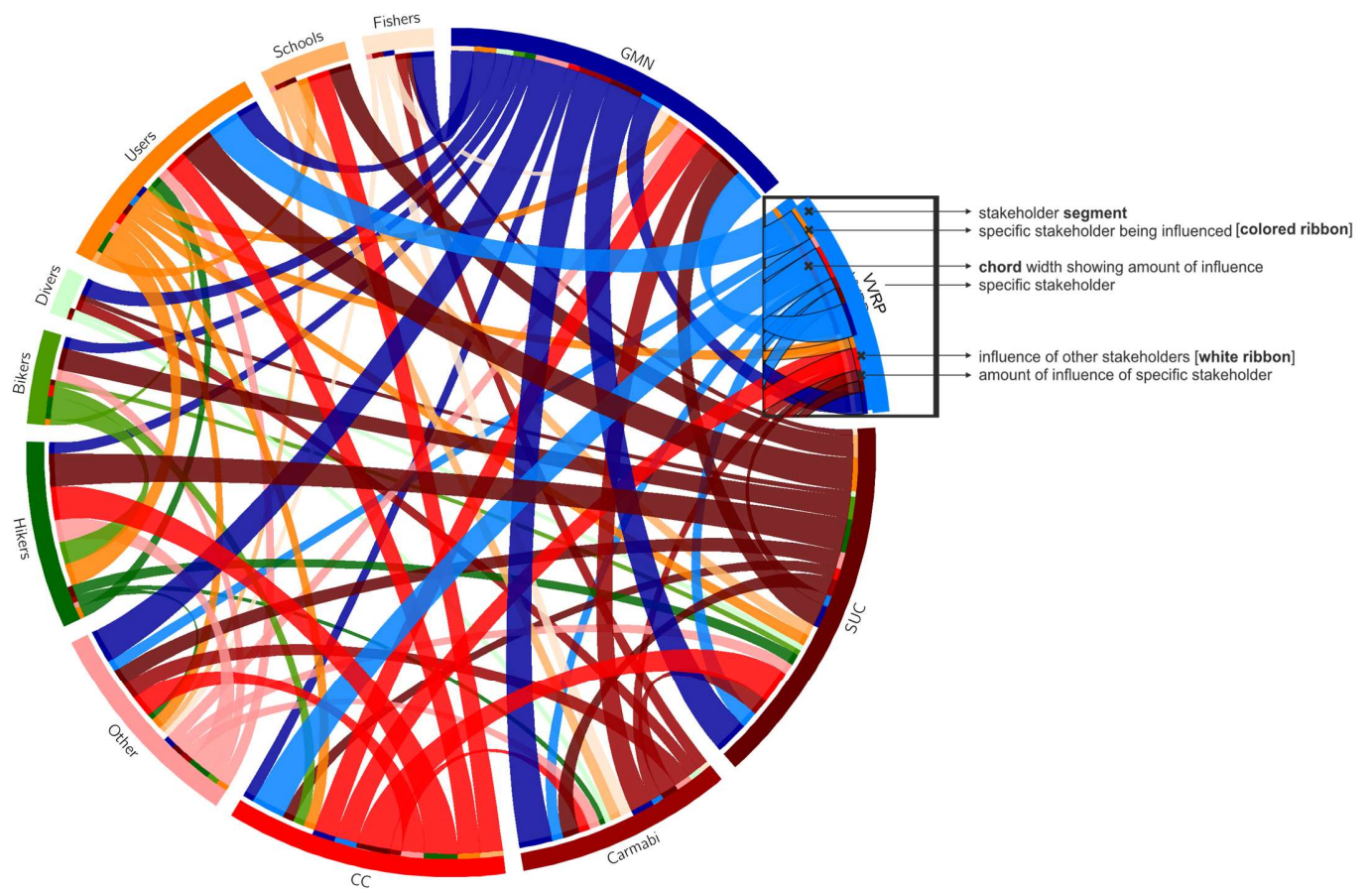


Figure 7 Circular stakeholder chord diagram

Illustrates the influence/impact stakeholders have on other stakeholders and vice versa. Abbreviations used: SUC, Stichting Uniek Curaçao; GMN, Ministry of Health, Environment and Nature; VVRP, Ministry of Traffic, Transport and Spatial Planning; CC, Crusaders Church.

6 POLICIES AND REGULATIONS

6.1 National Policies

6.1.1 Development Planning Ordinance (EROC)

Since October 10 2010, Curaçao is an autonomous constituent country within the Kingdom of The Netherlands, just like Aruba (1986) and Sint Maarten (2010) ([Ministry of Justice of The Netherlands, 2010](#)). Before this date, it was part of the island groups that together formed the Netherlands Antilles directed by a designated Island's Council. In 1976, this Island Council established the fundamentals for a development plan for The Netherlands Antilles ([Island Council Curaçao, 1980](#)).

Every single Island Territory of the Netherlands Antilles translated these fundamentals into their own development plan. Curaçao established its own plan called the "Eilandsverordening Ruimtelijke Ontwikkelingsplanning Curaçao (EROC) [Island Ordinance Spatial Development Planning]" ([Island Council Curaçao, 1980](#)). This EROC is the referential body where other ordinances, plans and regulations have been derived from ([Lakerveld, 2016](#)). The EROC provides a framework that describes many different procedures: Allocation plans, development permits, decision making, conflict resolution and more.

6.1.2 Spatial Development Plan (EOP)

In 1995, derived from the EROC, the development of a comprehensive zoning plan of Curaçao was completed, named the "Eilandelijk Ontwikkelingsplan (EOP) [Island Spatial Zoning Plan]" ([DROV, 1995](#)). This EOP puts the emphasis on land use by providing maps, gives a description of the different zones and puts forth some case studies for clarification.

The EOP has two main goals:

- 1) Conservation of valuable assets, ranging from economic and cultural to natural; prevent (unnecessary) conflicts and limit construction costs of (new) facilities.
- 2) The improvement of Willemstad [capital of Curaçao] as an urban zone where people can live and work and the development of the natural environment where people can unwind and enjoy themselves.

It is important to note that the EOP tries to limit the further expansion of the urban landscape. However, when comparing the island's zoning map with the topographical map of Curaçao (not included), it becomes evident that the urban expansion zone cannot expand further anymore. Thus, while this urban limitation seems promising, industry and economy are often considered too important to the government – probably due to the relatively high poverty rate of the island ([CBS Curaçao, 2016](#)). Hence, designated conservancy areas have a lower priority and are sometimes only conservation areas on paper, because there is little to no money for (proper) nature management.

The designated conservancy zones are very strict regarding the construction of (new) structures, further development of the area and even the carrying out of some management activities. This strictness partly has to do with the fact that the approach toward nature conservation is very conservative; a passive attitude is considered to be the preferred choice ([T. Van der Giessen, Personal communication, April 2016](#)). The problem analysis ([Section 6](#)) explores the impact of this outmoded approach towards nature conservation into greater detail.

■ Development permit

Due to the strict attitude toward nature conservation areas, many activities require a development permit. Examples include the construction of roads and paths, excavations or activities that affect the water table ([Island Council Curaçao, 1980](#)). Note that a development permit does not include the construction of any building. The

construction of buildings requires a building permit. The EROC defines a building as constructions made of wood, stone, metal or of other materials that are attached to the ground, both indirectly or directly.

If SUC wants to carry out more rigorous management activities, a development permit will be required. The designation as Ramsar site emphasises this requirement. Nevertheless, other options are still available such as the consultation of the Minister of Traffic, Transport and Spatial Planning (VVRP). The minister can ratify SUC in special cases so that no additional permit is needed (Lakerveld, 2016). As this management plan can help to clarify certain choices and states the scheduled activities for the future (Section 0Error! Reference source not found.), this route is preferred.

6.2 International Conventions

6.2.1 Ramsar Convention

In 1971 an international meeting on the conservation and management wetlands was held in Ramsar, Iran. This sitting led to the development of a treaty called the 'Ramsar Convention,' named after the place the meeting was held; it came into force in 1975 (Matthews, 1993). Although 18 countries initially signed the Convention, many countries ratified the convention as the number of members substantially increased. Since the last international meeting in 2015, 169 contracting parties have signed the Convention (Ramsar, 2015).

As stated by the official website, Ramsar's mission is "the conservation and wise use of all wetlands through local and national actions and international cooperation, as a contribution towards achieving sustainable development throughout the world (Ramsar, 2014)." This wise use principle that they refer to indicates a sustainable utilisation of the area, as the following citation explains: "The wise use of wetlands is their sustainable utilisation for the benefit of humanity in a way compatible with the maintenance of the natural properties of the ecosystem (Ramsar, 2014)." Where sustainable utilisation is defined as: *"Human use of a wetland so that it may yield the greatest continuous benefit to present generations while maintaining its potential to meet the needs and aspirations of future generations."*

Although the Ramsar Convention provides a general framework and establishes guidelines to manage Ramsar sites sustainably according to the wise use principle, the country that signed the Convention needs to develop national policies. Moreover, the Ramsar Handbook on national policies highly emphasises the need of a National Wetland Policy (Ramsar Convention Secretariat, 2010). Currently, no such policy derivatives exist in Curaçao. This absence of policies is a major limitation in the successful management of the Ramsar sites of Curaçao. Therefore, the government should urgently address this issue. SUC and other organisations can, on the other hand, put extra pressure on the adoption of new national nature policies that increase the effectiveness of nature management through more media exposure of the issue or lobbying.

6.2.2 Convention on Biological Diversity (CBD)

The Convention on Biological Diversity (CBD) is the most widely recognised and signed convention on and toward global biodiversity and nature conservation (McNeely, 1999). Currently, 196 countries signed the Convention (CBD, 2016). The Kingdom of The Netherlands also signed the convention, implicating that Curaçao also signed the convention. However, Curaçao never formally ratified this convention.

The Convention has three main goals (CBD, 2004):

1. the conservation of biological diversity,
2. the sustainable use of its components, and
3. the fair and equitable sharing of the benefits from the use of genetic resources.

The CBD does not have many practical implications for Curaçao, mostly because it has not developed a National Biodiversity Strategy and Action Plan (NBSAP). Such a plan would be encouraged, but due to the small area size

of the island of Curaçao it has little urgency; the Ramsar Convention is, in that regard, much more urgent and useful.

6.2.3 **Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)**

The Convention on International Trade in Endangered Species of Wild Fauna and Flora is a convention that dates back to 1973 and aims to reduce the trade in endangered species (CITES, 1973). Many nations, a total of 181 –including Curaçao in 1999 (CITES, 1999) – signed the Convention (CITES, 2016). The convention supplies several lists, among which are the list of endangered species and a list of threatened species on a global scale. The convention only focuses on the trade and is, in the field of nature conservation, just an advisory organ. The IUCN also supplies a list of endangered and threatened species and has an equivalent merit in comparison with the CITES list, but this list is not part of a convention countries can sign.

For Curaçao, the endangered species are all sea turtle species, the whales and dolphins and the Peregrine Falcon (Nature Foundation St. Maarten, 2004). The threatened species list is much larger and includes corals, birds, whales, birds, cacti and more. Although the species on the second list classify as threatened species on a global scale, this does not mean that the species are threatened on the island of Curaçao itself or in the rest of the Caribbean, e.g. like is the case with the Green iguana (*Iguana iguana*) (MINA, 1999).

7 PROBLEM ANALYSIS

The Ramsar site of Malpais/St. Michiel is, like many nature conservation sites in Curaçao, subject to several problems. Most problems relate to conflicts and accountability issues within the area and restrict the active management of the area.

These problems are categorised into the following categories:

- Safety
- Accountability
- Environmental impact

This section gives a detailed description of every problem below. The annex supplies a graphical representation of all problems and how they relate to each other in the form of a problem tree ([Annex II](#)).

7.1 Safety

7.1.1 Land ownership

Land ownership is the most urgent problem present in the Ramsar Site because it has a large impact on visitor numbers and safety of the park. In St. Michiel the problem is related to illegal building and occupation by residents of the Boca Sami suburb; in Malpais land claims and illegal plans by the Crusaders Church organisation are the main issues. In one case the illegal land occupiers in St. Michiel even attacked people with rocks ([Amigoe, 2016](#)); in Malpais, members of the Crusaders Church even threatened park rangers of SUC ([T. Ching, Personal Communication, 2016](#)).

Additionally, several other problems emanate from these issues, such as a decrease in visitors and the obstruction of park rangers.

7.1.2 Feral dogs

Invasive feral dogs are scavenging in the area and can pose a serious threat to hikers or other visitors. In the areas of Malpais and Von Pesjbaai, both visitors and volunteers of SUC encounter these dogs ([F. Mercelina, Personal Communications, April 2016](#)). Moreover, during the basic inventory, a group of 6 aggressive dogs appeared from the bushes surrounding the freshwater lake in Malpais and obstructed the hiking trail.

7.1.3 Criminality

The area in and surrounding Von Pesjbaai has been a meeting point for drug related criminals in the past. Due to the long, uninhabited coastline that stretches out to the Boca of the St. Michiel lagoon, packages with illegal drugs are dropped and picked up by boats late at night ([Volkskrant, 2003](#)). Since the increase in monitoring and maintenance activities, criminal activity lowered according to coastguards, but it is unsure to what extent.

7.2 Accountability

7.2.1 Lack of Enforcement

Although the governmental institutions GMN and VVRP know about most of the problems at the Ramsar site, these ministries take insufficient responsibility. GMN can only take note of law violation, but does not actively enforce regulations and is, by law, not allowed to do so. Ruimtelijke Ontwikkeling en Planning (ROP) [Spatial Development and Planning] is the executive governmental organisation that penalises violations of the spatial planning ordinances (see [Section Error! Reference source not found.5](#)). However, ROP is selective and does not always take action, even after repeated requests by other ministries, such as GMN ([Constansia-Kook, 2014](#)).

The illegal land occupation in St. Michiel illustrates this lack of enforcement quite clearly. Instead of enforcing the law and removing the occupants, who have been illegally active for a longer time, by force, GMN only places a sign that asks the perpetrators to stop (Amigoe, 2016).

7.2.2 Capacity

Although the government is responsible on paper, the government is under-capacitated and cannot successfully carry out sustainable nature management. GMN requests other organisations, such as SUC, to fill this capacity. However, without a contract that designates responsibilities for nature management, the impact of the management of these organisations is restricted.

7.2.3 Lack of Communication/Transparency

The designation of the area as a Ramsar site stresses the need for a more open correspondence to increase management effectivity. However, in reality, ROP does not react on requests made by GMN and SUC about the troublesome behaviour of members of the Crusaders Church towards other visitors (F. Dilrosun, *Personal correspondence*, May 2016). ROP ignores the issues and does not see the need to give a reply to GMN, which is strange because they both belong to the same government. The absence of cooperation of the governmental institutions causes them to work against each other, instead of together.

Next to this lack of communication are the problems regarding contracts. Contracts fail to describe the field of operation and the demarcation of the management boundaries. As can be seen on the zonation map (Annex VII), the current working field of SUC does not match up with the complete Ramsar site.

7.2.4 Policy and approach

Currently, a national wetland policy does not exist. Moreover, the government did not derive any policies from the Ramsar framework yet. The only policies that apply to the Ramsar sites are the standard conservation policies from the EOP and EROC, created in 1995 (see Section **Error! Reference source not found.**5). These nature conservation policies are not sufficient for the proper management of a Ramsar site as these current policies only rely on a passive, non-committal approach toward nature management.

7.3 Environmental impact

7.3.1 Landfill

The landfill in the north-west emits toxic fumes that pollute the adjacent Ramsar site because it incinerates all collected waste from the island. Next to these fumes, plastic that gets buried in the ground poses a threat to the surrounding area because it might affect the groundwater (GMN, 2014). Consequently, this groundwater will reach the seasonal lake where it might inhibit the development of fish species and disturbs the composition of the microflora.

7.3.2 Pollution

The mentality of the local population toward littering and waste dumping is still an enormous problem. Although Curaçao's inhabitants made many (social) endeavours toward changing the behaviour regarding littering and waste dumping, a large part of the majority still dumps and pollutes in and around nature areas. The various clean-ups hosted on the island (Amigoe, 2015) are not enough.

Daily, SUC needs to remove several garbage bags with litter from their contracted areas. Visitors throw away empty drinking bottles, dump household waste and do not clean up after themselves. The litter often ends up in the sea where it degrades into smaller pieces, or it gets eaten directly by the fauna. These plastic remains can cause suffocating and poisoning in many different species of fauna (Greenpeace, 2006; Laist, 1997). Entanglement by

plastic bags of birds and rabbits is another threat. Moreover, in the recent past, a couple of Caribbean Flamingos in St. Michiel died due to plastic entanglement (Amigoe, 2015).

Waste dumping has been a major problem in the past, but since the installation of the traffic booms, it has sharply decreased. But still, during the basic inventory, many corpses of dead dogs were found. Owners put these dogs in boxes and drop them close to the paths, where they start to rot and emit a bad, putrid odour. These waste dumps negatively affect the visits of the hikers and other visitors. It can also set a wrong example for other visitors.

