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Community participation and perspectives of Ambondrolava
mangrove restoration project

Nadine Shannon

SIT Madagascar: Biodiversity and Natural Resource Management

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Spring 2023

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Abstract

Madagascar's mangrove forests are intertidal ecosystems that provide numerous valuable ecosystem services but are nonetheless under pressure from large amounts of deforestation. On the southwestern coast of Madagascar, the village of Ambondrolava practices community led management of the mangrove and its resources. This research project studied the evolution of the mangrove area using GIS data, and investigated, through interviews, the relationship between the local community of Ambondrolava and the organizations that manage the mangrove ecosystem. From 2000 to 2018, the zone of the mangrove has experienced a net loss in area every year, despite reforestation efforts. Most community members interviewed expressed the importance of the mangrove forest and therefore its conservation, as well as benefits gained from the two management organizations, VOI Mamelon Honko and Reef Doctor Honko Project. However, participants also expressed discontent with the dishonesty and unreliability of the VOI leaders. To ensure the success of the conserving the mangrove, these issues of trust and transparency must be addressed, and alternative sources of income and food should be instituted to reduce anthropological pressure on the mangrove and improve community livelihood.

Résumé

Les forêts de mangroves de Madagascar sont des écosystèmes intertidaux qui fournissent de nombreux services écosystémiques précieux, mais qui sont néanmoins sous la pression de grandes quantités de déforestation. Sur la côte sud-ouest de Madagascar, le village d'Ambondrolava pratique la gestion communautaire de la mangrove et ses ressources. Ce projet de recherche a étudié l'évolution de la superficie de la mangrove à l'aide de données SIG et a examiné, au moyen d'entretiens la relation entre la communauté locale d'Ambondrolava et les organisations qui gèrent l'écosystème de la mangrove. De 2000 à 2018, la zone de la mangrove a subi une perte nette de superficie chaque année, malgré les efforts de reboisement. La plupart des membres de la communauté interrogés ont exprimé l'importance de la forêt des mangroves et donc de sa conservation, ainsi que les avantages tirés des deux organisations de gestion, VOI Mamelohonko et Reef Doctor Honko Project. Cependant, des participants ont exprimé aussi leur mécontentement à l'égard de la malhonnêteté et du manque de fiabilité des dirigeants du VOI. Pour assurer le succès de la conservation de la mangrove, il faut que ces questions de confiance et de transparence être abordées, et d'autres sources de revenus et de nourriture devraient être instituées pour réduire la pression anthropologique sur les mangroves et améliorer les moyens de subsistance de la communauté.

Introduction

Mangroves in Madagascar

Madagascar, the island well known as a “hotspot” for its abundant and endemic biodiversity, is also known as one of the most endangered hotspots due to the alarming rates of habitat loss throughout the country (Myers et al., 2000). One of the biggest threats to biodiversity in Madagascar is deforestation (Harper et al., 2007), a threat certainly observed within Madagascar’s mangrove forests, as a coastal ecosystem heavily used for its many resources. The mangroves of Madagascar constitute 2% of the world’s mangroves and 9% in Africa (Giri et al., 2010; FAO, 2007). There are nine species of mangrove trees in Madagascar, and almost all of the forests are found on the west coast, where the local populations often depend on the ecosystems for food and income (Jones et al., 2016). Unfortunately, Madagascar has faced over a 20% net loss in mangrove forests in response to deforestation in the span of 20 years (Jones et al., 2016), a loss that has only continued to increase in the past years. This destruction of mangroves not only holds larger implications for global climate change, but also for the livelihoods of local populations who rely on the forests.

Mangrove Characteristics

Mangrove forest ecosystems are situated in coastal intertidal zones and rely on a mix of freshwater and seawater to thrive. In adaptation to living in water with high salinity and low oxygen, mangrove trees are uniquely characterized by their salt filtration and aerial root systems. Generally, mangrove forests act as a bridge between terrestrial and marine ecosystems and are often interdependent with sea grass and coral reef ecosystems. As a result of mangrove ecosystem positioning and the trees stabilizing roots, these forests provide protection for coastal communities against erosion, flooding, and storms (*Mangrove Services*, Mangrove Action Project).

Situated on the coastline, mangrove ecosystems provide a habitat for a diverse range of aquatic, amphibian, and terrestrial flora and fauna, especially to fish and crustaceans as juveniles and for breeding, as many live and lay their eggs around the mangrove roots systems. Mangrove trees also filter water through the entrapment of sediments, resulting in a storage of nutrients and improved water quality (*Mangrove Services*, Mangrove Action Project). Furthermore, mangrove forests are well known to sequester large amounts of carbon, ranging from three to ten times the

amount stored in terrestrial ecosystems, even tropical rainforests (Donato et al., 2011). This storage of carbon helps to combat climate change, and consequently, contributes to a great amount of carbon release when mangrove trees are cut down.

Mangrove role and use

Mangrove forests are a source of numerous types of ecosystem services. Ecosystem services (ES) are attributes of an ecosystem that provide any type of benefit for humans, whether directly or indirectly (Getzner & Islam, 2020). Mangrove forest ES include the provision of wood for fuel and construction, habitat for fish and other biodiverse marine life, protection from storms and erosion, and regulation of soil and water nutrients, including carbon sequestration (Getzner & Islam, 2020). As a provider of these ecosystem services, mangroves are an invaluable resource for the communities they support. Unfortunately, without regulation of resource exploitation, use of the mangroves can easily become unsustainable. Excessive cutting of trees to produce charcoal or construction material, clearing of forest for agricultural use, and overfishing have all contributed to the diminution of mangroves and the floral and faunal species they support.

Community management

In response to the pressures exerted on mangrove ecosystems, community management restoration projects have formed to conserve mangroves throughout Madagascar. Conservation strategies include reforestation efforts, community education and awareness, the provision of alternative sources of income, ecotourism, and Payment for Ecosystem Services (PES). PES, which consists of a buyer “purchasing” an ecosystem service from someone(s) who ensures the provision of the ecosystem service, is a method that can involve and support local communities through community management of ecosystems (Rakotomahazo et al., 2023). In Madagascar, PES has already been implemented with Tahiry Honko, in the Bay of Assassins where the community mangrove restoration project works alongside Blue Carbon to receive payment for carbon sequestration in the form of carbon credits (*Tahiry Honko – Madagascar, 2020*). Around Madagascar there exist multiple community managed conservation projects for varying ecosystems, with the goals of empowering the community and implementing more efficient and sustainable conservation strategies (Gardner, 2013).

