4-29-2024

Community Conservation in Madagascar: Aligning Local Livelihoods and Biodiversity Protection

Jane Slentz-Kesler
Macalester College, jslentzk@macalester.edu

Community Conservation in Madagascar: Aligning Local Livelihoods and Biodiversity Protection

Jane Slentz-Kesler

Undergraduate Honors Thesis in Geography and Environmental Studies

Macalester College

2 April 2024

ABSTRACT

Community Conservation in Madagascar: Aligning Local Livelihoods and Biodiversity Protection

The management of natural resources in developing countries is of utmost importance as both high levels of biodiversity and local livelihoods often hang in the balance. The debate in conservation spheres often centers on 'fortress' versus 'community-based' conservation approaches, one emphasizing nature preservation and the other emphasizing the needs and empowerment of local communities in resource management. This study evaluates the management approach of a rainforest in northeast Madagascar, asking: how effectively does the COMATSA Sud protected area management system both preserve critical forest cover and provide for the local community? This research employs a mixed-methods approach, using interviews and focus groups with local residents in the study area combined with a random forest remote sensing analysis of Planet imagery to classify the landscape and analyze forest cover. Results suggest that the system is not successful in supporting community livelihoods or preserving forest cover due to a misalignment between the theoretical management model and the reality on the ground. Furthermore, while the management system does not provide economic benefits to the local community, the forest serves as an important safety net when economic difficulties arise. Results also show that the community is open to a more comprehensive management scheme conditional on the incorporation of complementary livelihood support into the system. These findings suggest ways forward for community-based conservation, emphasizing the importance of reforming older institutions to align with contemporary landscapes and local communities' needs.

Keywords: Africa, community based natural resources management, mixed-methods, remote sensing, conservation

Table of Contents

PREFACE

My work focuses on a rainforest and a village in Madagascar. This village almost feels tucked away from the outside world, hardly influenced by anything beyond the dirt paths leading to and from the forest and the neighboring villages. I know this is not true, and that this forest and this village are tied to larger trends of globalization, international markets, changing climate, music, movies, and technology. However, on a day-to-day basis, it doesn't feel like it. You rarely encounter people from outside of the region, and certainly very rarely people from another country--who are called *vazaha* in the local language, Malagasy. One of my favorite reactions to my presence in this region occurred after climbing a particularly difficult hill at the beginning of the protected area. We had already been hiking for six hours that day, myself, my research assistant, and our local guide, and we had just reached the last GPS point at the top of that hill. A group of Malagasy locals had ascended the hill as well and, as we convened for the usual lengthy greetings, I noticed one of the men was stopped in his tracks and staring at me. He continued staring, with a look that I could only describe as flabbergasted. Finally, he said something and everyone laughed, the tension broken. He said, "My god. Never in my life did I think I would see a *vazaha* on top of this hill."

When I am reading, writing, researching, and presenting about this rainforest and village at my college in the United States, it feels like all eyes are pointed at this little village. Studying this system through an academic lens, it is the ideal case study for the kind of tension occurring around the world between people's needs and the preservation of nature. So much has been understood by the academic community about rainforests, people's livelihood needs, how dynamics of international and domestic markets affect natural resource use, and how agricultural needs and production are related to all of the above. It seems that these topics are very important, that so many people care, and that a place like this village is of utmost priority. And yet when I am there, in the village and in the rainforest, it feels like a tucked-away corner of the world, left to fend for itself. There is scant evidence that "anyone out there" cares. For all that is known about these systems and the dynamics between rainforest conversion and local livelihoods, no real change is being made to address the myriad challenges in this system. Perhaps the necessary movements and resources and conceptual shifts just haven't reached this place yet, so I hope to be part of the energy, attention, and resources flowing in some way to this community. I do this research and write this thesis in the hopes that the story of this village and forest will one day look very different and that its people will have more power and peace in their daily lives.

Acknowledgments

The primary acknowledgment of this paper is the community in northeastern Madagascar that I have lived with for 5 months over the course of two research seasons. I was a very well-treated guest in the country of Madagascar as a whole and in this community, and for that I am eternally grateful and touched. The purpose of this paper and research is in hope of making a positive difference in some way for this community and as many other communities with whom these insights resonate. I am beyond grateful to Sandolin (last), my research other-half, who is exceptionally skilled in qualitative research and interpersonal intelligence and made this field season not only possible and successful but also a joy. I am so grateful to Bill Moseley, my primary thesis advisor and mentor, for enabling this process from the beginning and investing an incredible amount of time and energy in my development over my four years at Macalester. Thank you to James Herrera and the entire Duke Lemur Center SAVA Conservation team, who are doing some of the most amazing work in the world whether they fully realize it or not. A huge thank you to the rest of my thesis committee, Xavier Haro-Carrion, Christine O'Connell, and Stotra Chakrabarti, for your academic advising and personal mentorship; it means the world to me. And lastly, thank you to whoever may be curious enough to find yourself reading this paper; may there be something of value herein for you.

1. Introduction

The earth is unique in the universe, as far as we know, for the life that flourishes on the planet. Incredible manifestations of this life can be seen in human societies, in massive natural areas like the oceans, tropical rainforests, arctic tundras, and everywhere in between. One of the challenges of our modern world is to support as much of this life as possible, but sometimes this goal clashes with the livelihood needs of local people. Natural resource management is one of the main interfaces between people and the rest of the natural world, as people live in or next to natural areas, use natural spaces and resources in various ways, and make decisions regarding natural areas.

As the ideas of preserving and conserving nature solidified, two major approaches emerged: the fortress conservation model and the community-based model. One emphasizes strict rules, restriction of human access to natural spaces, and punishments for infractions. The other emphasizes an interwoven human-nature fabric, with an approach of active local involvement in management. The question of how humans will interact with, make decisions about, use, and understand natural spaces and natural resources is of utmost importance for not only the myriad of life contained within them but also for humans themselves. Which life forms will be able to survive and flourish? What will human relationships with the environment look like? Which humans will have access to and an understanding of natural spaces, and which humans get to decide?

I explore these broader themes through a study of a particular place in the world acutely confronted with these issues, with immediate and serious implications for human and non-human life. In this thesis, I study a rainforest in Madagascar and an adjacent community of indigenous, Malagasy people, aiming to understand the dynamics of the current management system of the protected forest and how this system could better support all of the life it contains. My overarching research question is as follows:

How effectively does the COMATSA Sud protected area management system both preserve critical forest cover and provide for the local community?

I first provide a context of the literature on the major debates concerning the management of natural spaces, including the two major models of “fortress conservation” and “community-based” conservation or natural resources management. Then, I describe the study site, including key geographical and historical elements of the area to consider. Next, I describe the methods used for collecting and processing both interview and remote sensing data. Lastly, I present the major findings of this research for human livelihoods and for forest cover, and I

discuss the implications of these findings for the broader conversation of natural resource management and policy in developing countries.

2. CONTEXT IN THE LITERATURE

In this section, I review the scholarly debates regarding various approaches to natural spaces, human-nature relationships, and the resulting approaches to conservation and natural resource management. The two main trends in these areas are human exclusion, whereby nature and thus conservation must function free from humans, and human inclusion whereby humans are an integrated part of nature, and conservation schemes reflect this connection.

Human Exclusion and Parks

To understand the conservation model of protected areas in the developing world, it is necessary to understand the development of the conservation movement in the United States which would serve as the model for worldwide conservation initiatives. The key concept originating in the United States conservation movement was the separation of people and nature, necessitating the creation of protected areas free from human influence. Early influential leaders in the US conservation movement included Theodore Roosevelt, Gifford Pinchot, and John Muir. Each had their unique perspective and contributions to conservation thought and policy, but together are regarded as the founding fathers of the movement in the early 1900s. Steinberg (2013) describes in his chapter *Conservation Reconsidered* that for guiding conservation policy, President Roosevelt turned to Muir and Pinchot, eventual founder of the Sierra Club and head of the U.S. Forest Service respectively. Muir advocated for the preservationist approach, at least at his outset, preaching the values of wilderness as an untouched space that serves as a cure to ‘the stresses of modern society.’ Pinchot, on the other hand, represented utilitarianism, the conservation of nature for the best sustained use by humans. Steinberg continues, describing a shift in the meaning of ‘wilderness’ for US Nationals since colonial times: while it was once regarded as desolate and lacking civilization, it came to symbolize natural beauty, an escape from urban life, and an untouched landscape in need of careful protection (Steinberg, 2013). From this mindset and the early founders of the conservation movement rose the US National Park system.

The concept of the national park was created during this time, and would become an "international model for the preservation of natural beauty and wilderness" (Library of Congress), epitomizing the legal protection of nature from humans. Gifford Pinchot describes the collectivist attitude towards natural spaces, saying "The natural resources of the Nation exist not for any small group, not for any individual, but for all the people" (Steinberg, 2013, p. 152). This 'nature belongs to everyone' mindset can be seen later as it was exported across the world and extended to worldwide biodiversity seen as globally owned, instead of belonging to individual countries in which certain species are found. Even the early US National Park System was fraught with problems, however, both ecologically and socially. People, with their limited understanding of ecological complexity, attempted to wrangle nature in certain ways, causing unintended consequences and ecological backlash. Attempts to preserve certain species, namely game species, and to eradicate others (predators), caused horrible population booms and busts for species like mice and deer due to trophic imbalance (Steinberg, 2013). Arbitrary park boundaries didn't correspond with animals' spatial ranges as well, causing constant problems with 'containing nature' within the established parks (Steinberg, 2013). Lastly, national parks were created for the benefit of middle-class recreation, after displacing and disenfranchising indigenous people and illegalizing hunting and other resource use which was previously a source of life for indigenous people and lower economic classes (Steinberg, 2013). As was codified in the Wilderness Act of 1964:

> "A wilderness, in contrast with those areas where man and his works dominate the landscape, is hereby recognized as an area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain" (The Wilderness Act).

However, as William Cronon argues in his 1996 essay, "*The Trouble With Wilderness*," this wilderness is not a true natural space that existed before humans 'contaminated the world with our existence,' but rather, wilderness itself is a human-constructed concept. He details the rise of the concept of wilderness as a sacred space, evoking strong sentiments of an 'American Frontier' identity, and its undertones of intertwined rugged individualism and traditional masculinity, with men threatened in their masculinity by the comforts of civilized life. Furthermore, there is glaring hypocrisy in forcibly removing the original indigenous inhabitants of the land to create the illusion of 'uninhabited wilderness' for white US Nationals to visit. As Cronon eloquently summarizes:

> “This, then, is the central paradox: wilderness embodies a dualistic vision in which the human is entirely outside the natural. If we allow ourselves to believe that nature, to be true, must also be wild, then our very presence in nature represents its fall. The place where we are is the place where nature is not. … We thereby leave ourselves little hope of discovering what an ethical, sustainable, honorable human place in nature might actually look like.” (Cronon, 1996, p. 17)

This idea of wilderness and protected conservation areas, born in the context of the United States as a foil to its rapidly industrializing early 1900s society, would come to proliferate across the world with dire consequences for those regions whose economic, cultural, and physical landscapes looked vastly different. In this exportation of conservation and protected area rhetoric across the world, colonialism and large international organizations played a key role. Macekura (2015) describes how, as colonized countries began to gain their independence in the 1950s and 1960s, some western leaders feared that this would mean the 'loss of Western control over Africa's wildlife,' showing the presence of western control over developing countries' landscapes in the first place. Such leaders went on to help found international non-governmental organizations like the International Union for the Conservation of Nature (IUCN) and the World Wildlife Fund (WWF). These organizations crossed national boundaries with their purpose of preserving nature around the world, emboldened by the belief that exotic species did not belong to the nations in which they were located, but rather to the whole world. This rhetoric then justified interventions by international organizations in nations that were perceived as not adequately protecting their wildlife. Many of these organizations such as the IUCN or WWF endeavored to maintain protected areas established during the colonial period, and even filled the place of imperial authority in postcolonial reserves and national parks. These international organizations feared that newly established governments would dismantle the national parks systems and so their postcolonial efforts focused on preserving these colonial arrangements, especially in Africa (Macekura, 2015).

From this proliferation of global conservation rhetoric and the creation of protected areas, national parks, and reserves across the world, two main currents in conservation have emerged, which I generally summarize as human-exclusionary approaches and human-inclusive approaches.

First, I discuss the human-exclusionary approach which forms the basis of the conservation movement and protected area rhetoric, rooted in the idea of a fundamental

human-nature separation and characterized by top-down management and adverse impacts on indigenous people. The human-exclusionary approach has undergone fluctuations in popularity and faced considerable backlash, but has nevertheless remained a strong current in conservation. National parks and protected areas have been a key method of implementing human-exclusionary conservation, by establishing areas that are designated for non-human nature only, and making illegal human activity or presence within them (besides tourism and research, in many cases). As Dowie (2011) describes in the introduction of his book, *Conservation Refugees*, protected areas were a 'central strategy of transnational conservation,' and their number and extent increased dramatically during the second half of the twentieth century. Between 1900 and 1950, there were 600 official protected areas worldwide, and that number had jumped to 1,000 by 1960. At the time of publishing *Conservation Refugees* in 2011, there were 110,000 protected areas worldwide and counting (Dowie, 2011). According to the Protected Planet Report, released in 2020 by the IUCN and the United Nations Environmental Program (UNEP), at least 17% of the world's land environments are protected, and there is a call to protect 30% by 2030. Dowie (2011) describes the results of parks on indigenous populations in his book, detailing how they displace people and fail to provide equivalent support for the land and livelihoods lost in this displacement. He says that organizations and countries implementing these protected areas do not count and meaningfully consider the indigenous people evicted from their lands, meaning that an accurate number of people displaced is unknown. He notes however, that one rural sociologist, Charles Geisler, believes that since the beginning of the colonial era, the figure may be as high as 14 million evictions in Africa alone (cited in Dowie, 2011).

The human-exclusionary approach also often results in armed conflicts and violence, as discussed in Peluso and Watts' *Violent Environments* (2001). Neumann's chapter in this book details how wildlife conservation institutions in Tanzania have resulted in reinforcing violent state power instead of producing harmony at the local level. Neumann argues that state efforts to control wildlife resources in Africa are inherently violent or at least conducive to violence. He argues that the frequency of weapons in confrontations over wildlife laws lends itself to the escalation of conflict to violence and that state formation in Africa often involved gaining control over natural resources at the expense of local people (whether direct assaults or reducing access to sources of nutrition with no alternative). He argues that the history of the creation of state conservation or natural resources units has often been closely linked to military activities, resulting in a paramilitary style of such agencies in Africa (Neumann, 2001). Richard Leakey, a prominent figure in Kenyan politics, archaeology, and conservation, is known for his

appointment as the head of Kenya Wildlife Services in 1989 by then President Daniel arap Moi and his support of violent conservation enforcement. As Leakey describes in his memoir *Wildlife Wars: My Fight to Save Africa's Natural Treasures* (2001)*:* "…in my very first meeting with President Moi, I insisted that we find a way to deal with the firearms issue. If he wanted his 'shoot-to-kill' policy against poachers enforced, our rangers had to be issued modern guns" (Leakey & Morell, *Wildlife Wars,* 2001, p. 73). Neumann opens his chapter by describing the killing of 50 villagers in Serengeti park by game rangers, with some linking the incident to this policy of violence against "bandits" found in parks.