7.3.3 Feral dogs

Feral dog groups are a threat to the endemic White-tailed deer population of Curaçao because these feral dogs use the same source of water as these deers. The White-tailed deer is very susceptible to noise and disturbance.

7.3.4 Condition of the dam

In 1960 Shell build a dam in Malpais for rainwater catchment. This dam has resulted in the two freshwater lakes located in Malpais, and it is therefore extremely vital to the breeding migratory waterbird species. The dam is currently in a poor state; a crack is present, and when a period of heavy rainfall occurs, the wetland might be adversely affected (Antilliaans Dagblad, 2013).

Furthermore, vandals destroyed the pumping system of the dam a couple of years ago (T. Van der Giessen, Personal Communication, April 2016).

7.3.5 Poaching

The Chinese community used to harvest marine life in te salina (Vermij & Chamberland, 2012). The unselective collection of marine organisms with large gill nets threatens the ecology of the salina and the residues that are left behind disturb the birds in the area. In Malpais, Chinese poachers also used to hunt ducks. These perpetrators were caught red-handed and were recorded on camera by SUC.

8 IMPLICATIONS FOR MANAGEMENT

In the previous chapters, the geography, stakeholders and problems have been analysed. These analyses have several implications for the management plan, and will be discussed below. The analyses are divided into three categories:

- Geographical
- Social
- Legislative

8.1 Geographical Implications

Ramsar's wise use principle asks for the implementation of an ecosystem approach. The ecosystem approach focuses on all functions of an ecosystem that the Ramsar site needs to provide. Therefore, the management needs to incorporate as many of these ecosystem services as possible.

8.1.1 Regulating services

Water management

For water management, the dam in Malpais, the boca in St Michiel and the reefs at Vaersenbaai/Von Pesjbaai need to be maintained in proper condition. In St. Michiel the water inlet needs to be monitored closely to prevent the silting up of the lagoon. In Malpais the poor maintenance of the dam at Malpais may eventually result in the desiccation of one of the freshwater lake during prolonged dry seasons, which can lead to a loss of Ramsar criteria. At Vaersenbaai and Von Pesjbaai the coral must be kept in a healthy condition as it will secure coastline stability.

Climate Control

For climate control, the management plan should aim to provide the necessary conditions for the development of larger tree species and increase the total area amount of forest patches. This development will increase the amount of carbon storage in the long term.

8.1.2 Cultural services

More diversity should be created in the vegetation and landscape, and new paths should pass sites with maximum diversity to provide better cultural services. Furthermore, the site should be kept clean, and more facilities should be created (and maintained), so that visitors will continue to recreate in the park. These facilities also include information provision. Also, the feral dogs around the freshwater lake should be executed or caught to protect visitors and prevent accidents.

8.1.3 Ecology supporting services

The management plan should stimulate services that support a healthy ecology. In other words, it should aim to improve biodiversity because it gives information about this health. For the management this implies that the management activities should have a low impact on the fauna and vegetation.

Water table

Drought is a limiting factor for biodiversity in this area, especially in Malpais. This implies that the groundwater table should be positively affected by enhancing the growth of large tree species. The formation of new gullies should also be closely monitored to prevent the washing away of fertile topsoil needed for the development of these trees.

Pollution

Lastly, the environmental impact of the landfill north-east of the Ramsar site should be assessed. The results should be used to get extra attention for this problem, which is essential for its solution.

8.2 Social implications

Awareness and Mentality

The management should aim to have a positive impact towards a mentality change of Curacao's population with regards to nature conservation. They need to value ecosystem services more, and the mentality of the local population toward littering and waste dumping should change. An active approach toward management is needed to achieve this mentality change. Contact with event organisers should be well maintained or improved, to increase involvement by the local population and to gain more revenue to maintain the park.

Apart from activities, the press can be used to increase awareness of the wise use of the wetland. Therefore, the management plan should aim to establish good ties with the press to ensure a beneficial impact.

Surveillance

The management plan should aim to improve social control and stimulate SUC to continue their surveillance activities to prevent poaching, reduce criminality and increase safety. Since the government is under-capacitated and cannot enforce law efficiently, SUC should get more authority so that they are not dependent on the government to enforce the law.

Conflict

The management plan should aim to resolve conflicts of land through dialogue with the relevant stakeholders. This management plan should aim to improve the communication with VVRP, to plan new objectives and steps to resolve the problem. Better with minister than with VVRP.

8.3 Legislative Implications

8.3.1 National policies

The national policies have several implications for the management plan of the Ramsar site. First of all, the plan needs to be set up within the framework of the EROC. Secondly, the management plan could aid to EOP's goal of limiting the further expansions of the urban landscape and conserve the designated areas, which currently have a low priority. Since the designated conservancy zones are very strict regarding the carrying out some management activities, a development permit will be required for SUC to carry out more rigorous management activities. Another option is contacting the minister of VVRP, which can then grant approval of certain activities which case no additional permit is needed (Lakerveld, 2016).

8.3.2 International Policies

A major limitation in the successful management of the Ramsar sites in Curacao is the absence of policy derivatives from the general framework of the Ramsar Convention, e.g. a national wetland policy. Due to the very strict policies of the EROC/EOP, the Ramsar framework is hard to implement because active management is severely restricted.

The Convention on Biological Diversity does not have many practical implications for the management plan, mostly because it has not developed a National Biodiversity Strategy and Action Plan (NBSAP). Lastly, the CITES convention needs to be translated into rules and regulations that are communicated towards the visitors.

MANAGEMENT

9 MANAGEMENT PLAN OBJECTIVES

Below the main objectives are stated. Every problem in the problem tree ([Annex II](#)) was converted to a concrete objective. All these objectives can be found back in the objective tree ([Annex III](#)). Next, the most relevant and achievable objectives were selected from this objective tree. These main objectives are further subdivided into specific results. The achievement of these results is reached through the execution of the management activities ([Section 0](#)). SUC cannot reach all these selected objectives by themselves. Thus, a better cooperation is needed between all the institutions and organisations

Objective 1: Number of visitors of the Ramsar site is increased

- **Result 1.1 The number of incidents related to illegal activities is lowered**

The safety of the area is dependent on several factors, such as roaming feral dogs that threaten visitors; illegal activities and the threatening of visitors by the Crusaders Church. The number of visitors and frequency of visits is decreasing if these issues are not being addressed. Furthermore, these safety issues also often relate to a negative environmental impact.

- **Result 1.2 Cultural functions of the Ramsar site are improved**

The wise use principle directly emphasises that the ecosystem approach must be respected to achieve sustainable management, i.e. ecosystem services need to be recognised ([Ramsar, 2014](#)). These ecosystem services include cultural services, such as ecotourism and aestheticism ([see Section 9](#)) and visitors that show awareness about nature are highly welcome and improve safety through social control.

Objective 2: Accountability by the governmental institutions is improved

- **Result 2.1 Responsibilities of the government are divided between the relevant stakeholders**

Through explicit statements and official documents, responsibilities are appointed, and proper contracts are set up. Unclear situations, such as the delineation of the management zones are resolved, and SUC is appointed more responsibility. Extra pressure is put on VVRP, through telephone calls and e-mails. The contacts with GMN are maintained and used as a platform to communicate with other important contacts.

- **Result 2.2 A proposal for a national wetland policy is developed**

After the signing of the Ramsar declaration of a new site, a certain protocol needs to be followed, and responsibilities need to be taken. One of these steps is the development of a "National wetland policy," which aims to improve sustainable use and management of the Ramsar site. Therefore, it is important that the development of the wetland policy needs to be put on the agenda, and the Ramsar handbook can serve as a proper venture point to support such a process.

Objective 3: Sustainable management is improved

- **Result 3.1 Environmental impact is researched**

With the landfill located in the northeast, a constant environmental pressure field is present. Research should be conducted to assess the impact of the fumes and the impact of the toxic breakdown components of the island's waste should be thoroughly investigated. Carmabi and GMN can support SUC by providing researchers that assess the current situation. Maintenance activities will resolve littering and waste problems.

- **Result 3.2 The scope and quality of management activities are improved**

The acquirement of more responsibility leads to an extension of the scope of the management activities. The quality can be increased through a systematic approach that gives clear insight into the current problems and derives corresponding management activities that can, therefore, be executed in a more structured way.

10 MANAGEMENT ACTIVITIES

The management area is divided into three management zones. Each zone has a different approach. In the case of SUC, the main focus is on visitors by improving the cultural services the nature area can provide: educational, aesthetical and recreational. Therefore, the management area has been divided into visitor hotspots, each with its unique, attractive values (see Figure 8):

- Malpais
- St. Michiel
- Vaersenbaai/Von Pesjbaai

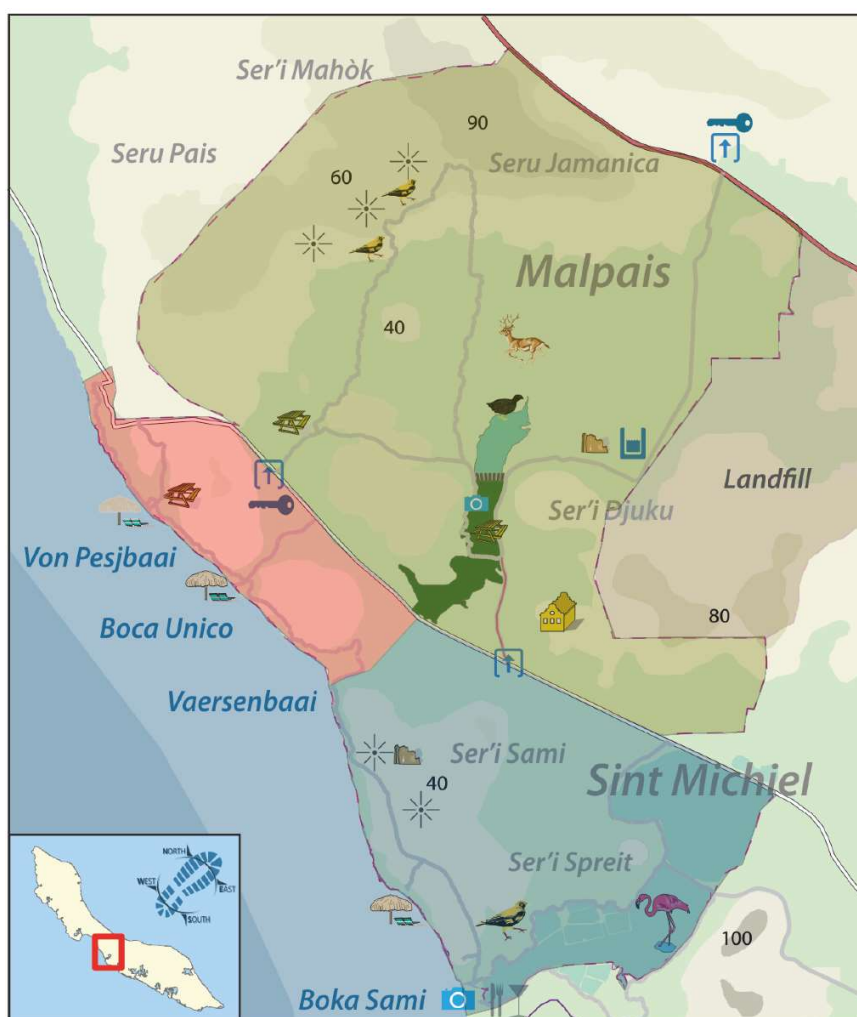


Figure 8 Zonation map showing Malpais, St. Michiel and the coastline Von Pesjbaai/Vaersenbaai

There will also be some activities that do not specifically belong to any of the above zones, therefore in the management activities section below there will also be a General Activities section.

Subsequently, the activities have been subdivided into the five categories: Rules and Regulations, Maintenance, Information provision, Facilities and Infrastructure and Management Evaluation and Monitoring. All activities can be found in the table below (Table 10) and are described further in the text below.

Table 10 Overview of the management activities

	General	Malpais	St Michiel	Vaersenbaai/Von Pesjbaai
Rules and regulations	1.1 request management permissions 1.2 renew and improve the management contract 1.3 establish the outline for a national wetland policy 1.4 propose an extraordinary police officer	2.1 a resolution is made with the CC 2.2 update rules and regulations sign	3.1 update regulations and place sign	4.1 update regulations and place sign
Maintenance		2.3 clean-up activities	3.2 clean-up activities	4.2 clean-up activities
Information Provision	1.5 develop programs for tours	2.2 update rules and regulations sign 2.4 place new informative signs	3.3 Organize free activities for local residents 3.1 update regulations and place sign	
Facilities and infrastructure		2.5 facility upgrades 2.6 path maintenance 2.7 address restoration Malpais dam		4.3 upgrade visitor facilities
Management evaluation and monitoring	1.6 assign an independent ecologist	2.8 detailed bird breeding site inventory 2.9 an environmental impact assessment is conducted 2.10 Management of feral dogs	3.4 monitor the inlet boca of the St. Michiel salina.	4.4 place reef balls 4.5 management of invasive lionfish

10.1 Zones

10.1.1 Malpais

Malpais constitutes the largest part of the total management area. It has three different terrain types: the undulating landscape in the centre, this the largest terrain type of Malpais; the higher terraces in the north-west, Last is the transition zone between the undulating landscape and terraces: the escarpments. Its terrain is ideal for hiking and easily accessible by car. Close to the entrance is a picnic spot surrounded by a forest patch with many tall trees that are uncommon for Curaçao. The seasonal freshwater lake is habituated by many different waterbird species, and the endemic white-tailed deer can also be seen regularly. There are some historical hotspots in the areas because it was already in use during the Spanish colonisation of Curaçao. The plantation house in the south-east is one of the historical remnants. One less ideal aspect of the site is the landfill in the northeast (run by Selikor).

10.1.2 St. Michiel

St. Michiel is located in the south-east of the Ramsar site and lies closest to the suburb called Boca Samí. It consists out of a hypersaline lagoon, Saliñas and lower and middle terraces. The hypersaline lagoon is famous for its flamingo population and is easily accessible by car. The St. Michiel lagoon also has important historical values because it was exploited by slaves for its salt. Along the coast are also the remnants of an old fort that was used to shoot cannonballs and protect the coast.

10.1.3 Vaersenbaai/Von Pesjbaai

Vaersenbaai and Von Pesjbaai are the coastline of the management area and are known for their coral reefs. The surrounding area is often vegetated by evergreen species on the calcareous substrates of the middle and lower terraces. The area is most used for diving and visitors taking a rest and enjoying the nice views.

10.2 Activities per Zone

10.2.1 General Activities

- **Rules and regulations**

Activity 1.1: Request management permissions

A request letter for management permission will be written and sent to Domeinbeheer [Domain administration]. This letter also attaches the GMN management set-up report that describes the responsibilities for SUC. Moreover, it will describe the intentions of SUC and it stresses the need for active management as described by the EOP (DROV, 1995).

Activity 1.2: Renew and improve the management contract

The old contract does not establish the necessary terms and conditions and needs to be improved. First, an explicit statement on the delineation of the management area of SUC must be made. Furthermore, the contract needs to assign explicit responsibilities to SUC, in line with the wise use principle of the Ramsar convention. This means the development of new paths, providing information and the development of facilities. It is recommended that his contract is both signed by the minister of GMN and the minister of VVRP to support the effective and active management and development of the area. This management plan aims to make these activities more transparent and describes their rationale.

Activity 1.3: Establish the outline for a national wetland policy

Since the designation as a Ramsar site, it is essential that a new national wetland policy is established. The first step is the determination of all the articles that should be in the policy, and Ramsar handbooks provide important information on the necessary steps in the process of the development of such a wetland policy. Carmabi and SUC should come together to establish a draft for such a wetland policy by performing all the steps provided in the Ramsar handbook.

Activity 1.4: Propose an extraordinary police officer

Currently, the government has not enough capacity to correctly fulfil the current laws and regulations. It is therefore needed to assign new extraordinary police officers that can enforce the law when necessary, especially for the Ramsar conservation sites. It would be highly beneficial that SUC acquires such an extraordinary police officer for their Ramsar sites. Therefore, a letter needs to be sent that requests the permissions of the minister of justice for this assignment. This extraordinary police officer can survey, persecute perpetrators and perform management tasks such as capturing/eliminating feral dogs. It must be noted, however, that this extraordinary police officer only can enforce the law on the predetermined conditions. Hence the effect of such an officer is limited.

- **Information provision**

Activity 1.5: Develop programs for tours

Several different tour programs will be developed with an educative character that spread knowledge and awareness about nature and cultural historical heritage within the areas. It is important to collect and store this data and put it into the archive, so it can be further developed in the future:

- **General tour**

- The outlines of a general tour that addresses natural values and ecosystem services of the Ramsar site will be developed. This tour mainly focuses on the importance of the wetland and the flora and fauna that can be found in the site.

- **Cultural historical tour**

- Several people with knowledge of the history and artefacts that can be found in the Ramsar site need to be contacted, and the outlines of a cultural historical tour need to be developed. Especially Malpais is a historic site that can be dated back to the late 17th century and thus has interesting stories that can be told.