Ambondrolava: mangrove and organizations

One such community operated mangrove conservation and restoration project is located in the village of Ambondrolava, just outside of Toliara, Madagascar. The mangrove is managed in part by the Vondron'Olona Ifotony (VOI) and by the Reef Doctor Honko Project (Reef Doctor). Vondron'Olona Ifotony in Malagasy translates to 'grassroots community' in English, and is an association comprised of local community members. The Reef Doctor Honko Project is a non-profit UK-based organization that serves as a technical and financial partner (TFP) for the VOI (*Mangroves*, Reef Doctor) The VOI and Reef Doctor work with community to welcome tourists for tours in the mangrove, host reforestation/replanting events, raise awareness about the mangroves, protect the forest from poaching, deforestation, and the movement of the dunes, and to sell artisanal crafts weaved from the reeds adjacent to the mangrove forest. However, the VOI and Reef Doctor are not the only two organizations centered around the mangrove. In 2012, the community created the women's association, Vannerie Mamelon HONKO, to employ and empower women in the community through activities such as creating artisanal crafts from the reeds and selling to tourists. In 2018, Reef Doctor Honko created the fish farming project called Fikambanan'ny Mpiompy Fia Mamelon Honko (FIMPFI MAHO), with the goal of providing an alternative source of income for the community and reducing fishing pressure on the mangrove area (L. Stanislas, personal communication, April 9, 2023). The local community also created an organization of patrols called Polisin'ala, with the purpose of protecting the mangrove from poaching and thievery. Each of these organizations interact with one another and the community, and collectively support the protection, conservation, and restoration of the mangrove (Figure 1).

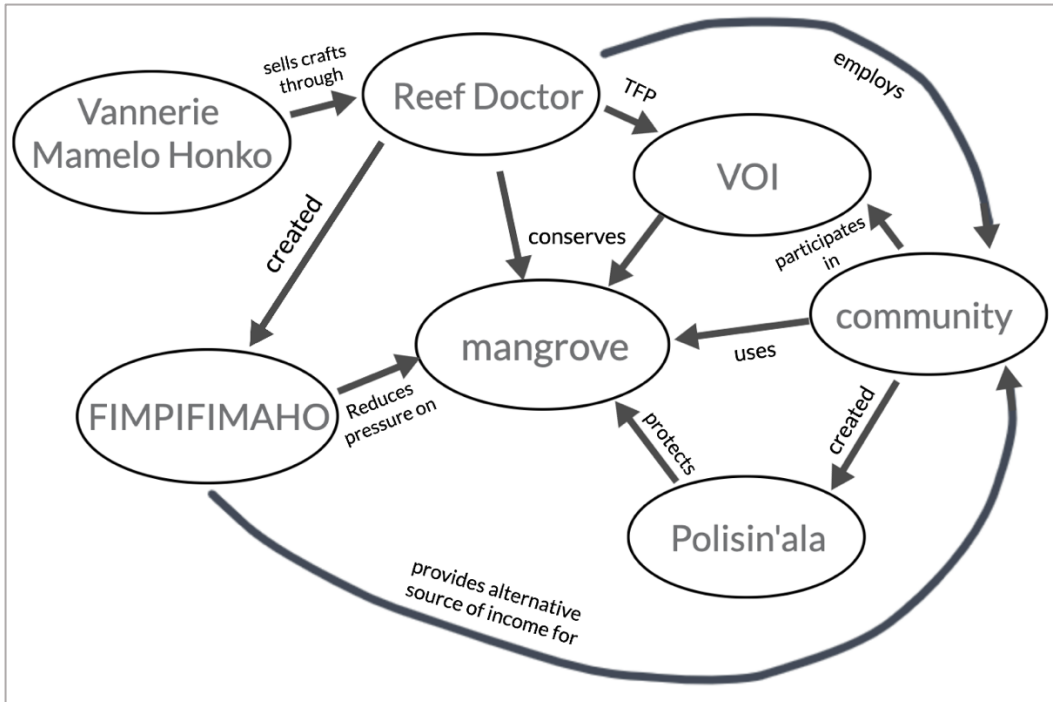


Figure 1. Concept map depicting the connections between the Ambondrolava community, the mangrove, and the organizations involved in the mangrove conservation.

Objectives

In Ambondrolava, as with other community led conservation projects, the success of the mangrove forest and the sustainable management is highly dependent on the participation and engagement from the community, and ultimately, such projects cannot succeed without the support of the community (Rakotomahazo et al., 2019). Consequently, the questions that this study aims to answer are centered around what the relationship is between the community of Ambondrolava and the management and conservation of the mangrove area. More specifically, how is the community involved in conservation and management? How does the community benefit from the restoration projects? How does the community perceive the management of the mangrove and its conservation? How successful has restoration been?

In response to these questions, I hypothesized that I would see an increase in the size of the mangroves, that the community benefits from and has a good relationship with the VOI and Reef Doctor, and the community is therefore supportive of conservation and reforestation efforts.

To identify the relationship between the community and the management and conservation of the mangrove, there were three main objectives:

- Study the perspectives of the local population about the goals and success of the mangrove restoration project
- Analyze the evolution of the mangrove area over time in response to conservation efforts
- Identify the benefits of the current management strategy for the community, as well as issues and desired changes for improvement.

Methods

Study Site

The mangrove and the associated VOI studied in my research are located in the village of Ambondrolava, which is part of the municipality Belalanda, situated about 12 km from the well-known city of Toliara. The municipality Belalanda, located in the district of Toliara-II and region of Atsimo-Andrefana, is found on the southwest coast of Madagascar (Figure 2). The ethnic group in this part of southwestern of Madagascar who work with the sea are called Vezo. Known as “the people of the sea”, the Vezo are mainly involved with fishing activities, rather than terrestrial animal or plant agriculture.



Figure 2. Location of Ambondrolava Honko in Madagascar. The red line located on the large map of Madagascar outlines the region of Atsimo-Andrefana. (Google Maps, 2023)

The mangrove ecosystem is composed of multiple parts, including the mangrove trees, the wetland area, the reeds, and the dunes. To the west of the mangrove lays the Mozambique Channel, which gives way to the ever-moving sand dunes. A canal of water, connected to the sea on the north end, splits the mangrove area, separating the dunes on the western side and the mangrove trees on the eastern side (Figure 3). Further east and just next to the mangrove forest lies the fields of the reeds, called vondro in the Vezo dialect. Currently, there exists about 550 ha of the total wetland, about 350 of the mangrove trees, and about 200 ha of the reeds and the dunes. There are seven species of mangrove trees in the forest, providing habitat for 81 species of fish, 76 species of birds, and 14 species of crab (L. Stanislas, personal communication, April 9, 2023). The mangrove forest of Ambondrolava is managed by the community surrounding it, through the VOI Mamelolo Honko and the Reef Doctor Honko Project.



Figure 3. Layout of the Ambondrolava mangrove, starting west of the map with the Mozambique Channel (A), which connects to the dunes (B). The mangrove forest (D) is split by the water canal (C). The tours (E) through the mangrove lead from the Reef Doctor center (G) to the canal. Just east of the mangroves lies the field of vondro (F). (Google Earth, 2022)

Research: GIS

The first part of my research project aimed to examine the progress and success of the restoration project in the Ambondrolava mangrove. To study this progress, I investigated the change in area of the mangrove forest using satellite imagery data. I obtained Geographic Information Systems (GIS) data on the evolution of mangroves throughout Madagascar since 2000, provided by Professor Le Don of Institut Halieutique et des Sciences Marines and sourced from Shapiro et al. (2019). Using the software QGIS, I isolated the visual representation of the evolution of the mangrove for Ambondrolava. Both the loss and gain of mangrove tree area was selected and visualized for the years 2000, 2005, 2010, 2015, and 2018. I additionally visualized the mangrove area that remained stable and the area that fluctuated inconsistently throughout the 19 years of imagery. The total loss and gain across all years were also shown alongside the stable and dynamic areas of the mangrove in Ambondrolava. From the same data set, the numerical area data for the region of Atsimo-Andrefana was also obtained and organized for comparison with the visual data of Ambondrolava. Regional data was used for comparison because it was the smallest numerical breakdown of the evolution of Madagascar's mangroves.