Neumann describes three broad types of violence resulting from the violent-prone characteristics of state-led conservation: displacement including evictions of people and loss of rights of access to land and natural resources, increased vulnerability to natural hazards such as wild animals, drought, and disease, and person to person violence including rapes, beatings, assaults, and killings (Neumann, 2001). This discussion of violence occurs in the context of human-exclusionary conservation approaches, with dire effects for human populations. Peluso and Watts argue that Neumann's case in Tanzania is also part of a larger "selectivity of historical memory" when it comes to violence, and how "the massive--and violent--colonial project in Eastern Africa of geographically separating wildlife and peoples is forgotten, ignored in narratives about community management of resources today" (Peluso & Watts, 2001, p. 37).

Despite a shift in conservation ideology during the 1980s and 1990s towards a more human-inclusive approach, the idea of human-exclusive conservation continued to have its champions in a counter-push that is often termed 'fortress conservation.' The rhetoric of fortress conservation sought to separate biodiversity conservation from social, economic, and political issues like development and poverty. As summarized by Dowie (2011), proponents of this protectionist approach emphasize the importance of maintaining the world's flora and fauna as a separate but equal issue, as much of a priority as social, economic, and political issues. Such proponents also champion the role of natural science in conservation, arguing that with an understanding of the ecological principles at play in protected areas, particularly about size and connectivity, natural science ought to take priority in conversations about conservation decisions (Dowie, 2011, p. 86).

One prominent figure in this line of thinking is John Terborgh, an academic staunchly supporting parks and human-exclusive conservation. Terborgh does not believe in the possibility of sustainable use, as he says in *Making Parks Work* together with co-editors Van Schaik, Davenport, and Rao, "The authors argue that the philosophical underpinnings of ICDPs [Integrated Conservation and Development Projects] are irreconcilable with the active protection

of parks that comprehensive conservation requires" (p. xviii). Furthermore, in Terborgh and Van Schaik's chapter 'Why the World Needs Parks,' they argue that efforts to conserve biodiversity face two major challenges: first, the need for more land to be legally protected, and second, land that is already legally protected needs to be protected from both legal and illegal 'erosive forces,' very much supporting a human-exclusive conservation approach. Addressing the prospect of sustainable development, Terborgh and Van Schaik state that they believe it is necessary outside of parks. However, to be integrated with conservation, they say that resource extraction from parks 'flies in the face of the very concept of what a park is' and that parks should remain a 'haven for nature' where people except visitors and staff are excluded. The authors state that "to advocate for anything else for developing countries simply because they are poor (one hopes, a temporary condition) is to advocate a double standard, something we find deplorable" (Terborgh & Van Schaik, 2002, p. 6). Terborgh's concerns for the conservation of wildlife are many, and he argues that the lack of strong political and social institutions in many developing tropical countries makes conservation extremely difficult. This ultimately leads him, and others who share this fortress conservation perspective, to conclude that we cannot afford to wait for the trudging pace of institutional development to establish itself, that nature requires immediate action funded by wealthier countries such as the United States and European nations. He suggests a few forms of action: an internationally funded conservation corps--armed rangers allowed to make arrests--entirely separate from the nations' politics and law enforcement, land acquisition through direct purchase by outside nations or international organizations, and a global watchdog organization akin to Amnesty International to monitor park management and health (Terborgh, 1999, p. 199-203). Terborgh's solution to the problems of conservation in developing countries is to fortify parks, impose punishments on transgressors, and increase the influence of outside organizations and nations, positing him as a figurehead for fortress conservation and the human-exclusionary approach to conservation.

Similarly, in the book *Parks in Peril,* the authors defend the national park system and caution that sustainable use schemes are dangerous for biodiversity and that some natural areas must be preserved through strict protection and prohibition of resource use (Brandon et al., 1998). Oates argues in his book, *Myth and Reality*, that "the linking of conservation to economic development has had disastrous consequences for many wildlife populations" and that the way to protect nature is to keep humans as far away as possible (Oates, 1999). Taking a stand from an ethics point of view, Holmes Rolston III concedes that for conservation and human livelihoods, he supports a "win-win" when possible, but that in the "real world," difficult decisions must be made and when it comes to conservation, those decisions must prioritize

endangered biodiversity (Rolston, 1998). Rolston, Oates, Brandon, and Terborgh are not alone in this line of thinking; there is a considerable contingent of conservation advocates who continue to see the necessary solution to biodiversity loss as the exclusion of humans from natural spaces and strict protection of natural resources from human use.

Human Inclusion and CBNRM

The other main current in conservation, opposing the fortress or human-exclusive approach, is a human-inclusive approach, aiming to integrate human communities, ecosystem management, and conservation. Here, I am using human-inclusive to refer to all conservation schemes that involve local people in their use and management, and or within their spatial boundaries. This approach aims to provide an alternative to the top-down Park Model which often involves dispossessing indigenous and local people of their land and resource use, as well as violence and punitive measures to enforce the imposed regulations. As described by Dressler et al. (2010), human-inclusive conservation approaches in the developing world first rose in the 1960s and 1970s as part of a larger global movement of increasing consciousness about international economic fairness. Communities and scholars argued that marginalized people deserve to define their own priorities and develop the capacity to take action accordingly, creating community-based environmental solutions. Advocates argued that because local people already used and managed natural resources, they were best positioned to conserve such resources (with external support). The 1980s and 1990s saw the rise of ‘sustainable development,’ institutionalizing the ideals of joint environmental and economic gains through integrated conservation and development projects, or ICDPs, and community-based natural resource management, or CBNRM (Dressler et al., 2010).

As summarized in a United States Agency for International Development (USAID) policy brief:

> “CBNRM aims to create the right incentives and conditions for an identified group of resource users within defined areas to use natural resources sustainably. This means enabling the resource users to benefit (economically) from resource management and providing strong rights and tenure over land and the resources.”

The document notes that CBNRM is not new, however, it is a practice that rural communities have had for centuries: managing natural resources through “traditional leadership, religious

beliefs, and cultural rules." This idea is supported by Kansanga and Kpienbaareh, who argue that in Africa, there is a history of traditional management of natural resources, which can be integrated with modern approaches to biodiversity conservation (Kansanga & Kpienbaareh, 2023, p. 126-127). Further explained in the USAID policy brief are three key factors for CBNRM to work effectively. First, communities must hold the rights to their land and resources, without fear of ownership being arbitrarily removed by the government or another body. Second, communities need representative and accountable institutions to make decisions on behalf of community members and oversee the distribution of benefits from the sustainable management of resources. Third, communities need to gain appropriate economic benefits from the resources they manage, benefits that exceed the costs (USAID). These factors hint at the complex dynamics underpinning this method, and the potential difficulty in truly implementing it.

As opposed to human-exclusive conservation, CBNRM represents an important attempt to value and support the lives of rural people in developing countries, instead of simply focusing on the biodiversity and wildlife that exist in the same systems. Nelson Mandela called for this framework at the World Parks Conference in 2003 in South Africa, as summarized by Dowie: "Mandela pled with conservationists not to 'turn their backs' on rural economies, and to treat indigenous peoples more fairly in the course of creating new parks and game reserves" (2011, p. xvii). Mandela later added, "I see no future for parks, unless they address the needs of communities as equal partners in their development" (Dowie, 2011, p. xix). Many studies have found that the complexity of conservation contexts necessitates an approach that is inclusive of people, such as through a CBNRM initiative (Pemunta, 2019; Jones, 2006).

Despite the commendable goals of CBNRM, across different contexts and countries the results have been mixed (Shackleton et al., 2002; Nelson & Agrawal, 2008; Radachowsky et al., 2012). Significant challenges have arisen, undermining the ability to serve the multiple purposes of supporting communities and preserving biodiversity. Dressler et al. (2010) outlined several of the main challenges of CBNRM as it has evolved since conception, finding that in many instances, CBNRM projects have failed to meet the community needs they purport to address. They found that CBNRM often ultimately disempowered the people it should have supported, for example in Southern Africa, the Philippines, and Madagascar, foreign-led ideas of preserving biodiversity took precedence over human concerns, and in Nepal, the benefits of a CBNRM program were disproportionately returned to local elites. They found that in many cases, environmental protectionism co-opted or sidelined CBNRM, with programs emphasizing market-oriented solutions that tended to serve state interests. Finally, the authors summarized the trend of CBNRM interventions being misaligned with local realities, a "global pre-packaged

solution to local problems" that often proved ineffective (Dressler et al., 2010, p. 12). DeMotts further supports this idea, enumerating the challenges of CBNRM including "struggles to create meaningful local participation, village elite co-optation, a lack of community interest and inadequate local management capacity, and different impacts for men and women" (DeMotts 2022, p. 132).

One landmark CBNRM program is Zimbabwe's Communal Areas Management Program for Indigenous Resources, or CAMPFIRE, launched in 1987. The program involves high fees being paid for hunting large game, the revenue from which can then be channeled into community development (Kansanga & Kpienbaareh, 2022). As summarized by Dr. Brian Child, former head of the CAMPFIRE unit in Zimbabwe's Department of National Parks and Wild Life Resources, CAMPFIRE consisted of two main active components. The first was bringing tangible, economic benefits to local communities in the form of revenue from fees, and the second was creating governance structures to empower communities to make collective decisions and govern their own affairs. In a 1997 summary, Child and co-authors were hesitant to immediately label it a "success," but rather emphasized the program as a "democratic process" and its pivotal "attempt to do the right thing by both communities and wild resources" (Child et al., 1997, p. 2).

Other examples of CBNRM that have been regarded as successes include Community Resources Management Areas (CREMA) in Ghana, a successful model of localized community-based conservation resulting in natural areas that served as both ecological corridors for the connectivity of wildlife populations and the regulated harvesting of fauna (Kansanga & Kpienbaareh, 2022, p. 127). In Namibia, community conservancies cover more land than national parks and have been successful in integrating with a globalized tourist economy, securing local rights to manage land and returning benefits to the community level (Nuulimba & Taylor, 2015). In Nicaragua, Bosawas Reserve is an indigenous community-managed area that has been regarded as a big success, with the needs of local people being a true priority and external organizations providing the necessary support and funding without co-opting the entire scheme for their own interests (Dressler et al., 2010). In Bangladesh, participation in community-based natural resource management was found to reduce the incidence and depth of poverty, as well as income inequality, suggesting that CBNRM is an effective tool for achieving sustainable development (Khan et al., 2023). One study found that community involvement in conservation led to increased health and well-being of members and to the social capital of the local community (Moore et al., 2006), and another

found that CBNRM initiatives in Kenya had a significant positive impact on local communities' livelihoods (Glew et al., 2010).

Another major approach to conservation is the zoning of natural areas, structured as a hybrid of strict protection and sustainable use, thus falling somewhere in-between a fortress and community-based approach (though particular projects, depending on their implementation, may lean more heavily to one side than the other). One of the main initiatives of zoning natural areas is the UNESCO Man and the Biosphere program, launched in 1971 (Ishwaran et al., 2008). In this initiative, biosphere reserves are created to promote "solutions reconciling the conservation of biodiversity with its sustainable use," involving the creation of three main zones in natural areas: core areas, buffer zones, and transition area (UNESCO). The zones are described as follows:

> **Core areas**: They comprise a strictly protected zone that contributes to the conservation of landscapes, ecosystems, species and genetic variation.
> **Buffer zones**: They surround or adjoin the core area(s), and are used for activities compatible with sound ecological practices that can reinforce scientific research, monitoring, training and education.
> **Transition area**: The transition area is where communities foster socio-culturally and ecologically sustainable economic and human activities. (UNESCO)

The concept of the biosphere reserve was to have clearly delineated zones, with the buffer zone particularly having "cooperative efforts" to ensure that land uses are compatible with the conservation and research goals of the biosphere reserve (Ishwaran et al., 2008, p. 121). The buffer zone was intended as a "zone of influence in which co-operative activities and harmonious land uses can be implemented," whose spatial dimensions would grow as the number of participants increased (Ishwaran et al., 2008, p. 122). Worldwide, biosphere reserves cover over 7 million square kilometers in 134 countries, with about 275 million people living within these areas (UNESCO).

Despite these admirable goals of combining biodiversity conservation with sustainable development, biosphere reserves and particularly buffer zones have been criticized for continuing oppressive conservation instead of creating a truly participative approach. Neumann argues that buffer zones in Africa actually result in increased state control over areas bordering protected areas, effectively encroaching on the land and resources of local people. He argues that buffer zones have perpetuated the fortress-style conservation approach, often resulting in

“forced relocations, curtailment of resource access, abuses of power by conservation authorities, and increased government surveillance,” rather than true integration of communities in conservation (Neumann, 1997, p. 564). As with many examples of CBNRM, biospheres and buffer zone models have struggled to implement their stated goals and often strayed from the key values in their conceptualization.

Conservation and natural area management has manifested in numerous ways, from strictly human-exclusive national parks to community-based sustainable use areas and everything in between. This debate is ongoing and has serious implications for worldwide biodiversity and human survival, making it a critical issue to examine and address with comprehensive solutions.

3. Background

Madagascar Parks and Natural Resource Management

Madagascar is a complex country with unique ecological, social, and economic characteristics that provide important context for understanding the management of natural resources. The island nation located off of the southeastern coast of Africa has a population of around 29 million people, with nearly 60% of the population under the age of 25 and a population growth rate of around 2.22% (Central Intelligence Agency). Malagasy heritage primarily comes from Indonesian and African Bantu immigration (Mackenzie, 2005), and there are around 18 main ethnic groups. Malagasy and French are the official languages, though there are several different dialects of the Malagasy language. The Merina empire, originating in the central highlands, conquered much of the rest of the island in the 1800s, creating ethnic tension between non-Merina and Merina people that has persisted through the 21st century (Campbell, 2004).

Madagascar’s economy involves vanilla and nickel as top exports, and the economy is largely based on agriculture with over 80% of the population engaged in agriculture and fishing (Purdy, 2007). Madagascar has struggled with slow economic growth and one of the world’s highest poverty rates, reaching 75% in 2022 using the national poverty line (World Bank, 2022). Furthermore, food insecurity and malnutrition are a huge problem, as food insecurity has increased drastically in the past 10 years and as of 2022, 8.8 million people across Madagascar

(about 33 percent of the population) were food insecure and 40% of the population was experiencing chronic malnutrition (Fayad, 2023). These challenges have persisted in Madagascar and provide context for the gravity of maintaining livelihoods in the country.

