

TECHNICAL REPORT

Study of natural and cultural values in
45 hectares at Santa Clara,
Bonaire, CN

F. Simal

Client: Caribbean Blokken
en Klinkers Fabriek BV

Date: December 28th, 2023



Jan Doran wil boei



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As the author of the Technical Report entitled “Study of natural and cultural values in 45 hectares at Santa Clara, Bonaire, CN”, I hereby declare that this is the only authorized version of the mentioned document.

Signed on Kralendijk, Bonaire, on November 28th, 2023

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KVK nr: 8953(0)
BTW nr: 310008190

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Table of Contents

<i>1</i>	<i>Introduction.....</i>	<i>3</i>
<i>2</i>	<i>Study area.....</i>	<i>3</i>
<i>3</i>	<i>Geology.....</i>	<i>4</i>
<i>4</i>	<i>Flora and Vegetation.....</i>	<i>5</i>
	<i>4.1 Literature sources.....</i>	<i>5</i>
	<i>4.2 Satellite imagery.....</i>	<i>7</i>
	<i>4.3 Fieldwork inside the survey area and surroundings.....</i>	<i>9</i>
<i>5</i>	<i>Fauna.....</i>	<i>12</i>
	<i>5.1 Bats.....</i>	<i>12</i>
	<i>5.2 Birds.....</i>	<i>14</i>
	<i>5.3 Reptiles.....</i>	<i>14</i>
<i>6</i>	<i>Relationship to Other Natural Important Areas of the Island.....</i>	<i>14</i>
<i>7</i>	<i>Cultural heritage value.....</i>	<i>15</i>
<i>8</i>	<i>Agricultural values.....</i>	<i>15</i>
<i>9</i>	<i>Conclusions and recommendations.....</i>	<i>15</i>
<i>10</i>	<i>Literature.....</i>	<i>18</i>



1 Introduction

On 16 December 2022, Openbaar Lichaam Bonaire (from here on, OLB) changed the Bonaire Zoning Plan or "Ruimtelijk Ontwikkelingsplan Bonaire" (from here on ROB) designation of the parcels of land with registration numbers 5-E-34 and 4124 from "Agrarisch-Kunuku" to "Bedrijventerrein-Zware Bedrijven", including the added designation of 'beton- en asfaltcentrales'. The purpose of these changes was to enable the company Caribbean Blokken en Klinkers Fabriek BV (from here on CBKF) to construct a plant for the manufacture of concrete building blocks and bricks. Presently, CBKF has completed the construction of its plant and is currently in operation.

One of CBKF's competitors has objected to the changes of the designation. In a decision dated November 3rd, 2023, the Court ruled that OLB did not motivate (as required pursuant to article 69.7 of the ROB) that CBKF has:

"demonstrated that the development of the plan has taken optimal account of the residential and living environment or natural, ecological, landscape, archaeological or cultural-historical values."

As a result of the Court's decision, OLB must now take a new decision addressing the above. Consequently, OLB has requested CBKF to demonstrate that it has taken optimal account of the residential and living environment or natural, ecological, landscape, archaeological or cultural-historical values. Regarding the natural and cultural heritage values that may have been present (or not) in these plots of land before the construction and operation of the plant, CBKF requested WILD CONSCIENCE BV to conduct a study of both terrains and their surroundings. The fact that vegetation has been removed and the plant has already been built, makes such a task extra challenging. However, valuable information can be found in existing literature, satellite imagery and also by looking at the natural and cultural values of the land surrounding these properties, which most likely presents the same flora and vegetation that was removed for the construction of the plant.

Below, we present the results of the study, together with our conclusions and recommendations regarding the natural and cultural values of the parcels.

2 Study area

Located north of Lac Bay, approximately 100 meters from the buffer area of this Ramsar site, our 45 hectares study area (Fig. 1), forms part of the Middle Terrace Geological Formation, which is mainly composed of limestone originated from past coral reefs (de Buissonjé, 1974). The area has been cleared of vegetation in the past, but a few patches of secondary or tertiary forest and several large individual trees remain. As expected, large portions of the area have been disturbed by the removal of native vegetation, filling with diabase, construction of permanent structures and solid waste dumping. Ongoing activities keep disturbing the remaining natural habitats, diminishing their value.

During our survey of the area and surroundings, we did not find any significant differences in flora and/or vegetation in the remnant vegetation patches when it comes to species richness and vegetation cover at three levels (ground: 0cm – 30cm, shrub: 31cm – 200cm, canopy: >200cm). This strongly suggest that what remains of vegetation is similar to what potentially had been removed for the construction of the new plant.

When it comes to its natural values, we find the most important aspect of this study area the fact that it is very near to Lac Bay and, most importantly, inside its rain catchment area.



Figure 1. Satellite image of the surveyed area (blue polygon) with an area size of approximately 45 hectares.

3 Geology

In Figure 2, a portion of the Geological and Land Use Map of Bonaire (Westermann and Zonneveld, 1956; de Buissonjé, 1960), we can observe that the entire area of study falls within the geological formation known as the Middle Terrace.