- **Herbal medicine tour**
Herbal medicine is still part of the cultural heritage in Curaçao. It would, therefore, be interesting to develop a special program that involves these local people to tell more about this tradition and which plants can be found and used. The knowledge and data these guides could provide can be used to monitor the plant species in the area.
- **Redevelop a treasure hunt program**
Before the conflicts in Malpais, SUC facilitated various treasure hunts. A volunteer or intern can develop a new treasure hunt program to attract and involve children to Malpais. It is also interesting to include a geocaching game in the Ramsar sites; then GPS devices can be used to find the 'treasures' hidden in the landscape and points can be obtained.

▪ **Management evaluation and monitoring**

(Activity 1.6: Assign an (independent) ecologist)

Monitoring is an important part of nature management because this can assess the effectiveness of the management. Therefore, it would be ideal to assign an ecologist that monitors characteristics related to fauna and flora in the four different Ramsar sites. In Malpais it is needed to assess the environmental impact of the landfill in the north-west for example. The conclusions from this ecologist are then used to revise the working plans. The assignment of such an ecologist was already proposed by Carmabi, but the budget for such an ecologist was scrapped by GMN because there was a deficit in the budget of the health sector (F. Dilrosun, *Personal communication, May 19, 2016*).

Table 11 General Activities Schedule

Activity #	Activity Description	Executive steps	Responsible	Date
A 1.1	Request for Management Permissions	Step 1: Request letter is drafted Step 2: Letter with attachments are sent	Director (SUC)	16-Sep
A 1.2	Renew and Improve the Management Contract	Step 1: Contract proposal, including delineation and responsibilities Step 2: Draft proposal together with GMN Step 3: Signing of the final contract by both VVRP (Domeinbeheer) and GMN	Director (SUC)	16-Oct
A 1.5	Develop Programs for Tours	Step 1: General tour Step 2: Cultural historical tour Step 3: Redevelop a treasure hunt program Step 4: Herbal medicine tour	Interns (SUC)	16-Dec
A 1.4	Propose an Extraordinary Police Officer	Step 1: Propose a candidate for designation Step 2: Write a recommendation letter to VVRP/GMN? Step 3: Raise funding for the traineeship Step 4: Establish a working schedule and assign responsibilities	Director (SUC) Park Ranger (SUC)	17-Feb
A 1.3	Establish The Outline for A National Wetland Policy	Step 1: Outline of the national wetland policy is made by following the Ramsar handbook Step 2: Send the national wetland policy draft to the minister Step 3: Put the national wetland policy on the agenda in the parliament	SUC Carmabi GMN	17-May
A 1.6	Assign an Independent Ecologist	Step 1: Propose a candidate (Carmabi) Step 2: Establish the necessary budget Step 3: Create a monitoring plan and assign responsibilities.	Carmabi GMN	-

10.2.2 Malpais

■ Rules and regulations

Activity 2.1: A resolution is made with the Crusaders Church

Through arranged meetings with the Crusaders Church, a more cooperative relation is established that aims to conserve the area as best as possible. Past issues are discussed, and the implications of a Ramsar-designated site are made. The meetings are meant to give more insight into the needs and wishes of the Crusaders Church so that a new proposal or agreement can be made. It is wise to offer the Crusaders Church an advisory role to avoid future conflicts. The first step is to set up an agenda and arrange a meeting with the board of the church.

Activity 2.2: Update rules and regulation sign

The entrance also is in need of an update to its rules and regulation sign. Unnecessary disturbance by visitors needs to be reduced by providing information on bird breeding sites. The following information should be provided:

- **Hunting**
Hunting is strictly forbidden within the area.
- **Campfire**
Campfires should only be made in the designated fire pits, and extreme caution should be taken to prevent possible bushfire.
- **Hiking**
Disturbance should be minimal.
- **Camping**
There are no laws and regulations on camping in conservation areas. Therefore, a registered camping regulation will be put in place so that campers can contact Uniek Curaçao if they are planning to camp at the Ramsar site. This will limit potential harmful effects by unsustainable campers because it will be logged which people were camping.
- **Dogs**
During the breeding seasons and in the salina, dog walkers pose a threat to the bird populations. Therefore, in line with the breeding map and calendar, dog walkers are not allowed to visit certain zones in the Ramsar site.
- **Waste**
Waste dumping is forbidden, and litter must be dropped into the waste containers that are placed within the area.

■ Maintenance

Activity 2.3: Clean-up activities

Every week the areas are visited to empty the containers and keep the paths clean, and a monthly grant is received by GMN to support this task. These activities will continue every week.

■ Information provision

Activity 2.4: Place new informative signs

New signs must be placed because the old signs have been vandalised. These signs will also increase the awareness about the valuable nature present in Malpais. The placement of these signs also contributes to a more pleasant experience by tourists as the signs provide a broader picture and give more insight into the nature and history of the area. The Crusaders church will be informed about the placement of these signs.

- A new entrance sign must also be placed, and this aims to give a general overview of the ecosystems in and history of Malpais. This also includes a rules and regulations section (see below).
- A sign similar to the turtle sign on Asencion should be placed at the dam, describing the white-tailed deer and the different waterbird species in Malpais.
- A sign giving information about the history of Malpais should be placed at the Faha

- **Facilities and infrastructure**

- Activity 2.5: Facility upgrades**

- In Malpais there are still old waste containers that are in need of an upgrade. SUC has developed a new, easy to collect waste container that can be emptied easily. The current containers will be replaced by these containers.

- Campfires are popular and are made in many areas. Therefore fire pits should be created where a fire has the least impact to prevent bush fires.

- Activity 2.6: Path maintenance**

- All the different trails must be maintained to ensure that visitors have a pleasant experience. Due to the land-owner issues, the trails in Malpais are in need of a rigorous maintenance task. There are several large cacti that are blocking the paths and other thorny scrubs that are covering the paths. Especially the east route of the Jamanica trail needs to be maintained. It is also necessary to place (new) yellow stones to give directions for the routes and trails because natural paths in the area can be confusing for visitors.

- Activity 2.7: Address restoration of the Malpais dam**

- The dam is important for the catchment of water for the seasonal lakes. The seasonal lakes offer various ecosystem services, and these lakes are essential for maintaining the criteria of the Ramsar site. Therefore, the dam should be restored and upgraded to prevent further degradation of the already damaged dam. Although the government has a budget allocated for an annual restoration project of several dams on Curaçao, Malpais is not on that list. Therefore, it should be made sure that the right priority is given, and pressure should be put on this restoration because the dam is critical for the Ramsar site.

- **Management, evaluation and monitoring**

- Activity 2.8: Detailed bird breeding site inventory**

- A detailed map and a breeding calendar of the important bird species needs to be developed. First, an inventory needs to take place throughout several months of the year, and data must be matched with old monitor reports to get a good overview of where the breeding sites of the important bird species are. Carmabi could help in providing this data and also offer support for this inventory. This can then be used to develop an ecological zonation map, where every zone has different rules throughout the year following the breeding calendar.

- Activity 2.9: An environmental impact assessment is conducted**

- The landfill site poses a long-term threat, which must be closely investigated. An environmental impact assessment is needed to get a clear view of the landfill's impact. The first step is to perform research on the effects of the Malpais landfill on groundwater quality around the Lago Dispersé. Ideally, the new ecologist can conduct this research. However, if the government cannot afford this ecologist, a backup plan should be executed. Interns or researchers of Carmabi should then be contacted, and a research proposal must be made. Finding external parties or the government to fund this research would be a recommended next step.

- Activity 2.10: Management of feral dogs**

- There have been several reports of observations of feral dogs in and around Malpais, and during the basic inventory the dogs were encountered as well. These dogs pose a threat to both nature and visitors. The dogs need to be caught or shot to prevent further complications. If the assignment of an extraordinary police officer succeeds, a request must be made that this officer is allowed to hunt on the dogs. Otherwise, special permission can be asked in the new contract that gives permission to a person with a shooting license that can hunt these dogs. Furthermore, it is necessary to update the list of invasive species that threaten other species in Malpais.

Table 12 Malpais Activities Schedule

Activity #	Activity Description	Executive steps	Responsible	Date
A 2.3	Clean-Up Activities	Step 1: Clean up along the paths and empty waste containers	Park Rangers (SUC)	Ongoing
A 2.6	Path Maintenance	Step 1: Remove dead trees, cut overhanging branches, prevent gully formation	Park Rangers (SUC)	Ongoing
A 2.1	A Resolution Is Made with The CC	Step 1: The church council is contacted Step 2: A meeting is arranged and needs and requirements of the church are identified Step 3: An agreement is made	Director (SUC)	16-Sep
A 2.2	Update Rules and Regulations Sign	Step 1: Verify and add categories Step 2: Write detailed description of ruleset Step 3: Establish a design and format for the rules and regulations sign Step 4: Request development permit Step 5: Place sign	Volunteer (SUC) & Director (SUC)	16-Oct
A 2.4	Place New Informative Signs	Step 1: Finish management plan Step 2: Extract useful data Step 3: Create a design for the signs Step 4: Sent signs to press Step 5: Place sign	Intern (SUC) & Director (SUC)	16-Nov
A 2.5	Facility Upgrades	Step 1: Construct 2 new waste containers Step 2: Place waste containers at their locations	Park Rangers (SUC) Volunteer (SUC)	16-Nov
A 2.8	Detailed Bird Breeding Site Inventory	Step 1: Contact Carmabi and volunteers Step 2: Write a proposal Step 3: Acquire funding Step 4: Carry out inventory	Carmabi/SUC	16-Nov
A 2.7	Address Restoration of Malpais Dam	Step 1: Establish a letter to LVV Step 2: Contact journalists of Amigo / Antiliaans Dagblad	Director (SUC)	17-Jan
A 2.10	Management Feral Dogs	Step 1: Dogs are shot by an extraordinary police officer	Extraordinary Police Officer	17-Jun
A 2.9	Environmental Impact Assessment	Step 1: Research proposal is written Step 2: Assessment is conducted	Carmabi/GMN	-

10.2.4 St. Michiel

■ Rules and regulations

Activity 3.1: Update regulations and place sign

Reduce disturbance by visitors by setting up and communicating the following rules and regulations:

- **Hunting**
Hunting is strictly forbidden within the area.
- **Hiking**
Disturbance should be minimal.
- **Dogs**
Dog walkers pose a threat to the flamingo populations because the area is very open and dogs can be spotted easily by the flamingos. Therefore, in line with the breeding map and calendar, dog walkers are not allowed to visit certain zones in the Ramsar site.
- **Waste**
Waste dumping is forbidden, and litter should be deposited in the waste containers.

■ Maintenance

Activity 3.2: Clean-up activities

Every week the areas are visited to empty the containers and keep the paths clean, and a monthly grant is received by GMN to support this task. These activities will continue every week.

■ Information Provision

Activity 3.3 Organise free activities for local residents

Local volunteers of Boca Sami and SUC will give a free tour twice per year for the local residents to walk around in the Ramsar site. SUC must, therefore, acquire contacts of volunteers for such a tour in Boca Sami that are willing to assist. Such a tour supports stewardship of the area and supports the process of keeping the area clean.

■ Management, evaluation and monitoring

Activity 3.4: Monitor the inlet boca of the St. Michiel salina.

The St. Michiel inlet needs to be monitored closely and if needed dredging activities need to be planned to keep the influx of sea water consistent and prevent the salina from getting too dry. The salina is an important foraging site for the (locally threatened) Caribbean flamingo population on Curaçao.

Table 13 St. Michiel Activities Schedule

Activity #	Activity Description	Executive steps	Responsible	Date
A 3.2	Clean-Up Activities	Step 1: Clean up along the paths, empty waste containers	Park Rangers (SUC)	Ongoing
A 3.4	Monitor The Inlet Boca of the St. Michiel Saliña.	Step 1: Establish the baseline Step 2: Measure height of silt (Step 3: If measurements are too high, contact government and devise a new plan of action)	Carmabi SUC	Ongoing
A 3.1	Update Regulations and Place Sign	Step 1: Verify and add categories Step 2: Write detailed description of ruleset Step 3: Establish a design and format for the rules and regulations sign Step 4: Request development permit Step 5: Place sign	Volunteer (SUC) Director (SUC)	16-Oct
A 3.3	Organize Free Activities for Local Residents	Step 1: Organise a neighbourhood meeting and identify volunteers Step 2: Develop a program and a route with volunteers Step 3: Facilitate the event	Front Desk Intern (SUC)	17-Feb

10.2.5 Vaersenbaai/Von Pesjbaai

■ Rules and regulations

Activity 4.1: Update regulations and place sign

Reduce disturbance by visitors by setting up and communicating the following rules and regulations:

- **Hunting**
Hunting is strictly forbidden within the area.
- **Campfire**
Campfires should only be made in the designated fire pits, and extreme caution should be taken to prevent possible bushfire.
- **Hiking**
Disturbance should be minimal.
- **Camping**
There are no laws and regulations on camping in conservation areas. Therefore, a registered camping regulation will be put in place so that campers can contact Uniek Curaçao if they are planning to camp at the Ramsar site. This will limit potential harmful effects by unsustainable campers because it will be logged which people were camping.
- **Waste**
Waste dumping is forbidden, and litter must be dropped into the waste containers that are placed within the area.
- **Sustainable diving guidelines**
 - No contact with the coral reef should be made
 - Use well-secured equipment
 - Avoid stirring up sediment
 - Do not stand on the bottom
 - If possible, carefully take litter out of the coral reef
 - Do not take living or dead 'souvenirs' out of the water

■ Maintenance

Activity 4.2: Clean-up activities

Every week the areas are visited to empty the containers and keep the paths clean, and a monthly grant is received by GMN to support this task. These activities will continue every week.

■ Facilities and infrastructure

Activity 4.3: Upgrade visitor facilities

At Vaersenbaai and Von Pesjbaai the waste containers need to be replaced by the new design that allows for easy waste collection.

■ Management evaluation and monitoring

Activity 4.4: Place Reef balls

Artificial reef balls can be placed to enhance the fish population along the damaged reef systems.

Activity 4.5: Management of Lionfish

Along the coastline of Vaersenbaai and Von Pesjbaai, the coral reef ecosystem is affected by the Lionfish (De Léon, et al., 2013). The Lionfish has a very fast breeding rate and disturbs the balance of the other fish populations. The lionfish should be hunted with special spears that mitigate damage to the reefs and with special diver's equipment. A list of volunteers for this management should be established that have the necessary equipment for hunting these Lionfish.

Table 14 Vaersenbaai/Von Pesjbaai Activities Schedule

Activity #	Activity Description	Executive steps	Responsible	Date
A 4.2	Clean-Up Activities	Step 1: Clean up along the paths and empty waste containers	Rangers (SUC)	Ongoing
A 4.1	Update Regulations and Place Sign	Step 1: Verify and add categories Step 2: Write detailed description of ruleset Step 3: Establish a design and format for the rules and regulations sign Step 4: Request development permit Step 5: Place sign	Volunteer (SUC) Director (SUC)	16-Oct
A 4.3	Upgrade Visitor Facilities	Step 1: Construct 2 new waste containers Step 2: Place waste containers at their locations	Park Rangers (SUC) Volunteers (SUC)	16-Oct
A 4.5	Management of The Invasive Lionfish	Step 1: Gather list of volunteer divers Step 2: Contact divers Step 3: Assign a team Step 4: Create planning with team Step 5: Establish sustainable procedure guidelines for lionfish hunting	Park Ranger (SUC) Volunteers (SUC)	16-Dec
A 4.4	Place Reef Balls	Step 1: Determine location Step 1: Raise funding Step 3: Buy reef balls Step 4: Place reef balls	Volunteers (SUC)	17-Aug

11 MANAGEMENT IMPACT

Currently, the Ramsar site cannot be managed optimally. This management plan provides the necessary steps that lead to a more sustainable management of the Ramsar site, by taking people, planet and profit into consideration as it is clear that all three factors people, planet and profit interact with each other and in the case of the Ramsar site.

Through the development of a coordinated management plan, the site will be managed in a more structured way, providing a basis for the sustainable management in the years to come. However, all stakeholders must be made aware that the conservation of a Ramsar site is a task that needs to be done together. Both people and governmental institutions must rethink their roles and change their mentality. This plan aims to stimulate this cooperation between several parties and appoints specific responsibilities to each party; cooperation is the basis for sustainable management. As the main responsible body is SUC, SUC must be appointed more responsibility through a new and better contract to increase its influence on the successful development of this cooperation.

By including cultural services such as ecotourism and aestheticism, the awareness among the visitors about the value of the park will be increased. By making the area cleaner and safer, more visitors are attracted to the site. This will increase the revenues gained by tours and the sale of hiking guides, which consequently will lead to more money for a better management of the site. It is clear that without financial means, a proper management of the complete site is restricted, as is currently the case.

11.1 Economic Impact

The more structured way of managing the site will lead to a more efficient use of financial resources. It also contributes to the visitors of visitors by improving the safety of the area and making it better known to the general public. The increased number of visitors can eventually lead to more jobs related to the Ramsar site, such as the ecologist/biologist that is proposed because more social consensus is achieved.

