Quick Scan Assessment of the Ecosystem Composition and Potential Negative Impacts of Aruba Ocean Villas on Commandeursbaai, Savaneta Nature Reserve (GEBIED 12C/12.11).

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Commissioned (without personal or institutional reimbursement) by: Aruba National Park Foundation (FPNA)

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Introduction

This Quick Scan Assessment Report of the Commandeursbaai, Savaneta Nature Reserve (GEBIED 12C/12.11) was requested by the Aruba National Park Foundation (FPNA) to be provided by the Dutch Caribbean Nature Alliance (DCNA). This Quick-Scan was requested in order to gauge the potential impacts the Aruba Ocean Villas (development in question) expansion project will have on an area designated as protected and under the management of FPNA.

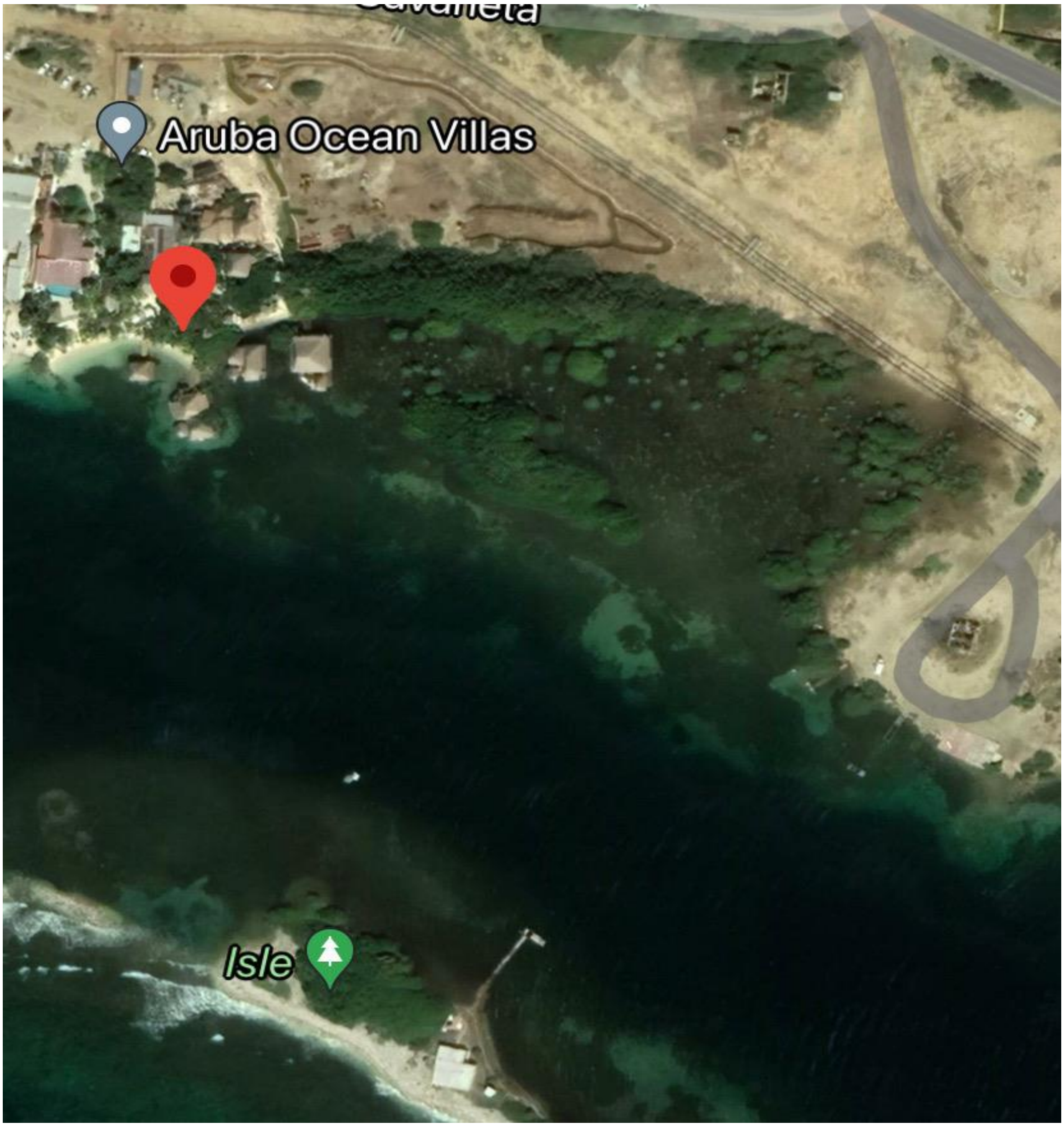

Figure 1. Commandeursbaai, Savaneta Nature Reserve (GEBIED 12C/12.11) Protected Area and adjacent property.

In 2020, numerous mangrove areas were placed under the management of Fundacion Parke Nacional Aruba (FPNA) via "AB 2020 no. 67, LB 2020 no. 1" with the primary goal of conserving their ecological function and natural values, which include biodiversity hotspots, nursery function for reef and fisheries target species, migratory bird habitat, seasonal wetlands, carbon sequestration, water filtration, erosion mitigation and more.