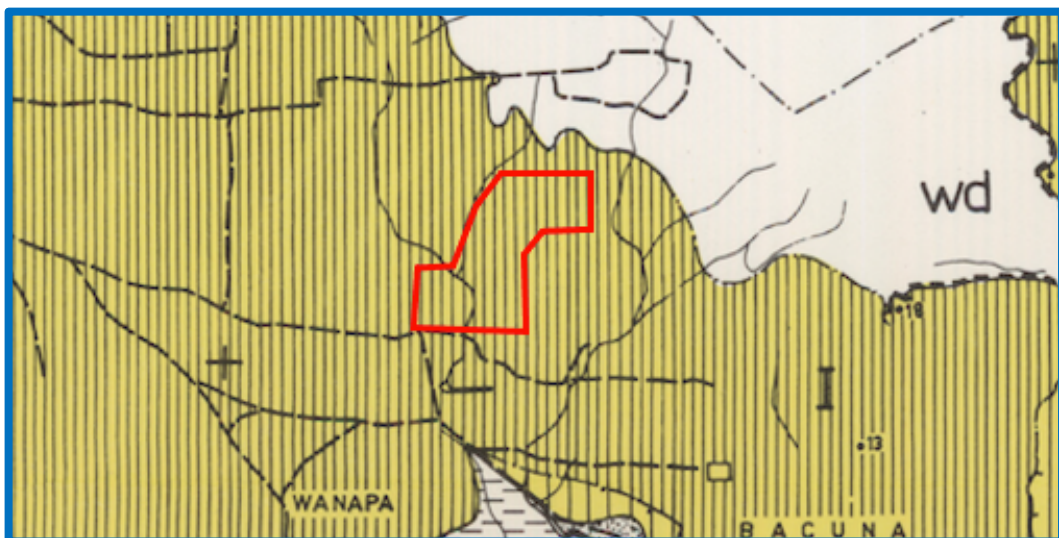


Figure 2. Portion of The Geological Map and Land use of Bonaire (Westermann & Zonneveld, 1956) depicting the plot of land (red polygon) as part of the Quaternary Limestone formation known as Middle Terrace (vertically black-stripped yellow area).

This formation is composed of Quaternary Limestone. In general, limestone formations are rich in sinkholes, shallow depressions, crevices, caves, and small holes that provide access to fresh ground water for many species of flora and fauna found on Bonaire. However, since we could not conduct proper ground exploration due to the before mentioned disturbances, we cannot provide insights on this aspect of the survey from our direct observations. Despite this, we are confident that it is unlikely that any of the geological features before mentioned would have been found in this plot of land. We base this deduction on the fact that the land is located in a non-remote area, next to the road and that, like most properties on Bonaire used for agriculture in the past, it has been explored



for fresh or brackish water for more than a century, when the need for fresh water sources was critical for subsistence.

Regarding geomorphology, this portion of land has very little inclination and shows only one flooding site during heavy rains. Usually, flooding locations in agricultural areas are caused by the remains of artificial dams created in the past for that purpose, yet others appear to be unintentional, as the consequence of road constructions, for instance. Flooding areas can become important fresh water sources for the native fauna and foraging habitat for resident and migratory shorebirds. Flooding areas surrounding this plot of land, together with a flooding spot inside the plot, can be observed in Figure 3A, a satellite image from January 2012, when precipitation was above average for the island of Bonaire and all flooded sites could be seen.

The most critical geological aspect to take in consideration is that these parcels are located in one of the seven catchments areas of Lac Bay (Debrot 2012) (Fig. 3B), a Ramsar site and nature area protected by local and international legislation. This means that precipitation runoff going over the parcels and, also percolating through the limestone, ends up in this ecologically important natural bay. Consequently, the management of water running through our area of study, and all the catchment area for that matter, needs special attention.

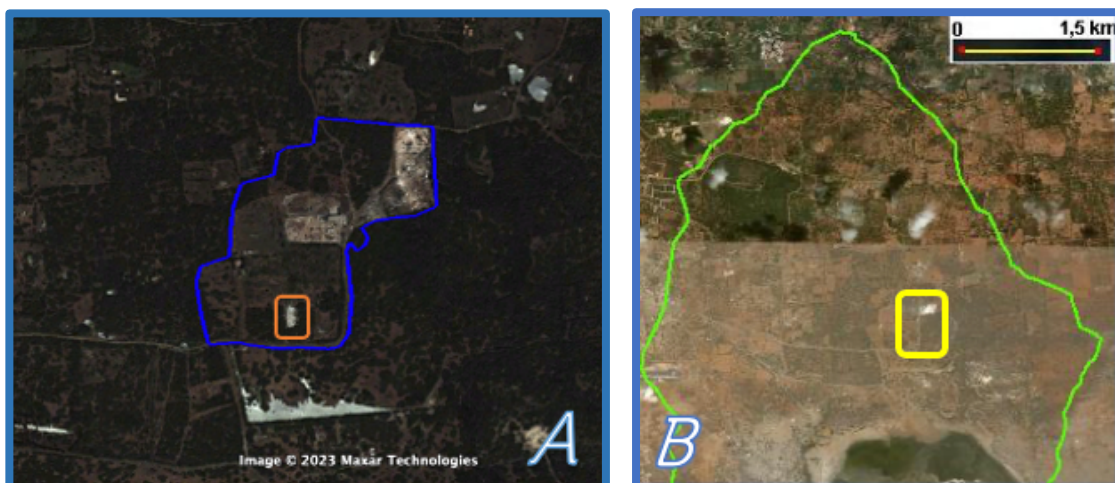


Figure 3. A) On the left, satellite image of the surveyed land (blue polygon) during the rainy season 2011-2012, depicting flooding areas surrounding the surveyed plot and one inside (orange polygon). B) On the right, Lac Bay's catchment area (green line), where our area of interest can be seen inside, as a yellow polygon. Image B taken from Debrot, 2012.

4 Flora and Vegetation

4.1 Literature sources

In the Landscape Ecological Vegetation Map of Bonaire (de Freitas et al. 2005) (Fig. 4), which is the most recent vegetation map of Bonaire, our area of study falls partially under the designation "TM9= Prosopis-Euphorbia Middle Terrace" and "A= Areas of former agricultural or anthropogenic structures". Overall, this designation matches our findings on the ground despite Euphorbia species not being as dominant as two of the three native species of columnar cacti (*Stenocereus griseus* and *Cereus repandus*). In addition, many large individuals of Cossie (*Vachellia tortuosa*) and Mesquite (*Prosopis juliflora*) were also present in larger numbers than Euphorbia spp.

It is important to observe in the image, that vegetation type TM9 is also present throughout much of the area, way beyond the boundaries of the land. This fact is significant because it corroborates



our initial theory, which is that the natural values that were present in the area before the construction of the plant can be inferred from what it is still present, combined with other sources of information, like satellite imagery and previous studies in this region of the island. In fact, the author has conducted several other studies in the wider area north of Lac Bay and consequently has good knowledge of the existing vegetation. We will discuss these studies in more detail further in this report.