Madagascar has been identified as a worldwide biodiversity hotspot, a place with an incredible diversity of flora and fauna but also mounting pressure on the species' survival. Among these biodiversity hotspots, it has even been named one of the world's 'hottest hotspots' due to its biodiversity and high levels of endemism (Ganzhorn et al., 2009, Ralimanana et al., 2022). In flora alone, the island is estimated to contain about 14,000 vascular plant species, around 95% percent of which are found nowhere else (Raven, 2022). Madagascar contains an incredible array of fauna as well, and 100% of the native Malagasy amphibian and terrestrial mammal species, 92% of reptiles, 44% of birds, and 74% of butterflies are endemic as well (Vences et al., 2009). Madagascar is also home to lemurs, the charismatic primate for which the island nation is best known to some, which are considered the most threatened mammal group on Earth (Schwitzer et al., 2014).

The ecosystems and biodiversity of Madagascar are extremely threatened, and tropical forests in Madagascar are drastically decreasing as a result of human activities, exacerbated by climate change and the resulting effects of intense drought and bushfires (Armstrong & Goodman, 2022). Madagascar is estimated to have lost about 90% of its original forest cover (Armstrong & Goodman, 2022), with the rate of deforestation increasing in the past 15 years, for example, the rate of forest loss from 2010-2014 was more than double the rate from 2000-2005 (Vieilledent et al., 2018). Madagascar has over 120 protected areas, and these protected areas directly correspond with the forest cover that is remaining (Armstrong & Goodman, 2022). Madagascar has consistently been the object of focus for biologists, naturalists, and conservation enthusiasts, extolling the need to protect the island's threatened life forms. Madagascar's unique mix of social and ecological characteristics makes the country an extremely important place to carefully address the challenges of supporting both livelihoods and biodiversity.

The history of natural resources management in Madagascar shifted in substantial ways during the pre-colonial, colonial, and post-colonial eras. Before the 18th century, people's relationship to the land was largely subsistence agriculture, hunting, fishing, and gathering with community institutions to manage these activities as well use of fire and conversion of natural land to agricultural land (Scales, 2014). However, the creation of the Merina state in the 1800s, effectively 'unifying' the country under the Merina kingdom, and French colonization weakened these community institutions to the point that they were often practically non-existent thereafter

(Pollini et al., 2014, p. 173; Bertrand et al., 2009). Raik summarizes the dominant narrative and policies in each era, beginning with the pre-colonial narrative that Madagascar was once fully forested and deforestation resulted from human activity, thus burning and settling in forests was forbidden by central authorities to preserve forests as royal property. During the colonial period, 1896-1961, the dominant narrative was that Madagascar's forests were for French use and that Malagasy people were incapable of managing the forests, and repressive forest policy was created through conservation areas and forbidding deforestation (though traditional practice of swidden agriculture or *tavy* continued). During this time, the French directly contributed to deforestation by opening the forests to logging concessions, especially for precious woods like ebony and rosewood. In the early independence post-colonial era, from 1962-1991, the state was seen as the only legal manager of forest resources, and repressive forest policy continued. During the colonial and early independence periods, the tension between the government and the people was strong, as forest policy attempted to outlaw *tavy* but the practice continued and these laws were largely unsuccessful. Raik argues here that since 1930, forest practices in Madagascar have been "open access," where both individual and group exploitation has been uncontrollable by the government. This resulted in a "paradoxical conflict between illegal local-level forest exploitation regarded as legitimate by local people, and the legally-sanctioned forestry policies regarded as illegitimate by local people" (p. 7). In the NEAP (National Environmental Action Plan) post-colonial era beginning in 1991, conservation rhetoric was strong at first and the creation of protected areas increased, though now alongside an effort to provide alternative economic activities. Finally, community-based forest management arose during the post-colonial era as well, with the narrative that local people can manage forest and the state is unable to effectively manage forests everywhere, leading to decentralization of forest management and the transfer of management rights to local people (Raik, 2007).

Reacting against this long-standing history of state park management and top-down forestry policy was the shift to include community-based natural resource management in Madagascar. This CBNRM approach was primarily enacted through a law called GELOSE or *Gestion Locale Sécurisée,* Law 96-025, voted in during 1996 (Cooke et al., 2022, p. 353, Toillier et al., 2008). GELOSE law works as a tripartite agreement between the national forestry services, the local commune government (the most local decentralized institution with elected leaders), and an association within the local community (Cooke et al., 2022, p. 353, Pollini et al., 2014, p. 174). These associations are often called by the French name *Communauté de Base*

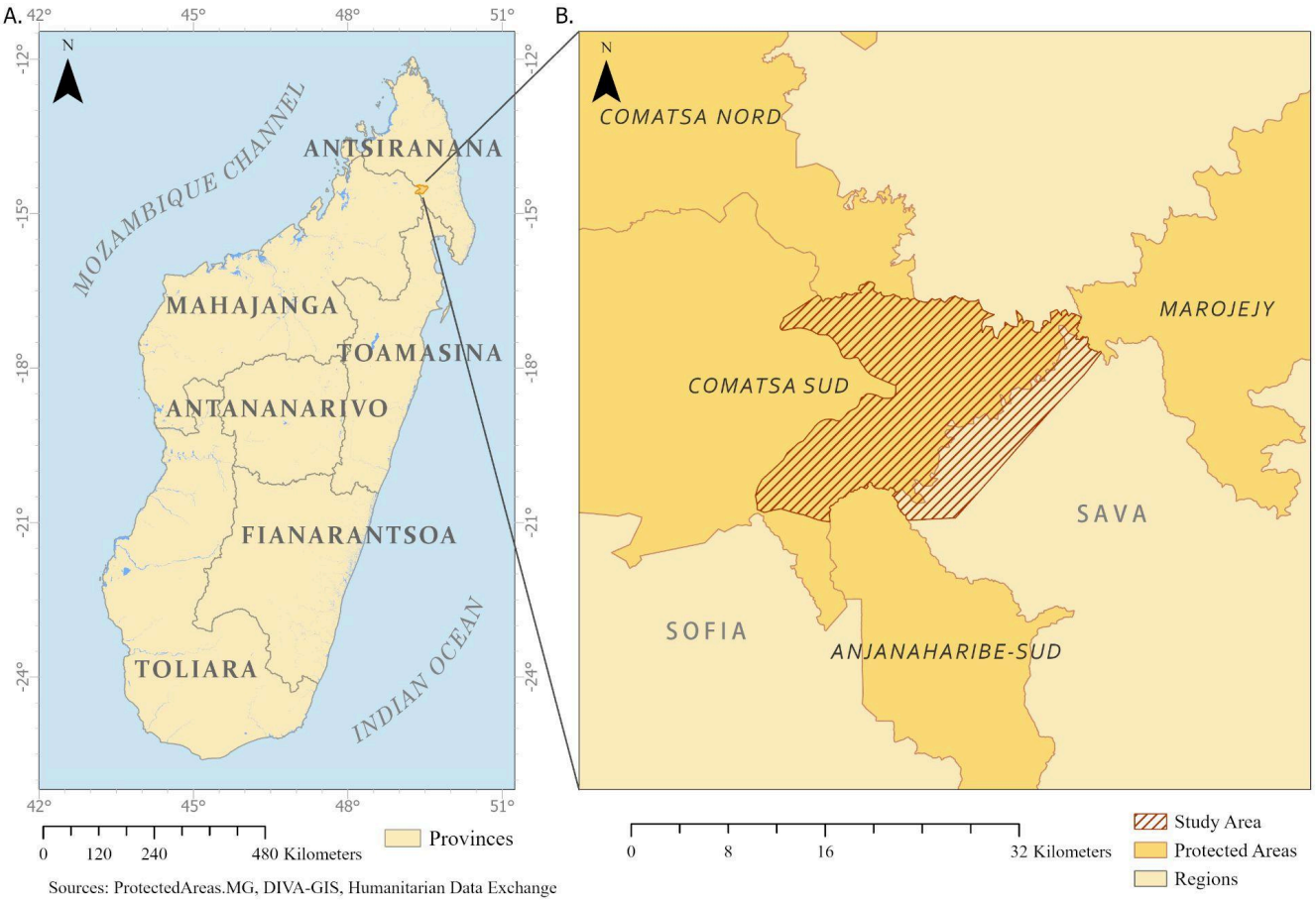
(COBA) or the Malagasy name *Vondron'ny Olona Ifotony* (VOI).[1] GELOSE law resulted in the legal transfer of management rights from the national government to these local communities, involving a mediator as well. Contracts for management would last for three years initially, with the possibility for renewal for a further 10 years based on satisfactory performance (Cooke et al., 2022, p. 353). However, the communities do not receive legal tenure or titles to the land (Raik, 2007, Toillier et al., 2008). A simplified version of the process was enacted as well in 2001, known as GCF or *Gestion Contractualisée des Forêts*, not requiring a mediator or participation of the commune (Cooke et al., 2022, p. 353) due to the complicated process of establishing GELOSE contracts (Toillier et al., 2008). Since its establishment, over 400 GELOSE and GCF contracts have been put in place throughout Madagascar (Raik, 2007). GELOSE marks an important turning point in Madagascar's conservation initiatives to devolve control from the traditional state ownership, but it has been critiqued for hasty implementation, continuing to overwrite true community priorities, and an inability to sustain over time (Toillier et al., 2008, Pollini et al., 2014, p. 176).

[1] The community involved in this study preferred to use the Malagasy name, *Vondron'ny Olona Ifotony* (VOI) for their association. As such, this is the name I will use to refer to these associations created through GELOSE law for the purpose of forest management.

Study Area and the COMATSA Sud

Figure 1

Map of the Study Area in northeastern Madagascar



Note. The location and extent of the study area in northeastern Madagascar. GIS data layers from ProtectedAreasMG, DIVA-GIS, and Humanitarian Data Exchange. Cartography by author.

My study focuses on a protected area in northeastern Madagascar and an adjacent village community. Figure 1A shows the island of Madagascar and its six provinces, with the study area located in the northeastern part of the island. Figure 1B shows the extent of the study area for the remote sensing analysis, covering approximately 300 square kilometers and including the eastern portion of the COMATSA Sud protected area in northeastern Madagascar

and an adjacent village community. The study area takes the eastern half of the COMATSA Sud, divided by the regional boundary between the eastern SAVA region and the western Sofia region, plus a strip of land outside of the protected area on the southeastern side, including the study village. Due to accessibility and logistical difficulties, training land cover data for the remote sensing analysis was only collected in this eastern portion of the protected area. The study area for the remote sensing analysis includes the village in order to fully encompass the socio-ecological system around the southeastern edge of the protected area, and to have sufficient training data for non-forest vegetation land cover.

The key characteristics of the region and the village study site are as follows: the elevation is approximately 500 meters above sea level at the village, with elevation rising to about 1,750 meters at the peak of the ridge in the COMATSA Sud protected area (Goodman et al., 2003). The area receives around 1700 mm of rainfall per year, with the majority of precipitation occurring in the rainy season from November to April, and a season of lower precipitation from May to October (Goodman et al., 2003). The village, which will remain unnamed to maintain anonymity, has a population estimated to be around 1,900 people, and the main ethnic group is Tsimihety. It is believed that the general region in which the village is found, known as the Andapa basin, only began to be populated in the early 1900s by (Malagasy) settlers who found the conditions suitable for vanilla cultivation (Goodman et al., 2003). This narrative was corroborated by village elders who described during an introductory community meeting that this village was founded by people who moved from a neighboring village, and the first houses were constructed around 1922. The village is extremely remote, requiring hours of travel on unpaved roads, which may become impassable due to mud and flooding during the rainy season.

The COMATSA Sud protected area is an IUCN class V protected landscape, containing a dense, tropical rainforest, established in 2015 with the help of the WWF. It is part of a larger network of protected areas, helping to establish a continuous forest and one of the largest terrestrial protected areas in Madagascar. These protected areas help ensure the water supply of the Sava and Sofia regions, critical for subsistence crop and cash crop production (*COMATSA Sud,* WWF, 2016) COMATSA is a corridor forest, linking the three other protected areas of Marojejy, Anjanaharibe-Sud, and Tsaratanana further to the northwest, thus giving its acronymic name of COMATSA (COrridor-MArojejy-Anjanaharibe-Sud-TSAratanana). The COMATSA Sud protected area is part of the northeastern Madagascar forests, one of the most critical conservation areas in the country, housing wildlife including amphibians, reptiles, birds, lemurs, and carnivores (Herrera, 2017; Zaehringer et al., 2015; Ross et al.; 2020, Rabearivony

et al.; 2015). One of the most charismatic lemur species found in the COMATSA, *Propithecus candidus* (Silky sifaka or *simpona*), is highly endangered and has become a flagship species for conservation in the northeastern corridor (Schwitzer et al., 2014). Furthermore, COMATSA's positioning as a corridor forest enables connectivity of wildlife populations, critical for their survival (Rabearivony et al., 2015; Beier & Noss, 1998). Food insecurity in northeastern Madagascar is high as well, with one study finding that over 70% of households reported having insufficient food to feed their family at some point during the previous three years (Herrera et al., 2021). As such, stakes are high for rainforest preservation, wildlife habitat, and local livelihood outcomes. The challenges arising in Madagascar and across the world are exemplified in the COMATSA Sud and adjacent communities, making it an important site to study and to provide insight into broader trends of environmental management.

4. METHODS

My thesis uses a combination of qualitative and quantitative methods to evaluate the following question: How effectively does the COMATSA Sud protected area management system provide for the local community and preserve critical forest cover?

Interview Data Collection

Interview data was collected from June 2023 to August 2023 in the study village. I lived in the study village during this time and collaborated with a team of Malagasy researchers to complete the fieldwork. I received IRB approval from Macalester College for my research and methods. In total, 40 sessions of interviews and focus groups were conducted by myself and my research assistant, with a mix of semi-structured and open-ended questions and responses. Given that my research assistant and I conducted every interview, consistency was maintained across interviews, decreasing potential variability due to protocols, the manner of posing questions, and interviewers' identities. These interview conversations were conducted in the indigenous Malagasy language and specifically in the local Tsimihety dialect. This is critical, as few rural Malagasy speak French, and using another dialect of Malagasy (namely the Merina dialect) would either be impossible or significantly decrease the nuance of answers.