Ecotourism can also contribute to the development of new businesses and organisations around the conservation areas, such as diving schools and restaurants. Because the population is low in this area of Curacao, even a small number of jobs generated by this project may be significant. This economic impact can increase political land financial support for conservation. The benefits associated with tourism and recreation in protected areas tend to be tangible. For example, visitors will spend money on lodging, food and other goods and services, thereby providing employment for both local- and non-local residents.

The Ramsar can potentially provide many benefits to society, such as biodiversity, maintenance of watersheds and storm mitigation. These benefits are intangible; they form a safety net. These positive economic impacts can, in turn, lead to increased support for the Ramsar site.

11.2 Socio-cultural impact

First and foremost, this plan will lead to an increased awareness of the value of the natural area among visitors, governmental institutions as well as companies. The increased number of visitors attracted by the ecotourism and aesthetic activities will get to know the area better. This in turn will lead to more social control, also decreasing the amount of vandalism and waste dumping. This management plans will lead to more jobs and livelihoods for the Ramsar site, as well as provide more security in the region. On the other hand, there will be parties less happy with this project, such as the Crusaders Church and other people who illegally claim pieces of land or illegally build in the Ramsar site. Also, the landfill might not be happy at first when the impact of it will be researched.

Furthermore, by researching the industrial and urban environmental impact, awareness about this impact will be increased. Lastly, the better cooperation and shared responsibilities between the governmental organisations and

SUC, will lead to a change in the way of thinking and handle these environmental issues into a more positive and collaborative way. If the government better adheres to its own rules, illegal building and occupation of the land can be reduced. Overall, this leads to a better, cleaner and safer site which is more appealing to visit.

11.3 **Ecological impact**

This management plan will lead to the preservation of the current flora and fauna in the Ramsar site; optimally it will also lead to an increase in biodiversity. Especially the wetland maintenance is a positive impact as it will have a positive impact on the number of birds in the area. It will also have a positive impact on the landscape, and it conserves several different habitats.

Furthermore, the research on the impact of litter in the area might reduce the amount of trash, further supported by the social security provided by the ecotourism aspect of the plan. The reduced amount of trash will positively impact the ecology of the site as well as the animals living in the ocean. In total, the more sustainable management and the increased control on violations of the law by the governmental institutions will help to protect the site further.

13 FUTURE OUTLOOK

This management plan provides a framework for sustainable development. In Curaçao, one of the most important steps is an update toward the ecosystem approach, and this is achieved by recognising the importance of nature on the island by government officials and local residents. Only then can effective policies be written and more budget can be generated to tackle the difficulties.

Curaçao already made a step in the good direction by designating the four Ramsar sites and this momentum can be used to push for new steps toward sustainable management. The Ramsar convention stresses the need for the development of a national wetland policy as this is a critical document that can be used for further sustainable development, a policy that should put Curaçao on the correct path.

13.1 Monitoring and Revision

Although the major problems in the area have been identified, these problems might change over time, and new problems might come into existence. Therefore, this management plan is subject to (small) changes and adaptations. Hence, it is necessary to monitor characteristics and effects of the activities, so new problems can be identified at an early stage. Monitoring will also help to assess the effectivity of the management activities. If negative changes occur, a revision should be made to the working schedule and new management activities should be established. In the Ramsar site, there are several things which give a good overview of the current situation.

The monitoring activities are:

- The status of the dam
- The amount of silt around the inlet at St. Michiel
- The bird population
- The feral dog population
- Environmental impact of the landfill

It is recommended that every year a new annual working plan is made that describes and plans the important activities for that year. This annual working plan should incorporate revisions to the management plan that were made through the monitoring assessments. The annual working plan comes up with concrete steps that are needed to carry out these (new) activities. Thus, an annual working plan also includes detailed work plans for the activities from the nature management plan and establish the budget for that year.

13.2 Opportunities for future development

This management plan provides a basis for future developments. If all of the management activities in this current management plan are carried out, new opportunities can be developed and implemented. This paragraph presents some ideas for such new opportunities.

13.2.1 Water

■ Dams

Throughout the centuries several water dams have been established, also in and around the Ramsar site Malpais/St. Michiel. Some of these old dams can be restored and rehabilitated to increase the watertable in the area.

- **Enrichment plantings**

If more dams have been restored, new vegetation can start to develop. This vegetation can be directed through enrichment plantings of large tree species, e.g. Acacia. The root systems of these larger trees will support the watertable by holding the rainwater.

- **Water provision**

When shell established the dam in 1960, it was in use as a water storage facility to clean the heavy machinery. It can, under close supervision, still serve as a water provisioning service for urban demand in the future. The freshwater lake in Malpais can, for example, offer a additional drinking water. Currently, Curaçao obtains its drinking water through desalinization of ocean water.

13.2.2 Ecotourism

- **Companies**

If more tourists visit the area, it possible that new companies will start to establish in the area. In turn, these companies will attract even more visitors. Moreover, new developments can be made and advertisement for the Ramsar site can be made by companies.

- **Paths**

SUC can acquire the rights to manage the complete Ramsar site with this management plan so that new paths can be developed and open the degraded nature area in the north-west. This area has a very low ecological value (very dry) and is currently unreachable.

13.2.3 Future management plans

This management plan is also meant as a reference and venture points for new management plans. Interns can use this format to develop new management plans for other Ramsar sites and apply the logical framework approach to develop a scientific-backed systematic report. Moreover, the management plan guide in the annex provides the necessary steps to follow during the writing process (Annex V). Furthermore, all scientific reports and relevant GIS data has been stored on SUC's private database to conduct a detailed geographical analysis.

14 REFERENCES

- Agriculture Canada. (1976). *Glossary of terms used in soil science*. Ottawa: Canada Department of Agriculture.
- Amigoe. (2015, September 19). Curaçao Clean Up 2015. *Amigoe Curaçao*.
- Amigoe. (2015, August 15). Landsverordening Openbare Orde van kracht [Public Order Ordinance in effect]. *Amigoe Curaçao*.
- Amigoe. (2015, March 17). Saliña St. Michiel onder de loep. *Amigoe Curaçao*.
- Amigoe. (2016, April 1). Interministeriële aanpak nodig voor illegaliteit bij Boca Samí. *Amigoe Curaçao*.
- Antilliaans Dagblad. (2013, November 3). Dammenplan 2013 niet uitgevoerd. *Antilliaans Dagblad*.
- Antilliaans Dagblad. (2015, November 3). Dammenplan 2013 niet uitgevoerd. *Antilliaans Dagblad*.
- Baake, K. W. (2016). Nature Management Plan: St. Michiel, Malpais, Vaersenbaai and Von Pesjbaai. Velp: Van Hall-Larenstein.
- Beckmann, G. G., Thompson, C. H., & Hubble, G. D. (1974). Genesis of red and black soils on basalt on the Darling Downs, Queensland, Australia. *Journal of Soil Science*, 25, 265-281.
- Beers, C. E., De Freitas, J., & Ketner, P. (1997). *Landscape Ecological Vegetation Map of the Island of Curaçao, Netherland Antilles*. Hilversum, The Netherlands: Verloren Hilversum.
- Beets, D. J. (1972). Lithology and stratigraphy of the Cretaceous and Danian succesions of Curaçao. Amsterdam: University of Amsterdam.
- Breteler, H. G. (1981). Geschiktheid voor akkerbouw, tuinbouw en grasland, de beste gronden van Curaçao, herinterpretatie van de klassen 1 en 2 van de bodemgeschiktheidskaart van het Grontmij & Sogreah rapport (1968). Wageningen: Wageningen University.
- CARMABI. (2012). *Carmabi Annual Report 2012*. Curaçao: Carmabi.
- CBD. (2004). Strategic Plan: future evaluation of progress. *Conference of the Parties to the Convention on Biological Diversity, 7th meeting*. Kuala Lumpur, Malaysia. Retrieved from CBD international: <https://www.cbd.int/doc/decisions/cop-07/cop-07-dec-30-en.pdf>
- CBD. (2016, May). *List of Parties*. Retrieved from Convention on Biological Diversity: <https://www.cbd.int/information/parties.shtml>
- CBS Curaçao. (2016, February 2). Povertyline 2008-2015. (M. Jacobs, Ed.) Willemstad, Curaçao. Retrieved from http://www.cbs.cw/website/statistical-information_229/item/poverty-tables_472.html
- CIA. (2013). *The World Factbook 2013-14*. Retrieved from Central Intelligence Agency: <https://www.cia.gov/library/publications/the-world-factbook/index.html>
- CITES. (1973). Convention on International Trade in Endangered Species of Wild Fauna and Flora. *CITES*. Bonn, Switzerland.
- CITES. (1999, July 07). *Netherlands*. Retrieved from Convention on International Trade in Endangered Species of Wild Fauna and Flora: <https://cites.org/eng/cms/index.php/component/cp/country/NL>
- CITES. (2016, May 2). *List of Contracting Parties*. Retrieved from Convention on International Trade in Endangered Species of Wild Fauna and Flora: <https://www.cites.org/eng/disc/parties/chronolo.php>
- Constansia-Kook, J. (2014). Ramsarconservering [Ramsar conservation]. GMN.
- Davidson, N. C. (2014). How much wetland has the world lost? Long-term and recent trends in global wetland area. *Marine and Freshwater Research*, 65, 934-941.
- DCNA. (2014). *Dutch Caribbean Nature Alliance*. Retrieved March 2016, from Christoffel/Shete Boka Park: <http://www.dcnanature.org/christoffel-park-and-shete-boka-park/>
- DCNA; WUR. (2016). Zoning Plan (EOP). Wageningen. Retrieved 2016, from <http://www.dcbd.nl/island/curaçao>
- De Léon, R., K. V., Bertuol, P., Chamberland, V. F., Simal, F., Imms, E., & Vermeij, M. J. (2013). Effectiveness of lionfish removal efforts in the southern Caribbean. *Endangered Species Research*, 22(2), 175-182.

- De Vries, A. J. (2000). The semi-arid environment of Curaçao: a geochemical soil survey. *Netherlands Journal of Geosciences*, 79(4), 479-494.
- Debrot, A. O., & De Freitas, J. A. (1991). Wilderness areas of exceptional conservation value in Curaçao, Netherland Antilles. *Nederlandse Commissie voor Internationale Natuurbescherming*, 26, 1-25.
- Debrot, A. O., & Wells, J. (2008). *Important Bird Areas in the Caribbean: key areas for conservation*. Cambridge, UK: Birdlife International.
- Debrot, A. O., De Freitas, J. A., Brouwer, A., & Van Marwijk Kooy, M. (2001). The Curacao Barn Owl: Status and Diet, 1987-1989. *Caribbean Journal of Science*, 3(4), 185-193.
- Diebold, J. (2009). Submarine volcanic stratigraphy and the Caribbean LIP's formational environment. *Geological Society Special Publications*, 328, 799-808.
- DROV. (1995). *Eilandelijk ontwikkelingsplan Curaçao 1995: EOP*. Willemstad. Curaçao: Dienst Ruimtelijke Ontwikkeling en Volkshuisvesting.
- FAO. (2015). World reference base for soil resources 2014. International Soil classification system for naming soils and creating legends for soil maps (Update). Rome: Food and Agriculture Organization for the United Nations.
- Focke, J. W. (1978). Limestone cliff morphology and organism distribution on Curaçao (Netherlands Antilles). *Geological Proceedings From Leiden*, 51, pp. 131-150. Leiden: Naturalis.
- Forman, R. T. (1995). *Land mosaics: the ecology of landscapes and regions*. Cambridge, UK: Cambridge University Press.
- Fouke, B. W., Beets, J. C., Meyers, W. J., Hanson, G., . . . Melillo, A. J. (1996). 87Sr/86Sr chronostratigraphy and dolomitization history of the Seroe Domi Formation, Curacao (Netherlands Antilles). *Facies*, 35(1), 293-320.
- Georgie, N. J., & Zafiriadis, K. (2006). The impact of park trees on microclimate in urban areas. *Urban Ecosystems*, 9, 195-209.
- GMN. (2014). Management Set-up: Ramsar area Malpais/St. Michiel. Willemstad: GMN.
- Gómez-Baggethun, E., De Groot, R., Lomas, P. L., & Montes, C. (2009). The history of ecosystem services in economic theory and practice: From early notions to markets and payment schemes. *Ecological Economics*, 69(6), 1209-1218.
- Gopal, B. (2009). Biodiversity in Wetlands. In *The Wetlands Handbook* (pp. 65-95). Wiley-Blackwell.
- Greenpeace. (2006). Plastic Debris in the World's Oceans. Greenpeace.
- Grontmij & Sogreah. (1968). Water and land resources development plan for Aruba, Bonaire and Curaçao. De Bilt: Grontmij.
- Gunal, H., & Ransom, M. D. (2006). Clay illuviation and calcium carbonate accumulation along a precipitation gradient in Kansas. *CATENA*, 68(1), 59-69.
- Island Council Curaçao. (1980, September 8). Landsverordening grondslagen ruimtelijke ontwikkelingsplanning [National Ordinance Spatial Development Planning Fundamentals]. Willemstad, The Kingdom of The Netherlands: Eiland Gebied Curaçao [Island Territory Curaçao].
- James, K. H. (2007). *The Caribbean Ocean Plateau—an overview, and a different understanding*. Caribbean Plateau. Institute of Geography and Earth Science. Aberystwyth, Wales (United Kingdom): University of Wales.
- Kapila, S., & Lyon, F. (2006). *People Orientated Research*. London: Geography Outdoors.
- Kerr, A. C., & Tarney, J. (2005). Tectonic evolution of the Caribbean and northwestern South America: The case for accretion of two Late Cretaceous oceanic plateaus. *Geology*, 33(4), 269-272.
- Laist, D. W. (1997). Impacts of marine debris: entanglement of marine life in marine debris including a comprehensive list of species with entanglement and ingestion records. (J. M. Coe, & R. D. B, Eds.) *Marine Debris. Sources, Impacts, Solutions*, 99-140.
- Lakerveld, S. (2016, June). Unieke Rechtssituatie Curaçao? [Unique Legal Situation Curaçao?]. *Bachelor Thesis*. Breda: Avans Hogeschool.

Limper, M., Thai, K. T., Gerstenbluth, I., Osterhaus, A. D., Duits, A. J., & Gorp, E. C. (2016). Climate Factors as Important Determinants of Dengue Incidence in Curaçao. *Zoonoses and Public Health*, 63, 129–137.

Loewen, M. W., Duncan, R A, K., J, A., & Krawl, K. (2013). Prolonged plume volcanism in the Caribbean Large Igneous Province: new insights from Curaçao and Haiti. *Geochemistry, Geophysics, Geosystems*, 14(10), 4241-4259.

Matthews, G. V. (1993). *The Ramsar Convention on Wetlands: its History and Development*. Gland, Switzerland.: Ramsar Convention Bureau.

McNeely, J. A. (1999). JEFFREY A. McNEELY (1999). The Convention on Biological Diversity: a solid foundation for effective action. Environmental Conservation. *Environmental Conservation*, 250-251.

Meine, C., Soulé, M., & Noss, R. F. (2006). A mission-driven discipline”: the growth of conservation biology. “A mission-driven discipline”: the growth of conservation biology, 20, 631-651.

Metereological Department Curaçao. (2016, February 02). *Summary of Climatological Data, Period 1971 - 2000*. Retrieved from Climate Summary: http://www.meteo.cw/Data_www/Climate/documents/CLIM_SUM_Cur.pdf

MINA. (1999). *Natuurbeleidsplan Bonaire 1999-2004*. Kralendijk, Bonaire: Department of Environment and Nature.

Ministry of Justice Curaçao. (2015, July 22). Landsverordening openbare orde. LANDSVERORDENING van de 22ste juli 2015 houdende vaststelling van regels ter bevordering van de openbare orde, rust en veiligheid, en ter bescherming van de gemeenschap.

Ministry of Justice of The Netherlands. (2010, October 1). Besluit van 23 september 2010 tot vaststelling van het tijdstip van inwerkingtreding van de artikelen I en II van de Rijkswet wijziging Statuut in verband met de opheffing van de Nederlandse Antillen. 387. The Netherlands: Ministerie van Justitie [Ministry of Justice].

Moberg, F., & Folke, C. (1999). Ecological goods and services of coral reef ecosystems. *Ecological Economic*, 29, 215-233.

Nagelkerken, I., & Nagelkerken, W. P. (2004). Loss of coral cover and biodiversity on shallow Acropora and Millepora reefs after 31 years on Curaçao, Netherlands antilles. *Bulletin of Marine Science*, 74(1), 213-223.

Nature Foundation St. Maarten. (2004, August). *International Treaties and Conventions Summary*. Retrieved from Nature Foundation DXM: http://www.naturefoundationsxm.org/downloads/legislation_treaties/International_Treaties_Conventions_Summary.pdf

Nijman, V. (2010). The Importance of Small Wetlands for the Conservation of the Endemic Caribbean Coot Fulica caribaea. *Caribbean Journal of Science*, 46(1), 112-115.

Noguera, M., Stedman, C., First, E., Lord, E., Parrinello, A., Wright, J. E., & Colgan, J. (2009). Detrital Zircon Geochronology of Paleocene/Eocene Turbidites from Venezuela and Offshore Islands: implications for Late Cretaceous Subduction Initiation along the Leeward Antilles and Aves Ridge. *Joint Annual Meeting*. Geological Society of America.