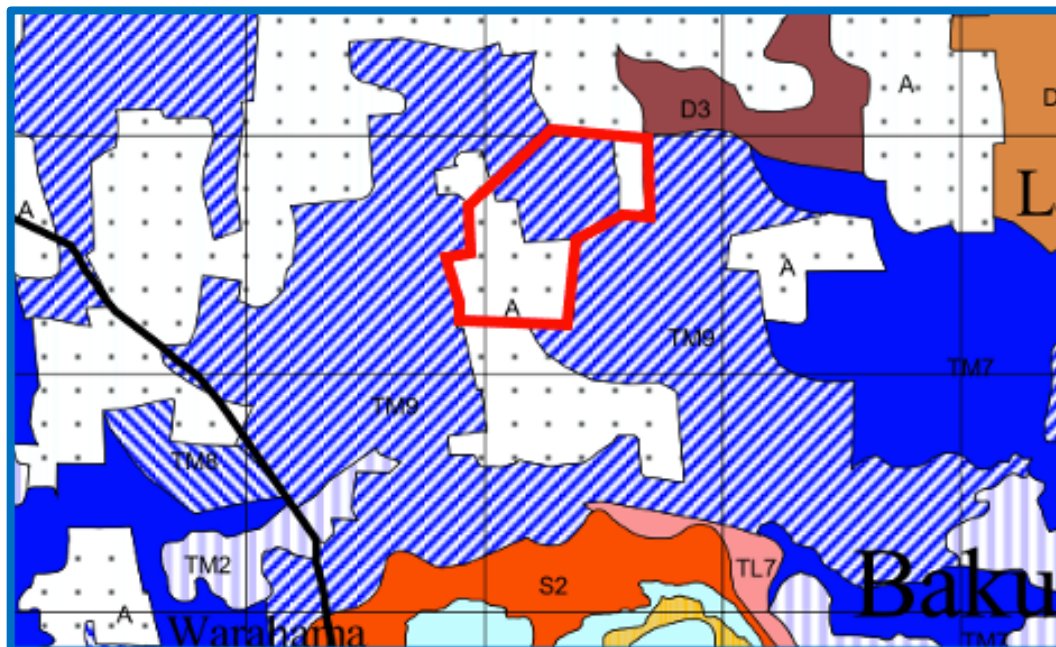


Figure 4. The surveyed area (red polygon) in the Landscape Ecological Vegetation Units Map of Bonaire (de Freitas et al. 2005). The area is depicted as "TM9=Prosopis-Euphorbia Middle Terrace" and "A=Areas of former agricultural or anthropological use".

Like in all agricultural areas of Bonaire, the existing vegetation is typical for areas where exotic invasive herbivores like goats and donkeys have had access for decades and the only plant species present are the ones unpalatable to these exotic invasive species of herbivores. This results in a very poor species richness of native plants. In total, we could identify fourteen species, from which ten are native and the rest introduced (Table 1).

Table 1. Plant species found during this study and their conservation status: a=protected under international treaties, b= protected under CITES-Appendix II, c=protected under local legislation.

Scientific name (van Proosdij, 2012)	English	Papiamentu	Status
A			
<i>Agave spp.</i>	Century plant	Pita	Introduced
<i>Aloe barbadensis</i>	Aloe	Sendebibu	Introduced
B			
<i>Bursera bonariensis</i>	Birch tree	Palu di sia blanku	
C			
<i>Calotropis gigantea</i>	Milkweed	Katuna di seda	Exotic invasive
<i>Casearia tremula</i>	-----	Palu di Boneiru	
<i>Cereus repandus</i>	Columnar cacti	Kadushi	a, b
<i>Crescentia cujete</i>	Calabash	Kalbas	
<i>Croton flavens</i>	Wild sage	Welisali	
L			
<i>Lantana camara</i>	Teabush	Basora kora	
O			
<i>Opuntia caracassana</i>	Opuntia	Infrou	a, b



P			
<i>Pithecellobium unguis-cati</i>	Cat's nail	Uña di gatu	
<i>Prosopis juliflora</i>	Mesquite	Pali' kuida	
S			
<i>Stenocereus griseus</i>	Columnar cacti	Yatu	a, b
V			
<i>Vachellia tortuosa</i>	Cossie	Obada	Introduced

Another relevant map for this study is the older, "Vegetation Map of Bonaire" (Stoffers, 1956). (Fig. 5A). This map shows that the native vegetation was already disturbed by that year in the form of removing native vegetation for agricultural purposes. Yet, we consider this map less detailed than the one elaborated by de Freitas et al. in 2005. In addition, a secondary or tertiary forest was very likely formed in the circa 50 years that separate the elaboration of both maps. Finally, the Bonaire Werbata map, dating from 1906, also shows cultivation of aloe and Divi-divi pods inside this property (Fig. 5B). Contrary to the cultivation of aloe, Divi-divi pods farming respected (sometimes) the existing vegetation and forest patches around them were not unusual.

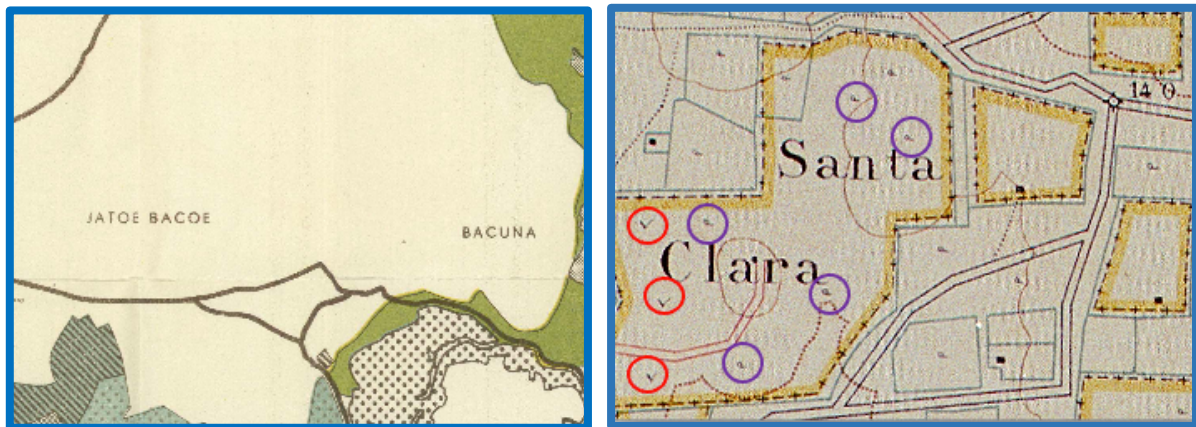


Figure 5. A) Portion of the Vegetation Map of Bonaire (Stoffers 1956) showing the entire area north of Lac Bay as "Cultivated and semi-cultivated areas" (light yellow color). B) Portion of the Werbata map with icons indicating aloe cultivation (inside red circles) and farming of Divi-divi trees pods or forest patches (inside purple circles).