. The interview sessions comprise the following groups:

- 1 community meeting [~50 people present]
- 15 interviews with community members, not members of the VOI[2] [8 women, 7 men]
- 15 interviews with VOI community members [7 women, 8 men]
- 1 focus group with the VOI Leadership [3 men, 1 woman]
- 1 focus group with the Polisin'ala[3] [5 men]
- 5 interviews with the Polisin'ala [5 men, the same people as in the focus group]
- 2 interviews with a WWF representative [1 woman, over two different interview sessions]

Individual interviews typically lasted between 1 hour and 1.5 hours, while focus groups typically lasted 2 hours. VOI Leadership, Polisin'ala, and the WWF informant were selected based on their important role in the management system while VOI members and community members were randomly chosen. VOI members were chosen from a list of all VOI members using a random number generator. Community members were selected using a spatially stratified random sample. An aerial image of the village was used to divide the village into neighborhoods with the help of a village elder, and households within each neighborhood were selected using a random number generator. Across these 30 interviews, an equal number of men and women were interviewed. Informants were not part of vulnerable groups and were at least 18 years old. Informed consent was acquired before beginning interviews, in accordance with the IRB-approved research protocol. Interviews and focus groups were recorded with permission during the session and later translated into English for data analysis. The general topics discussed in each type of session are summarized in the table below.

[2] Vondron'ny Olona Ifotony: the name for the forest management association in the village, the Malagasy words translating to 'association of local people'
[3] Polisin'ala are the forest police, a subset of people in the VOI (forest association) responsible for forest patrols

Table 1

Overview of Interview Data Content

Type of Session	Content	Structure
1 Community Meeting	Basic history of the village and forest management in the region and overview of important economic dynamics in the region	Unstructured
15 Community Member Interviews	Dependence on forest, use of forest resources, benefits from forest protection	Semi-structured
15 VOI Community Member Interviews	VOI member details, dependence on forest, use of forest resources, benefits from forest protection	Semi-structured
1 VOI Leadership Focus Group	History of VOI and forest management, goals of forest management, responsibilities of VOI leadership and members, benefits of VOI membership, collaboration with other organizations (WWF and other), conceptual model of forest zones, local dependence on and use of forest, challenges and successes of management	Unstructured
1 Polisin'ala Focus Group	Responsibilities of Polisin'ala, details of collaboration with other organizations and the larger VOI, details of duties, patrols, and permits, legal processes and punishments, demographics of forest resource users, conceptual model of forest zones, history of protected area boundary and signage	Unstructured
5 Polisin'ala Interviews	Goals of forest management, local dependence on and use of the forest, use of the permit system, dynamics of the protected area boundary, benefits from forest protection	Unstructured
2 WWF Interviews	History of COMATSA Sud protected area and VOIs, WWF activities in the region, conceptual model of forest zones, local use of forest, permit system, legal system of forest management, goals of forest management, benefits from forest protection	Unstructured

Interview Data Analysis

Interviews were analyzed using Atlas TI to identify themes and quantify responses. To understand general background information and the functioning of the management system, a synthesized descriptive summary of the WWF official, VOI board, and *Polisin'ala* interview data is presented in section 5.1. For the 30 community members, responses to the first set of questions were categorized by main resource: timber, fuelwood, handicraft materials, traditional medicine, and land. Within each resource group, specific trends were analyzed including use, access over time, and permit requirements, with some resource groups having follow-up questions such as spatial trends, price trends, and others (depicted in section 5.2). Overarching questions about forest use and livelihood benefits were posed to each individual as well, and results were quantified. Where applicable, other informant groups (VOI board, *Polisin'ala*, WWF official) were asked as well and their responses were included in the results. Quantified responses were visualized in graphics using R Studio.

Remote Sensing Data Collection

To capture the most important land cover types in and across the border of the COMATSA Sud protected area, I classified the area into six main land cover types: forest, tall vegetation, short vegetation, built, exposed, and water. The three main classes of forest, tall, and short vegetation are the main types of land cover as observed on the ground and reflect processes of forest cover change. For example, a typical clearing and farming cycle would include clearing a section of forest, planting rice for a few years, i.e. 'short vegetation,' and then allowing the plot to grow longer either to plant vanilla in a semi-shaded environment or to lay fallow until the next agricultural cycle, both of which would be 'tall vegetation.' The remaining three land cover classes, built, exposed ground, and water, are present in the landscape as well but with a much smaller extent. Table 2 describes each land cover class in more detail. Training point land cover data was collected in the study area from June to August of 2023, using a handheld GPS to record the coordinates of various land cover types. Data was recorded near the village and in the protected area as well. The GPS points were taken around the perimeter of critical land cover types, both at the edges and in the interiors, to be made into polygons with a GIS application. Information about land use and land use history was recorded when available.

Table 2

Description of land cover classes

Land Cover Class	Description
Forest	Dense tropical rainforest, not cleared in known history
Tall Vegetation	Vegetation 2 meters or taller, including fallow plots with secondary succession regrowth trees and taller agriculture [agroforestry, coffee, banana, avocado, vanilla agroforestry, etc]
Short Vegetation	Vegetation shorter than 2 meters, including hillside rice cultivation, shorter agricultural cultivation [beans, pineapples, carrots, lettuce, corn, non-agroforest vanilla, etc], and grasses
Built	Houses, metal roofs
Exposed	Bare soil, walking paths
Water	River, irrigated rice cultivation

Remote Sensing Data Analysis

Preparation of Training Data

Data was compiled primarily from the GPS points that I collected in the field, supplemented with GPS land cover data from Camille DeSisto's botanical plots in the region (ongoing research). All data points were compiled and adjustments were made to the vegetation class points as needed according to the notes taken in the field. Training data for the built, water, and exposed classes were created using Google Earth Pro. A separate feature class for each land cover class was then created. Polygons were created based on the points (the corners of plots) and random points were created within these polygons for training data. The GPS and other point data was processed in Google Earth Pro and ArcGIS Pro. The final training dataset was 5000 points, comprising 2358 forest points, 767 short vegetation points, 706 tall vegetation points, 325 built points, 350 exposed points, and 494 water points. Data were separated into 70% of points used for the classification and 30% of points reserved for an accuracy assessment.

Imagery

I used a cloud-free monthly composite image from PlanetScope with a resolution of 4.77 meters per pixel for the classification. The image is for August 2023, corresponding with the date of field data collection of land cover points.

Random Forest Classification

I performed a random forest classification in Google Earth Engine (Gorelick et al., 2017). This classification technique was selected due to its high accuracy and resistance to overfitting. I used five predictors: the red, green, blue, and near-infrared bands, plus the calculated Normalized Difference Vegetation Index (NDVI). The classification used 400 trees, with a seed value of 100. I was able to access this imagery freely through the Norway International Climate and Forest Initiative (NICFI) Program linked to Google Earth Engine, which makes PlanetScope images within the geographical boundaries of the tropics free to access.

5. Findings

5.1 Structural and Historical Context

Process of management transfer

I conducted an interview with a key WWF official who has worked in the region for 17 years and is the regional expert on conservation and forest management. This interview provided insights into the history of the protected area and the process of forest management transfers as well as structural elements of the WWF's work in the region. The WWF official described that before WWF assumed management of the corridor forest, which would later become the COMATSA Sud protected area, the forest belonged to the national government as did all forests at the time. However, the government could not effectively manage all of the forests in Madagascar, so a national policy was created to transfer management rights to local

communities, to the Vondron'Olona Ifotony. This was the GELOSE law (*Gestion Locale Securisée*, or Secure Local Management), in the late 1990s as described by Cooke et al. (2022, p. 353), Pollini et al. (2014, p. 174). The informant described that WWF worked to educate communities and raise awareness about this policy so that forest-adjacent communities could organize and request management rights. After this first step was initiated, there would be a public consultation to confirm that the request for forest management was "really the idea of many people," not just a few individuals or a few families in a village. The process progressed from the most local level, the *fokontany*, to the commune, to WWF, to the district, and to the region. After this process, the transfer of management would be executed. WWF began working with the management transfers process in this region in the early 2000s.

As reported by the WWF official, the VOIs receive a contract to manage the forest for initially only three years. After the first three years, the VOIs would be evaluated on their performance, their ability to protect forest and follow the rules set out by the transfer agreement. If the management was satisfactory, the VOIs would receive ten more years of management until re-evaluation. If the management was mediocre, they would only receive three more years of management rights until re-evaluation. If the management was really substandard, the management rights would immediately return to government jurisdiction.

In 2015, the corridor forest gained the legal status of protected area and the name COMATSA Sud at a meeting in Mahajanga in northwest Madagascar. As the official described, the corridor was protected because of its importance for endemic Malagasy wildlife habitat: "We protect the *simpona* (Silky Sifaka lemur) and the little chameleon, *Brookesia nana.* They are only found in Madagascar, that's why it's important to protect them." WWF helps to manage the COMATSA Sud corridor forest, connecting reserves like Marojejy and Anjanaharibe Sud which are managed by the government and Madagascar National Parks (MNP). The role of WWF is to facilitate the transfer of management from government to local communities, helping to create and finance the forest management associations.

History of Village VOI

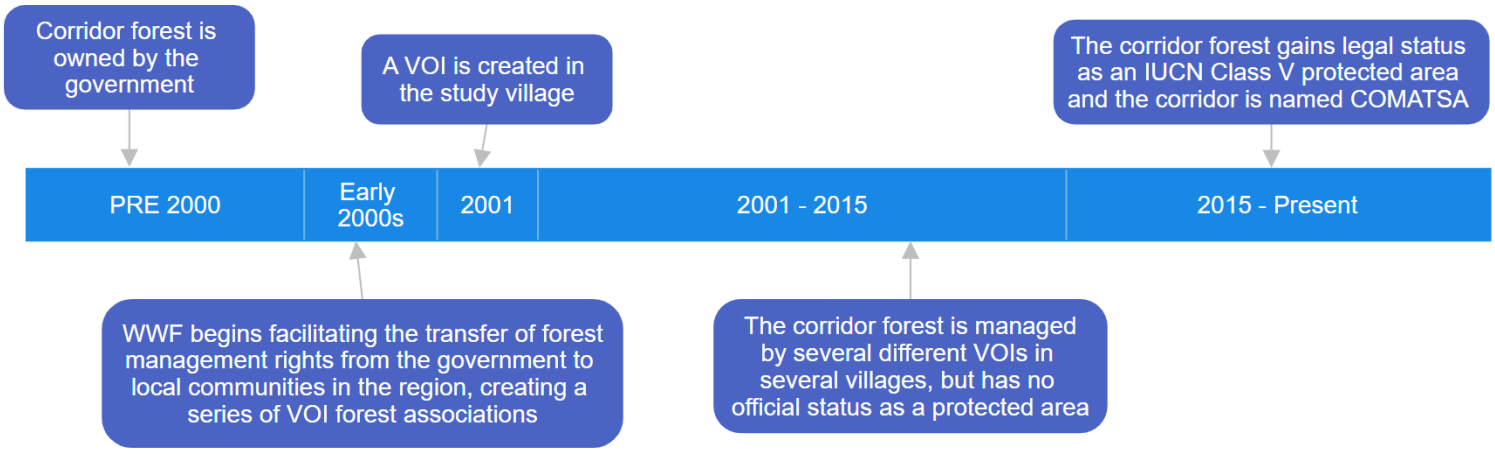
I conducted a focus group interview with the leadership board of the VOI (four members out of five present), to better understand the history of the VOI, the technical aspects of forest management, and leadership in the association. These four members had been in office for about three years, and they were elected by the members of the association, with elections happening every three years. The board described that previously, the forest was managed by

lehibeniala (a Malagasy word typically indiciating the government, often through a representative of one of the government ministries), but in 2001 this VOI was established through a transfer of management facilitated by the government, DREDD (*Direction Régionale de l'Environnement et du Développement Durable*), and WWF. Originally, the association was called by the name of the national policy, GELOSE, but is now primarily called the VOI (though I observed that various community members in the village, as well as association members themselves, would refer to the association as GELOSE, COBA (the French name for the association *Communauté Locale de Base*), or the VOI. For clarity and to respect the wishes of the association, I will refer to it only as the 'VOI,' the Malagasy acronym for the association).

As for the corridor officially becoming the COMATSA Sud and gaining the legal status of a protected area, the WWF official said that WWF educated the local communities about this change at the time, but that no change in the management rules occurred. The VOI board reported that they did not know of any new authority or rights that the community gained in 2015 and that the rules of forest management have never changed. Essentially, the status of the corridor forest changed on paper, but this did not result in any meaningful changes to forest management on the ground. Similarly, in the thirty interviews conducted with community members, most people were confused when I asked about any management changes that happened around 2015 and did not know of any changes regarding the forest that happened this time.

Figure 2

Timeline of forest management and VOI establishment



Note. Timeline data is according to interviews with the VOI leadership board and the WWF official.

WWF

WWF works with a few collaborators, HELVETAS and GSDM, to deliver various trainings and activities regarding forest protection in the region. They teach communities about financial management, such as creating financial security and credit associations. They teach communities about agricultural practices to increase land fertility organically, not through chemicals, and to increase yields for cash crops and food crops. They teach communities sedentary agriculture techniques, discouraging shifting cultivation which is more likely to encroach on forest. They teach fish farming, gardening, and vanilla and clove cultivation as well. WWF participates in forest patrols, sometimes collaborating with polisin'ala, DREDD, or an armed security force. WWF also works to do reforestation, both "active," planting saplings where the forest has been cleared, and "passive," demarcating areas that were cleared but are naturally regrowing and should not be cleared again. The informant described that "sometimes, people make mistakes because they don't have knowledge about it. WWF is trying really hard to educate them to prevent them from wrong-doing out of ignorance."

VOI

The VOI (*Vondon'Olona Ifotony*) is the forest association, one of many in the region that have undergone the transfer of management process to receive rights to forest management. In the VOI in this village, there are 198 members, comprising 53 women and 145 men. The only requirement to become a VOI member is to pay the yearly fee of 1,000 ariary;[4] everyone is eligible. There are five people on the VOI leadership board, and they are elected every three years by the VOI members. Within the VOI, there is a subset of members who are the *Polisin'ala,* forest patrollers, whose role will be explained in the next section.

The main activities of the VOI are reforestation, through maintaining a tree nursery and planting trees with members, and generally supervising the harvest of timber and ensuring that people obtain timber permits. The VOI is also responsible for overseeing forest patrols and placing signs and painting trees to demarcate different zones of the forest. Meetings with the entire association are held every three months.

[4] The conversion rate for USD to Malagasy ariary at the time of the study, 2023, was approximately $1 USD = 4,300 ariary.