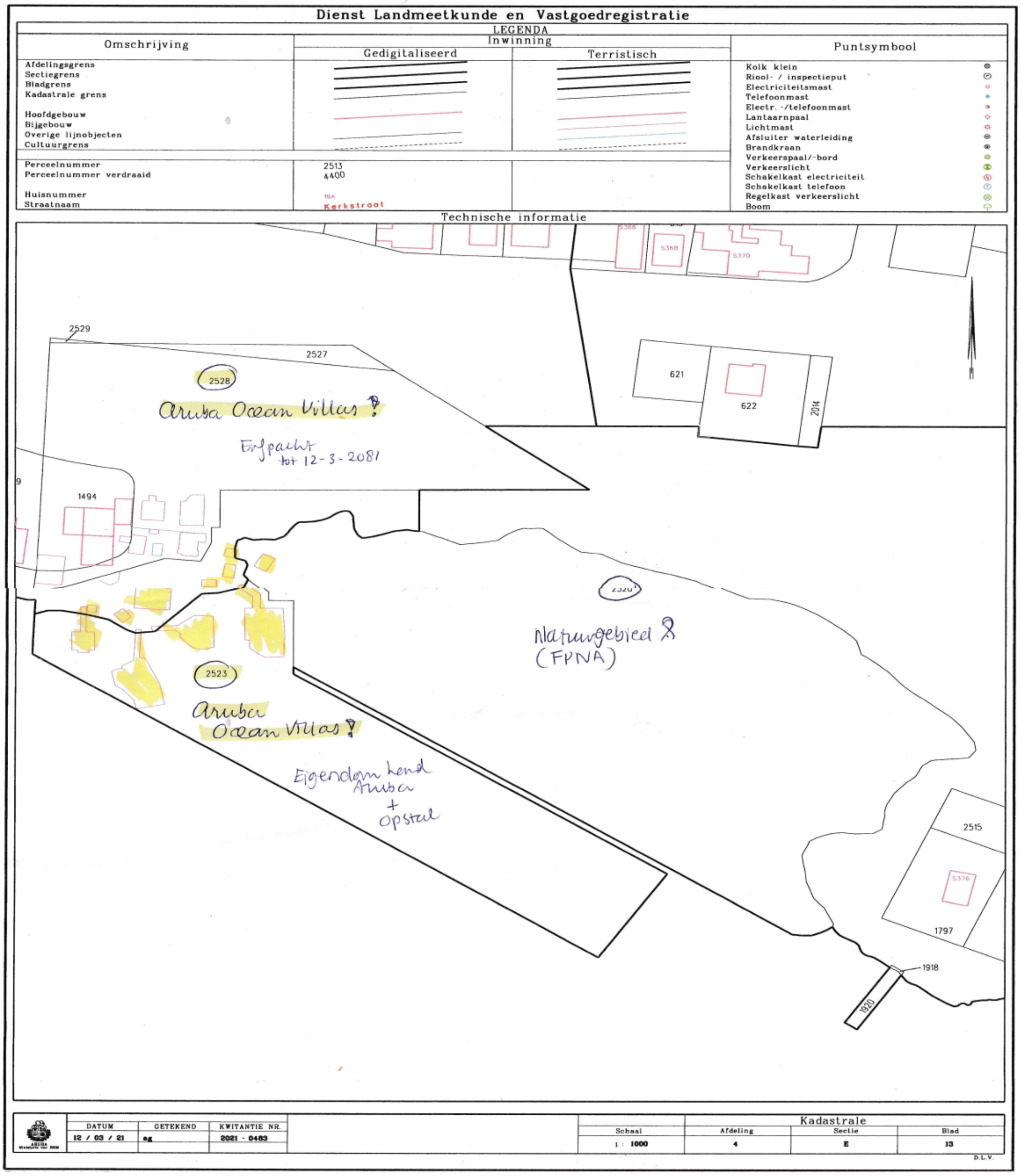

Figure 2. Sketch showing development footprint of area and the designated protected area.

Despite the designation of the area as protected, the expansion of Aruba Ocean Villas, and in particular the methods of construction, the proximity of construction activities to sensitive habitat without buffer considerations, and unclarity related to infrastructure will likely result in significant negative impact to what is a relatively healthy mangrove/ seagrass wetland habitat under official protection.

The data collection as a part of this report was conducted on May 1st 2021 *in situ* by Tadzio Bervoets (MSc.), director of DCNA and Roxanne-Liana Francisca (MSc.), biologist at the STINAPA Bonaire Nature Unit. The two data collectors will henceforth be referred to as “assessors”.

This report was written without any receipt of monetary or in-kind compensation and was conducted as a part of the capacity support DCNA extends to the protected area management organizations of the Dutch Caribbean.

Background

In 2020, numerous mangrove areas were placed under management of Fundacion Parke Nacional Aruba (FPNA) via "AB 2020 no. 67, LB 2020 no. 1" with the primary goal of conserving their ecological function and natural values, which includes biodiversity hotspots, nursery function for reef and fisheries target species, migratory bird habitat, seasonal wetlands, carbon sequestration, water filtration, erosion mitigation and more, however one of these areas, namely Commandeursbaai, Savaneta Nature Reserve (GEBIED 12C/12.11) is under significant pressure from a nearby development, namely the expansion of Aruba Ocean Villas.

Figure 3. Rendering of proposed development.

Although the footprint of the project expansion is not directly within the protected area it is immediately adjacent, and hence not providing any buffer function on the negative impacts of both the project construction as well as the impacts which will invariably arise from having a functioning, over-water bungalow development immediately adjacent to sensitive mangrove and seagrass habitat.

During an assessment of plans to expand overwater bungalows in Jamaica (Jamaica has the most overwater bungalow projects in the insular Caribbean), the Jamaica Environmental Trust in their 2016 Policy Brief on overwater bungalows states that:

"Erosion and terrestrial run-off during the construction and operational phases of the development will cause serious degradation of the seagrass meadows and coral recruitment areas. Storm water run-off can also become deleterious by introducing nutrients, sediments and toxic substances (especially petroleum based) to the marine environment. Any increase in sediments could have serious consequences for the mangrove root community."

"Firstly, during the construction phase of the development, the shallow and sensitive nature of this area predisposes it to degradation. Sea grasses and coral recruits do not do well in areas that have high sedimentation rates. The use of heavy equipment could be problematic. The use of pilings to support these structures would mean the interruption of the current flows now occurring. Changing flow characteristics could lead to loss of beach sand due to erosion and absence of natural replenishment. Scouring would also occur around the foot of the pilings. The structures themselves would also create an additional problem of shading. Seagrasses and corals are photosynthetic and do not occur where sunlight is not optimal."