4.2 Satellite imagery

Another valuable source of information to assess the existing flora and vegetation in this area previous and post construction of the plant, is satellite imagery and aerial photographs. As the following series of images in Figure 6 show, we can determine important aspects of habitat patches, like for instance their area size and the approximate percentages of vegetation cover.

Despite of the lack of sharpness of the two images at the top (1970 and 1985), which is caused for the lack of better technology back in those years, we can clearly see a diminishing area size of natural habitat on both the north and south vegetation patches as time goes by. We can also observe that not many changes occurred up to 2009. This is important for this case, because 2009 was the year before the implementation of the ROB, which is the main driver of this study. Therefore, it is from this year on, and not previously, that changes applied to this zoning plan can be addressed. In other words, this image is important as a baseline for this case.

As the north portion of the area was designated for "Industrial use" when the ROB legislation was passed in 2010, we will focus on the southern portion of the land, which is also where the new plant



has been built. Additionally, We can observe that the first reduction in area size of this southern patch appears in the 2014 image and then remains practically unaltered until 2023, when the construction of the new plant took place.

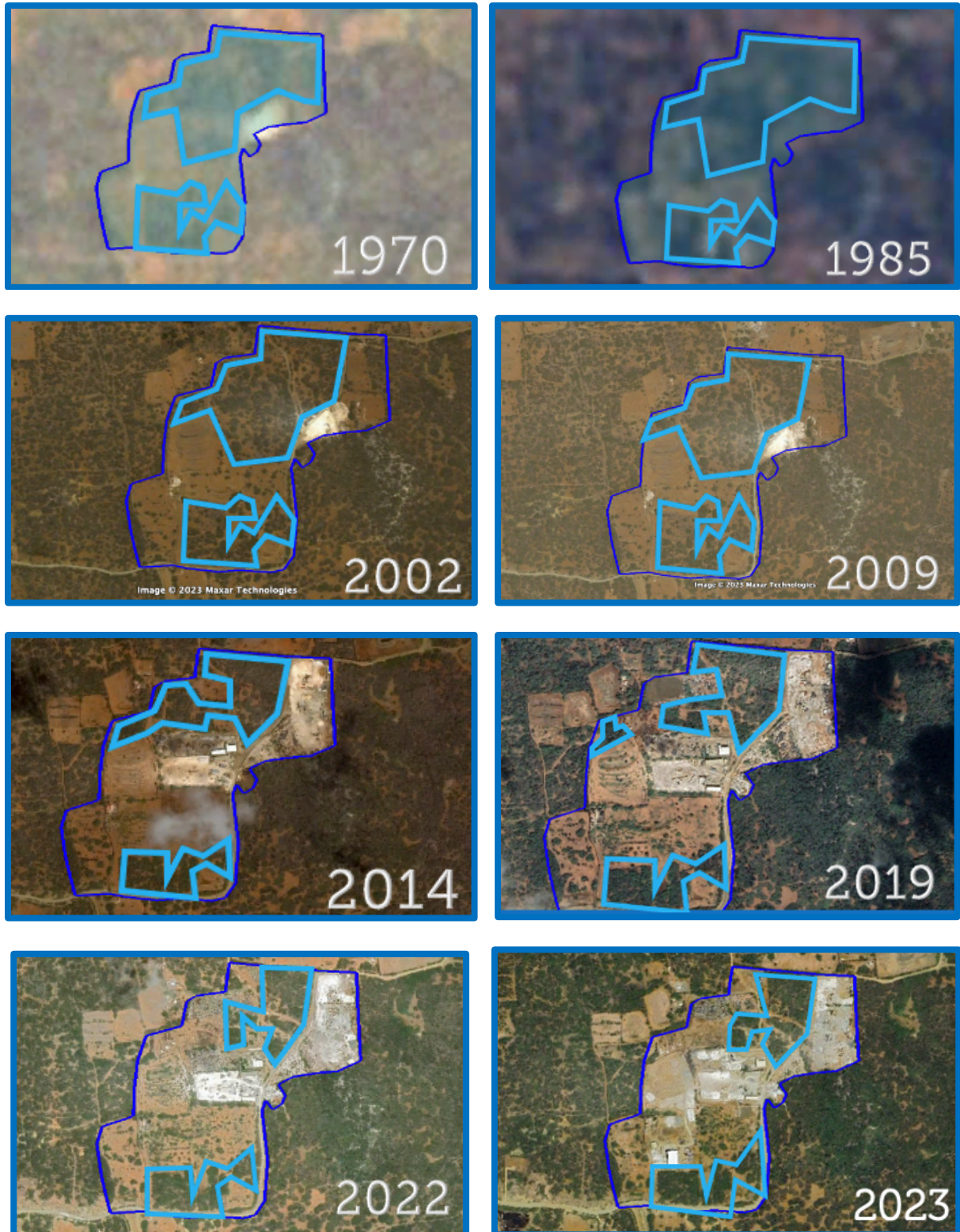


Figure 6. From top left to bottom right, chronologically ordered satellite images and/or aerial pictures of the surveyed area (dark blue polygon), depicting as light blue polygons the reduction in size of the better habitat patches for over 50 years, since 1970 until 2023.



A more detailed look at this southern habitat patch shows that from 2003 to 2023, there was a small reduction in area size from approximately 4.25 hectares to 3,85 hectares (Fig. 7). However, we can also see that the vegetation cover increased significantly, even when we account for differences in appearance during the dry and the rainy season. In our view, despite its reduction in area size of approximately 9.5%, the current habitat patch has more value (due to a larger biomass) for the native flora and fauna of the island than as it was in 2003, so both patches can be considered of approximately the same natural value.