Polisin'ala

I conducted a focus group with all of the *Polisin'ala,* comprising five men and one woman. They described their primary responsibilities as doing patrols in the forest and supervising permits. Patrols happen around twice a month, but it depends on the VOI board and when they instruct the *Polisin'ala* to make patrols; several months could pass with no patrols if the VOI board has not instructed them. During a patrol, they record the GPS coordinates of each observed instance of forest clearing, mining, or animal traps. They conduct these patrols in groups of 3-5 people because they fear retaliation by "forest destroyers" they may encounter on the patrols. While conducting the patrols, they do not follow trails but rather rely on their intimate knowledge of the forest or specific areas of interest to supervise. The *Polisin'ala* are paid by the VOI on the day of the patrol and by WWF when they send patrol reports to the WWF (they note, however, that it is also easy for anyone, such as the VOI board members, to sign the report and receive money as well, even if they did not actually help conduct the patrol).

As for permits, the *Polisin'ala* describe that there should be a system whereby when people from the community want to get a timber permit, the *Polisin'ala* specifically assigned to that section of the forest must sign off on the permit and supervise the collection. However, the current reality is that permits only need approval from the VOI board. As such, there is concern that permits are given too freely and without the proper advice and supervision of *Polisin'ala*. The *Polisin'ala* are generally frustrated with the management system, feeling that communication and collaboration with the larger VOI and with WWF is insufficient, and that they do not have the resources or support necessary to effectively protect the forest through patrols.

Purpose and Goals of VOI

The WWF official described the primary reasons for the transfer of forest management and the goals of the creation of VOIs as the following:

a. Lack of government capacity: The government was ineffective in managing forests, so it made sense for local communities to assume control and "protect the forest as their own property."
b. Watershed protection for agriculture: The headwaters of rivers in this region are in the mountainous forests, and "if the core forest is destroyed, the rivers downstream will run dry." Because the majority of people in this region are farmers, their livelihoods would be impossible without the forest providing this source of water.

c. Access to permits: Previously, local people would have to travel far to obtain a timber permit in the regional city of Andapa. With the VOI association located in their village, permits can be accessed easily.
d. Community engagement and education: “If people work together, they can make great things happen. The goal is for everyone in the village to be a VOI member and manage the forest together, and to understand the importance of the forest--if they really understand this, they will be eager to protect it.”

The VOI board described the reasons for creating the VOI and the primary goals of the VOI as the following:

a. Forest protection and sustainable development
b. Local management capacity: “WWF may be more powerful than the VOI, but it is local people who are best positioned to protect the forest. People in this village really know the secrets of the forest.”
c. Easier access to permits
d. Benefitting the wider community: The VOI can help to finance projects in the village such as building their office and rebuilding schools, which can benefit the whole community.

In both of these explanations can be seen the joint goals of protecting the forest and providing for the community by facilitating easier access to permits, providing community infrastructure, and protecting forest ecosystem services.

Benefits to VOI members and to the larger community

The WWF official described that the VOI creates many benefits for the whole community. Accessibility of timber permits as previously mentioned is a big benefit, as is the ability for the VOI to invest in community infrastructure like schools and hospitals if the association is flourishing and has the money to do so. Furthermore, the forest provides ecosystem services such as maintaining good air quality, which benefits the entire region even hours away from the forest itself. As for the WWF’s direct activities, however, they are mostly focused on the members of the VOI, not everyone from the community. The WWF has given farming tools to the VOI in the past, trains the VOI leadership, and covers per diem and accommodation costs for travel necessary for training. There are certain activities, however, like community reforestation efforts, that are open to everyone’s participation.

The VOI leadership name the main benefits to the whole community as community infrastructure as well, and the community’s ability to use the VOI office for meetings or prayer.

Furthermore, the VOI has contributed money to build a new town hall office in the mayor's city. As for VOI members, the primary benefit is that a timber permit is cheaper (1,000 ariary for non-members, 500 ariary for members). Additionally, VOI members have the opportunity to be hired as porters for research missions in the protected area (a well-paid and coveted opportunity), while non-members do not. VOI members can also borrow farming tools from the association like watering cans and wheelbarrows, and members can receive free tree saplings as well.

Forest Zoning Structure

The WWF official, the VOI leadership board focus group, and the *Polisin'ala* focus group all detailed a zoning structure for the forest on which the management system is based. This zoning structure closely resembles the UN Biosphere Model, with a core protected zone and exterior zones of allowed resource use. The forest is divided into multiple zones, with varying names and types of activities and resource use allowed within. The first zone is called '*zone d'occupation*,' or 'zone of occupation,' and this area is for farming and settlements, thus including the village and the nearby agricultural land.

The second zone is called the '*zone d'utilisation*,' or 'zone of use,' and beginning with this zone should be the exterior of the forest. This area is the primary area from which people should be taking firewood and timber for making houses and furniture. The VOI board added that this zone is the most common area for collecting firewood or making charcoal, because it's closer to the village than the other zones.

The third zone is the '*ala kajiny*,' or 'reserve forest.' The WWF official describes this zone: "the forest is here is like a bank, if the rest of our money runs out, we can take money from the bank," but it (timber) should be taken slowly and sparingly, while the zone d'utilisation regrows and can become the primary source of timber again. The *Polisin'ala* echo this idea that the reserve forest should be only a backup if the zone of use runs out of timber. However, the WWF official notes that in the reserve forest, people are not allowed to collect trees to sell them, but rather only take trees for their own construction needs. Furthermore, if people cut one tree, they should plant ten, to keep the zone of use forested. "It is not that, for example, the *ala kajiny* is used up, so people move to the *ala fady* -- that is not our goal." The WWF official emphasizes that these two zones, the zone of use and the reserve forest, must be managed very carefully to ensure a constant supply of trees, and reforestation is essential for this continued availability. The VOI board, on the other hand, describes this third reserve forest zone as the main zone for

people to take timber if they have gotten a permit to do so. However, they note that some trees like rosewood are forbidden to be cut down at all, no matter which zone they are in. People can also get handicraft materials in this zone if they have gotten a permit from the VOI. As such, some discrepancies between groups in their understanding of forest management can already be seen, and I will discuss this at length in a later section.

The fourth zone is the *ala fady*, Malagasy for 'forbidden forest,' which I will refer to as the 'protected area.' Other names for this zone given in various interviews were the 'core,' 'zone of total protection,' and 'big forest.'The WWF official described that people are not allowed to take anything from this zone; it should be "untouchable." The VOI board echoed this rule, saying that people are forbidden from taking anything, "not even medicine, not even one leaf of a plant." People are not even supposed to enter the protected area just to walk around. The *Polisin'ala* also say that "everything is forbidden," but they add that people who want to just walk around could get permission from the VOI.

Table 3

Description of zoning model

Level	Zone	Description
1	Zone of Occupation	Village, houses, animal husbandry, agriculture
2	Zone of Use	Forested zone, primary zone for timber harvest and other forest resource use
3	Reserve Forest	Forested zone, timber use permitted only if Zone 2 has run out. Timber may be taken only for personal use, not in large quantities for sale.
4	Protected Area (*ala fady,* "forbidden forest")	Total protection, people are not allowed to take trees or any other resource, regardless of the state of the other zones.

Figure 3

Conceptual model for forest zones

Note. This model is the consolidation of the models drawn during the WWF official interview, WWF official, *Polisin'ala* focus group, and VOI leadership board focus group.

Punitive process

The *Polisin'ala* described that when they are conducting patrols, the two main offenses for which they would apprehend are illegal timber cutting and forest clearing. However, forest clearing is a much more serious crime than timber cutting, because there is a process for people to get the appropriate permission and permit to cut timber, but "there is no law to permit the clearing of forest." The main punishments for transgressions are fines, confiscation of timber, and in more serious cases, court and jail.

The *Polisin'ala* describe that when someone is caught doing an illegal activity during a patrol, i.e. cutting timber or clearing the forest, the *Polisin'ala* intervene peacefully. They ask questions, take GPS coordinates, and write down details about what the person was doing and who the person is, and they will then create a report to send to the VOI board. After the report has reached the VOI board, the perpetrator is called to the VOI office and, in the case of timber cutting, their timber is confiscated. In the case of forest clearing, a special council is called to administer the appropriate punishment (fine), or the *dina*. The specific *dina* to be applied are

written in the ‘book of law,’ which prescribes the appropriate fines to be paid by the perpetrator depending on the size of the forest clearing. Some offenders are sent to higher levels of authority for punishment, particularly to the court in Antalaha, where people may be sentenced to jail time. The VOI described that transgressions occurring in the lower levels of the forest such as zone 2 or 3 result in local *dina* punishment, but that people breaking the laws in the protected area will be sent to higher authorities outside of the village.

The WWF echoed that the gravity of the offense determines the punishment, whether locally VOI-applied *dina* or if the person will be sent to higher authorities and potentially jail. The WWF official described that sometimes, forest patrols are conducted by DREDD representatives and an armed police force, whereby people caught in the core forest are arrested and forcibly removed.

Despite the structure of this process in theory, the *Polisin’ala* focus group and VOI board focus group described several difficulties with this process. For one, it is difficult for the *Polisin’ala* to actually catch people; often, they run away or are not actually present at a clearing of forest or timber operation that is found. Furthermore, even when people are sent to court in Antalaha and put in jail, it is easy for those with more money to buy their way out of jail and easily return to the village, undermining the entire system by de-legitimizing the punitive process. In the community meeting, people protested the instruction from higher levels of authority (presumably the WWF or the government) for local people to apprehend forest destroyers. They expressed that it is unreasonable to ask the community to oversee this task, and rather, this is a task for the national government or an armed force. Lastly, the *Polisin’ala* and people in the community meeting described that sometimes people from outside of this community receive ‘outside permits,’ from some entity outside of the village, to do otherwise illegal activities in the forest. The community expressed that this is a form of corruption, as only the VOI in this village should have the authority to grant permits, but that they cannot protest the permits that were granted by a higher level of authority.

5.2 Provision for Community Livelihoods

Resource Use

This section will address the first part of the research question: how effectively does the COMATSA Sud protected area management system provide for the local community? To

answer this question, it is first important to understand how the community is interacting with the landscape and with critical resources. The VOI board focus group and test interviews revealed that local people are using forest resources in a variety of ways, particularly for timber, but also for fuelwood, traditional medicine, handicraft materials, agricultural land, and less commonly for mining, hunting, and foraging. I asked 30 randomly selected community members (15 VOI members and 15 non-members) about the more common resource uses, timber, fuelwood, handicraft materials, traditional medicine, and farmland, to better understand the community's resource use in this landscape and its relationship to the forest.

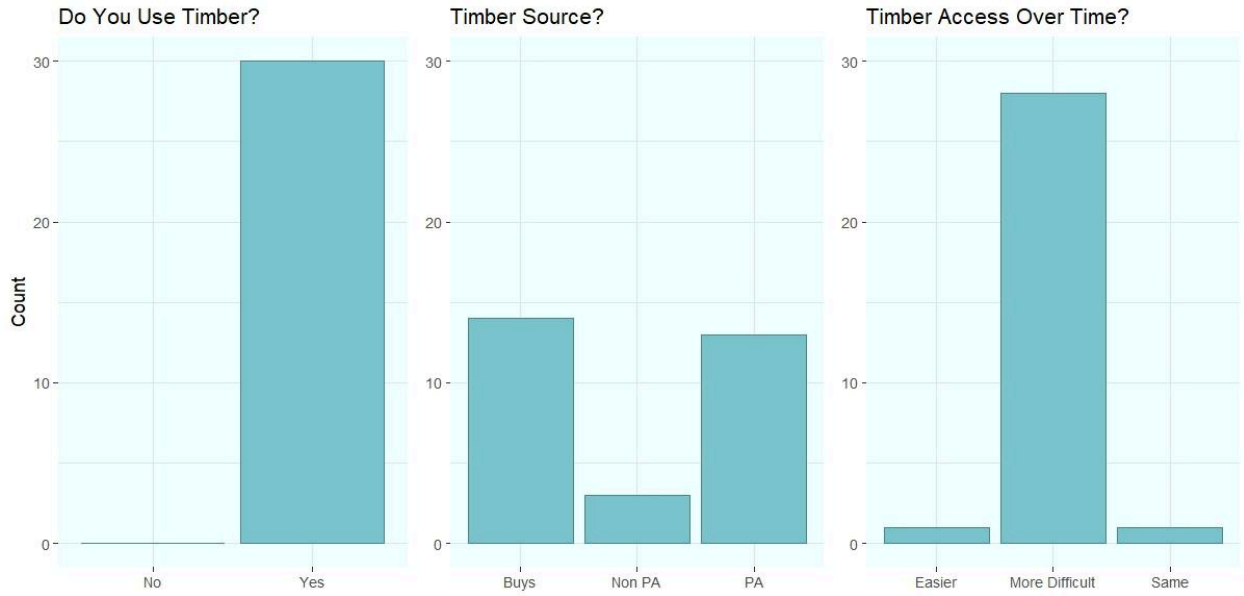
Timber

The first resource in question is timber, which includes all materials for house construction that come from trees (planks, poles, beams, etc) used for different parts of houses and requiring different types of wood. 100% of respondents use timber, revealing the importance of this resource for the lives of the community. As shown in Figure 4, respondents' direct source of timber varied, with 43% harvesting it themselves from the protected area, 10% harvesting it themselves from outside of the protected area, and 47% buying it from a timber seller.[5] Next, I asked how the ability to access timber has changed over the past 10 years, and 93% of respondents reported that it has become more difficult to access timber over time, with 57% offering unprompted that trees for timber are becoming scarce and more difficult to find, and 63% detailing that the forest is receding and trees are becoming further away (Figure 5).

[5] It is important to note that, given that timber harvesting in the protected area is technically illegal and speaking with a foreign researcher about this topic may be intimidating, there is a high probability that resource use in the protected area is underreported. Even still, these numbers provide a helpful estimate and suggest that at least this many people are directly using protected area resources, if not more.