The expansion of Aruba Ocean Villas will have similar impacts to the adjacent sensitive protected area while no mitigation plans have been presented by the principle.

Preliminary Meeting with Principle

On Saturday May 1st the assessors, in the company of the Chief Conservation Officer (CCO) of FPNA and a representative from the Government of Aruba, met with the principle of Aruba Ocean Villas. During the meeting, the principle maintained a hostile, uncooperative attitude. Principle mentioned that she has commissioned both a quick-scan and an Environmental Impact Assessment (EIA) personally but has not shared said reports, despite it being common practice (even for privately funded assessments) that principles submit EIAs for review to the officially designated Management Authority of the to be impacted area as well as to the government of the respective territory. The non-cooperative stance of the principle of Aruba Ocean Villas despite her having, according to her statements, paid for both a quick-scan and EIA out of pocket, raises red-flags in terms of the objectiveness of the reports completed.

The principle of Aruba Ocean Villas repeatedly mentioned that she does not authorize any pictures or assessments done of her property, which included areas of seagrass beds and mangroves. The data collection executed for this report was done outside of areas informed by the principle as private property.

Methods

Surveys were performed by conducting visual assessments (including photo analysis) along 30 meter transects perpendicular to the shore above seagrass meadows and adjacent to mangrove areas[1]. Measurements along these transects included position, meadow depth and visual estimations of seagrass cover and composition, density and productivity of mangroves. Supplementary work included camera surveys to determine the position of the deeper edge of meadows and mangrove areas. In total, 820 meters of the shoreline were surveyed and 15 data points were collected. Seagrasses and mangroves were growing all along the monitored shoreline. Benthic species were recorded using photoquadrats and later analyzed for species composition with unlimited time to locate and photograph specimens.

[1] Note that only the marine side of the nature reserve was included in the quick scan. The saliña side of the nature reserve was omitted due to problems with accessibility without violating the principle's explicit demands.

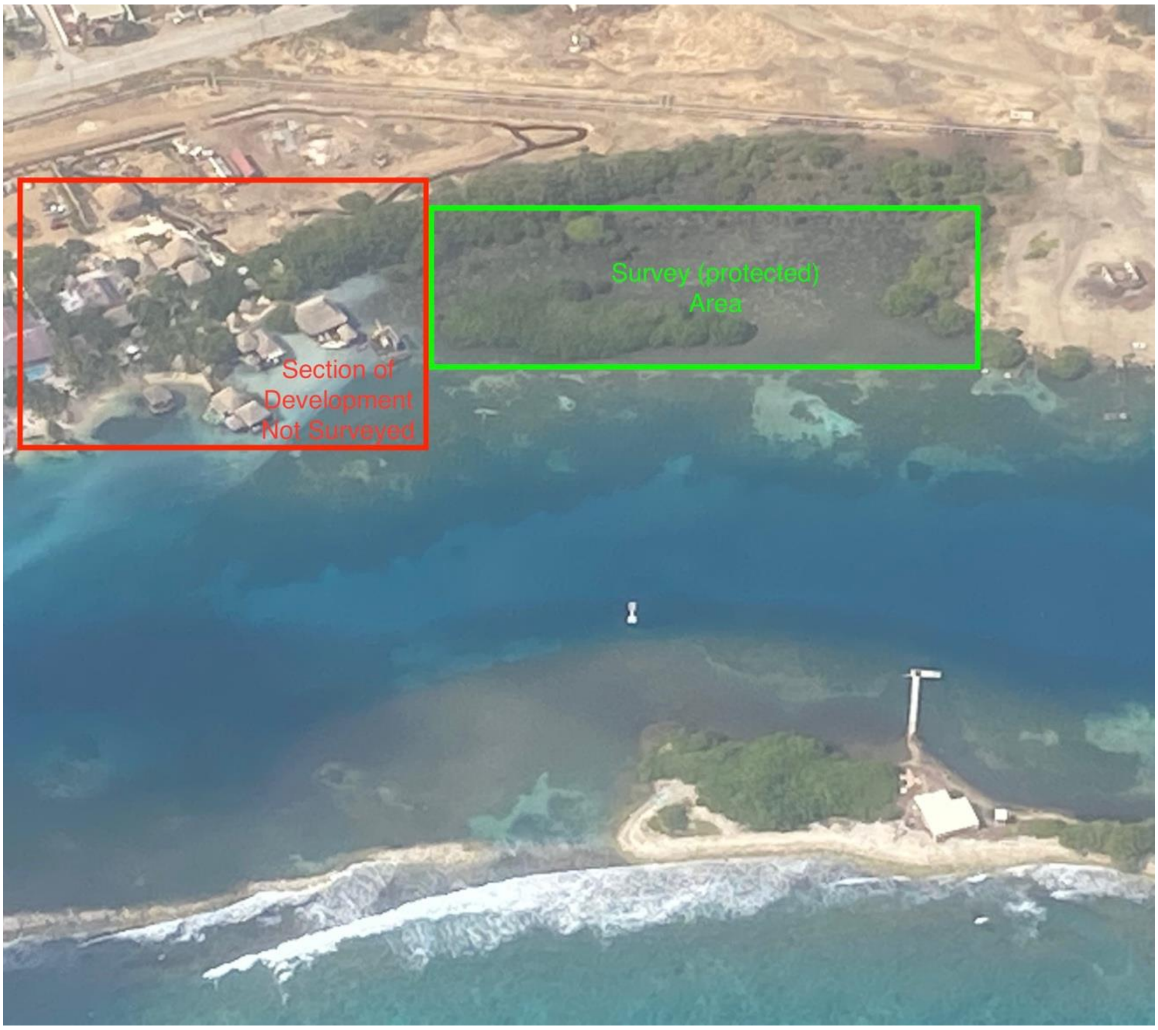

Figure 4. Survey Area- Green Box (12.26'37"N 69.56'31"W).