Research: Interviews

The second part of my research focused on investigating the community perspectives on and relationships with the two management organizations and the overall project to conserve and restore the mangrove. To investigate the participation and perspectives of the local villagers in Ambondrolava, I conducted a total of 41 interviews. The study population included village authorities, leaders of the VOI, VOI members, Reef Doctor Honko employee, and community members who are not a part of the VOI. Interviews consisted of questions concerning the interviewee's personal use of the mangrove, participation in and perspective on the VOI and Reef Doctor, involvement in mangrove conservation and restoration, desired changes, and views on the success of conservation and reforestation. (See attached questionnaire) At the start of our research, we were introduced to the community through a guide who subsequently brought us through the village to community members to conduct our interviews. Before beginning all interviews, we obtained the permission to speak with and record the responses of each participant. Participants were made aware of their complete voluntary participation (their right to skip any question or terminate the interview at any time) and the confidentiality of the study (See attached consent form). Each interview was recorded by phone for later translation. During my research, I worked alongside a student from the Institut Halieutique et des Sciences Marines, for aiding in translation during interviews and with recordings. Interviews were translated separately, through listening of recordings, to provide time for more accurate and meaningful representation of participant responses.

Following data collection and translation, the interview responses were organized anonymously by question using Microsoft Excel. Depending on the question, responses were further organized into categories based on main ideas or themes of the answer. Any identifying information or information not relevant to the study questions or objectives was omitted from analysis. As categorical analysis is not all encompassing of participant responses, the themes and nuances of answers are further discussed with the results.

Results

GIS data: Mangrove area evolution

There were five years of mangrove area data, spanning across a total of 19 years. For each year represented, there was a greater amount of area lost than gained (Figure 4). For the year 2010, however, there is much greater loss observed, when compared to other years and when compared to the area gained (Figure 4.D). In the years following 2010, there is much less loss of mangrove forest, but there is not much more gain of forest. It is interesting to note that the year of 2010 is also the same year the VOI Mamelolo Honko was founded. For the year 2018, only data for the loss of mangrove area was provided, so there is no comparison to the amount gained in that year (Figure 4.F). Across all years, the largest amount of the area remains stable, but there is a much greater loss of area than gain of area. There is no net gain of mangrove area observed for any individual year or for the total 19 years.

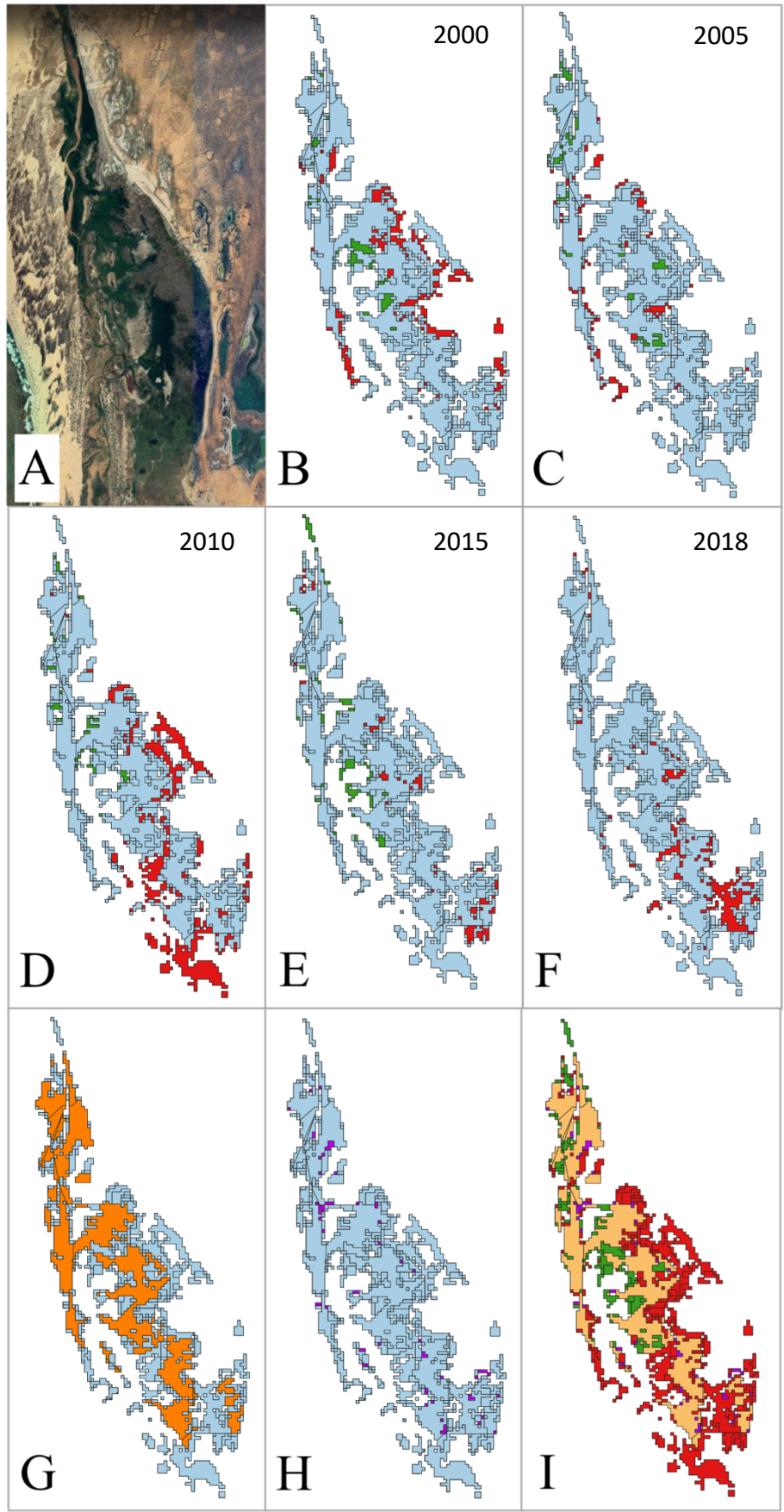


Figure 4. Evolution of the Ambondrolava mangrove forest. **A)** 2023 Google Earth map of mangrove area. **B,C,D,E,F:** Loss(red) and gain(green) of the mangrove area for the year 2000(**B**), 2005(**C**), 2010(**D**), 2015(**E**), and 2018(**F**). **G)** Stable area(orange) of the mangrove throughout all years. **H)** Area of the mangrove that changed(dynamic) inconsistently throughout all years(purple). **I)** Total loss(red), gain(green), stable(orange) area, and dynamic(purple) area of the mangrove from 2000-2018.

The observed net loss of mangrove forest area in Ambondrolava is consistent with the GIS area data for the larger region of Atsimo-Andrefana. The stable area of the mangrove is similarly much larger than the area lost or gained through the years. For the entire region of Atsimo-Andrefana, there was a net loss observed for each year, as well as a total net loss of about 2700 hectares across all years (Table 1).

Table 1. Numerical GIS data of mangrove area evolution for the region of Atsimo-Andrefana.