Figure 4

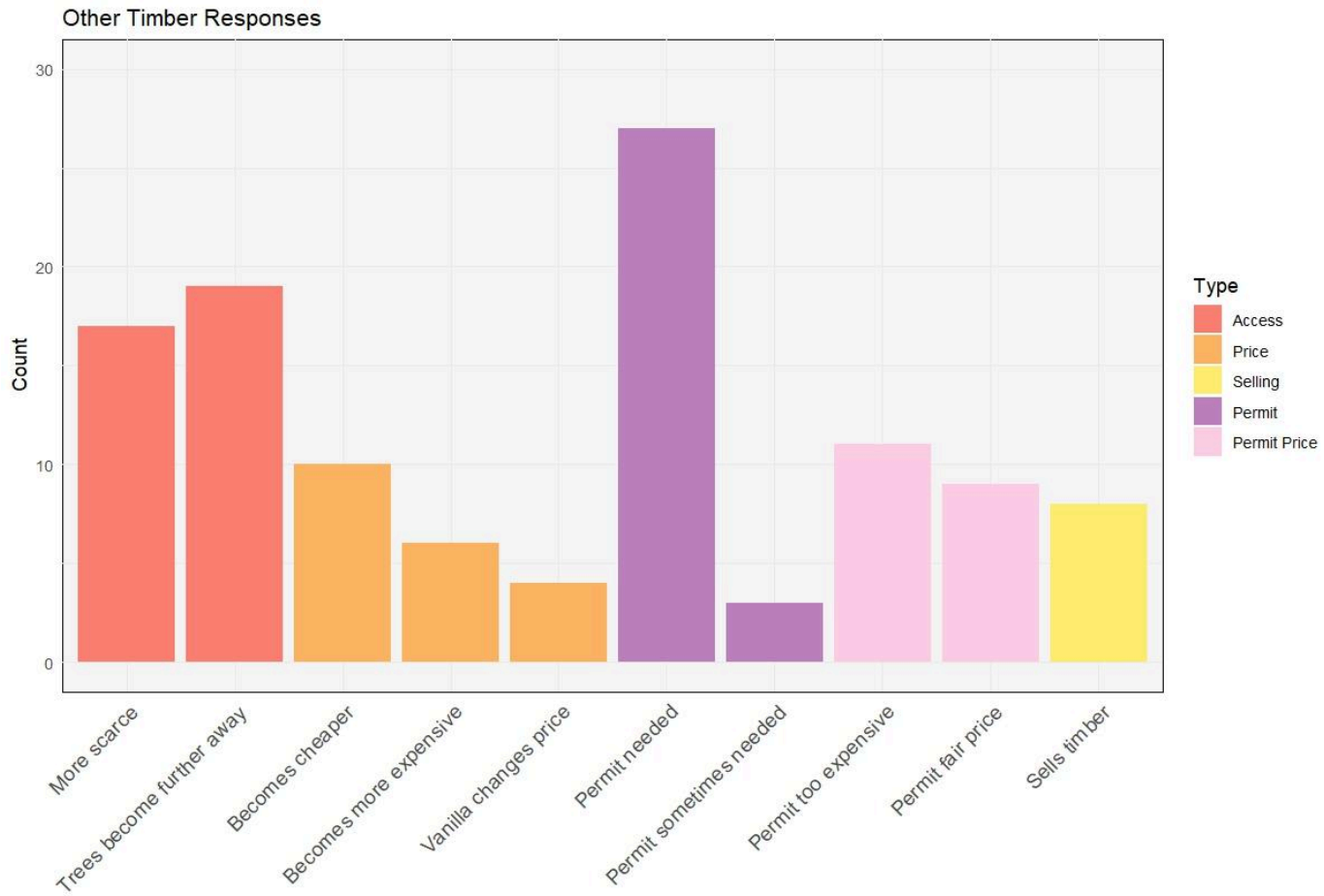
Standard Timber Results



As displayed in Figure 5, other interesting trends to note are that most people reported that a permit is required to harvest timber, but 39% of people who get a permit find the permit price too expensive (6 VOI members, 5 non-members). As one person explained, if you want to build a whole house, you need to pay the permit price for each plank of wood, and this quickly adds up. As they said, “Compared to people’s living costs, the price is not fair.” Another person echoed this statement: “In this day, the permit is too expensive, because money is rare.” When the price of timber was discussed, there was no consensus on price trends: 33% of people reported that timber has become cheaper, but 20% of people reported it has become more expensive. This confusion may be due to the rapidly changing local economy, often determined by the prices of vanilla sale, such that even if the price of timber has technically decreased from previous years, the vanilla price being very low means that people do not have much money so timber is more difficult to afford, even if it is relatively cheaper. The dynamics of vanilla crop production and sale will be further discussed in the discussion. Lastly, 8 people actually shared that they are timber sellers themselves; this is slightly shocking that anyone would share this information with me, and highly probably underreported.

Figure 5

Other Timber Results



Fuelwood

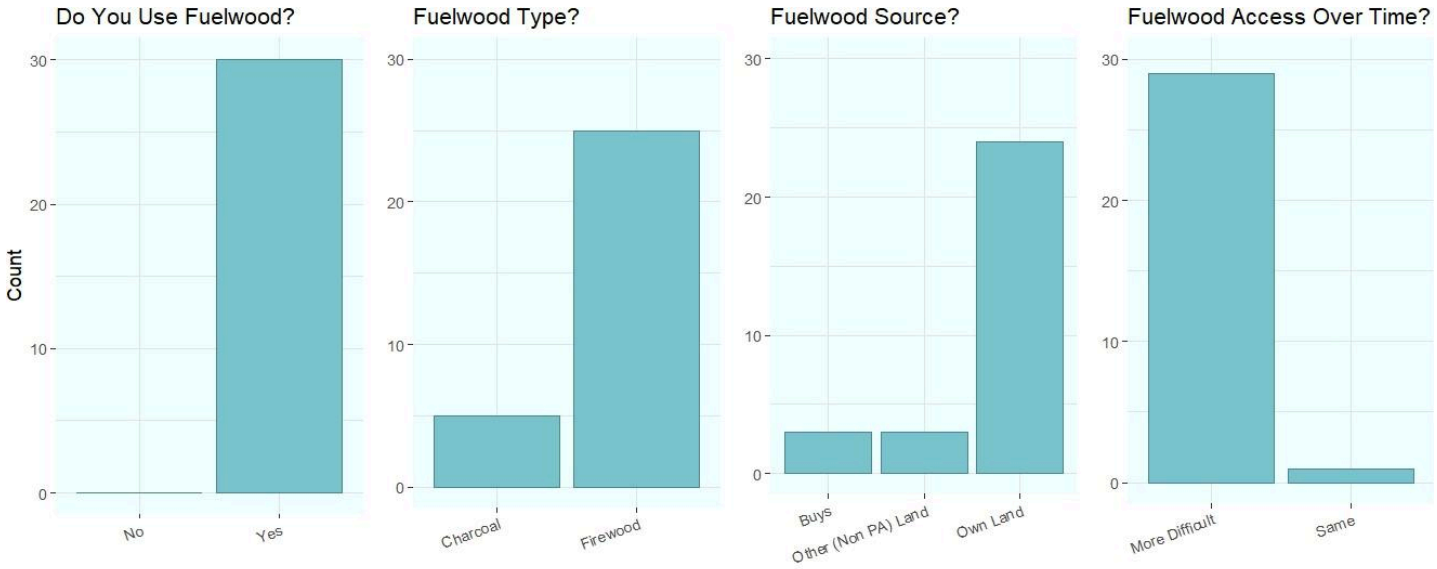
The second resource in question is fuelwood, organic materials used for making fires for cooking, heating water, and warmth. As shown in Figure 6, 100% of respondents use fuelwood, indicating the importance of this resource for daily life. Firewood is much more common, with 83% of people using firewood, while only 17 % use charcoal. People's direct source of fuelwood is most often their own parcels of land (80%), with a small percentage of people buying fuelwood (10%) or collecting it from another location (10%). No one reported taking fuelwood from the protected area; the *Polisin'ala* say that this is because it is too far to feasibly take daily fuelwood from the protected area but rather people may collect it opportunistically if they are

already there for another purpose. As for the ability to access fuelwood over the past 10 years, 97% of people said that it is becoming more difficult to access fuelwood. One community member described:

“It’s much more difficult to get firewood now. In the past, we could just take fallen trees. But now, if you don’t plant and raise trees [to eventually harvest], you cannot get firewood because the trees are becoming scarce.”

Figure 6

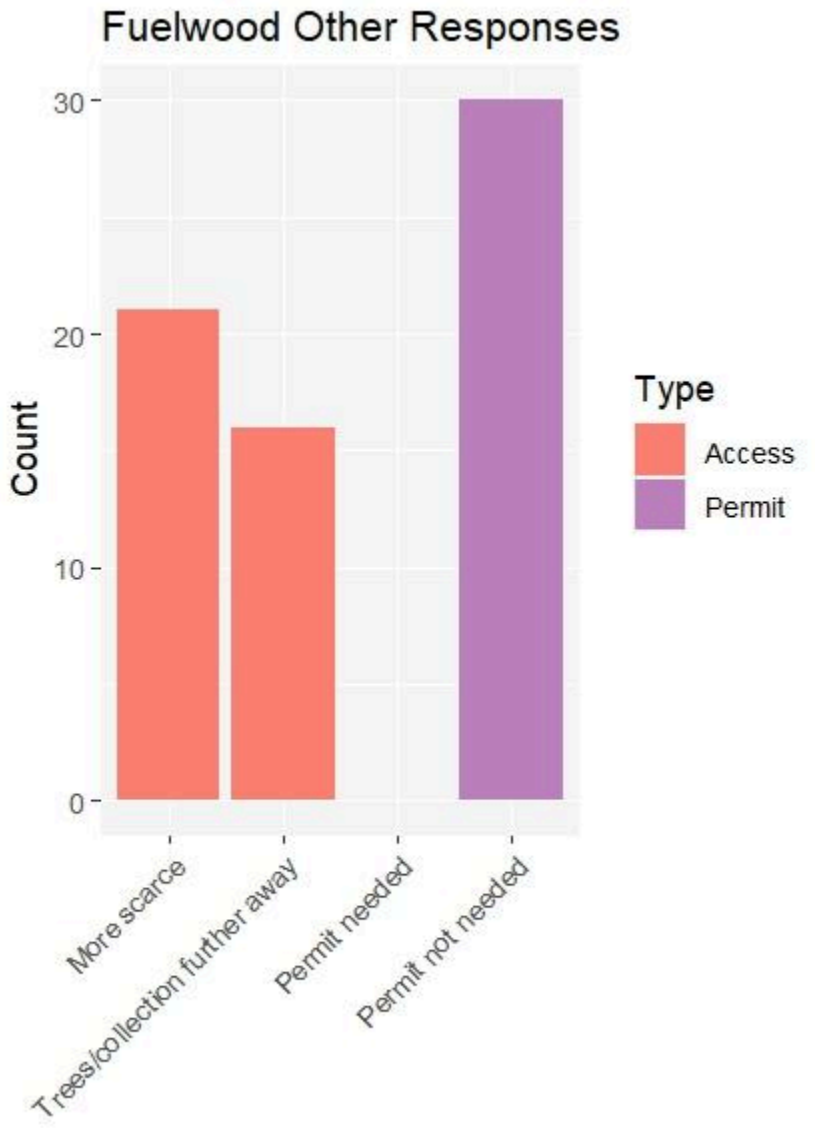
Standard Fuelwood Results



As shown in Figure 7, 70% of respondents unpromptedly added that fuelwood is becoming more scarce and difficult to find, and 56% percent echoed the earlier theme that trees are ‘becoming further away,’ that one has to go further to find fuelwood than in the past. 100% of respondents agreed that a permit is not needed for the collection of fuelwood.

Figure 7

Other Fuelwood Results

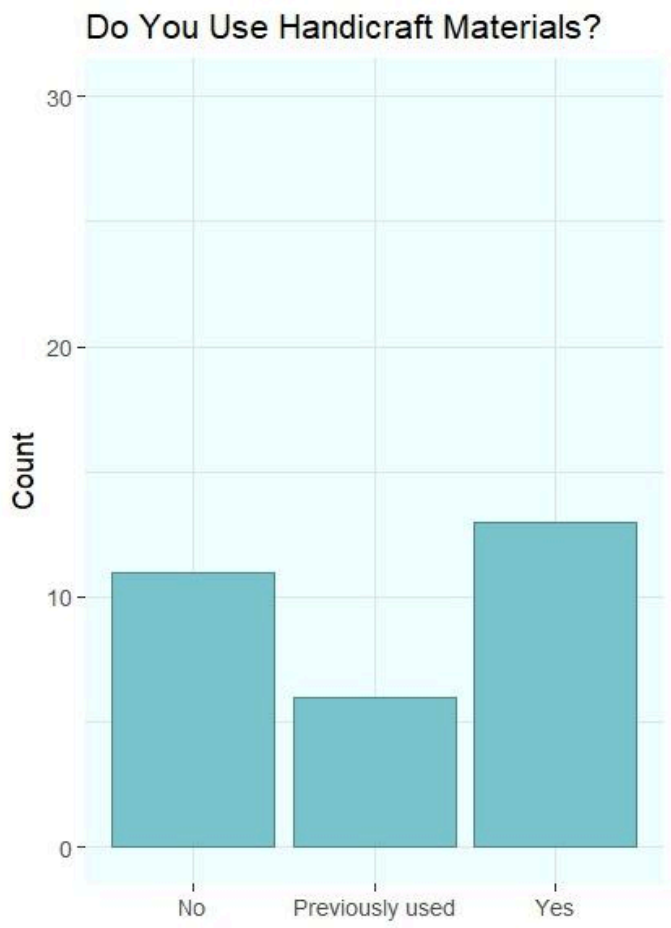


Handicraft Materials

The third resource in question is handicraft materials, organic materials used for weaving items like bags, mats, fans, etc, often made from raffia palm (genus *Raphia*) or screwpine (genus *Pandanus*). As shown in Figure 8, 43% of respondents currently use handicraft materials, 20% used handicraft materials in the past, and 37% do not use handicraft materials.