Results:

Sea Grasses

Seagrasses are flowering plants that live underwater. Like land plants, seagrasses produce oxygen. The depth at which seagrasses are found is limited by water clarity which determines the amount of light reaching the plant. Seagrass beds form in shallow coastal lagoon areas. The main species of seagrass found during the surveys conducted was Turtle Grass (*Thalassia testudinum*).

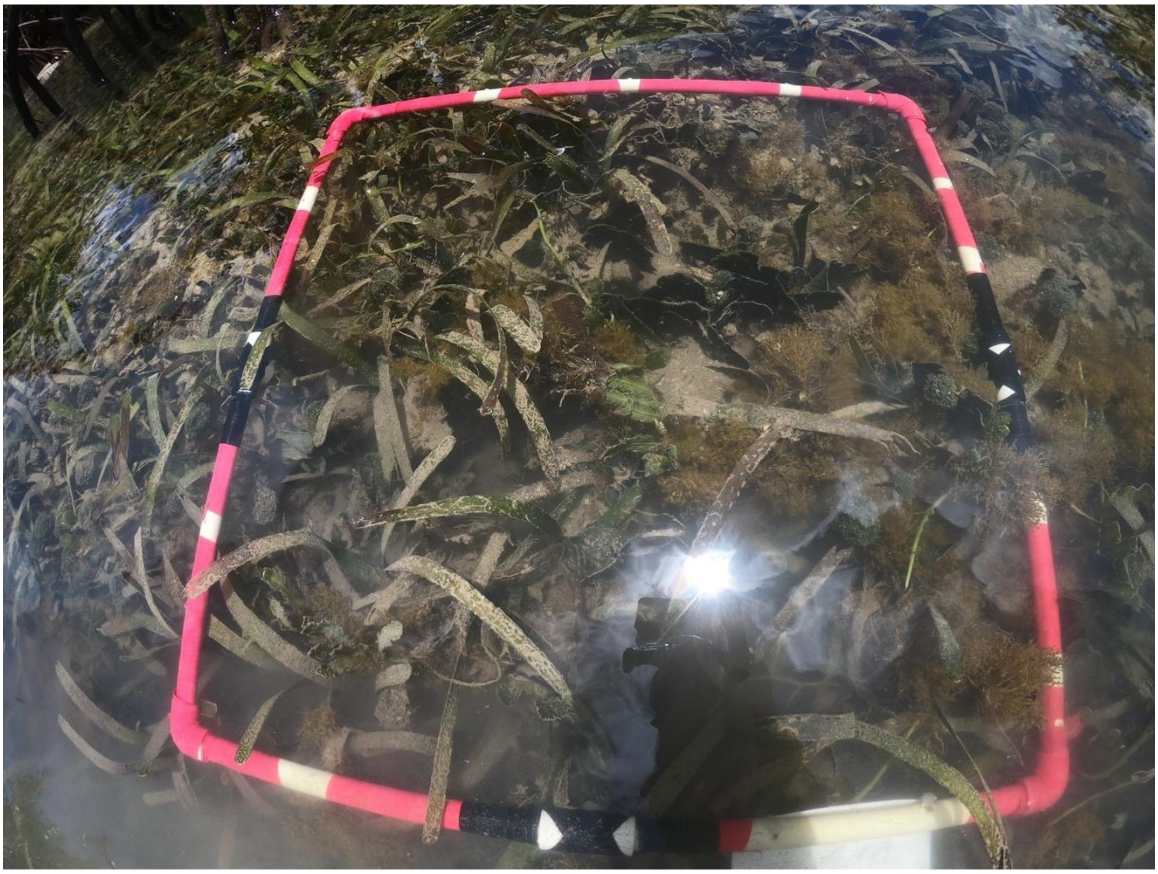

Figure 5. Benthos survey quadrat

Seagrass ecosystems are considered to be amongst the most productive in the world; an average growth rate of seagrass leaves is about 5mm per day, with entire stands of seagrass being turned over every 16 weeks with 3-4 crops annually (Edwards, 2000). In addition to this, the blades of seagrasses provide a huge surface area for settlement of epiphytes (plants that live on the surface of another organism such as calcareous green algae, crustose coralline red algae, cyanobacteria, diatoms and epifauna (animals that live on the surface of another organism such as sponges, hydroids, bryozoans, foraminiferans)). For a square metre of seabed, a dense seagrass stand may have 20m2 of leaf area for other organisms to settle on. The productivity of the epiphytes can be twice that of the seagrasses themselves.

The seagrass stands surveyed are dominated by Turtle grass (*Thalassia testudinum*) and banks of calcareous alga (*Halimeda sp*). Through a succession of growth seagrasses turn vast areas of unconsolidated sediments into highly productive plant dominated, structured habitat with a diversity of microhabitats.