Noss, R. F. (1990). Indicators for monitoring biodiversity: a hierarchical approach. *Conservation Biology*, 4, 355-364.

Ogden, J. C. (1988). The influence of adjacent systems on the structure and function of coral reefs. *Proc. 6th Int. Coral* (p. 6). Townsville, Australia: ICRS.

Petit, S. (1995). The pollinators of two species of columnar cacti on Curaçao, Netherlands Antilles. *Biotropica*, 27, 538-541.

Petit, S. (1996). The status of bats on Curaçao. *Biological Conservation*, 77, 27-31.

Pors, L. P., & Nagelkerken, I. A. (1998). *Caribbean Coral Reef, Seagrass and Mangrove Sites*. Curaçao, Netherlands Antilles: CARICOMP.

Prentice, C. S., Mann, P., Crone, A. J., Gold, R. D., Hudnut, K. W., Briggs, R. W., . . . Jean, P. (2010). Seismic hazard of the Enriquillo-Plantain Garden fault in Haiti inferred from palaeoseismology. *Nature Geoscience*, 3, 789–793.

Ramsar. (2014, September 2). *The Designation Process*. Retrieved from Ramsar: <http://www.ramsar.org/about/the-designation-process>

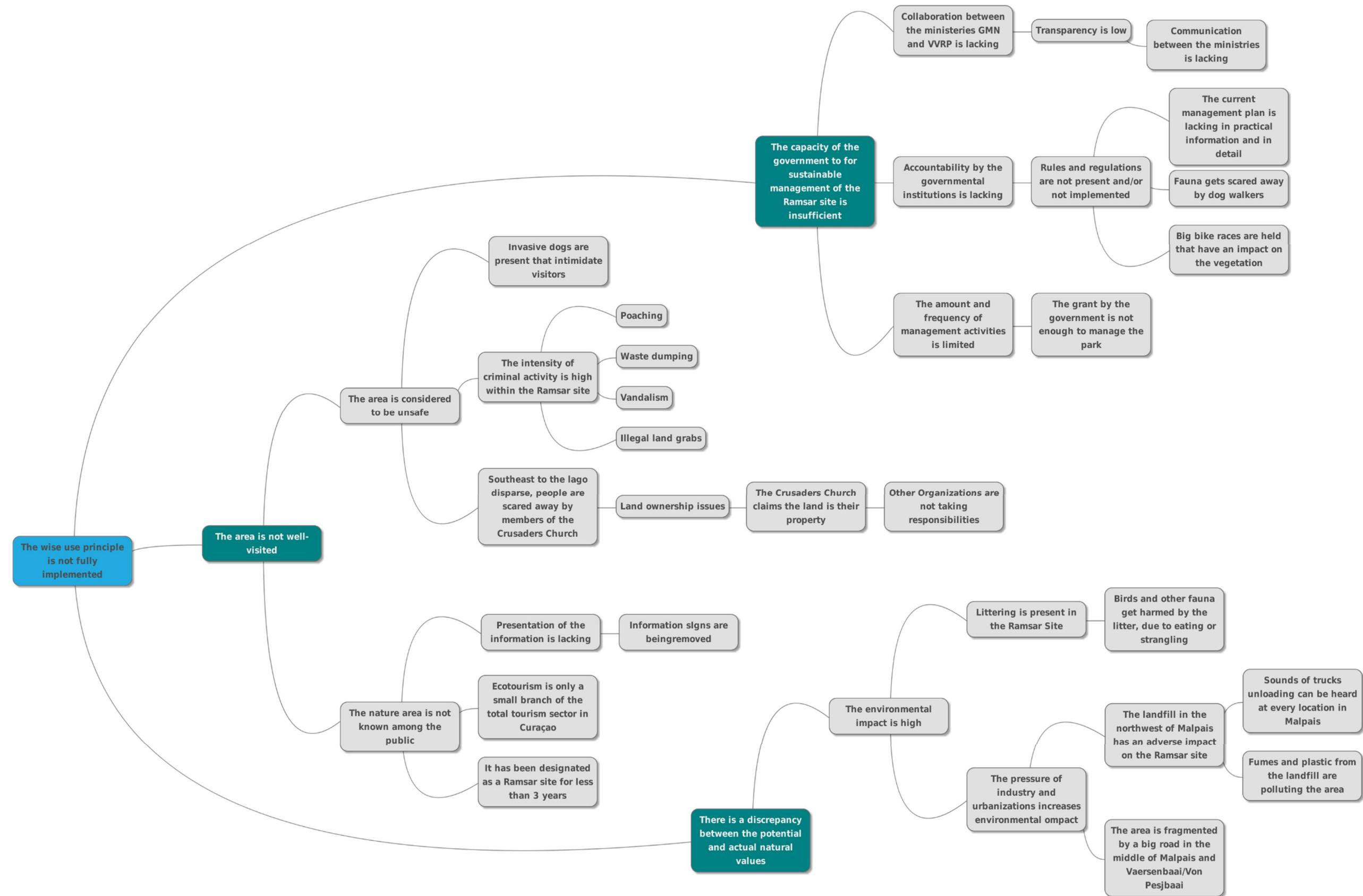
- Ramsar. (2014, September 29). *The Ramsar Convention and its mission*. Retrieved from Ramsar: <http://www.ramsar.org/about/the-ramsar-convention-and-its-mission>
- Ramsar. (2014, October 14). *The Wise Use of wetlands*. Retrieved from Ramsar: www.ramsar.org/about/the-wise-use-of-wetlands
- Ramsar. (2015, September 5). *Contracting Parties to the Ramsar Convention*. Retrieved from Ramsar : http://www.ramsar.org/sites/default/files/documents/library/contracting_parties_list_e.pdf
- Ramsar Convention Secretariat. (2010). *National Wetland Policies: Developing and implementing National Wetland Policies* (4th ed., Vol. 2). Gland, Switzerland: Ramsar Convention Secretariat.
- Russi, D., ten Brink, P., Farmer, A., Badura, T., Coates, D., Förster, J., . . . N, D. (2012). The Economics of Ecosystems and Biodiversity for Water and Wetlands. *UNEP/CBD/COP/11/INF/22*. Hyderabad, India: UNEP.
- Schoonmaker, K. (1999). Rapid Rural Appraisal (RRA) and Participatory Rural Appraisal (PRA): A Manual for CRS Field Workers and Partners. Baltimore: CRS.
- Snoke, A. W., & Noble, P. J. (2001). Ammonite-radiolarian assemblage, Tobago Volcanic Group, Tobago, West Indies—Implications for the evolution of the Great Arc of the Caribbean. *Geological Society of America Bulletin*, 113(2), 256-264.
- Taylor, M. A., & Alfaro, E. J. (2005). Climate of Central America and the Caribbean. In *Encyclopedia of world climatology* (pp. 183-189). Springer Netherlands.
- USGS. (2016, March). *USGS Earth Explorer*. Retrieved from USGS: <http://earthexplorer.usgs.gov/>
- Van Buurt, G., Faraclas, N., Severing, R., Weijer, C., & Echteld, E. (2009). A short natural history of Curaçao. *Crossing Shifting Boundaries, Language and Changing Political status in Aruba, Bonaire and Curacao*. 1, pp. 229-256. Dominica: Proceedings of the ECICC Conference.
- Van den Goorbergh, F., & Scheffers, J. (2012). *Participatie @ groene ruimte*. (V. Hall-Larenstein, Ed.) Wageningen: Landwerk.
- Vermij, M. J., & Chamberland, V. G. (2012). *Information Sheet on Ramsar Wetlands (RIS)*. Carmabi. Willemstad, Curaçao: Ramsar. Retrieved from <https://rsis.ramsar.org/RISapp/files/RISrep/NL2117RIS.pdf>
- Volkscrant. (2003, December 20). Eilanden van de zon, zee en coke. (T. Koelé, & S. Ramdharie, Eds.) *de Volkskrant*.
- Voous, K. H. (1983). *Birds of the Netherland Antilles*. Zutphen: Walburg Pers.
- Wright, J. E., & Wyld, S. (2010, August 1). The Albion-Turonian Island Arc Rocks of Tobago, West Indies: Geochemistry, Petrogenesis, and Caribbean Plate Tectonics. *J Petrology*, 54, 1607-1639.

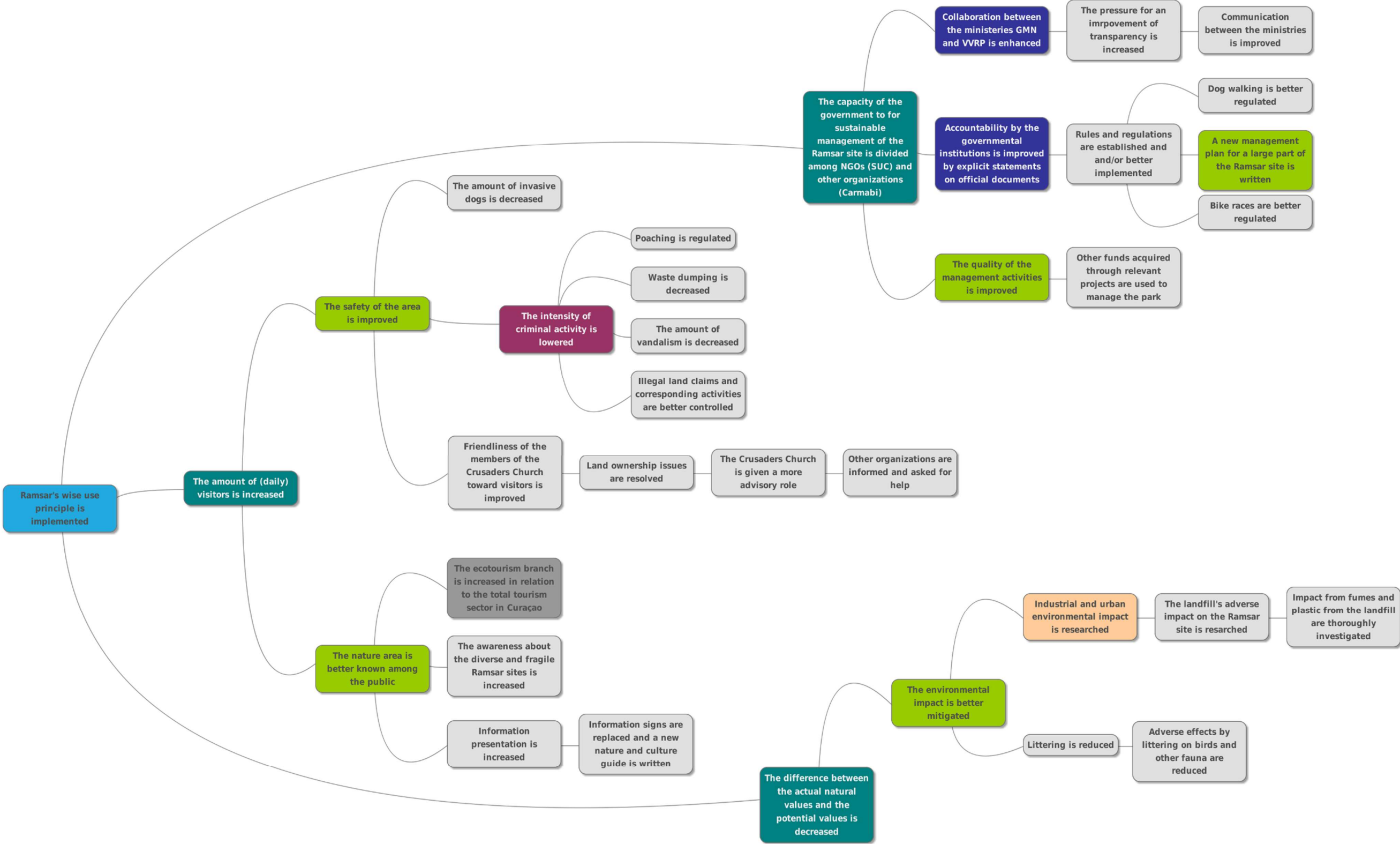
ANNEX

Annex I Log Frame Matrix

Objectives				
Overall objective Establish and rehabilitate new nature areas and parks while increasing awareness about nature and its services among the local population.				
Purpose Enable "Uniek Curacao" to autonomously set up management plans and carry out the management activities in a systematic way.				
Results	Indicators	Verification Source	Assumptions	
R1 Management plan document of a (new) natural park is developed.	I1A Detailed description of the natural resources within the park is given. I1B Objectives are set that address the needs and expectations of the different stakeholders. I1C A subdivision of the park into management compartments. I1D Activities to achieve these objectives per compartment are stated and planned. I1E Contains various relevant maps of the park: Geological Maps; (Potential) Vegetation Map; Infrastructure and ecotourism maps; Annual management map.	V1.1 Part 1 of the submitted thesis in the thesis repository of Van Hall Larenstein, University of Applied Sciences in Velp. V1.2 Archive of the Uniek Curacao Foundation.	A1 Insufficient capacity or budget to carry out the inventory on natural resources due to reliance on volunteers.	
R2 A management plan guide for future natural parks is provided.	I2A A step for step management plan is supplied that contains instructions on writing and setting up a future management plan on Curaçao, including: explanation of LFA; problem & stakeholder analysis; setting SMART objectives and a detailed methodology. I2B An open source QGIS software guide that describes all necessary steps to take to perform all necessary geoprocessing from the GIS data of the provided database from R2 is included in its annex. These steps include: creating new shapefiles; using geoprocessing tools and lay-out functions.	V2.1 Annex of the thesis. V2.2 Archive of the Uniek Curacao Foundation.	A2 The management plan guide is sufficiently applicable to future situations and corresponds to the new needs and requirements.	
R3 A comprehensive database of relevant information is established.	I3A Geodatabase is included with GIS data of Curaçao: Elevation data; Topography; Geology; Geomorphology; Vegetation; Satellite images; Spatial planning. I3B Scientific literature is assembled in a dossier that contains data on both biotic and abiotic processes that influence the island.	V3.1 Folder on an online cloud service that the foundation has access V3.2 Screenshots are supplied in the annex of thesis part 2 document.	A3 The availability of scientific literature is insufficient and the necessary geodata is not available.	

Annex II Problem Tree





Annex IV Interview structure

Theo van der Giessen (SUC director)

- Can you describe in general what Stichting Uniek Curaçao is about?
- Can you describe its internal organization?
- What is the mission of SUC?
- Can you describe the environmental problems in Malpais?
- How does SUC combat littering?
- Does SUC know what the implications of the EOP are?
- And other laws and policies?
- What is the effectiveness of the implementation of laws and regulation on Curaçao?
- What does the land ownership conflict in Malpais look like?
- What is the role of ROP?
- For what activities are permits required?
- How does this process of requesting a permit go?
- Is there a solution to his obstacle?
- How important is environmental impact for the government?
- Should more policies and regulations must be developed regarding nature and environment?

Terrence Ching (Park ranger)

- Are there obstacles for SUC in nature management? Could you give a couple of examples?
- What is the advantage of these guides and signs?
- Has the Ramsar designation changed anything?
- What is the relation of GMN and VVRP to the Ramsar convention?
- Can you describe the waste management situation within the conservation areas in general?
- What is Selikor's role exactly?
- What is the government's stance on the waste management situation?
- Are environmental impacts taken into proper consideration by the government?
- What would your advice be regarding an improvement of nature management?
- What is your opinion on the implementation of policies and laws in nature? i.e. law enforcement?
- Could you give a history of the illegal activities relating to the landownership issues in Malpais?
- What is VVRP's (ROP) role in this situation?
- Have you got any recommendations toward a better implementation?

Mirjam Joncker (ROP)

- What is the influence of the ROP and VVRP?
- Can you describe the relation of ROP with SUC?
- Could you describe the procedure for a permit?
- What are the conditions on which a permit will be granted?
- Could you describe the capacity of ROP regarding law enforcement?
- Are environmental concerns taking into consideration?
- Do you think the capacity of ROP and cooperation with other organizations should be increased?

Paul Stokkermans (Carmabi)

- What are Carmabis experiences regarding nature management?
- Can you describe Carmabis relation to governmental institutions?

- Has anything changed over the years regarding the approach toward nature conservation?
- Does Carmabi perform activities without a development permit?
- Could you explain more about VVRPs role in executing the EOP?
- What is Carmabi's opinion on nature conservation in general in Curaçao?

Faisal Dilrosun (GMN)

- Can you describe the relation between GMN and SUC?
- Can you describe the relations and influence of GMN with the other ministries?
- Can you describe the relation with ROP (VVRP) in detail?
- What can GMN do to influence the permit process?
- Can you describe the procedure when an illegal environmental situation takes place?
- How can extraordinary police officers offer support?
- What is the job of the minister of VVRP and of GMN?
- What would be the next step for a successful implementation of nature and environmental policies?