Figure 8

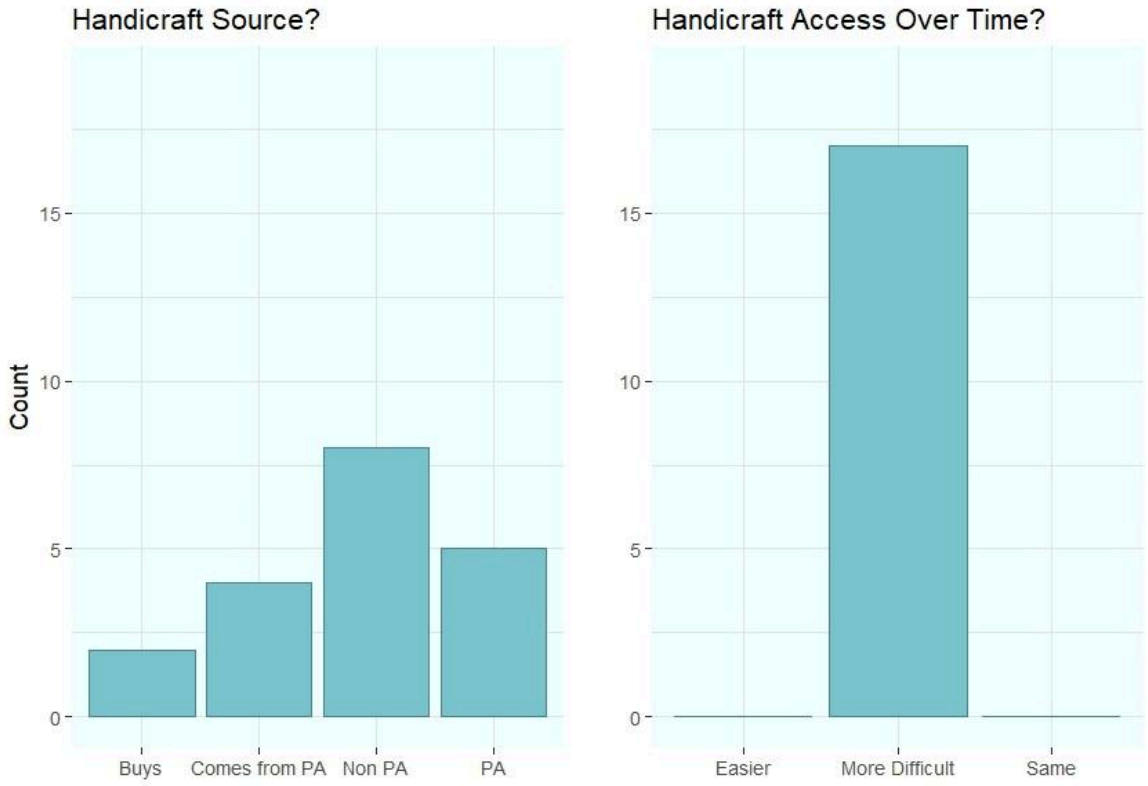
Standard Handicraft Materials Results



As shown in Figure 9, of those who do use handicraft materials, 47% of people either harvest it themselves from the protected area or someone else harvests it for them from the protected area. 42% of people harvest it themselves from outside of the protected area, and 11% buy it from someone else (location of harvesting unknown). As for the ability to access handicraft materials over the past 10 years, 89% of users said that it has become more difficult to access over time and 11% did not know.

Figure 9

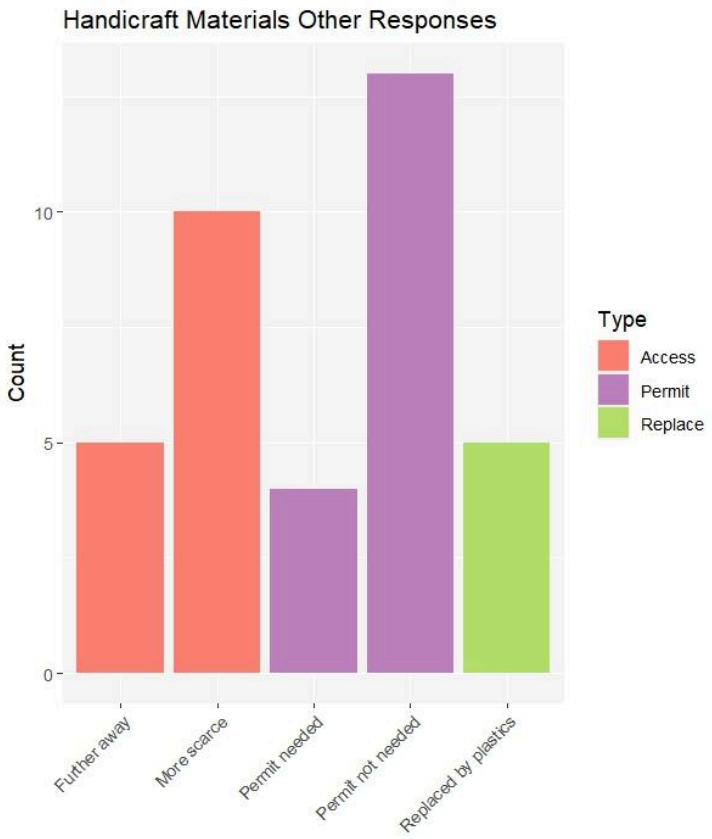
Handicraft Materials Users Results



As shown in Figure 10, 53% of handicraft users added unprompted that handicraft materials are becoming scarce and more difficult to find, and 26% added that people have to go further to find the plants than in the past. Most users (68%) said that a permit was not needed for collecting handicraft materials, but a smaller group of 21% said that it was necessary. Another interesting trend is that 26% of handicraft users reported that traditional weaving has been largely replaced by plastic materials; the mats that people used to weave from plants can now be purchased as plastic sheets from small stores.

Figure 10

Handicraft Materials Other Results



Though only about half of the respondents use handicraft materials, the source for around half of the users is the protected area. Again almost all users agree that it is becoming more difficult to access, with the plants themselves becoming more scarce and longer distances required to access them.

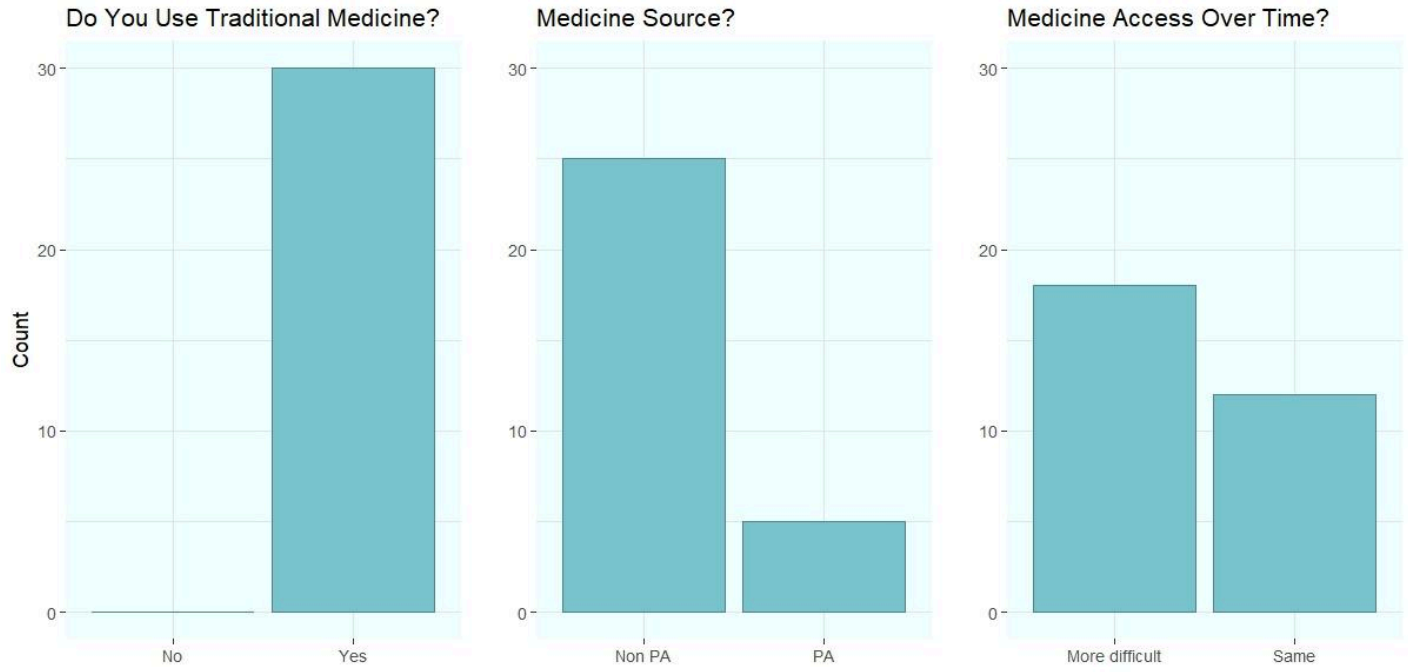
Traditional Medicine

The fourth resource in question is traditional medicine, which includes many different plants, tree bark and wood, roots, and so on, which are used to treat a variety of ailments. As shown in Figure 11, 100% of people used traditional medicine. 17% of people report that they harvest it from the protected area, and 83% of people report that they harvest it from outside of the protected area. As for the ability to access traditional medicine over the past 10 years, 60% of people say that it has become more difficult, and 40% of people say that it has stayed the same. This may be due to the proliferation of many traditional medicinal plants along rivers,

paths, and in farm fields; there are many medicinal plants that can be found outside of a forested area. However, there are several types of traditional medicine that can only be found in forested areas. One such example is the use of rosewood (*Dalbergia spp.*), a valuable and endangered hardwood tree found only in the protected area: “I bought a very small piece of rosewood, and it has lasted 7 years. If you are poisoned, rosewood is the medicine that can heal you.”

Figure 11

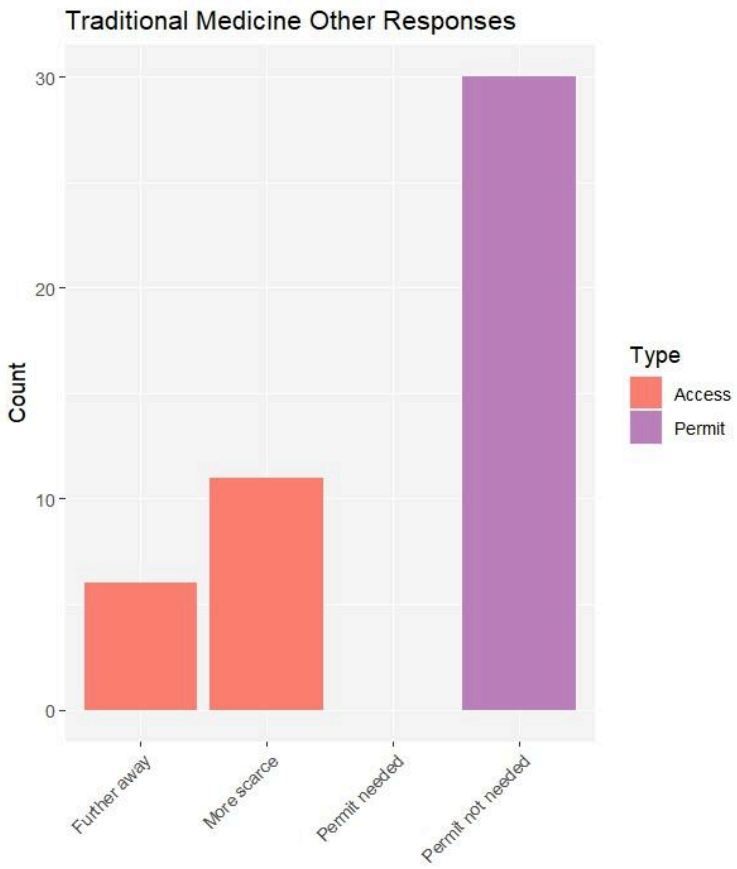
Standard Traditional Medicine Results



As shown in Figure 12, 37% of respondents added unprompted that traditional medicinal plants are becoming more scarce and difficult to find, and 20% added that you have to go further to find them now than in the past. 100% of respondents agreed that you do not need a permit to harvest traditional medicinal plants.

Figure 12

Other Traditional Medicine Results



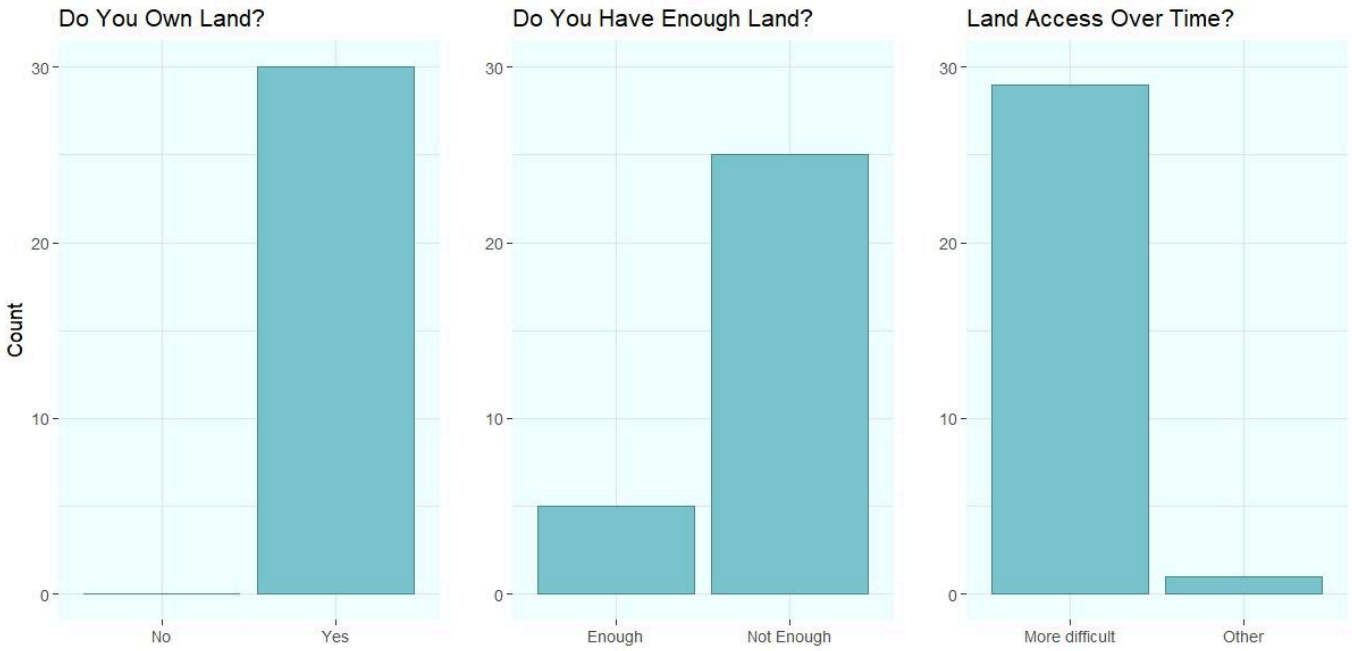
Agricultural Land

The fifth resource in question is agricultural land, which is a land use that is occurring within the protected area forest, and an important resource to understand in this community. As shown in Figure 13, 100% of respondents have agricultural land, confirming community leaders' descriptions that farming is the main livelihood for people in the village. 83% of people feel that they do not have enough agricultural land, while 17% of people feel that their land is sufficient. As for the ability to access or purchase land over the past 10 years, 97% of people reported that it has become more difficult to access and that there is less available land.

To understand land dynamics, it is important to note that land inheritance was raised by 63% of respondents, and 43% of respondents discussed trends of the village population growing or their own family growing and this putting a strain on the farming system.