Figure 6. Quadrat showing *Thalassia testudinum* as the dominant benthos

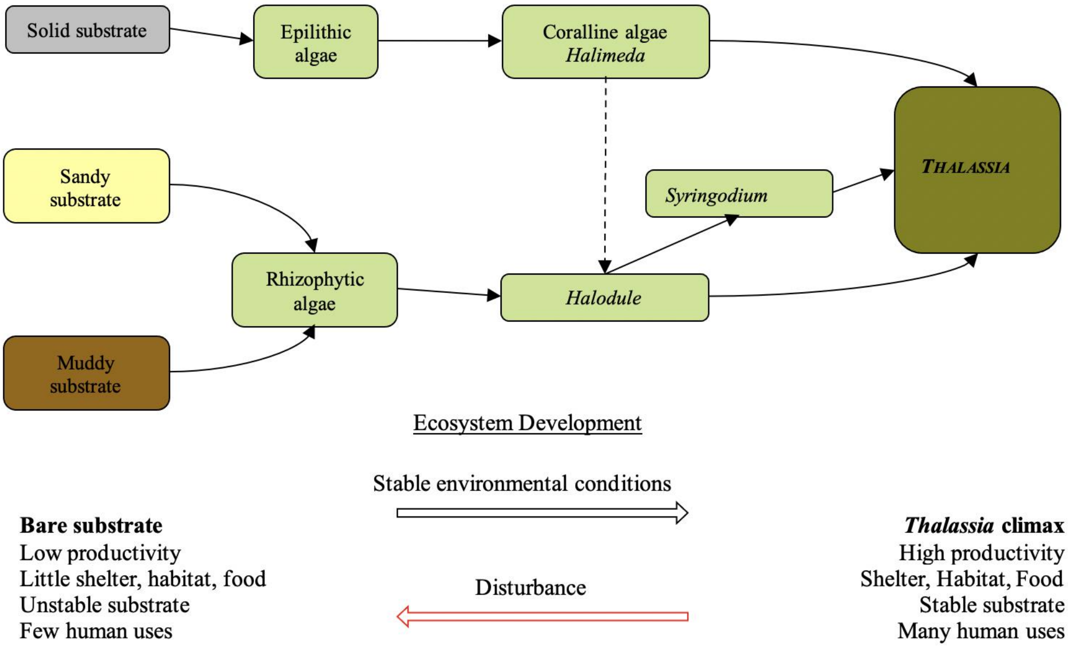

Figure 7. Seagrass succession diagram (Edwards, 2000)

Significant invertebrates found in seagrasses include Queen Conch (*Strombus gigas*), Cushion Stars (*Oreaster reticulata*), Sea Cucumber (*Holothuria mexicana*), Sea Urchins (*Tripneustes venricosus, Lytechinus variegates, Meoma ventricosa*) and the Upside-Down Jellyfish (*Cassiopeia frondosa*).

Condition

The seagrasses surveyed were healthy furthest away from the development, with shallow mats with more than 90% cover being dominant to approximately 50 meters away from the structures. Less than fifty meters away from structures composition changes to the invasive *Halophila stipulacea*, which is indicative of a degraded ecosystem due to the ongoing development.

There has also been dredging activity recorded as a part of the construction of the project, with evidence of dredging of significant areas of seagrass. Dredging without any silt-screening will result in sedimentation of seagrass meadows and roots which will cause mortality and limit growth and ecosystem functionality of the protected area.

Value

Seagrass beds provide a biological filter system for the marine ecosystem. The seagrass beds also provide a nursery and habitat for numerous commercially and recreationally valued marine animals such as Conch and juvenile fish. Internationally endangered species such as turtles also depend on the well-being of the seagrass for their survival. This value will decrease due to the activities conducted by the project in question.

Presence of *H. stipulacea*

During the surveys, significant mats of the invasive seagrass *H. stipulacea* were discovered closer to the completed structures of the project in question. This invasive seagrass becomes dominant in areas where native seagrass mats have become eroded due to various activities, including dredging and driving of stabilizing piles. Having an area dominated by *H. stipulacea* will result in a less functioning ecosystem, resulting from a significantly less caloric value of the invasive grass than that of the native Turtle Grass monitored in the survey area more away from the structures in question.

H. stipulacea is a tropical seagrass with a native range east to India, west to eastern continental Africa, south to Madagascar, and north to the Red Sea and Persian Gulf (Den Hartog, 1970). The seagrass genus *Halophila* is comprised of fourteen species on a worldwide basis (den Hartog, 1970; Sachet and Fosberg, 1973; Eiseman and McMillan, 1980; Kuo and den Hartog, 2001; Green and Short, 2003) and four species are currently known from the warm subtropical and tropical western Atlantic Ocean (den Hartog, 1970; Eiseman and McMillan, 1980). The west Atlantic representatives are: *Halophila decipiens* Ostenf., *Halophila engelmanii* Asch. and *Halophila johnsonii* Eiseman.

Figure 8. The closer to the completed structures the more dominant the invasive seagrass becomes and the less dominant the native species is.

Origin of the Invasion

The opening of the Suez Canal in 1869 facilitated the expansion of *H. stipulacea* into the Mediterranean Sea. From the mid-1800s *H. stipulacea* migrated west through the Mediterranean Sea, reaching Malta in 1970 (Schembri and Lanfranco, 1996), the Ionian Sea in 1992 (Van der Velde and Den Hartog, 1992), and the north coast of Sicily in 1997 (Procaccini et al., 1999). In 2002 *H. stipulacea* became only the second seagrass to make a transoceanic migration with the discovery of a 300 m^2 mono-culture of *H. stipulacea* in a single bay on the Caribbean coast of Grenada, West Indies (Ruiz and Ballantine, 2004).

The success of *H. stipulacea* as an invasive in the Mediterranean Sea can be attributed to its rapid vegetative expansion (Marba and Duarte, 1998), habitat flexibility (Coppejans et al., 1992; Pereg et al., 1994), tolerance of a wide salinity range (Por, 1971), adaptation to high irradiance (Schwarz and Hellblom, 2002), and ability to grow at depths from the intertidal zone to greater than 50 m (Beer and Waisel, 1981). The rapid growth and pervasiveness of *H. stipulacea* is similar to another aggressive invasive macrophyte, *Caulerpa taxifolia* (Boudouresque and Verlaque, 2002; Anderson, 2005).

H. stipulacea in Survey Area

The presence of *H. stipulacea* was verified by examining the characteristic features of the species based on the description of Den Hartog (1970). Rhizome diameter measured 1–2 mm with a single root at each node and an internode distance of 7–50 mm. Leaf scales were folded and elliptic in shape with a length of 6–18 mm and width of 2–6 mm. Blades were elliptic, oblong to linear, and pale to dark green in color with a length of 22–57 mm and width of 5–9 mm. The surface of each blade had a distinct mid-rib originating at the petiole and ended near the apex of the blade where it merged with the circumventing intramarginal nerve. Serrations were present along the lateral margin and at the apex of the blade. Additionally, the blades had numerous and often paired cross-veins extending from the mid-rib to the intramarginal nerve at a 30–608 angle. Blade dimensions of samples (n = 30) taken from three beds within the surveyed (protected) area (based on Willette, Ambrose 2009).