Year	Area_Ha
<i>Net 2000</i>	-760.86885
<i>Net 2005</i>	-309.1182
<i>Net 2010</i>	-852.38168
<i>Net 2015</i>	-645.63649
<i>Loss 2018</i>	138.76535
<i>Stable (all years)</i>	9963.61753
<i>Gain total years</i>	521.70115
<i>Loss total years</i>	3101.46598
<i>Net total years (including 2018)</i>	-2706.7706

Interview responses:

Utilization of mangrove

Within the participants of this study, 88% assented that they used the mangrove personally. Purpose of personal utilization was both for sustenance (food and materials) and revenue. The most frequent reported use of the mangroves was for fishing (46%) and catching crustaceans

(26%), including different fish, eel, crabs, and shrimp. Fishing within the mangrove serves as means of providing support for families, through both supply of food and selling of the catch. The next most mentioned use of the mangrove was planting and cutting of the vondro (11%), the Vezo name for the reeds that grow in front of the mangrove trees. The harvesting of the vondro has many uses for the community. In addition to its use in the construction of houses, the vondro are weaved into baskets, hats, and bags that are both used by the community and sold in the Reef Doctor Honko center. Further personal use of the mangrove included mangrove tree wood for firewood and construction, medicinal plants found within the mangrove forest area, and work involving reforestation of the mangrove and protection as a patrol.

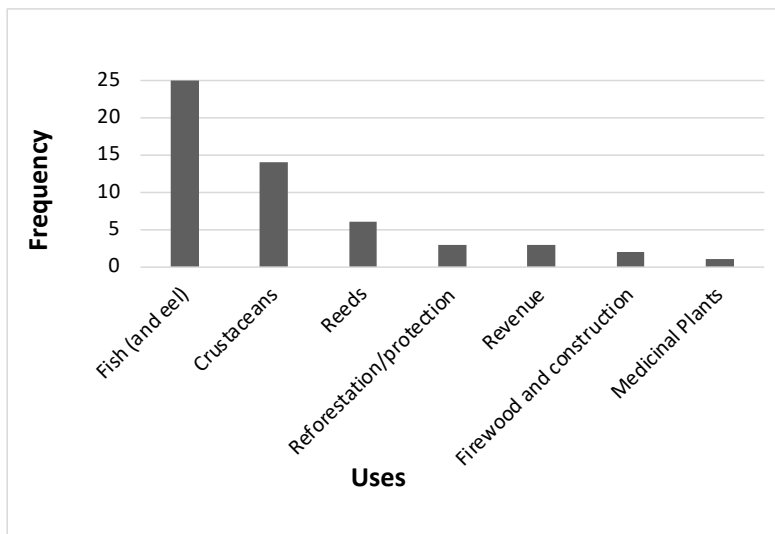


Figure 4. Personal uses of the mangrove area



Figure 5. Use of the vondro for construction (left) and basketry (right).

Participation in and importance of conservation

All participants interviewed in this study had participated in the conservation or restoration of the mangrove area before. Due to the organized reforestation events, the majority of participation involved reforestation, whether through planting propagules, seedlings, or managing the nursery. Another form of participation constituted the conservation and protection of the mangrove. Some interviewees were involved in protecting the forest as a patrol with the community organization, Polisin'ala, and others participated through creating a reserve in the mangrove to protect against deforestation. Conservation of the mangroves also included cleaning of waste in the mangrove and wetland area, and along the water canal that runs to the sea.

As a separate measure of the community's perception of the goals of the VOI and Reef Doctor, we asked participants what the importance of conserving the mangrove was to them. There were many reasons why the community valued conservation of the mangrove forest area. Primarily, conserving the mangrove remains important because of the resources the mangrove area provides for the community, as villagers depend on these resources for both sustenance and as a source of revenue. As the mangrove provides a habitat and nursery for fish, crabs, shrimp and other animals, protection of the area allows for sustainment of these animals and a fishing zone closer to the community. The mangrove trees also provide wood for construction, firewood, and the fabrication of charcoal. In addition, the forest area contains a variety of medicinal plants used by the surrounding villages.

Participants also valued conservation of the mangrove for other ecosystem services it provides, beyond food and income. Most mentioned of these services was the presence of the mangrove trees contributing to an increase in rainfall and purification of the air. Additional mentioned ecosystem services included the large amounts of carbon sequestered by the mangrove trees and protection offered by the forest from the sand dunes.

Another importance of the mangrove for the villagers regarded the attraction of tourists. Through the tours and conservation projects with the mangrove, the community of Ambondrolava has become internationally known, leading to an increase in tourism. Tourist visits, in turn, provide

revenue to the community, by means of paid tours and the sale of food and souvenirs. According to interviewees, this money paid by visitors is beneficial because it is used towards the development of the community. Similarly, conservation of the mangroves was important for villagers because it corresponds with a continuation of financial opportunities for the community, such as with reforestation events or artisanal craft events organized by Reef Doctor and the VOI.

Participants additionally mentioned that conservation of the mangrove forest is important because it harbors a large amount of biodiversity that needs be protected. Furthermore, because mangrove forests are one of the vastest green ecosystems, conserving and restoring this mangrove remains important to a larger goal of restoring Madagascar as the Green Island it once was. Finally, participants cited the need to ensure the mangrove remains present and intact for future generations.



Figure 6. The nursery for the Ambondrolava mangrove (left). A reforested area of the mangrove(right).

Participation and perception of VOI Mamelô Honko

The VOI Mamelô Honko was established in 2010, when the management of the mangrove was transferred to the five surrounding villages: Ambondrolava, Belitsake, Belalanda, Tanambao,

and Ambotsibotsike (L. Stanislas, personal communication, April 9, 2023). In our specific study site, the village of Ambondrolava, 76% of interviewees are currently members of the VOI, and 24% are not currently members, including those who previously were but have since left the organization. The goals of the VOI, as stated in the receipt of management transfer, are to 1) rationally manage the forest resources, 2) take charge of management of the renewable natural resources for their sustainability, 3) take charge of the future of the communities with regard to the use of these resources, and 4) protection of these resources from fires and irrational exploitation (Fahade, 2017).

Considering the original VOI goals, participants were each asked about their own perception of the actions and goals of the VOI Mamelohonko. The largest category of responses named the VOI as an organization that manages, protects, and conserves the mangrove (Figure 7). Responses under this category include maintaining infrastructure in the mangrove and managing poaching and illegal cutting of trees. The second largest category identified the VOI as an organization that reforests the mangrove, through the organization of, participation in, or financing of. Following those two largest categories, the VOI was also cited as employing the community (through reforestation projects and hiring of poaching patrols), spreading awareness about the importance of conserving the mangrove and protecting the general environment (Figure 7). Additional mentioned roles of the VOI referenced the organization of artisanal craft projects (which has since stopped from lack of funding) and the distribution of tourist money to the community. Multiple responses included a mix of these roles to identify the VOI, as many are not mutually exclusive.