LOCAL RESIDENTS

Schools

Schools are invited on a regular basis to visit the nature areas so a tour guide can teach the children about nature and its importance. Therefore, Children form an important group because they are part of the future population. Many ecosystems on Curaçao, such as coral reefs and mangroves fulfil important functions (climate control, storm mitigation) and need to be protected. The only way to do this is to emphasize on their importance, which starts already at youth. Hence, children are also included in some of the management activities, such as organized clean-ups so they can observe the harmful effects on nature at first hand.

Scouting

Although outdoor activities are not very popular among the adult population, there are many scouting groups present on the island. These group host a whole range of activities, from camping to education. They form an important group as many scout members are children and form the next generation and thus also share a big overlap with the school subgroup.

Fishers

Close to the bays of Vaersenbaai and Von Pesjbaai several fishers are active. Most of these fishers use simple fish lines; some of these fishers use nets, but they are required to have a license to do so. Fishers are not specifically bound to the location; they fish close to the complete coastline of the island. Several species are popular among the fishers including

Illegitimate users

Poverty in Curaçao is often related to opportunistic delinquencies and therefore robberies sometimes take place, especially vehicle burglary is an activity that is frequently reported. Next to this, other criminal activities have been going on in the area: Poaching, vandalism, waste dumping, (illegal) land claims and drug deals. Waste dumping is not limited to household waste as deceased dogs are also often dumped in crates or boxes. Not only is this a visually dissatisfying sight, but it also causes a penetrating odour due to the rotting process. Due to illegal activities, other stakeholders can feel threatened and unsafe and therefore this group has the biggest (negative) impact on the other stakeholders.

Dog walkers

Since dogs are popular pets among the local population, dog walkers form a part of this stakeholder group. Often a group of dogs is taken into the area instead of one dog. These groups of dogs can scare birds away and also defecate on paths and in the Saliña.

TOURISTS

Hikers

SUC has had an excellent success selling their renowned Curaçao Hiking Map and gained revenue of the vending of these maps. Hiking routes were not well-known before the construction of this map and therefore hikers form an important asset and can be considered the largest subgroup of the Tourist stakeholder group. However, a large part of the composition of this group is foreigner. SUC wants to increase this composition in the favour of local residents, but currently the local population has not experienced this type of recreation and still needs to 'learn' how to hike.

Divers

Vaersenbaai and Von Pesjbaai have aesthetically pleasing coastlines, mainly because of the clear water and coral reef. However, divers do not form a big part of the tourist stakeholder group. The reason is that there is no diving school located within a close distance to the Von Pesjbaai and the hard to reach coastline due to the installed boom barrier at the entrance. Therefore, divers form a potentially growing subgroup within this stakeholder group. Currently, most divers are visiting the coastline of these bays either individually or in small groups. Both local residents and foreign tourists fall under this group and thus overlap, although foreigners still can be considered the majority of divers in the area.

Campers

In the past camping in and around several zones within the Ramsar site was popular. However, since the increase in illegal activities, this group has declined noticeably. Nevertheless, it still forms a potentially interesting group of outdoor passionate people.

Mountain bikers

The Ramsar site is relatively popular among mountain bikers who visit the area by car and unload their bicycles to ride through the Ramsar site. SUC has not established official mountain bike routes, hence they often combine several hiking trails together. Some major mountain bike events are hosted annually in Curaçao where larger groups of bikers come together to race each other competitively and regulations are not thoroughly established regarding these events.

GOVERNMENT

Ministry of Health, Environment and Nature (GMN)

The ministry of Health, Environment and Nature (GMN) is the official responsible body for managing the Ramsar site. However, they do not have the capacity to implement the policies and guidelines according to nature management of a designated conservation site, especially a Ramsar site. Consequently, GMN contracts other organizations – SUC, Carmabi – to implement the management activities. GMN are entitled to the same rights as the Ministry of Traffic, Transport and Spatial Planning (VVRP) but are, unlike VVRP, not the legal owners of the areas. Nonetheless, GMN can be considered as the most important governmental body that can adapt rules and regulations.

Ministry of Traffic, Transport and Spatial Planning (VVRP)

As stated above, VVRP is the ministry that holds the official landownership. Before the eighties, the multinational Royal Dutch Shell company was the legal landowner of the area. After the departure of Shell company from the island they sold all their land to the government for a symbolic amount of 1 ANG. On paper the legal land owner now is Domeinbeheer, which is part of VVRP. Although, since the release of the Spatial Zoning Plan (EOP) in 1995, all of the SUC contracted areas within the Ramsar site are officially managed by GMN. The governmental service Spatial Planning and Development (ROP) falls under the VVRP ministry and is the official responsible body for directing law enforcement. However, the

ORGANIZATIONS

Stichting Uniek Curaçao

SUC has a maintenance contract with GMN and CTB to manage the area. Keeping the area clean is one of the main activities in the park and most of the funds received go towards maintaining the Ramsar site clean. Unfortunately, because this restricts other management activities that could help towards a better rehabilitation of the degraded areas within the Ramsar site. Path maintenance forms the other important regular activity. Irregular activities mainly include facilitation and reparation of facilities that were already in place but have been damaged by vandals and/or storms. Facilities include recycle bins, picnic tables and stairs. SUC is also a central organ in the hosting of tours and events. Because of all these features, SUC has the biggest overlap with all stakeholders.

Carmabi

Carmabi is a research station located in the North-West of the island. It has been established in 1955 and many researchers have visited and contributed towards sustainable nature development over the years. Carmabi has had a major role in the appointing of the Ramsar site Malpais/St Michiel and also supported in the collection of the necessary data for its recognition as Ramsar site. Carmabi primarily has an advisory responsibility regarding nature management. Their broad network also offers many valuable contacts. On a governmental level they can also have a noticeable impact.

Selikor

Selikor is the organization that runs the land fill that is located in the north west of Malpais. It has been in operation since 1985 and is the island's biggest waste management organization. Sounds of the trucks that stop to dispose their waste can be heard clearly throughout Malpais. Smoke plumes from the incineration process are also clearly visible.

Crusaders Church

The crusaders church is a church located in Malpais. It forms a community of religious members and has been in the area before Royal Dutch Shell's land donation. Moreover, the owner of the church had a contract with shell of a small part of Malpais. This previously land under contract is located in the south-east of Malpais and a very healthy vegetation grows here because of the moist soil conditions. The church still sees this land as their property up to this day. However, the

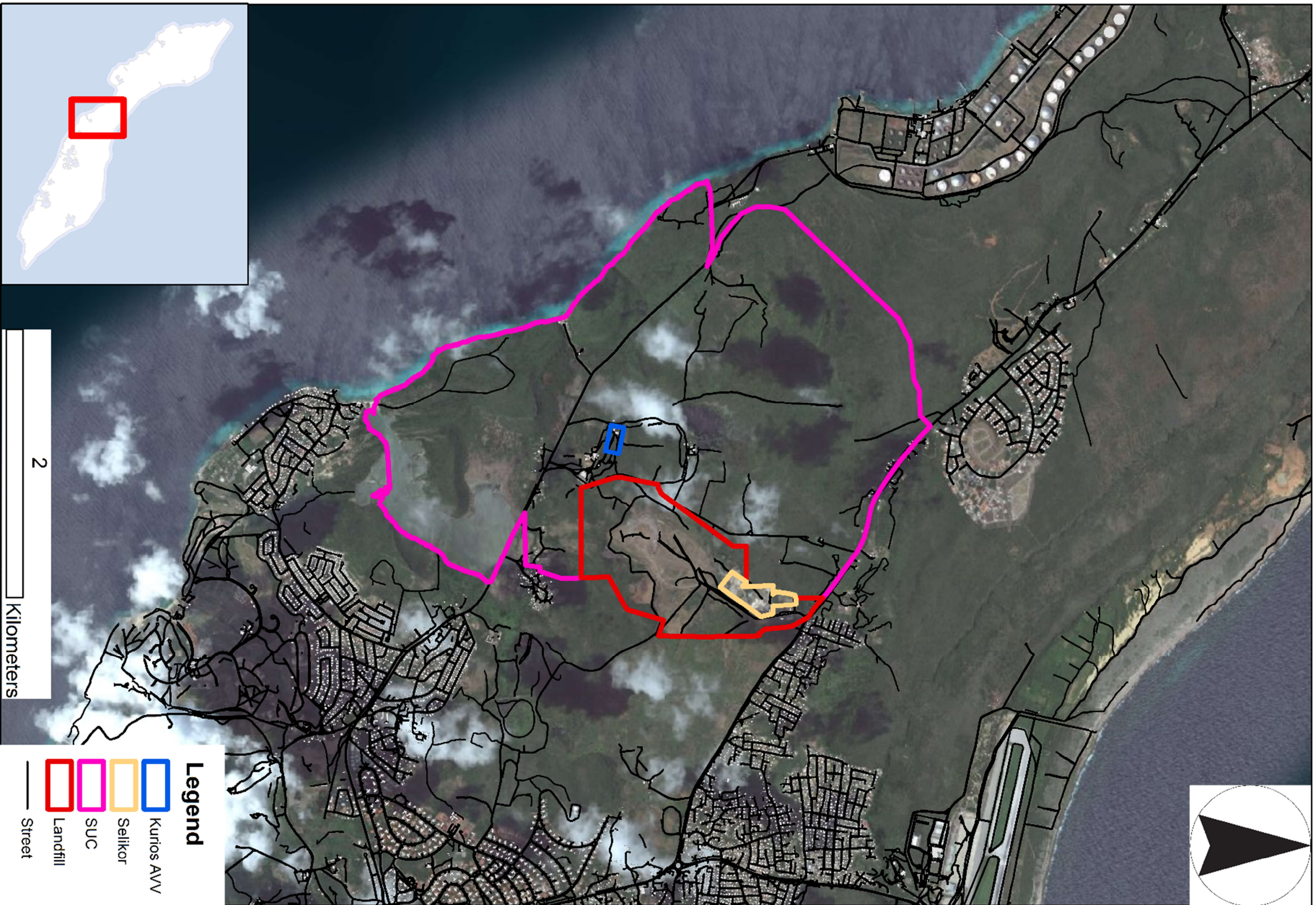
Renegades paintball association

The Renegades paintball association is located close north to St Michiel and the east of the Crusaders Church. It has no official license and their agreement is made with the Crusaders Church.

Other Tour operators

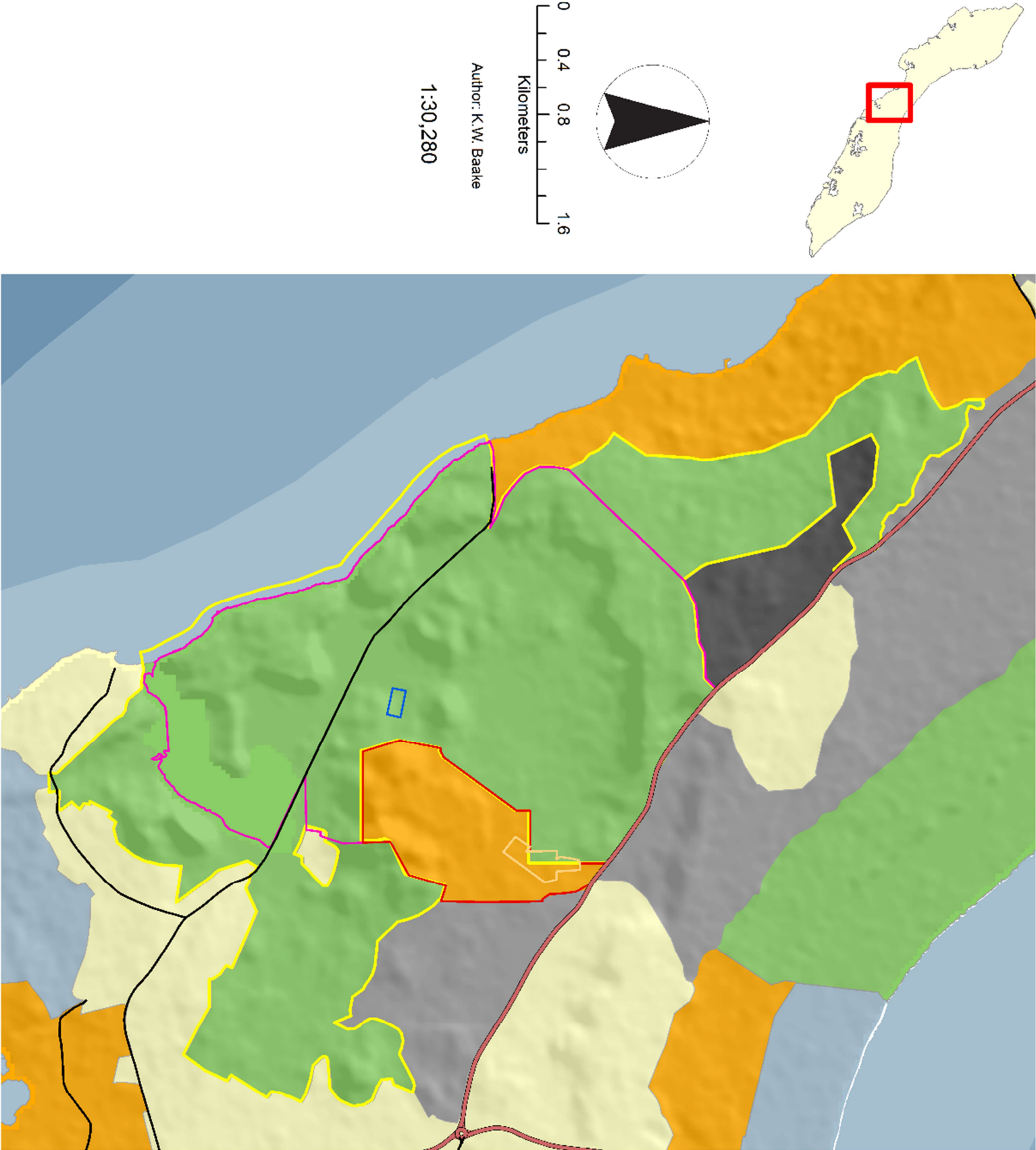
There are several other organizations active. Such as the Carribean Footprint organization or Mondi addiction. These operators host informational walks in the area, but have been less active in the last few years, because of land ownership conflicts.