Figure 9. Dominance of invasive seagrass closest to Aruba Ocean Villas indicating a degraded and eroded substrate habitat.

Figure 10. Confirmation of invasive seagrass.

The depths at which specimens were found were fairly consistent throughout, with an average collection depth of 0.5 to 1.5 meters. The water temperature during collection was a steady 27 degrees Celsius.

Effects of the Invasion

The presence of a seagrass that is tolerant to a wide range of environmental factors could occupy open space and thus re-shape the local marine resources, such as near-shore fisheries. Differences in *H. stipulacea*'s structural morphometrics at different depths, and to some degree different patch sizes, highlights the seagrass' plasticity when growing in a broad range of conditions. If *H. stipulacea* expands into existing seagrass beds, it may result in the loss of biodiversity. In biologically depleted zones such as the area impacted by the development, the rapid colonization of recently disturbed habitats by *H. stipulacea* could interfere with natural seagrass succession. Likewise, if *H. stipulacea* is displacing native seagrasses on the island, a loss of seagrass diversity may occur. The displacement of an indigenous species may not only compromise that species (for examples, see Race, 1982; Fogarty and Facelli, 1999), but may also have a cascading effect on any organisms supported by that species (for examples, see Spencer et al., 1991; Levin et al., 2006; Khan et al., 2003; Byrnes et al., 2007; Daskalov et al., 2007), such as sea turtles that rely on Turtle grass with a higher nutritional content. Further studies of *H. stipulacea* will be needed to resolve the question of its ecological impacts in the Caribbean basin.

H. stipulacea patches often occurred exclusive of the otherwise dominant seagrasses of the Caribbean (Willette, Ambrose 2009). The potential for the expansion of *H. stipulacea*, combined with its tolerance for a wide spectrum of environmental conditions, positions it as a serious potential threat to local and regional biodiversity.

Mangroves

Mangrove forests world-wide are under severe pressure and disappearing at an alarming rate. It is estimated that about 60% of the total mangrove areas in the world have disappeared. This is mainly contributed to large scale land clearance for coastal development. Mangroves are trees growing in inter tidal areas.

Around the area surveyed, four species of mangroves were recorded: *Rhizophora mangle* (Red Mangrove), *Avicennia germinans* (Black Mangrove), *Laguncularia racemosa* (White Mangrove) and *Conocarpus erectus* (Buttonwood). Despite its small size, the area had a dense thicket of healthy mangroves as well as numerous juvenile specimens, which shows that the area is a functional environment for natural mangrove regeneration. This despite the coastal development immediately adjacent to the area which has not allowed any buffer to protect the afore-mentioned mangrove strands (and indeed the entire mangrove/seagrass wetland ecosystem). This may result in a significant reduction in both the mangrove and seagrass density of the area which will have a significant negative impact on the coastal / coastal-wetland ecosystem dynamic of Aruba in its entirety.

Figure 11. Arial photo of protected area

All the four mangrove species that occur on Aruba are protected by national law (AB 2017 no. 48). Mangroves are also protected in international treaties (SPAW protocol annex III).

Mangrove forests grow in a pattern from the native terrestrial plants through to the highly adapted Red Mangroves with their specialised prop roots. Table 1 summarises the characteristics of the different vegetation zones.

Table 1: Typical Mangrove zonation

A	Terrestrial vegetation	Vegetation that grows on land and is intolerant of salty soil or water, such as Macubari (*Gaupira pacurero*), Watapana (*Caesalpinia coriaria*) and Wayaca (*Lignum Vitae*)
B	White Mangrove zone	The White Mangrove, *Laguncularia racemosa*, usually occupies the highest elevations farther upland than either the red or black mangroves. Unlike its red or black counterparts, the white mangrove has no visible aerial root systems. The easiest way to identify the White Mangrove is by the leaves. They are elliptical, light yellow green and have two distinguishing glands at the base of the leaf blade where the stem starts
C	Black Mangrove zone	The Black Mangrove, *Avicennia germinans*, usually occupies slightly higher elevations upland from the red mangrove in tidal areas that are inundated during high tides. The Black Mangrove can be identified by numerous finger-like projections, called pneumatophores, which protrude from the soil around the tree's trunk.
D	Red Mangrove zone	The Red Mangrove, *Rhizophora mangle*, is probably the most well-known. It typically grows along the water's edge, especially along Aruba's southern coast. The Red Mangrove is easily identified by its tangled, reddish roots called 'prop roots'. The roots are usually exposed at low tide but covered at high tide.

Mangrove forests provide a habitat for a number of different plants and animals dispersed from the muddy sediments through the trees into the canopy. These include many invertebrates, reptiles, fish and birds.

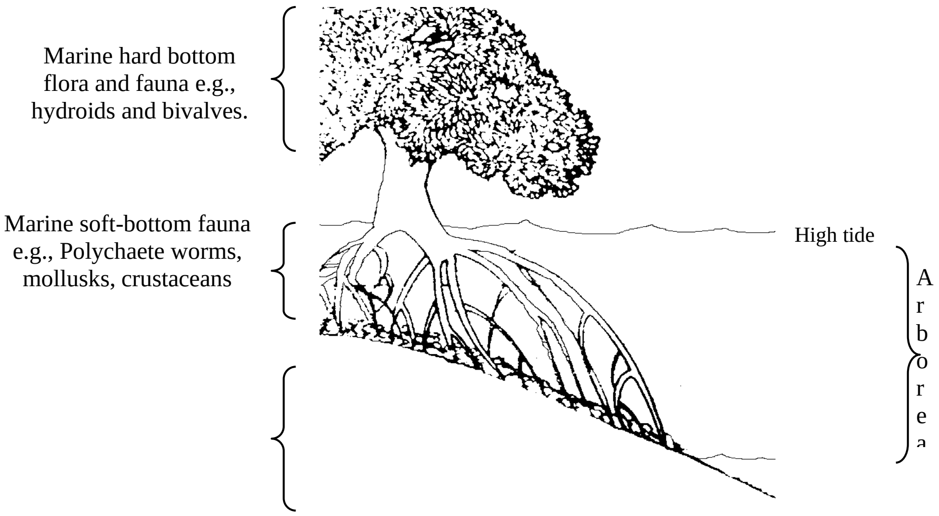

Figure 12: The vertical distribution of large animals in mangrove forests.