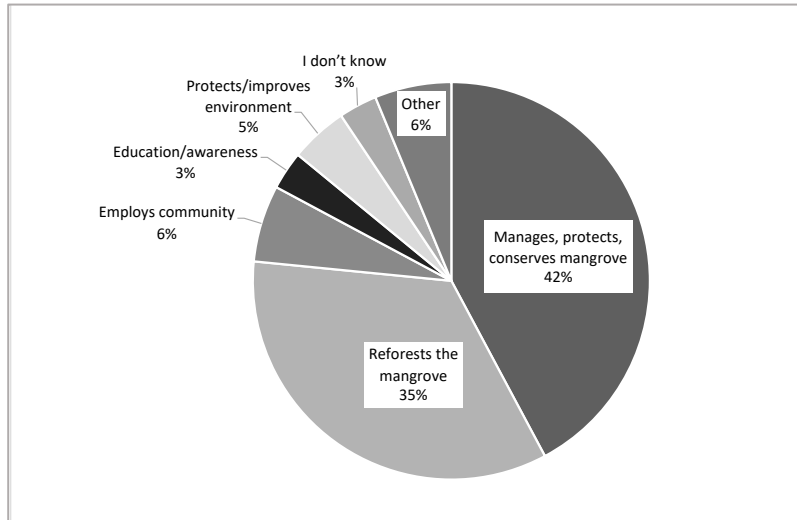


Figure 7. Participant named goals and actions of the VOI



Figure 8. Entrance to the path towards the VOI/RD center.

Participation and perception of Reef Doctor Honko Project

The Reef Doctor Honko Project was formerly known as the NGO Honko Mangrove Conservation & Education. Honko was founded in 2007 and taken over by Reef Doctor in 2017 but remained a technical and financial partner (TFP) of the VOI Mamelon Honko and continue to welcome volunteers and researchers (L. Stanislas, personal communication, April 9, 2023). The

goals of the Reef Doctor Honko Project remain similar as well, with commitment to “reversing the degradation of mangrove forest ecosystems in the Bay of Ranobe” and “empower[ing] the community in mangrove management and alternative livelihoods to create a more sustainable future.” (*Mangroves*, Reef Doctor)

When participants were asked about their perception of the actions and goals of the Reef Doctor Honko Project (Reef Doctor), there were two most frequent categories of answers. The most frequent category (39%) names Reef Doctor as a TFP with the VOI that provides financial support and organizational help for community projects. The second category (39%) identifies Reef Doctor as an organization that protects, conserves, and manages the mangrove, including the organization and funding of reforestation events and protection against poaching and deforestation (Figure 9). Next mentioned as the actions of Reef Doctor were working with tourists and visitors (9%), employing the community to protect and replant the mangrove (6%), and developing the environment (2%) (Figure 9). As with the previous question, some responses contained more than one of these categories.

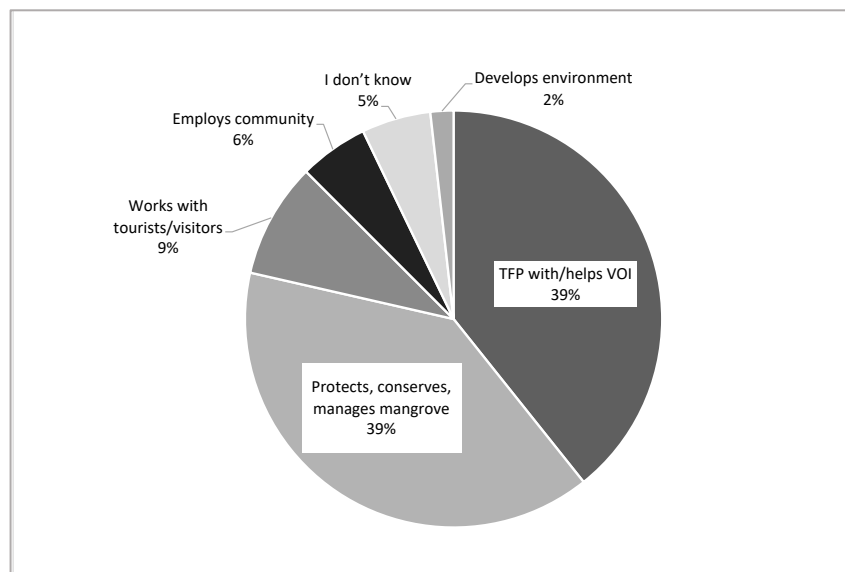


Figure 9. Participant named goals and actions of the Reef Doctor Honko Project

Benefits/disadvantages of the VOI/Reef Doctor

After discussing the actions of the VOI and Reef Doctor, we asked interviewees how they were affected by these organizations, and whether they received benefits or otherwise. 76% of participants said that they received benefits from the VOI and Reef Doctor. Most mentioned as a benefit was the creation of employment opportunities that both organizations offered, through replanting events, propagule, and seed collection, and hiring poaching patrols, all of which provide a source of income to the community (Figure 10). Additional benefits mentioned were the conservation of the mangrove ecosystem, which allows for the continued use of the mangroves for fishing and other resources, and the promotion of the women’s organization through artisanal craft events and construction of the dam.

On the other hand, 15% of participants replied that they did not gain any benefits (Figure 10). Reasons named included that only VOI members or bureau members receive benefits, that the VOI was selective in who participated in job opportunities, that these organizations have stopped organizing the beneficial projects, and that only Reef Doctor was providing benefits.

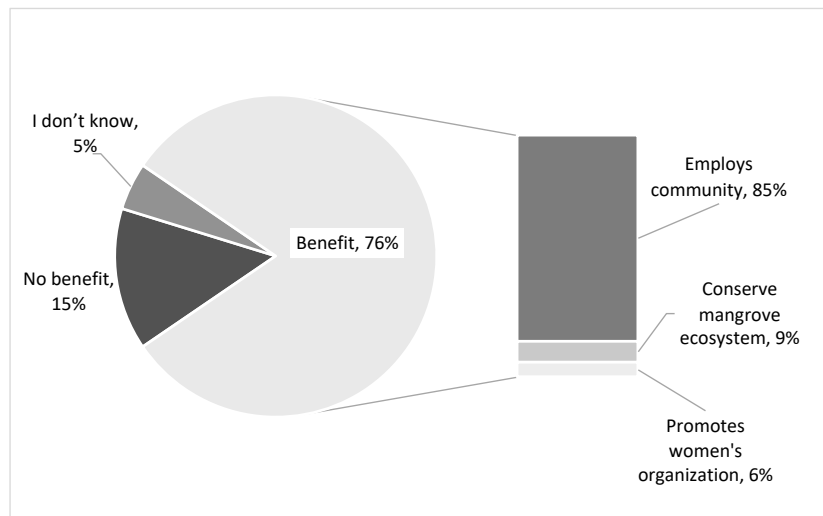


Figure 10. Percentage of participants who viewed the VOI and Reef Doctor as beneficial or not (left), and the benefits provided (right).

Desired changes

Participants were also given an opportunity to speak about any changes they wished to see regarding the VOI, Reef Doctor Honko, and the community. Out of the total participants

interviewed, 11% did not think that there was a need for changes, while 66% of interviewees assented that they wished to see changes. In reviewing responses, there were six main categories of desired changes. The most frequent category was the desire to change the management of the VOI. These responses stemmed from discontent with the lack of transparency from the VOI president and members. Villagers called for a change in the current members of the organization, induction of more members from more villages, a restoration of trust between the community and VOI, and greater transparency around the money that is or is not distributed to the community (from both tourism and the projects the community members participate in). In explanation of the distrust between the community and the VOI, interviewees described projects of planting and infrastructure repair that they had not yet been paid for, patrols who had stopped working in response to not being paid, as well as opportunities for employment were only certain community members were selected to participate.