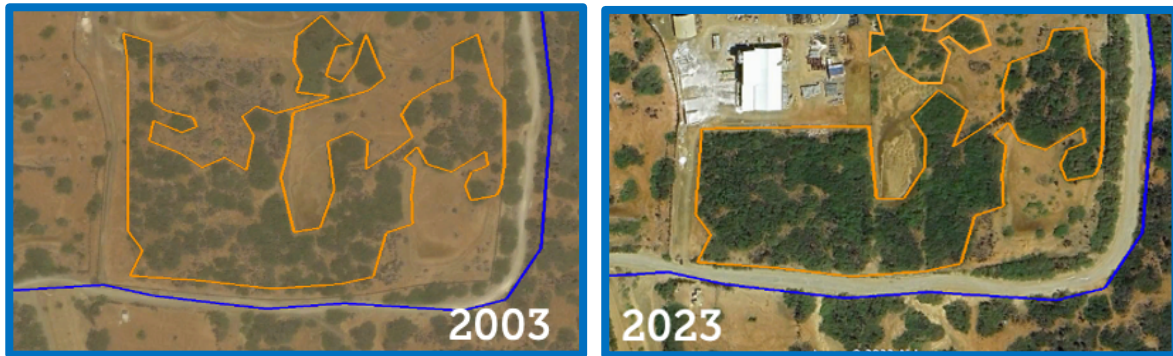


Figure 7. Satellite images from 2003 and 2023 of the southern habitat patch, where the decrease in area size and the increase in vegetation cover can be observed.

4.3 Fieldwork inside the survey area and surroundings

We conducted one field visit to the area during the month of December 2023. We studied vegetation patches both inside our survey area and its surroundings. In addition, the author has conducted in recent years several studies in areas with the same geological characteristics relatively close to this plot of land. After carefully reviewing these past studies and looking at the data collected during our field work, we have no reasons to believe that the vegetation removed for the construction of the new plant or even the one removed previously for the construction of the stone crushing plant and other facilities, differs significantly from the existing one, both inside the area and its surroundings. Therefore, we are confident that our list of species presented in Table 1 has a high degree of accuracy, especially for the dominant species. Yet, it is possible that a few (<5) species were missed.

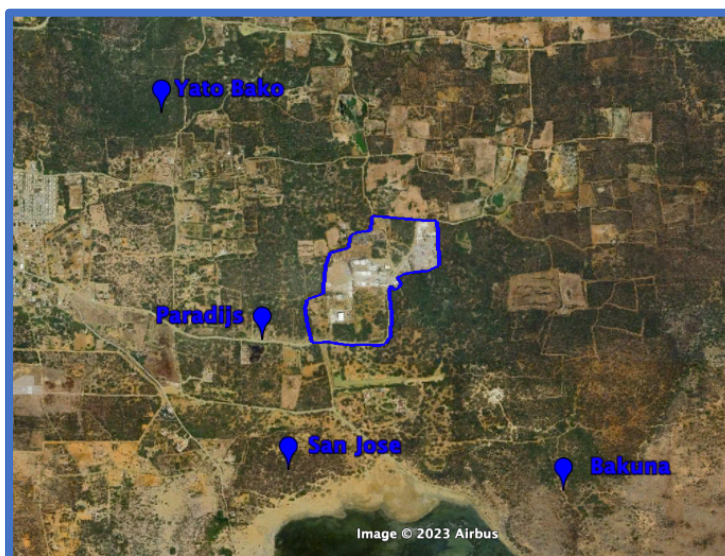


Figure 8. Satellite image showing areas near the surveyed area where previous studies of natural and cultural values have been conducted by WILDCONSCIENCE BV.

In such case, we feel confident that Lignum-vitae (*Guaiaecum officinale*), Calabash (*Crescenta cujete*) and Brazilwood (*Haematoxylum brasiletto*) were the most likely to be present. From these three species, the first is protected by local legislation.

Regarding legal protection, in Table 1 we find several species protected by international legislation, namely all the cacti, which are protected under the CITES treaty, Appendix II, which makes necessary a permit for their trade. Local legislation only protects these cacti species and most trees when they have a circumference of



65cm or larger at 130 cm height. During our fieldwork, we registered a few cacti individuals that meet this criterion. They belong to the species of cactus known as "Yatu" (*Stenocereus griseus*) and "Kadushi" (*Cereus repandus*). Likewise, a few large individuals of the Cossie tree (*Prosopis juliflora*) and White Birch (*Bursera bonariensis*) were registered.

Overall, our observations on the field match our findings in the existing literature when it comes to flora and dominant species in the vegetation, which supports our high level of confidence in assessing the previous and current natural value of the area despite of the plant being built already. Below, in Figure 9, we can observe examples of the general aspect of the vegetation inside and surrounding our area of study, together with large individual plants protected by local legislation.



Figure 9. Images A, B and C show the general aspect of the vegetation inside and surrounding our study area, where native species of columnar cacti, *Opuntia* spp. and thorny trees like Mesquite and Cossie can be observed dominating the landscape. Image D shows one of the few (non-dominant) species of tree (darker green), an individual tree of the species Cat's nail. Images E, F and G show examples of individual plants protected by local legislation given the size of their trunk (>65cm at 130cm height). Notice that in most pictures the plant facilities, or the road leading to it, can be observed.



Other relevant observations made during our fieldwork include the presence of many dead adult individuals of the Divi-divi tree (*Caesalpinia coriaria*) but not young or sub-adult individuals to replace them. As previous surveys conducted by the author have shown, this is a common occurrence in agricultural areas of the island, including limestone terraces north of Lac Bay. Once again, this fact corroborates our position that the vegetation inside our study area is (or was) similar to the one we observed in surrounding areas.



Figure 10. Two examples of dead adult individuals of Divi-divi observed during our fieldwork.

Finally, as expected, we found lots of disturbances inside the surveyed area (Fig. 11). Clearly, these disturbances not only diminish its natural and potential cultural values, but also threaten the existing native flora and fauna. The most obvious and also the most concerning are: a) dumped solid waste, b) presence of exotic invasive herbivores (like goats and donkeys), c) presence of exotic invasive species of plants and, d) indiscriminate vegetation clearing. Other disturbances, with a lesser direct impact but still diminishing the value of the area, include accumulation of diabase piles, noise and emissions of heavy traffic of both large and small vehicles and wind-blown dust.