Significant invertebrates in the mangroves are similar to those found in seagrasses e.g., Queen Conch (*Lobatus gigas*), Milk Conch (*Strombus constates*), Cushion Stars (*Oreaster reticulata*), Sea Cucumber (*Holothuria mexicana*), Sea Urchins (*Tripneustes venricosus, Lytechinus variegates, Meoma ventricosa*), Upside-Down Jellyfish (*Cassiopeia frondosa*) and the Atlantic Triton (*Charonia variegate*).

Many different fish species use the mangroves of the area as both permanent and nursery habitat. The species that are known to have fidelity to mangroves /seagrass beds during the various life stages are: Caribbean Spiny Lobster (*Panilirus argus*), Striped Parrotfish (*Scarus croicensis*), Bluehead (*Thalassoma bifasciatum*), Silversides, Herrings and Anchovies (families *Atherinidae, Clupeidae, Engraulidae*). Other interesting species that use the mangroves include Spotted Eagle Rays (*Aetobatus narinari*), various species of Moray Eels and young sharks.

Several species of birds were recorded on and around mangroves, including American Coot (*Felucia Americana*), Moorhen (*Gallinula chloropus*), Yellow-crowned Night Heron (*Nyctanassa violacea*), Green Heron (*Butorides striatus*), the Brown Pelican (*Pelicanus occidentialis*) and several plovers.

Condition

All of the mangroves on Aruba, even for those included in protected area under the management mandate of FPNA, are threatened by pollution and development. Even though the area in question only covers a very small area of the coastline, it is a highly functioning ecosystem. Despite this high functionality there have been very little considerations by the developer for the sensitivity of the habitat. This is evident by the eroded benthos closest to the structures and the ongoing use of dredging without silt screens or sedimentation barriers, causing sedimentation to impact especially the sensitive seagrass areas and mangrove roots, eroding the functionality of the area.

Figure 13. Highly functional seagrass (Turtle Grass dominant) and Mangroves of the Protected Area.

Value

Mangroves are an important sanctuary, breeding and foraging ground for many wetland birds, marine invertebrates and fish. In the past, the bays have also been home for two globally endangered species: Green Turtles (*Chelonia mydas*) and Queen Conch (*Strombus gigas*).

Mangroves act as a filter for water being washed off the land by preventing harmful sediments from smothering the coral reef. By establishing themselves successfully, the mangrove trees become a thriving habitat for many other plants and animals as well as an important nursery for many species of fish. Fish using the mangroves as a nursery include Schoolmasters (*Lutjanus apodus*), Gray Snapper (*Lutjanus griseus*), Great Barracuda (*Sphyraena barracuda*) and the Foureye Butterfly (*Chaetodon capistratus*).

Recent research has valued mangroves forests at more than $900,000 per square kilometer per year (United Nations Environment Program). They serve as storm buffers, filters of run-off, supply fisheries, support birdlife, and provide aesthetic enjoyment.

Red Mangroves are the only tree in the Caribbean region which can grow in salt water. Their extensive prop roots stabilize the coastal soil, especially important during negative weather events, and can actually collect sediment and increase the storm barrier area. Perhaps one of their most astounding attributes, mangroves are able to clean the water. Through a process called rhizofiltration, these remarkable trees remove pollutants from the water.

These values may erode significantly if the project in question is allowed to progress without any consideration for buffer zonation, ecosystem functions or the mitigation of impacts from construction.

Claims by the Owner Regarding Mangrove Area

According to a report provided by FPNA (Natural Mangrove Regeneration. Gebied 12C/ 12.11 Commandeursbaai, Savaneta) "Osyth Henriquez/Aruba Ocean Villas claims in the ROP 2019 Zienswijze and in a meeting with the executive board of FPNA on 19 February 2021 that she is responsible for the mangroves being present in Commandeursbaai and the mangroves should therefore not be protected as "Natuurgebied", and that the Aruba Ocean Villas should be allowed to expand into the "Natuurgebied".

However, FPNA has demonstrated in their report through satellite imagery that the mangroves in Commandeursbaai are the result of a natural regeneration process seen around Aruba and is highly unlikely that the presence of mangroves can be attributed to Aruba Ocean Villas. Only the mangroves present on the headland, the landfill area expanding into the sea, can be attributed to actions of Aruba Ocean Villas. The author of this report supports this statement; the structure and extent of the mangroves in the area observed empirically as well as the findings outlined in the report from FPNA it is highly unlikely that the area was solely planted by the developer.

The author of this assessments also agrees with the report's statement that:

"Regardless of how the mangroves regenerated in the area, the current natural values are of great importance for local marine ecosystems and economic activities. Moreover, the loss of this functional mangrove habitat will decrease reproduction capacity of target fisheries species, loss of birdlife, loss filtration capacity for adjacent seagrass beds reducing the seagrass health, loss of seagrass ecological function, loss of carbon sequestration / increase in carbon emissions with increased degradation and more, ultimately resulting in a decrease in coastal protection, climate resilience and long term economic income for other sectors on Aruba including fisheries (Meesters, Becking & van der Geest 2019, Debrot 2017, Hutchison et al. 2014)."