Topographic Map Malays/St. Michiel

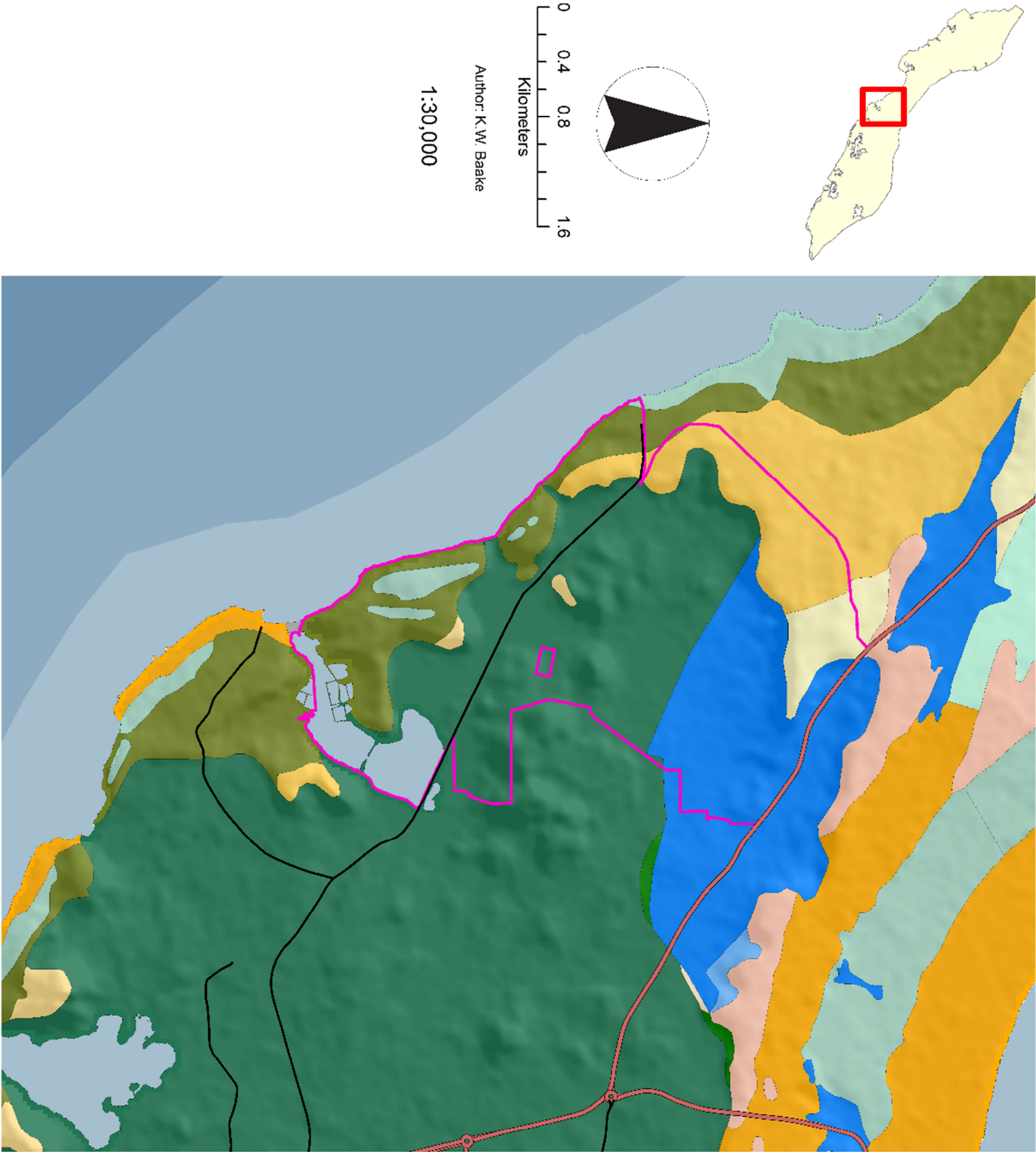


Ramsar Area Malpais/St Michiel

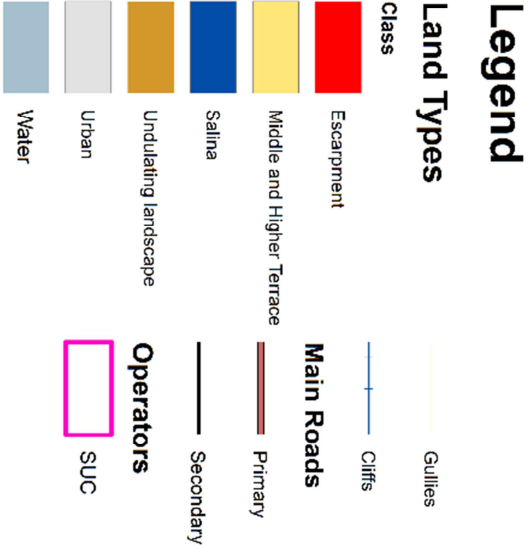
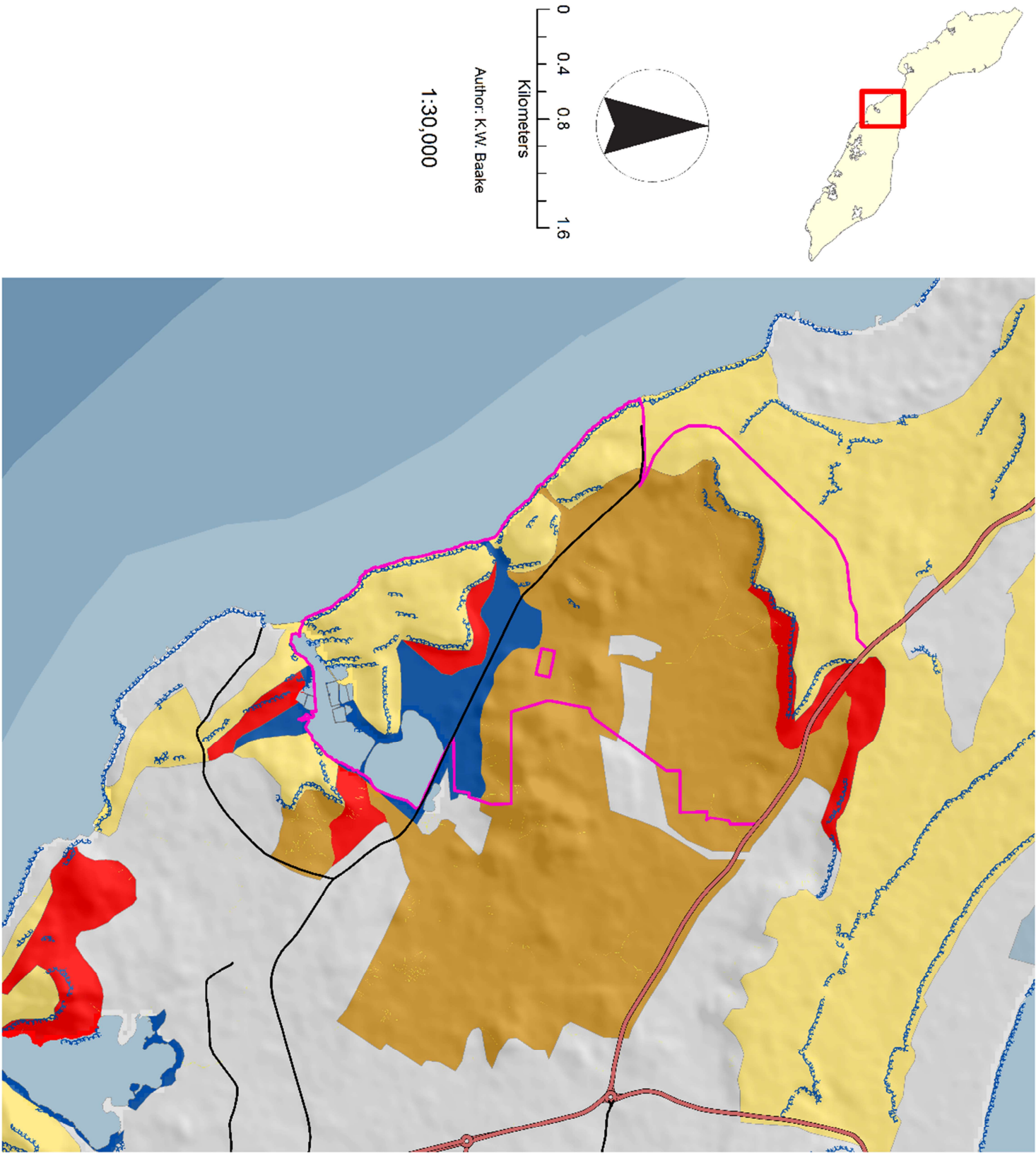
Zonation Plan (EOP)



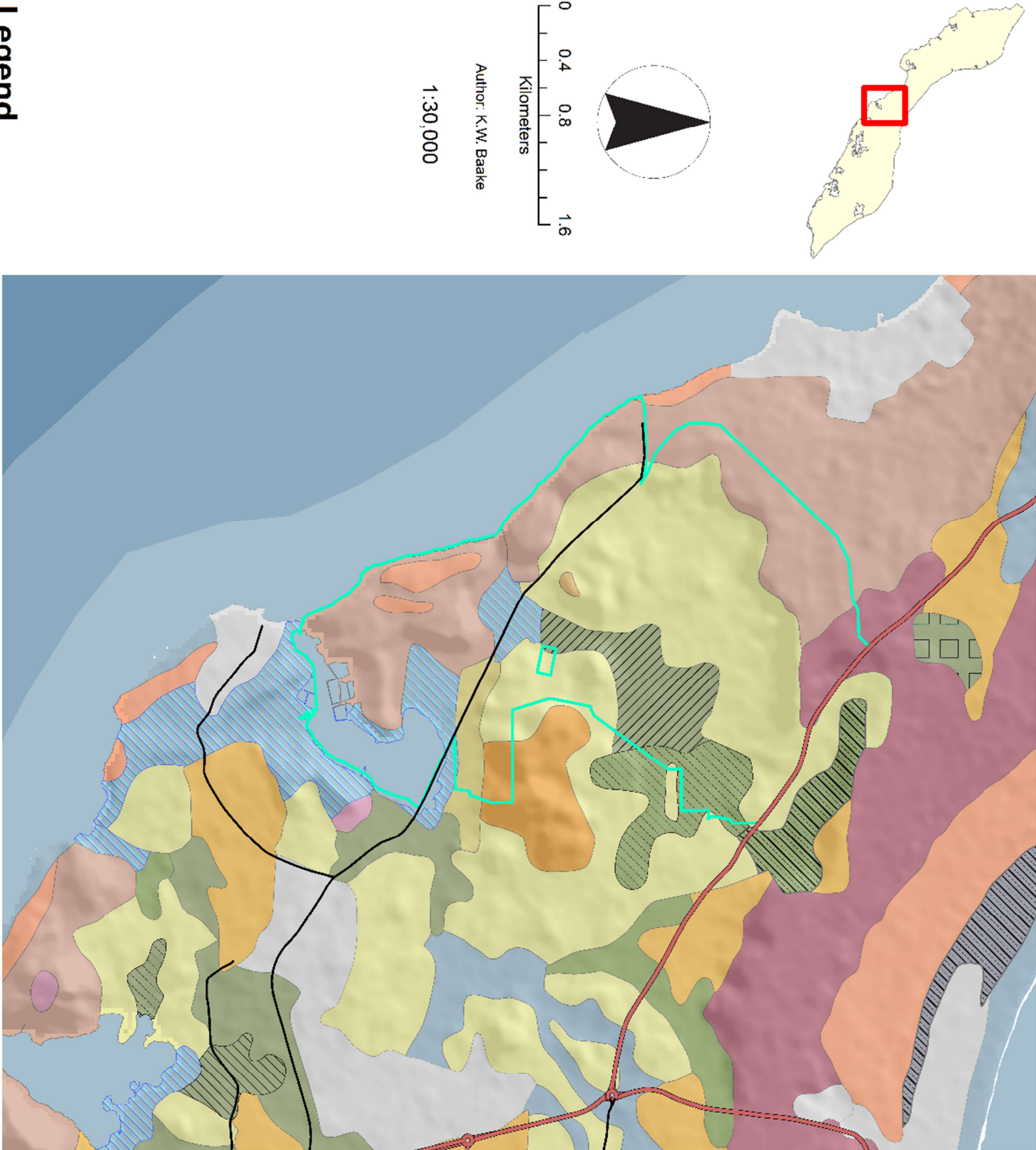
Geological Formations Malpais/St Michiel



Land Types Malpais/St Michiel



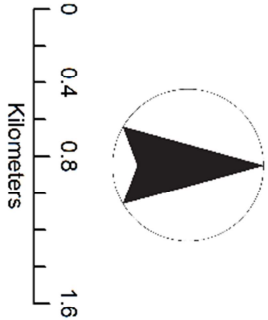
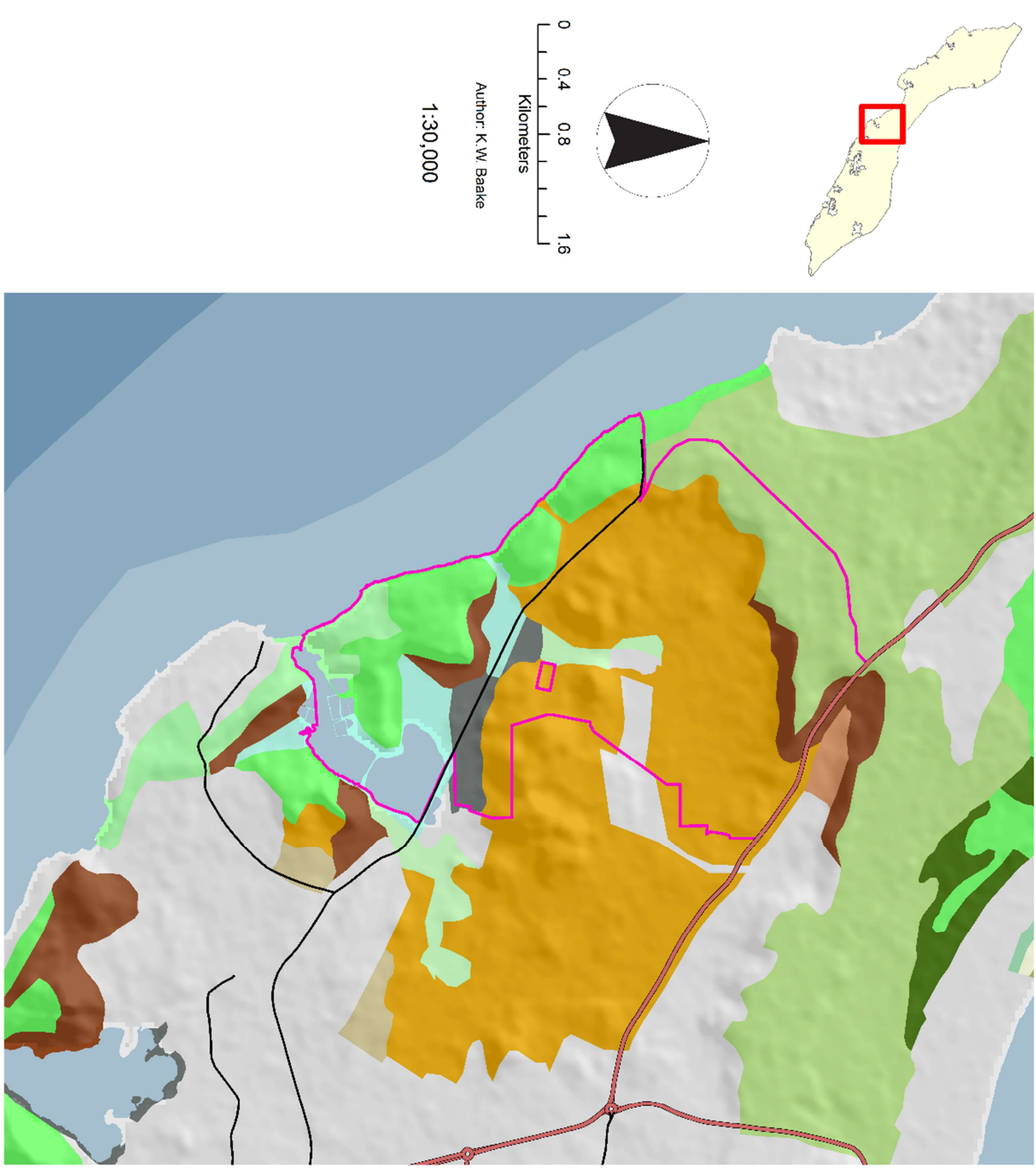
Soil Types Malpais/St Michiel



- Legend**
- Soil Types**
- Lagunal soils of lower depositional terrace (nearly level)**
- cTab Predominantly (moderately) deep clayey soils. *
- Rock land of depositional and erosional terraces**
- Tm Middle terraces, flat, partly slightly dipping.
 - Tn Higher terraces, slightly dipping.
 - Te Various erosional terraces, dipping.
 - Tr Terrace remnants, (stony)rock land, eroded.
 - Tx Rocky plateau land and cap-rocks, dipping.
- Hilly land (on Diabase formations)**
- Dh High hills.

- Soil Types**
- Dm Medium high and/or low hills.
 - Du Undulating land with low hills.
- Valley land (on Diabase Formations)**
- Dv Complex valleys with root system and dams.
- Roof bottom and plain soils (Predominantly nearly level)**
- cAb9 Predominantly (moderately) deep clayey soils. *
 - lAb9 Predominantly (moderately) deep loamy soils. *
- Miscellaneous**
- U Urban area
 - Sa Salina, strongly saline.
 - Water
- Salinity**
- (se) Predominantly slightly saline soils
 - (se)/sa Slightly saline and saline-(alkali) soils
 - sa Predominantly saline soils
- Modifier**
- c Heavier textured subsoil
 - ch Cherty texture
- Main Roads**
- Primary
 - Secondary
- Operators**
- SUC