Dumped solid waste is of high concern because soil polluting agents (e.g., electrical components, chemicals and old roof planks containing asbestos) are usually found at these dumping locations. Confirming these potential types of pollution and determining their magnitude is beyond the scope of this study. However, we recommend cleaning these areas as soon and as much as possible. This is because, as previously stated in the report, the potential pollutants are being transported by precipitation runoff and percolating through the limestone, consequently ending up in Lac Bay.

Exotic invasive herbivores are the main threat to the island's native vegetation; however, little can be done by individual enterprises. On the contrary, exotic invasive species of plants, which are an important threat to the island's native flora and fauna as well, can be controlled to a certain extent. Therefore, it is important to eliminate their sources when possible. Inside the fenced portion of the surveyed area, we found species that are easily dispersed by the wind, like Milkweed (*Calotropis spp.*). Similar to the case of solid waste, we recommend eliminating this source of invasive plant species as soon as possible.



Figure 11. Images A and B show solid waste dumping sites and, image C, several individuals of the exotic invasive species of plant, Milkweed (*Calotropis gigantea*) inside the fenced area of the surveyed land.

5 Fauna

5.1 Bats

There was no fieldwork aimed directly to the study of bats during this study. However, previous research executed by the author and colleagues in caves and all terrestrial habitat types found on Bonaire, show that the remnant habitat patches found in the area can be used as a feeding habitat by at least six of the nine species of bats registered for the island (Simal & Lim, in preparation). In Table 2, we present the six species found during our previous studies, which are present at this site.

From all the species mentioned, the most important are the two species of nectar-feeding bats, the Miller's Long-tongued Bat (*Glossophaga longirostris*) and the Curaçaoan Long-nosed Bat (*Leptonycteris curasoae*). These two species are the only pollinators and important seed dispersal



agents of the three native columnar cacti. These ongoing ecological interactions between bats and cacti, which are circa seven million years old, makes them the only recognized keystone species of Bonaire's semi-dry terrestrial ecosystem. Columnar cacti provide shelter, food and water to a wide range of native vertebrates and invertebrates, especially during the dry seasons and, most importantly, during severe long droughts, when they become the only available source of food and water for many species of the island's terrestrial fauna, including flag species such as the iconic, Yellow-shouldered Parrot (*Amazona barbadensis*). Therefore, protecting columnar cacti on Bonaire is essential to preserve its terrestrial biodiversity.

Table 2. Presence/absence of bats in all habitat types on Bonaire (and their conservation status: a=protected under local legislation, b=IUCN Red list Least concern, c=IUCN Red list-Vulnerable).

Bonaire Bat species and status	Mangrove Forest	Dry Forest	Dry Shrub	Cacti Forest	Salinas	Urban	Agriculture
Long-nosed bat (a, c) <i>Leptonycteris curasoae</i>	X	√	X	√	X	X	X
Long-tongued bat (a, b) <i>Glossophaga longirostris</i>	√	√	√	√	√	√	√
Funnel-eared bat (a, b) <i>Natalus tumidirostris</i>	√	√	X	X	X	X	X
Ghost-faced bat (a, b) <i>Mormoops megalophylla</i>		√	X	X	X	X	X
Little brown bat (a, b) <i>Myotis nesopolus</i>	√	√	√	X	X	X	√
Free-tailed bat (a, b) <i>Molossus molossus</i>	X	√	X	X	X	√	√
Greater bulldog bat (a, b) <i>Noctilio leporinus</i>	?	?	?	?	?	?	?
Naked-backed bat (a, b) <i>Pteronotus davyi</i>	?	√?	√?	?	?	?	?
White-shouldered bat (a, b) <i>Ametrida centurio</i>	?	?	?	?	?	?	?

The closest known bat maternity roosts to our study area are located at a distance of approximately 1.9 km and 4.2 km (Fig. 13). The distance from these roost to the surveyed area is enough to conclude that no negative impacts to the important bat roosts of the island can be expected from the construction of the new plant.



Figure 13. Satellite image showing the location of the two closest important bat maternity caves to the area of study and their distance to the area of study.



5.2 Birds

Despite of not having made bird observations for this study, we can provide relevant insights on the importance of this plot of land as a terrestrial bird habitat. The author has been conducting terrestrial bird surveys on the entire territory of the Island of Bonaire and Klein Bonaire since 2009, including many patch forests similar to this one. Based on previous observations, we noticed *an average species richness and abundance* of terrestrial birds in the remnant habitat patches inside and the surroundings of the surveyed area. We did not find however, any important bird roosting or nesting sites during our fieldwork. Finally, since we not collected data specifically for this purpose, we do not provide a species list of terrestrial birds.

5.3 Reptiles

During our fieldwork, native reptiles were found in average densities on the surroundings of the land when compared to other areas of Bonaire. Three species were observed occasionally while trying to go deeper inside this densely covered habitat patch. We observed the Bonaire endemic species of Whiptail lizard (*Cnemidophorus ruthvenii*), the Green iguana (*Iguana iguana*) and the endemic species of Tree lizard (*Anolis bonairensis*). Given the small number of species, we will not provide a table for reptiles. The lack of direct observations of other species of reptiles is most likely caused by their low densities, their evasive behavior if compared to other areas on the island where they are more used to humans and, in the case of geckos, because of their nocturnal habits.