The next most named wish was that the VOI and Reef Doctor provide more fixed employment opportunities. Provided examples included organizing reforestation and planting events more often, rehiring of patrols, or cultivation of the vondro, as well as financing for alternative sources of income. Following these categories, participants also expressed the desire that the VOI and Reef Doctor Honko focus on developing and improving the livelihood of the community and ensuring that all community members benefit from financed projects. Interviewees additionally expressed the need to improve infrastructure in the mangrove forest area. Such infrastructure included fixing of damage from the most recent cyclone, Freddy, maintenance of the boardwalk for mangrove tours, building of the dam, and, as a larger project, creating a channel through the dunes to give the mangroves better access to the Mozambique Channel (Figure 11). The fifth desired change regarded the wish for a continued existence and cooperation of the VOI, Reef Doctor Honko, and the community, given the current conflicts and distrust as previously mentioned. The last repeated category called for more education and raising of awareness in the community about the importance of conservation in the mangrove, citing a lack of these efforts in the past five or more years.

Additionally mentioned changes from individual interviewees included provision of more security for the mangrove, a return of activities involving the women's association, and implementation of a marine reserve in front of the mangroves to allow for a regeneration of fish.



Figure 11. A) A part of the boardwalk in need of maintenance. B) A structure damaged by the recent cyclone Freddy.

Perspectives on success of conservation

To identify the community perspective on the success of the mangrove conservation and its future outlook, participants were asked a few questions regarding the mangrove area. When asked whether the area of the mangrove had increased or decreased in the past five to ten years, 83% of interviewees responded that they believed it had increased. Reasons cited for the increase of area encompassed the conservation and reforestation efforts of the VOI and Reef Doctor, decreases in deforestation, and community knowledge of mangrove importance. Contrarily, 12% of interviewees responded that they believed the mangrove area had decreased, citing increased amounts of poaching, the onset of the dunes, and use of trees for charcoal.

Participants were also asked whether poaching and deforestation in the mangrove forest had decreased or increased in the past five to ten years. Out of those who responded, 67% of participants believed that poaching and deforestation had decreased, and 30% believed that these activities had increased in the past five to ten years. Those who responded that poaching had decreased attributed the success to the conservation and protection provided by the VOI and patrols, sanctions for illegal cutting and poaching, and community knowledge of importance. For

those who responded that poaching had increased, they cited an increase in thievery and poaching in the forest, the current lack of patrols, pressures from COVID-19, the recent cyclone Freddy, and conflicts between the community and the VOI.

Interviewees were additionally questioned whether they believed the mangrove area would last forever. Out of all those interviewed, 51% of participants answered that they believed the mangrove area would last forever. There were multiple reasons provided by those that had confidence the area would last. One main reason explained that the community relies on the mangrove and understands the importance of its conservation, and therefore will continue to protect and take care of the mangrove ecosystem. Additionally, participants answered that the mangrove area will last because reforestation efforts have already grown the mangrove, there is more space to continue with reforestation, poaching has stopped due to patrols, and the VOI protects the mangrove.

42% of participants replied that whether the mangrove area would last forever depended on multiple different factors. The permanence of the mangrove, according to interviewees, depends on the actions of the community, and whether villagers continue to protect or exploit the mangrove. Participants also mentioned that resilience of the mangrove relies on cooperation between the VOI, Reef Doctor, and the community, to ensure proper management of the area. This included a return of patrols to protect the mangroves. For some participants, this cooperation further depended on a change in the current management and corruption within the VOI. Outside factors such as climate change and the advancement of the dunes were also mentioned as possible future impacts on the mangrove resilience.

Discussion

Research questions

How successful has restoration been?

The GIS data for Ambondrolava has shown a large portion of stable mangrove forest, indicating success in the protection of that area. In addition, in the years following the creation of the VOI Mamelon Honko, there is much less loss of mangrove observed, suggesting there may be a decrease in deforestation responding to the management of the VOI. However, there was a net

loss of mangrove area observed in each year and across all years. These higher rates of mangrove area loss compared to mangrove area gain indicate that pressure from the surrounding community and poachers is still high, and that rates of reforestation and protection have not been sufficient to combat the rates of deforestation and poaching.

How is the community involved in conservation and management?

As mentioned previously, the community of Ambondrolava is very involved in conservation and management of the mangrove forest. Every interviewee had previously participated in conservation of the mangrove in some way, most often through events of reforestation. Three quarters of those interviewed are members of the VOI, and many are active in other organizations involved directly or indirectly with the conservation of the mangrove. Additionally, most participants use the mangrove personally, and therefore value its conservation. However, although participant responses indicated an understanding of the goals of the VOI and Reef Doctor, there is discontent with the lack of transparency and favoritism within the VOI. As a result of these current issues, participants pointed out, there is an unequal involvement in conservation of the mangrove amongst the community.

How does the community benefit from the restoration projects?

Three quarters of participants expressed that they receive benefits from the VOI and Reef Doctor. Together, these associations organize events of reforestation about twice a year, and (in the past) have organized artisanal craft events alongside Vannerie Mamelon Honko. Through these provided opportunities, members of the community are employed and paid for doing the work of reforestation (which was the largest category of perceived benefits). With success of these restoration projects, community members are also able to continue using the vital resources and services provided by the mangrove. Unfortunately, while some members of the community are employed through these organizations, other interviewees were discontent with the selectiveness of the VOI for such opportunities of employment. Additionally, reforestation events occur only around twice a year, leading to a desire among the community members for an increase in employment opportunities. The projects of mangrove restoration are indirectly beneficial to the community because of the continued existence of resources for use, and directly beneficial to the community members that are employed. To benefit the community more fairly, it is necessary that opportunities for participation in such employment becomes more frequent and accessible.

How does the community perceive the management of the mangrove and its conservation?

The majority of interviewees had positive views with the conservation of the mangrove and provided many reasons for its importance. In addition, 76% of participants are currently members of the VOI and participate firsthand in the management of the mangrove. The community also perceives both the VOI and Reef Doctor to be very involved with the protection, restoration, and management of the mangrove forest; actions which align with the stated goals of both organizations. Nonetheless, as shown in the results, more than half of participants believed there should be some changes in the relations between the VOI, Reef Doctor, and the community. There were repeated accounts of distrust and discontent with the current president and management of the VOI, and subsequent discontent with the management of conservation in the mangrove forest. This combination of responses indicates that there are many community members who believe in the importance of conservation but are currently unwilling to or unable to work with the VOI to protect or reforest the mangroves.

Hypotheses

The hypotheses proposed in response to these research questions were that I would see an increase in the size of the mangroves, that the community benefits from and has a good relationship with the VOI and Reef Doctor, and the community is therefore supportive of conservation and reforestation efforts. Through interviews, I did observe an overall community support of conservation and reforestation of the mangrove, as well as employment and resource benefits received from the VOI and Reef Doctor. However, the survey of the GIS data did not support my hypothesis, as I observed a decrease in mangrove size in the years 2000 to 2018. In addition, the relationship between the community and the VOI is varied between community members. (Participants did not mention issues with Reef Doctor) There are community members who hold a good relationship with the VOI, and some who are unhappy with the current leadership and management.