Vegetation Types Malpais/St Michiel



Autor: K. W. Baake

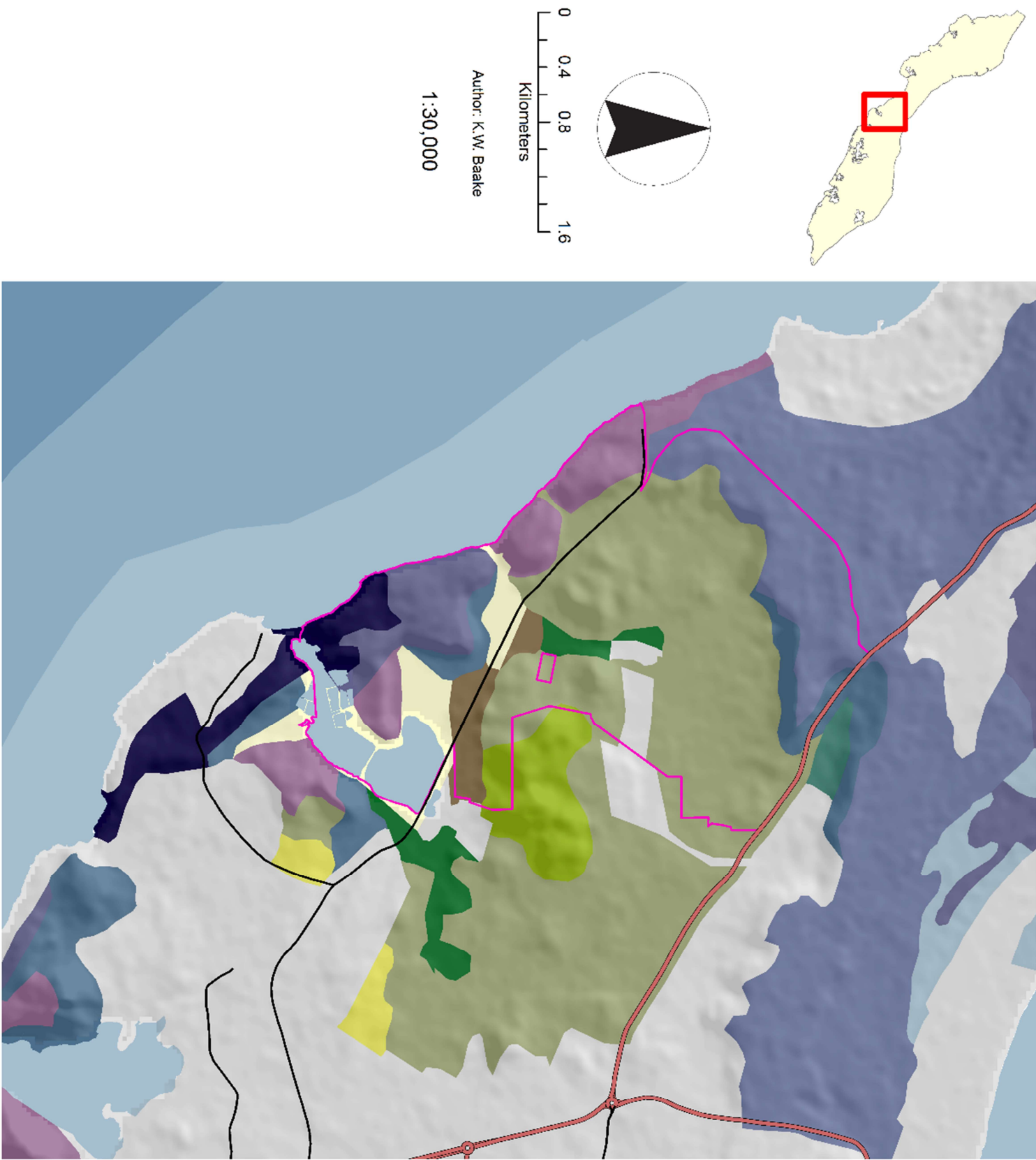
1:30,000

Legend

	Mixed evergreen-deciduous thorn woodland		Sclerophyllous evergreen shrubland		Main Roads
	Sclerophyllous evergreen woodland		Mixed evergreen-deciduous Acacia shrublands with succulents		Secondary
	Hemisclerophyllous evergreen woodland		Mixed evergreen-deciduous Acacia shrublands with succulents		Operators
	Sclerophyllous woodland and hemisclerophyllous evergreen woodland		Tidally flooded perennial forb vegetation		
	Sclerophyllous & mixed evergreen-deciduous thorn woodlands		Dunes with sparse vegetation		
	Mixed evergreen-deciduous shrubland & forb-grassland with succulents		Pavement vegetation (Conocarpus- Euphorbia)		
	Mixed evergreen - drought-deciduous dwarf shrubland		Urban and/or industrial		
	Succulent evergreen shrubland		Water		

Vegetation Classes Malpais/St Michel

Landscape Ecological Vegetation Classes



Legend

Landscape Ecological Vegetation

D2	Croton-Aristida landscape
D3	Croton-Acacia glauca landscape
D4	Acacia tortuosa-Prosopis landscape
D5	Bourreria-Haematoxylon landscape
D7	Hippomane rooi
E	Bourreria-Acacia tortuosa escarpment

S1	Sesuvium salina
S2	Conocarpus salina
T2	Croton-Acacia tortuosa terrace
T3	Haematoxylon-Bourreria terrace
T4	Coccoloba-Erithalis terrace
T5	Haematoxylon-Rhynchosia terrace
Urban	Urban landscape
Water	Water

Main Roads

Primary
Secondary





























Operators

SUC

Hiking Map Malpais



Legenda

	Beach		Panoramic view		Flamingo trail
	Ruins		Well		Papaya trail
	Item of interest		Plantation house		Jamanica trail
	Food/Drinks		Picnic area		Bini trail
	Flamingo's		Closed entrance		Roi Kenepa trail
	Entrance Walking Area		White-tailed deer		Coast trail
	Waterbird		Important birds		SJC management
	Dam		Landf II		Small road
	Hyper Saline Lagoon				Main road
					Sea
					Woods

Annex IV Schedule

Activity #	Location	Activity Description	Executive steps	Responsible	Date
A 2.3	Malpais	Clean-Up Activities	Step 1: Clean up along the paths and empty waste containers	Park Rangers (SUC)	Ongoing
A 2.6	Malpais	Path Maintenance	Step 1: Remove dead trees, cut overhanging branches, prevent gully formation	Park Rangers (SUC)	Ongoing
A 3.2	St Michiel	Clean-Up Activities	Step 1: Clean up along the paths and empty waste containers	Park Rangers (SUC)	Ongoing
A 3.4	St Michiel	Monitor The Inlet Boca of the St. Michiel Salina.	Step 1: Establish the base line Step 2: Measure height of silt (Step 3: If measurements are too high, contact government and devise a new plan of action)	Carmabi/SUC	Ongoing
A 4.2	Vaersenbaai/Von Pesjbaai	Clean-Up Activities	Step 1: Clean up along the paths and empty waste containers	Rangers (SUC)	Ongoing
A 1.1	General	Request for Management Permissions	Step 1: Request letter is drafted Step 2: Letter with attachments are sent	Director (SUC)	Sep-16
A 2.1	Malpais	A Resolution Is Made with The CC	Step 1: The church council is contacted Step 2: A meeting is arranged and needs and requirements of the church are identified Step 3: An agreement is made	Director (SUC)	Sep-16
A 1.2	General	Renew and Improve the Management Contract	Step 1: Contract proposal, including delineation and responsibilities Step 2: Draft proposal together with GMN Step 3: Signing of the final contract by both VVRP (Domeinbeheer) and GMN	Director (SUC)	Oct-16
A 2.2	Malpais	Update Rules and Regulations Sign	Step 1: Verify and add categories Step 2: Write detailed description of ruleset Step 3: Establish a design and format for the rules and regulations sign Step 4: Request development permit Step 5: Place sign	Volunteer (SUC) & Director (SUC)	Oct-16
A 3.1	St Michiel	Update Regulations and Place Sign	Step 1: Verify and add categories Step 2: Write detailed description of ruleset Step 3: Establish a design and format for the rules and regulations sign Step 4: Request development permit Step 5: Place sign	Volunteer (SUC) & Director (SUC)	Oct-16
A 4.1	Vaersenbaai/Von Pesjbaai	Update Regulations and Place Sign	Step 1: Verify and add categories Step 2: Write detailed description of ruleset Step 3: Establish a design and format for the rules and regulations sign Step 4: Request development permit Step 5: Place sign	Volunteer (SUC) & Director (SUC)	Oct-16
A 4.3	Vaersenbaai/Von Pesjbaai	Upgrade Visitor Facilities	Step 1: Construct 2 new waste containers Step 2: Place waste containers at their locations	Park Rangers (SUC) & Volunteer (SUC)	Oct-16
A 2.4	Malpais	Place New Informative Signs	Step 1: Finish management plan Step 2: Extract useful data Step 3: Create a design for the signs Step 4: Sent signs to press Step 5: Place sign	Intern (SUC) & Director (SUC)	Nov-16
A 2.5	Malpais	Facility Upgrades	Step 1: Construct 2 new waste containers Step 2: Place waste containers at their locations	Park Rangers (SUC) & Volunteer (SUC)	Nov-16
A 2.8	Malpais	Detailed Bird Breeding Site Inventory	Step 1: Contact Carmabi and volunteers Step 2: Write a proposal Step 3: Acquire funding Step 4: Carry out inventory	Carmabi/SUC	Nov-16
A 1.5	General	Develop Programs for Tours	Step 1: General tour Step 2: Cultural historical tour Step 3: Redevelop a treasure hunt program Step 4: Herbal medicine tour	Intern (SUC)	Dec-16
A 4.5	Vaersenbaai/Von Pesjbaai	Management of The Invasive Lionfish	Step 1: Gather list of volunteer divers Step 2: Contact divers Step 3: Assign a team Step 4: Create planning with team Step 5: Establish sustainable procedure guidelines for lionfish hunting	Park Ranger (SUC) & Volunteers	Dec-16
A 2.7	Malpais	Address Restoration of Malpais Dam	Step 1: Establish a letter to LVV Step 2: Contact journalists of Amigo / Antiliaans Dagblad	Director (SUC)	Jan 17
A 1.4	General	Propose an Extraordinary Police Officer	Step 1: Propose a candidate for designation Step 2: Write a recommendation letter to VVRP/GMN? Step 3: Raise funding for the traineeship Step 4: Establish a working schedule and assign responsibilities	Director (SUC) & Park Ranger (SUC)	Feb-17
A 3.3	St Michiel	Organize Free Activities for Local Residents	Step 1: Organize a neighbourhood meeting and identify volunteers Step 2: Develop a program and a route with volunteers Step 3: Facilitate the event	Front Desk Intern (SUC)	Feb-17
A 1.3	General	Establish The Outline for A National Wetland Policy	Step 1: Outline of the national wetland policy is made by following the Ramsar handbook Step 2: Send the national wetland policy draft to the minister Step 3: Put the national wetland policy on the agenda in the parliament	SUC/ Carmabi /GMN	May-17
A 4.4	Vaersenbaai/Von Pesjbaai	Place Reef Balls	Step 1: Determine location Step 1: Raise funding Step 3: Buy reef balls Step 4: Place reef balls	Volunteers (SUC)	Aug-17
A 2.10	Malpais	Management Feral Dogs	Step 1: Dogs are shot by an extraordinary police officer	Extraordinary Police Officer	Jun-17
A 2.9	Malpais	Environmental Impact Assessment	Step 1: Research proposal is written Step 2: Assessment is conducted	Carmabi/GMN	-
A 1.6	General	Assign an Independent Ecologist	Step 1: Propose a candidate (Carmabi) Step 2: Establish the necessary budget Step 3: Create a monitoring plan and assign responsibilities.	Carmabi/GMN	-

Nature Management Guide Curaçao

Part of the Tropical Forestry and Nature Conservation
Bachelor Thesis



Kees Baake 2016



1. Guide introduction

Since 1995, Curaçao established a Zoning Plan (EOP) that designates every part of the island to a certain category, of which one of these categories is nature conservation. These designated conservation areas ask for a proper management, so that the ecosystem services and goods they provide are used in sustainable way. Therefore, a plan needs to be developed, such a plan is called a nature management plan.

SUC has been active in nature management and park maintenance for over 25 years and has done so through the help of volunteers and interns. Its legal form is a NGO and it is completely dependent on donations in goods and money by thirds. Although many success has been achieved, the foundation is aiming to improve its management and the improvement of the quality of their management plans is a step into this direction.

For the carrying out and writing of a nature management plan of sufficient quality, certain steps and guidelines need to be followed. This guide provides these guidelines and steps, so that SUC can increase their field of operation and provide documents that help in the acquirement of new conservation areas. It also improves transparency and sets milestones for every objective achieved.

It must be noted, however, that this guide only described the steps and should not be used as a template for a nature management plan. For this reason, a high standard management plan of the Ramsar site of Malpais/St. Michiel was written (Baake, 2016). This sample management plan deals with layout and structure and can be used in combination with this guide to achieve its main purpose: Enable the reader to write practical management plans that are adapted to SUC's unique situation.

An effective management plan always starts with a thorough analysis. After the analysis, the implementation, i.e. management, can be written and implemented. This guide therefore first explains all the necessary steps needed to conduct the analysis and then explains how to translate this analysis into practical management activities.

2. Analysis

The first step of the analysis is the assessment of literature and the collecting of data in the form of maps, articles, journals and field data. After such a resource assessment, objectives can be set. These objectives must address the issues and problems present in the management area. So before relevant objectives can be set, a problem analysis must be made. However, every problem has a certain context, this context is provided by conducting the stakeholder analysis.

2.1. Resource assessment

The resource assessment is the first tool that is used to get a grip on the available resources within the area. Although this step is very important for the writer of the management plan, the section site description (which presents this assessment data) is included after the stakeholder and problem analysis. The reason for this is to put the focus on the problem and stakeholder analysis, which are more important for the reader because they relate directly to the objectives. These objectives can be measured during and after the project.

This collection is useful to get more insight into the terrain characteristics of the area; these range from geological, geomorphological, soil and vegetative characteristics, which are of course all interrelated.

In the chapter site description, a complete geographical overview is provided. This overview is constructed by collecting all available, scientifically relevant information about the management area.

2.2. Ecosystem services

Since the turn of the millennium, the nature conservation approach has shifted from a landscape approach to an ecosystem approach. Every ecosystem has important services for people, animals and vegetation. These services can be categorized under the following types: regulating, provisioning, cultural and supporting. Especially the regulating services fulfil important functions for humans and can have a major economic impact. For example, flooding and storms can have detrimental effect for residents on the island and nature can mitigate these extremities.

The government of Curaçao has not established any new policies and regulations that take these services into consideration and therefore a good example must be set that can shift the mentality and approach toward nature conservation on the island. Every management plan should therefore include a chapter that stresses the importance of these ecosystem services.

2.3. Stakeholder analysis

Stakeholders are all the individuals, groups and organizations that have an influence to or are influenced by the management area. These could range from terrain owners, government institutions, tourists, local residents to children. Many areas in Curaçao share the same stakeholders due to the small size of the island. Nevertheless, every area is unique and thus also has its own unique stakeholders.

The next step is the construction of representative diagrams to provide insights into the relationships between these stakeholders, i.e. how they overlap. Some stakeholders will share nothing with each other and others will have a large interconnectedness. If stakeholders have a large overlap, friction can occur between these stakeholders if a (new) problem comes into existence. After the construction of a problem tree (explained in the next paragraph) such problems can be related to these friction field.

2.4. Problem analysis

Once the stakeholder analysis has been conducted, the problem analysis can start. The easiest method is the formation of a logically structured problem tree that identifies the roots and causes of the problems. This tree can best be constructed during a brainstorm session. To get a broader overview, this brainstorm session can best be done in conjunction with other participants, such as the identified stakeholders.

The tree serves as a visual representation of all problems and is structured in such a way that the main problem is at the top and all causes are represented as branches and roots of this main problem. This means that by solving one problem in the tree, a contribution to the resolving of other problems – that are positioned above that problem – is made as well. The absolute distance between the two determines the effectivity. As stated before, the problem analysis is the foundation for the objective tree.

3. Implementation

3.1. Objectives

The main goal of the analysis was to set logically consistent objectives. The problem tree can be used directly to set objectives by matching realistic objectives with the corresponding problems. What becomes evident after exe-

cutting this step is that some objectives cannot be achieved. However, the objectives underneath these unachievable objectives can be achieved and therefore they can make a contribution to the overarching objective. It can also be the case that a close collaboration is needed with other stakeholders to tackle the underlying problem.

Therefore, the next step is to divide these objectives into achievable and realistic results that can, ideally, be measured. Once these are described, the management activities can be established. However, for an effective management in the field a zonation is necessary.

3.2. Zonation

Every area has different landscapes and habitats. Some areas are restricted because, for example, important birds breed there. Some areas are visited frequently; other areas are less popular. Therefore, the management activities will differ from area to area. Zonation is a tool that divides the area in zones, and every zone has a different approach.

Areas which have a high ecological value, should have a more non-committal approach and areas that are close to the entrances should have a more park like management with facilities for the visitors. The site description forms an important part of the process to determine these different management zones; vegetation, soil and geological maps form the basis for the delineations. An inventory of nesting birds and other important fauna would also be very useful, but in practice, especially for SUC, this might be a more cumbersome process. Other organizations can help in the determination of these areas.

3.3. Management activities

Once the zonation process is completed, the management activities can be established. From the results and objectives several activities are deduced and divided among the different zones. A detailed description is given and it is made clear to what effect the management activity has. It is important to set realistic activities that match with the implementing organization, otherwise the results are not met and the effectivity of the management cannot be assessed.

After the management activities have been described, they can be planned. A management plan will provide an outline, especially of the first year, but revisions must be made to keep it up to date with annual working plans. After the planning of the activities, the budget can be determined. In the case of SUC, this estimation can attract donors and the rest of the management plan gives an assurance of the effectivity for these donors.

4. Future outlook

4.1. Sustainability and impact

If the implementation works out as planned, a certain impact can be expected. The impact is important for funders and government officials as the expectations of the management activities are summarized in this chapter. There are several types of impacts, these are: Economic impact, Socio-cultural impact and ecological impact. These impacts can be directly related to the people, planet and profit approach, i.e. a plan is considered to be sustainable if these three 'p's are taking into consideration.

Economic impact addresses the effects on the local economy through new job offers, new businesses, etcetera.

Socio-cultural impact addresses the mentality change among the population after the activities have been carried out.

Ecological impact addresses all the beneficial effects that are expected on the fauna and flora, i.e. biodiversity.

4.2. Monitoring and revision

Not everything can be predicted, hence the management plan is subject to (small) changes and adaptations. Through monitoring activities, the effectivity of the management activities can be assessed and if they are not effective enough a new management activity should be established. In this chapter you describe which characteristics must be measured and to what degree to give a proper representation of the effect of the management activities.

It is recommended that every year a new annual working plan is made that points out the important activities for that year. This annual working plan addresses all the revisions and comes up with concrete steps that are needed to carry out these (new) activities. Thus, an annual working plan also includes detailed work plans for the activities from the nature management plan.