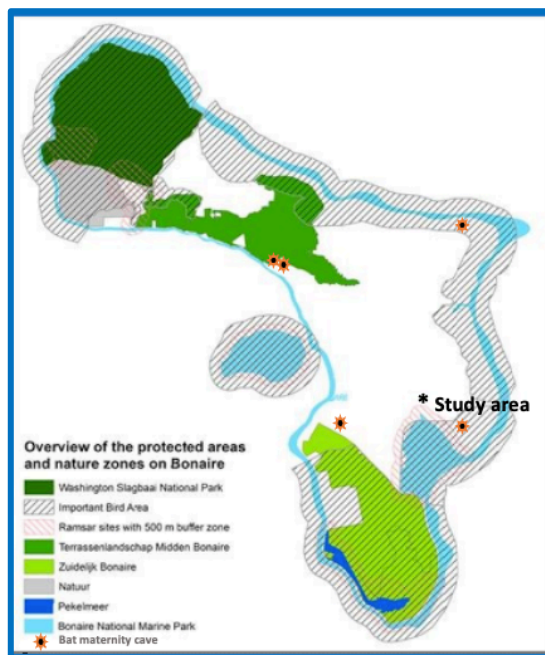


Figure 14. Map of important natural areas of Bonaire (Langley et al. 2017), depicting our study area outside of them. Location of important bat maternity caves added by the author.

6 Relationship to Other Natural Important Areas of the Island

Two important areas and two important sites for the conservation of bats (Spanish acronyms AICOM and SICOM) have been recognized and officially designated on Bonaire by the international group of experts known as RELCOM (Spanish acronym for the Latin American and Caribbean Bat Conservation Network) (Nassar & Simal, 2019). Similar to these, the well-known organization BirdLife International recognizes the ecological importance of areas for bird conservation by designating them as IBAs (Important Bird Area) using established criteria. On Bonaire, six of these IBAs have been designated (Wells & Debrot, 2008). In Figure 14, the before mentioned sites and other nature areas of importance of the island like the national parks and Ramsar sites are depicted, together with the location of our study area. This plot of land is located outside of the important natural areas. However, its location near to and, most importantly, inside the basin area

of Ramsar site Lac Bay is something to be carefully considered. As indicated in the Geology section of this report, precipitation runoff water flowing over the plot will end up in Lac Bay, both traveling on the surface and percolating through the limestone towards the ground water system.



7 Cultural heritage value

The Werbata map, dating from the early 1900s, depicts Santa Clara as an important plantation in those days. In this map we can observe that one of the main roads from those times goes inside the property all the way to the center of it while the plantation is also partially surrounded by secondary roads. In addition, a semi-permanent human structure (most likely a "kas di bara") was already in place. This means that, important agricultural and commercial activities were taking place during those times. This is confirmed by the aloe plantation icons observed by the west and south portions of the land and the "Divi-divi garden" icons, both before mentioned and shown in the "Flora and vegetation" section of this report. Aloe extract and Divi-divi pods were important agricultural products, used both locally and for export.

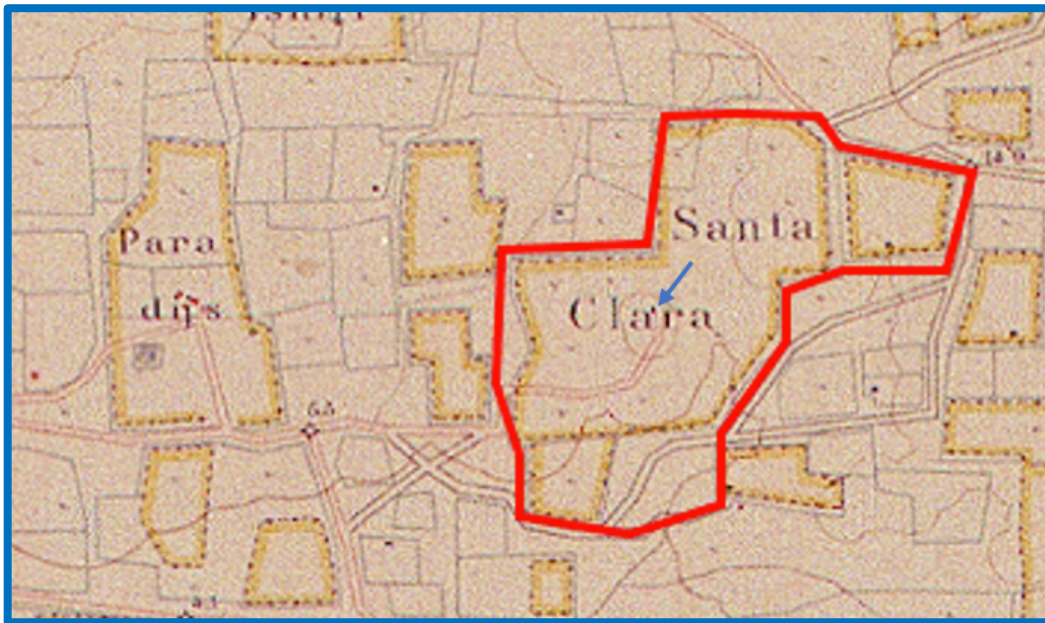


Figure 15. Portion of the historic Werbata map, dating from 1911, showing one of the main roads (depicted as parallel red lines) going inside the property and secondary roads crossing bordering it. By the label "Clara", next to the letter "a", the icon of a human built structure can be seen (pointed at by blue arrow).

Given the level of disturbance of this property, we did not look for artifacts that could have a cultural value for the island. Based on the above mentioned, we derive that there are few tangible significant cultural heritage values for Bonaire as an island in our surveyed area. This includes the Bonaire's people sense of identity.

8 Agricultural values

The designation of a portion of this area in the Bonaire Zoning Plan as "Agriculture", in addition to the before mentioned importance of this area in the early 1900s, which is reflected in the Werbata Map, indicate that this property has significant agricultural value. It is beyond the scope of this report to look further into the magnitude of this value (soil quality, past uses and crops, etc.). Therefore, we can only highlight the presence of this value as another item to consider in this case.

9 Conclusions and recommendations

- Our initial proposition that we could conduct a valuable study of the natural and cultural values of this area after the construction of the plant, was confirmed by the findings of our literature research, satellite imagery and visit to the parcels and surroundings.



- We find our study can be useful for OLB and the Court in the process of revising the land designation change in the ROB that prompted this study by CBKF.
- Regarding flora and vegetation, if we look at parameters like vegetation cover at three levels (ground, shrub, and canopy), species richness, and presence of plant species protected by local and/or international legislation in the remnant habitat patches, we find the natural value of this area very similar to the one surrounding properties.
- If we look at the percentage of remnant habitat patches versus the percentage that has been cleared of vegetation, our surveyed area rates low in natural value when compared to surrounding properties. This is because 75%- 80% of the land has been denuded of vegetation several decades ago. However, it still rates higher than other surrounding plots that are completely denuded of vegetation (Fig. 16).