Study limitations

For the GIS data during my research, there was only data up to the year 2018, which leaves out the most recent five years of mangrove evolution. In the future, accessing more recent GIS data for the mangrove, especially to capture any possible effects of COVID, would provide more relevant information on the growth of the mangrove. In addition, analysis of the GIS data for the

Ambondrolava mangrove included only visualizations because the numerical data could not be split into smaller regions. For future studies, it would be insightful to find data to perform numerical analysis of the mangrove area for solely Ambondrolava.

Interviews for this study were conducted in Malagasy, and therefore involved both translation of the questions and the responses. As a result, both some questions and some answers were lost in translation, leading to inconsistencies in the subject of responses, and therefore more nuanced data analysis. Our method of translation also prevented me from asking follow up or clarification questions during the interview. In addition, I was dependent on a guide for an introduction to the community and to bring me to members of the community to interview, so I was unable to interview all the categories of people I originally had planned for. This dependence could have also influenced the composition of interview responses, due to personal biases when choosing participants. As another interview bias, my presence as a foreigner and as a researcher creates an inherent dynamic with participants that could have influenced trust and honesty in interviews.

Furthermore, research for this project included only the village closest to the mangrove. As there are four other surrounding communities who use the mangrove area and who take part in the VOI, it would be insightful to investigate community perspectives on the mangrove conservation in the other villages (Belitsake, Belalanda, Tanambao, and Ambotsibotsike) for future research.

Suggestions and future research

Community based management of ecosystems has been increasingly praised and implemented throughout Madagascar, but requires cooperation, transparency, inclusion, and support of the community to succeed (Gardner et al., 2013). Within the case of Ambondrolava, the community relies heavy on the mangrove for personal use every day; most villagers live off revenue, food, or materials obtained in the forest. As a result, most members of the community value the mangrove ecosystem and understand the importance of protecting the trees and the consequences of their destruction. However, the previously mentioned examples of the VOI not paying patrols and other villagers for the work they completed, as well as favoritism and a lack of transparency with the use of money, demonstrate the existence of current trust issues between the community and management organizations that must be addressed. There are now only about 60

members in the VOI, 31 of which were interviewed in Ambondrolava. As the management of the mangrove is the responsibility of the five surrounding villages, it may be beneficial for the VOI to include more members from additional villages, as well as more members overall. The inclusion of more members could add more voices to the decision-making process and help to combat corruption within the VOI.

A lack of communication and trust between the community and the VOI can easily lead to a disruption of conserving the mangroves as well. As shown in the results section, the mangrove area for Ambondrolava has overall (net) decreased each year, despite reforestation efforts. This decrease demonstrates the continued pressure of the villagers and poachers on the mangrove forest. As people remain to be the largest threat to the mangrove, it is therefore important to provide more financial opportunities and alternative sources of income and food.

The Reef Doctor created organization, FIMPIFIMAHO, has already begun working with fish farming in Ambondrolava as an alternative source of food and revenue. The area of Ambondrolava contains access to freshwater and open land, which provides sufficient conditions for fish farming. Because of this, increasing the amount of fish farming in the community of Ambondrolava would provide more food and income to farmers, while simultaneously reducing human pressure on the mangrove area.

In addition, the reforestation events that occur twice a year should be organized more frequently and encompass more community members. With more people participating in replanting, more trees would be planted, and more villagers would be employed. Similarly, arranging a return of the artisanal craft projects would provide alternative avenues for income, and once again reduce pressure on the mangrove ecosystem.

Another form of alternative income, payment for ecosystem services (PES), does not yet exist in Ambondrolava, despite the many ecosystem services the forest provides. The area was surveyed for a Plan Vivo blue carbon project in 2012, with a plan to implement carbon credit for the VOI (Winders, 2012). However, the project was never finished, and the VOI and community of Ambondrolava remain without connection to the carbon share market today. The Plan Vivo foundation has previously conducted research on the feasibility of the Ambondrolava mangrove, which indicates that there exist preliminary structures for setting up a carbon share project

(Winders, 2012). Initiating PES, and more specifically, blue carbon shares, into the community of Ambondrolava would provide a significant alternative source of income in response to reforestation of the mangrove.

Conclusion

Overall, the VOI Mamelolo Honko and Reef Doctor Honko Project have introduced a management system to the Ambondrolava mangrove that involves and employs the local community, and organizes the conservation, protection, and restoration of the mangrove forest. While the past 20 years have observed a continued loss of mangrove area, this project has demonstrated that most community members share a belief in the importance of the mangrove conservation and a support of the goals of the VOI and Reef Doctor. Unfortunately, there is distrust that exists between some villagers and the VOI, and it is necessary to find resolution of these conflicts to ensure the success of the mangrove conservation. Through an inclusion of more villagers and diverse opinions in the decision-making processes, the goals of protecting the mangrove can be better aligned with the needs of the surrounding communities. Furthermore, through an implementation of more fixed and alternative sources of income, villagers will exert less pressure on the mangroves and obtain more means for developing the community. While the mangrove forest in Ambondrolava continues to be threatened, the goals of the VOI and Reef Doctor and the investment of the local population provides hope for conservation for future generations.

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Appendix

I. Glossary

Ecosystem Services – attributes of an ecosystem that provide any type of benefit for humans, whether directly or indirectly

FIMPIFIMAHO – Fikambanan’ny Mpiompy Fia Mamelon Honko, the freshwater fish farming project created by the Reef Doctor Honko Project to reduce pressure on the mangrove and provide an alternative source of income for the community

FTP – Financial and Technical Partner

PES – payment for ecosystem services, a system where a buyer “purchases” an ecosystem service from someone(s) who ensures the provision of the ecosystem service

Polisin’ala – the community organization of patrols with the purpose of protecting the mangrove from poaching and stealing

Reef Doctor Honko Project – formerly Honko Mangrove Conservation & Education

Vannerie Mamelon Honko – the women’s organization created to employ and empower women through reforestation and artisanal projects

Vezo – the ethnic group in the southwestern coast of Madagascar known as “the people of the sea” for their main activity of fishing

VOI Mamelon Honko – the community run organization for managing the mangrove area

Vondro – the Vezo name for the reeds

II. Interview Questions/Questions d'entretiens

- Name
- Nom
- Anarana

- Age
- Âge
- Taona

- Occupation
- Profession
- Asa atao

- Do you personally use the mangroves/mangrove area? If so, what for?
- Est-ce que vous utilisez les mangroves ou le zone de mangroves personnellement ? Si oui, pour quoi vous utilisez les mangroves ?
- Mampiasa honko ve ianao/ na miasa ao anatiny toerana misy azy ? raha Eny, dia afaka azavainao ve oe fa maninona no mampiasa honko ianao ?

- Do you know the VOI Mamelon Honko?
- Est-ce que vous connaissez le VOI Mamelon Honko ?
- Fantatrao ve ny fisiany VOI Mamelon honko ?

- Are you a member of the VOI Mamelon Honko or involved in the NGO Honko in any way? If so, how?
- Est-ce que vous êtes un membre du VOI Mamelon Honko ou est-ce que vous êtes impliqué dans l'ONG Honko ? Si oui, comment est-ce que vous êtes impliqué ?
- Mikambana ao anaty VOI Mamelon honko ve ianao sa

- If not, why are you not a member?
- Si non, pourquoi pas?
- Raha tsia? Fa maninona ?