Species Composition

Twenty-six species from eight phyla were identified from the quick scan survey transects and photographs as described in the methods. Some specimens could not be identified to species, such as the white sponge. Table 2 is a quick scan and is not representative of the full scale of species present in the area.

Table 2. Species Assessment

Seagrasses/ Algae	
Caulerpa sp.	*Caulerpa sp. (C. toxifolia?)*
Green Feather Algae	*Caulerpa sertlarioides*
Three-loped Leaf Algae	*Halimeda incrassata*
Mermaid's Wineglass	*Acetabularia calyculus*
Seapearls	*Valonia sp.*
Turtle Grass	*Thalassia testudinum*
Invasive spp.	*Halopilla stipulacea*
Mulusca	
Flat Mangrove Oyster	*Isognomon alatus*
Echinodermata	
Sea Cucumber	
Thorny Starfish	*Echinaster spinulosus*
Cnidaria	
Upside-down Jelly	*Casseopia xamachanna*
Ringed Anemone	*Bartholomea anulata*
Pale Anemone	*Aiptasia pallida*
Porifera	
Fire Sponge	*Tedania ignis*
Pink Mangrove Sponge	*Haliclona implexiformis*
Green Sponge	*Haliclona viridis*
Chordata	
Mangrove Tunicates	*Ecteinascidia turbinata*
Black Tunicate	*Ascidea nigra*
Testudines	
Green Sea Turtle	*Chelonia mydas*
Fish	
Mojarra	*Gerres cinereus*
Juvenile Schoolmaster	*Lutjannus apodus*
Juvenile Barracuda	*Sphyraena barracuda*
Mangrove/Grey Snapper	*Lutjanus griseus*
Arthropoda	
Barnacles	
Caribbean Spiny Lobster	*Panilirus argus*

Conclusion and Recommendations

Conclusion

Despite the principle arguing that the Aruba Ocean Villas is a sustainable, nature-based project, the expansion of Aruba Ocean Villas will have significant impact on the Commandeursbaai, Savaneta Nature Reserve (GEBIED 12C/12.11). The data collected for this report shows that the area is highly functional in terms of ecosystem services, but it is also very sensitive to negative external impacts. These negative impacts outlined in the body of the report above have, in the opinion of the author, not been sufficiently assessed and mitigated by the principle. There is no consideration for mitigation of the negative effects from construction (increased sedimentation and siltation on mangrove roots and seagrass meadows) nor has a buffer function been considered to protect the sensitive ecosystem both during construction and when operational.

Recommendations

Overwater bungalows and their negative environmental impacts are well understood both in the Caribbean Region and in other areas where these projects have become numerous and problematic. There are significant environmental risks related to the various stages of construction which should be significantly recorded and measured as with every case of similar projects impacting sensitive habitat. Below the risks are outlined. It is recommended that the proper procedures and considerations, including those outlined below, are measured, implemented, and controlled.

ENVIRONMENTAL RISKS

Overwater rooms – construction phase

- Siltation in the marine environment as a result of dredging and/or the driving of piles to support the rooms.
- Damage to the marine environment from installation of pipelines to remove wastewater and bring fresh water to the rooms.
- Damage to the marine environment from poorly controlled solid and construction waste.
- Removal of seagrasses to construct the rooms.
- Shading of seagrass beds by the rooms, resulting in thinning of seagrasses or die-off of seagrasses and the communities of invertebrates, fishes, and turtles that these seagrass beds support.
- Disruption of ocean currents, sand transport and deposition.

Overwater rooms - operational phase

- Artificial aggregation of marine organisms to the structure created by rooms.
- Disruption of migration routes and feeding/behavior by marine organisms.
- Attraction of birds to lights, disrupting feeding and roosting behavior.
- Potential impacts of noise pollution, disrupting feeding and roosting behavior.
- Potential impacts of sewage spills in the marine environment in storm conditions.
- Potential impacts of destroyed rooms due to hurricanes and storms.
- Potential for solid waste (trash) and food waste to blow/fall off the decks and into the marine environment, where it may be ingested and cause harm to marine species.

Overwater rooms in bad weather

- Overwater rooms work best in very sheltered areas (lagoons in coral atolls, for example) with naturally restricted access by sea and sand bottoms.
- Overwater rooms may be affected by high seas several times per tourist season by northers or tropical weather systems. Guests will have to navigate boardwalks to land in potentially dangerous conditions.

Secondary risks:

- Removal/degradation of seagrasses leading to reduced sedimentary budgets and beach erosion nearby or remotely, reduced habitats, reduced protection from storms.
- Permission granted for one set of overwater rooms will be used as a precedent for many other overwater rooms.

Other issues:

- **Ecological survey**: Before overwater rooms are approved anywhere else, a thorough ecological survey of terrestrial and marine species and habitats (dunes, seagrass beds, seafloor, mangroves, reefs) must be conducted objectively and reviewed by the respective environmental management areas. In the event that any of these habitats are likely to be affected, an EIA must be done and the required environmental permitting undertaken.
- **Monitoring:** Monitoring should be required during the construction period. The impacts of any constructed overwater rooms on water quality, biodiversity health, beach erosion and the stability and integrity of any area of coastline needs to be diligently monitored for at least five years post construction.

It is further recommended to take the portion of seagrass bed located directly south of the survey (protected) area into consideration for its ecological value and protection (figure 4). This portion of the seagrass bed lays deeper within the water column and supports larger protected marine species such as Green Turtles (*Chelonia mydas)*, adult conch (*Strombus gigas*), and adult lobster (*Panilirus argus*). Deeper seagrass beds with such proximity to mangroves, as seen in this location, are a rare and valuable ecosystem within Aruba's marine environment. The construction of water bungalows is planned to occur on top of the deeper portions of the seagrass bed resulting in the loss of native and protected seagrass with corresponding loss in ecological functions for protected sea turtles, adult conch, adult lobster, and more.

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