Figure 16. Satellite image of our surveyed area (blue polygon) and surrounding properties where many different sizes of remnant habitat patches can be seen at each property, including some completely denuded of vegetation.

- If we look at the native fauna using the remnant habitat patches as a habitat, we find the natural values of this land is very similar to the ones of the surrounding plots. In other words, the amount and/or diversity of native fauna that these habitat patches can sustain, depends exclusively on the size of the patches, since their species composition and vegetation cover are very similar.
- If we look at disturbances and threats to the natural environment in general, and the native flora and fauna of Bonaire in particular, our surveyed land has the lowest natural value in the entire area. Clearly, as a consequence of the combination of the large amount of cleared vegetation, permanent structures built, ongoing industrial activities, heavy traffic, amount of dumped solid waste and potential pollutants going into the soil and being transported by precipitation runoff.
- We consider the amount of vegetation removed between the year 2009 (before the implementation of the ROB) and the year 2023 (for the construction of the new plant) almost insignificant for the estimation of the natural and cultural values of this plot of land. The new



plant was built on a portion cleared from vegetation since the year 2002, or perhaps earlier according to satellite imagery.

- One aspect of this study that we cannot make exact conclusions about, is the number of individual plants protected by local legislation (given their size) that could have been destroyed during the construction of the new plant. However, given the density (plants/hectare) in which we find these protected plants in other studies within the area, combined with the findings during our recent visit to the area, we are confident that no more than 10 of these plants were potentially destroyed.
- Our only recommendation after this study is to try to diminish the amount of pollutants transported to Lac Bay by precipitation runoff and/or percolating through the limestone. This recommendation is not only for the parcels subject to this study but for the entire catchment area of Lac Bay.



10 Literature

- Bonairegov. (2010, Oktober 08). Ruimtelijk Ontwikkelingsplan Bonaire. Kralendijk, Bonaire, Nederlandse Antillen: Eilandsgebied Bonaire. Retrieved 07 14, 2015
- Bonairegov. (2010). Sortonan protehá. Retrieved June 2019, from Openbaar Lichaam Bonaire: <https://www.bonairegov.com/sites/default/files/uploads/Beschermde%20soorten%20Bonaire.pdf>
- Coblentz, B. E. (1980, September). Goat Problems in the National Parks of the Netherland Antilles. Corvallis: Oregon State University.
- de Buissonjé, P. H. (1974). Neogene and Quaternary Geology of Aruba, Curacao and Bonaire. (78). Utrecht, Utrecht, The N: Natuurwetenschappelijk Studiekringvoor Suriname en de Nederlandse Antillen.
- Debrot, A., Carsten, W., Wulfsen, A., D. (2012) Baseline survey of anthropogenic pressures for the Lac Bay ecosystem, Bonaire. IMARES Wageningen UR-C092/12. Bas code: BO-11-007-000-IMARES-9.
- de Buissonjé, P. H. (1974). Neogene and Quaternary Geology of Aruba, Curacao and Bonaire. (78). Utrecht, Utrecht, The N: Natuurwetenschappelijk Studiekringvoor Suriname en de Nederlandse Antillen.
- de Freitas, J. A. (1996). De Inheemse Bomen van de Benedenwindse Eilanden (Curacao, Bonaire en Aruba). Oranjestad: CARMABI.
- de Freitas, J. A., Nijhof, S. B., Rojer, A. C., & Debrot, A. O. (2005). Landscape Ecological Vegetation Map of the Island of Bonaire (Southern Caribbean). Amsterdam: Royal Netherlands Academy of Arts and Sciences.
- Haviser, J. B. (1991). The first Bonaireans: Reports of the Archaeological-Anthropological Institute of the Netherlands Antilles. Oranjestad: Archaeological-Anthropological Institute of the Netherlands Antilles.
- KLM Aerocarto B.V. (1982). Topographic Map of Bonaire. Kralendijk, Bonaire: Netherlands Antilles, Cadastral Survey Department.
- LNV, 2020. Plan for land and Water - Nature and Environment Policy Plan, Caribbean Netherlands 2020-2030. Ministries of Agriculture, Nature and Food Quality, Infrastructure and Water Management and Interior and Kingdom relations of The Netherlands. Unpublished. 49pp.
- Nassar, J. M. and F. Simal. 2019. Contribución de los AICOMs y SICOMs a la conservación de la quiropterofauna de la Isla de Bonaire. Boletín de la Red Latinoamericana y del Caribe para la Conservación de los Murciélagos, 10: 4–8.
- Newton, M., van der Krogt, P., & Verstappen, H. (1906). Topographical Maps of the Colony of Curacao, Aruba, Bonaire, St. Martin, St. Eustatius and Curacao. Willemstad, Curacao: Fotomatiko del Caribe.



- PPRABC. (2015, July 14). PPR Islanan ABC. Retrieved from Bats of the ABC Islands: http://www.pprabc.org/index.php?option=com_content&view=article&id=73:bonairean-bats&catid=18:article&Itemid=101&lang=en
- Ramsar. (2017). Netherlands. Retrieved from Ramsar: <https://www.ramsar.org/wetland/netherlands>
- Simal, F., & Lim, B. (in preparation). Use of different habitat types by Bonaire bats.
- Smith, S. R., Davaasuren, N., Debrot, A. O., Simal, F., & de Freitas, J. A. (2012). Preliminary inventory of key terrestrial nature values of Bonaire. Wageningen: Imares Wageningen UR.
- Voous, K. H. (1983). Birds of the Netherlands Antilles. Zutphen: De Walburg Pers.
- Wagenaar Hummelinck, P. (1943). Zoogeografische opmerkingen over de Nederlandsche Benedenwindse Eilanden. West-Indische Gids , 168-180.
- Wells, J., & Debrot, A. O. (2008). Bonaire. In D. C. Wege, & V. Anadón-irizarry, Important Bird Areas in the Caribbean (pp. 95-102). Oxford: BirdLife International.