- What do you think of the VOI? What do you think of their goals and actions?
- Qu'est-ce que vous pensez du VOI ? Qu'est-ce que vous pensez de leurs objectifs et de leurs actions ?
- Manao ahoana ny fahitanao ny VOI ? manao ahoana fahitanao ny tanjona sy ny asa atao izy ireo ?

- Do you know the NGO Honko?
- Est-ce que vous connaissez l'ONG HONKO ?
- Mahalala ny ONG HONKO va ianao ?

- What do you think of the NGO? What do you think of their goals and actions?
- Qu'est-ce que vous pensez de l'ONG ? Qu'est-ce que vous pensez de leurs objectifs et de leurs actions ?
- Manao ahoana ny fahitanao ny ONG HONKO ? manao ahoana fahitanao ny tanjona sy ny asa atao izy ireo ?
- How do the actions or goals of the VOI and NGO affect you? Do you benefit from these organizations in any way? Are you harmed by these organizations in any way?
- Comment est-ce que les actions ou les objectifs du VOI et de l'ONG vous affectentelles ? Est-ce que vous profitez de ces organisations ? Est-ce que vous êtes désavantagé par ces organisations ?
- Are there any changes you would like to see in the relation between the community here and the VOI and NGO?
- Est-ce qu'il y a des changements que vous voulez voir concernant la relation entre la communauté ici et le VOI et l'ONG ?
- Misy fanovana tianao ho atao ve mahakasika ny fifandraisana misy eo anivon'ny mponina sy ny fikambanana VOI sy ONG HONKO ?
- Have you ever participated in managing or restoration of the mangroves?
- Est-ce que vous avez déjà participé à la restauration ou la gestion des mangroves ?
- Efa nandray anjara tamin'ny fanajariana sy fintantana ny mangrove va ianao ?
- If not, why? If so, how did you participate? And what led you to participate?
- Si non, pourquoi pas? Si oui, comment est-ce que vous avez participé ? Et quels sont les raisons de votre participation ?
- Raha tsia ? fa maninona ? raha eny ? inona ny antony anaovanao an'izany ?
- Do you think that the mangrove area will last forever?
- Est-ce que vous pensez que le zone de mangrove va durer éternellement ?
- Raha ny fahitanao azy manokana, mety haharitra mandrakizay ve io mangrove io ?
- Do you think that the area of the mangrove increased or decreased in the past 5-10 years? How much?
- Pensez-vous que le superficie de mangrove a diminué ou augmenté au cours des 5 à 10 dernières années ? Combien ?
- Tsapanao mihena ve ny velarantany misy io mangrove io, tao anatin'ny folo na dimy taona zay ? mety nihena firy eo eo ?
- How important is the conservation and restoration of the mangrove area to you?
- Quelle est l'importance de la conservation et de la restauration de la zone des mangroves pour vous ?
- Inona no tena hitanao fa tena maha zavan-dehibe ny fanajariana sy fiarovana ny mangrove ?

- Do you think the revenue from tourism has been beneficial or has supported efforts of reforestation?
- Est-ce que vous pensez que les revenus des touristes ont soutenu les travaux de la reforestation ?

- Does there exist payment for ecosystem services? Do you think that has been successful, have you received payment for the reforestation work that has been done?
- Existe-il paiement pour les services écosystémiques ? Si oui, est-ce que vous pensez que cela a été un succès ? Est-ce que vous avez déjà reçu les paiements ?

- Have you observed an increase or decrease in amount of deforestation or poaching in the past 5-10 years?
- Est-ce que vous avez observé une augmentation ou une diminution de déforestation ou de braconnage au cours des 5 à 10 dernières années ?

III. Consent Form

Informed Consent Form/Formulaire de Consentement

Student Researcher/Chercheur: Nadine Shannon

Title of Project: Community Participation and Perspectives of Belalanda Mangrove Restoration Project

Titre de projet : Perspectives et participation communautaire du projet de restauration de la mangrove de Belalanda

I am asking for your voluntary participation in my research project. Please read the following information about the project. If you would like to participate, please sign in the appropriate area below.

Je vous demande votre participation volontaire à mon projet de recherche. S'il vous plait, lisez les informations suivantes sur le projet et si vous voulez participer, signez dans l'espace approprié ci-dessous.

Research objectives: To observe relations between the community and the mangrove restoration projects and identify successes or issues that may exist.

Objectifs de recherche : Observer les relations entre la communauté et les projets de restauration et identifier les succès ou les problèmes qui existent.

Tanjona : hijery ny fifandraisana eo anivon'ny fokonolona sy ny tetikasa fanajariana, ary koa hijery ireo asa efa nahitana fahombiazan sy ireo olana izay mety hitranga.

If you participate, you will be asked to respond to a series of interview questions about your participation with and perspective of the VOI, NGO, and overall mangrove restoration. The interview will be conducted verbally, with a voice recording.

Si vous participez, vous allez répondre à une série de questions sur votre participation et perspective sur le VOI, l'ONG, et la restauration des mangroves. L'entretien sera mené verbalement, avec un enregistrement vocal.

Raha handray anjara ianao : dia hamaly fanontaniana vitsivitsy mahakasika ny VOI, l'ONG, ary ny fanajariana ny mangrove. Ny tafatafa dia atao ambava miaraka amin'ny fakana feo ireo olona hadihadiana.

Potential benefits of project: If this research is used in future studies or influences local government, the results could contribute to improvement of community understanding of restoration goals and more direct benefits to the surrounding community.

Avantages potentiels de ce projet : Si cette recherche est utilisée dans des études futures ou si elle influence le gouvernement local, les résultats peuvent contribuer à l'amélioration de la compréhension communautaire des objectifs de restauration et plus d'avantages directs pour la communauté local.

Ny mety ho tombotsoa azo avy amin'ny ity tetikasa ity : raha ampiasana amin'ny sehatra ny fikarohana ity asa ity indray androany, dia mety hanampy ireo rehetra mpitantana eto an-toerana amin'ny fitantanana ny mangrove ary koa hanampy ny fisitrahany bebekokoa ny fokonolona ny tombotsoa ny fanajariana.

Confidentiality: You have the choice to exclude your name, appearance, and specific occupation from the final report. Any irrelevant information or identification that you choose will be omitted from the report and all data will remain confidential.

Confidentialité : Vous avez le choix d'exclure votre nom, et profession spécifique du rapport final. Les informations qui ne sont pas pertinentes ou l'identification que vous choisissez seront omises du rapport final et toutes les données resteront confidentielles.

Voluntary participation: Participation in this study is completely voluntary. If you decide not to participate there will not be negative consequences. If you decide to participate, you may stop participating at any time and you may decide not to answer any specific question.

Participation volontaire : Votre participation est complètement volontaire. Si vous décidez de ne participer pas, il n'y a pas les conséquences négatives. Si vous décidez de participer, vous pouvez arrêter votre participation à tout moment et vous pouvez décider de ne répondre pas à une question spécifique.

By signing this form, I am attesting that I have read and understand the information above, and I freely give my consent to participate.

En signant ce formulaire, j'atteste que j'ai lu et je comprends les informations ci-dessus, et je donne librement mon consentement pour participer.

Research Participant Printed Name
Nom Imprimé du Participant

Signature

Date

Researcher Printed Name
Nom Imprimé du Chercheur

Signature

Date