Figure 13

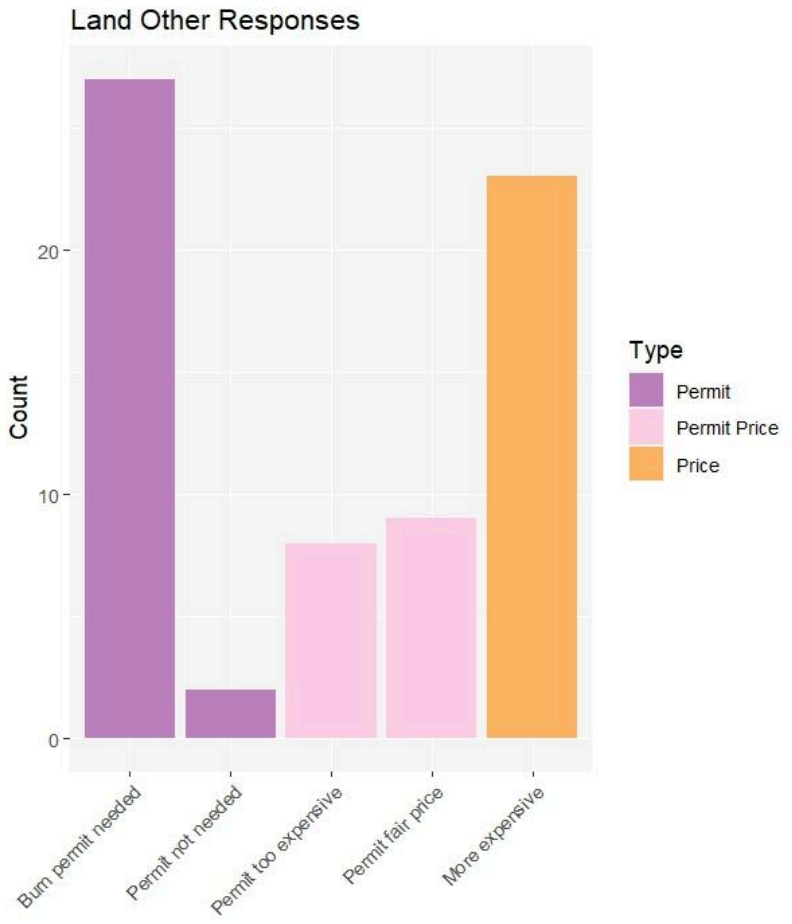
Standard Land Results



Elaborating on these land trends, Figure 14 shows that 77% of people describe that land has become more expensive over time, making it more difficult to access or purchase land. Most people (90%) described the need for a type of permit for burning land for rice cultivation, and 30% of people thought this permit was a fair price while 27% thought this permit was too expensive.

Figure 14:

Other Land Results



Relating this information to trends of resource use across the landscape, we can see that resources like timber, firewood, traditional medicine, and land are extremely important with 100% of respondents using them, and only handicrafts are partially used. Several of these resources come from the protected area, particularly timber, but also some handicrafts and traditional medicine, and land dynamics are likely very important in driving forest land cover change. We can see that all resources are becoming more difficult to access, a concerning trend that suggests increased pressure on the forest. Farmland is particularly insufficient for families already. There is little farmland available for purchase, and of the land that is available, it is becoming incredibly expensive.

Economic Benefits

As stated in the USAID definition, CBNRM aims to create the “right incentives and conditions” for people to use natural resources sustainably, and this means “enabling the

resource users to benefit (economically) from resource management." As such, it is important to evaluate if forest management is providing this economic benefit for the study village bordering the COMATSA Sud.

To evaluate whether the management system includes significant benefits to the community through supporting their livelihoods, I asked 30 randomly selected community members about the benefits they may receive from the VOI association and from outside entities such as the WWF or the government. As shown in Table 4, 90% reported no significant direct livelihood benefits from the VOI association. The other 10%, all of whom were VOI members, reported benefits, which were the ability to get a loan from the VOI association, receiving spades and plows, and receiving tree saplings to plant. As such, the majority of people report that there is not a significant component of supporting people's livelihoods from the VOI, and of those who named a benefit, only a loan constitutes a serious contribution to a livelihood.

As for benefits from outside entities such as the WWF or the government, 87% of community member respondents reported no significant benefits from outside entities. The benefits that the remaining 13% reported were only receiving some farming materials, like spades and plows, one time several years ago. As such, even these benefits are perhaps not significantly impactful for people's livelihoods as they were provided only one time several years ago.

To further understand the 'benefit' to the community from protected area management and its 'provision' for the community, I will draw a distinction between the forest itself and the system of management regarding the forest. As seen with the previously reported results, the management system itself does not involve an inherent aspect of community livelihood support. In other locations of CBNRM, this kind of economic benefit is income from trophy hunting permits, income from tourism, direct payments for ecosystem services, or the building of infrastructure. In other instances of CBNRM, there is some kind of reward or incentive to the community for successful management, or some alternative source of income to offset the lack of access to a valuable resource. In this system, however, with 90% of people reporting no such economic benefit from the VOI and 87% percent reporting no such economic benefit from outside entities, there is only a punitive process with no incentive. The economic benefit is clearly lacking.

However, separating the management system (the association and its activities, the rules and regulations about zoning and permits, and the punitive system for transgressions), from the forest itself, the community is certainly receiving benefits from the forest, but results suggest that it is in a risky and unsustainable way. As reported in the earlier resource use

section, people are using timber, handicrafts, and traditional medicine, all of which have some source in the protected area forest. For timber specifically, 100% of people use timber with 43% of people harvesting it themselves from the protected area and 47% of people buying it from a timber seller.

Timber harvesting from the protected area is an important source of income and especially a safety net for income, largely driven by economic difficulty and especially pronounced in the 'crisis' season of the year and when the vanilla price is low. The trend emerged that timber is generally a very important source of livelihood for many people in the village, with people often saying phrases like "timber is the main source of money for people here" and "most people's livelihoods depend on trees." The VOI board cited this as well, saying "Taking wood for planks is the most common activity that people do in the forest, it happens every day." Furthermore, timber is especially important in times of economic difficulty, occurring in two main ways. First, there is a yearly cycle of economic prosperity and difficulty relating to farming seasons and the vanilla selling season which leaves many people without much income or food beginning as early as January and ending around April. This season is called *silagno* or *hasara*, referred to in English as the 'crisis.' During the crisis from around January to April, 90% of community members reported that timber harvesting increases substantially, as did 100% of *Polisin'ala*. As one community member described, "Timber making really increases in January up to April, because people have no source of money so they go to the forest and make timber. People work in the *ala fady* at that time, to get food and support their livelihoods." Another person said "At that time, people fight against the famine. People are starving so they go to the forest and take and sell timber in order to get food to eat." One member of the *Polisin'ala* illustrated how difficult life is in this season, and how difficult it is to enforce the rules:

> "In February and March, not a day passes when people don't take timber from the forest. The timber workers cannot be stopped. When we try to stop them, they bring their children to our house. They say, 'You must feed this child since you despise us going to the forest.' How can we protest that?"

Second, vanilla is an important cash crop in the region, and the price that farmers can earn per kilogram may vary widely from year to year. In years when the vanilla price is low, farmers make a much lower income and many face economic difficulty. 80% of community members and 80% of *Polisin'ala* reported that during years when the vanilla price is low, timber harvesting increases substantially. During the community meeting as well, this trend was

mentioned three times, with one person summarizing: “When prices went down, people were suffering and had to turn to forest products. If vanilla was stable, it would make life easier, we wouldn't have so much need to go to the forest.” Inversely, people described that times of prosperity see decreased use of forest resources.

> “If the vanilla price is high, no one takes trees. If you go there, it will be only you in the forest. You will not hear the sound of people making timber. The forest is silent--that’s how you know the vanilla is expensive.”

This relationship between economic difficulty and timber harvest shows that the forest serves as an important economic safety net, providing much-needed income in difficult times. As such, the forest itself is providing for the community in this way. However, this becomes problematized when we consider the protected area management system.

According to the management rules and the buffer zones structure, timber can only be taken from the first three zones and not from the core protected area. However, according to the *Polisin’ala* and WWF data, the large majority of timber is coming from the fourth zone, the core protected area. The *Polisin’ala*, having the best insight into community forest use as patrollers who spend significant time in the forest and understand the zoning system, estimate on average that 72% of harvested timber is coming from the protected area (Table 5). Furthermore, the *Polisin’ala* estimate on average that 74% of timber workers do not have a permit. Similarly, of the 30 randomly selected community members, 5 out of 7 people who said that they harvest their timber themselves take it directly from the protected area. The 14 others who bought their timber are buying from a timber seller who likely harvested the timber in the protected area. The WWF official confirmed as well: “Zone 1, 2, and 3 have run out of timber, so local people go to the core. When you give them permits, they go directly to the *ala fady.*”

Table 4

Interview Benefits Results

Finding	**Respondent Type**	**Percent of Respondents**
No significant livelihood benefits from the VOI association	Community Members	90%
No significant livelihood benefits from outside	Community Members	87%

entities (WWF, government, or other)		
Timber extraction increases during ‘crisis’ season from January to April	Community Members	90%
Timber extraction increases during ‘crisis’ season from January to April	*Polisin’ala*	100%
Timber extraction increases during low vanilla price years	Community Members	80%
Timber extraction increases during low vanilla price years	*Polisin’ala*	80%
The forest provides important ecosystem services	Community Members	93%
The forest provides important ecosystem services	*Polisin’ala,* VOI board, WWF official	100%

Table 5

Polisin’ala Timber Estimates

Average estimated percentage of timber coming from the protected area	72%
Average estimated percentage of timber taken without a permit	74%

Thus, the majority of timber harvest is illegal according to the management system, making this resource use risky and potentially liable to losing access. As such, the forest itself is providing for the community through timber income, but the management system would completely prohibit access to these resources if it was more strictly enforced.

Ecosystem Services

The final subject to address regarding provision for the community is ecosystem services. The interview results show that the forest is providing critical ecosystem services for the community, as reported by 93% of the randomly selected community members and by 100% of the other informants (VOI board, *Polisin’ala*, and WWF official) in Table 4 as well. The most commonly referenced were the provision of water, through rainfall and the river, maintenance of soil quality and clean air, temperature regulation, human health, and general human happiness

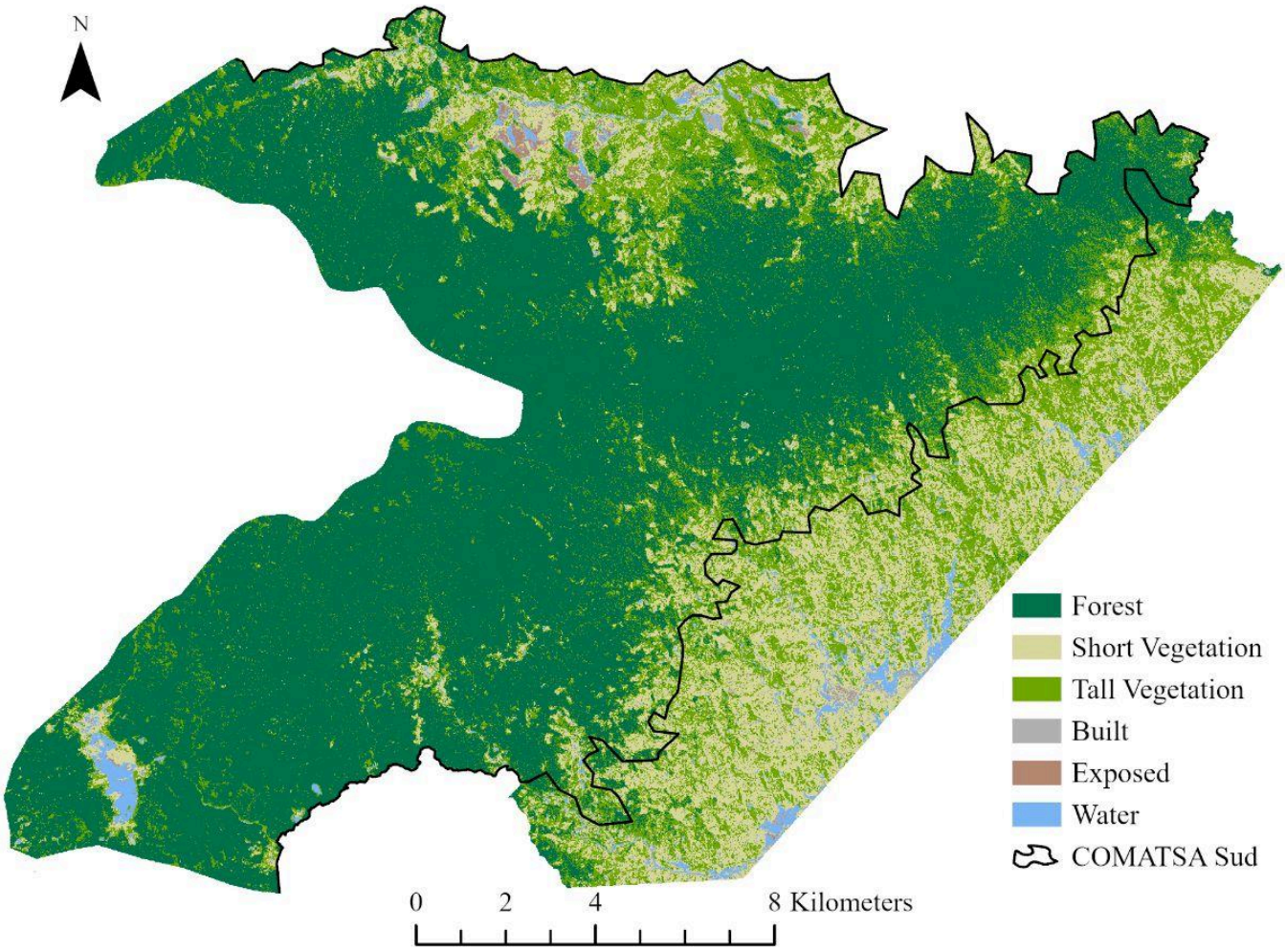
and well-being. One community member put it: “If the forest disappeared, we would suffer because the water would dry up and the weather would become hotter.” Another community member said, “If the forest is protected, we will have enough rain for rice farming.” Another community member described: “The benefit of the forest is having much rain and good health for the body. People get pure, fresh air, and clean water as well.” A *Polisin’ala* described: “Out of my love for the forest, the forest should be protected for the animals inside and to ensure human prosperity as well. Because the forest is the source of life for all living beings. Everything lives on trees and water.” However, an important distinction to make is that this benefit comes from the forest itself, but not directly from the management system in the form of an economic benefit. Though ecosystem services are extremely important, they do not fulfill this important pillar of a successful management system in a money-based economy.

5.3 Preservation of Forest Cover

This section will address the second part of the research question: how effectively does the COMATSA Sud protected area management system preserve critical forest cover? Using the random forest algorithm in Google Earth Engine (PlanetScope imagery with a resolution of 4.77 meters per pixel), I classified the landscape into six main land cover types: forest, tall vegetation, short vegetation, water, built, exposed ground, and water. Figure 15 displays the result of the classification with the boundary of the protected area overlaid. Built, exposed ground, and water land cover types are minimal in the landscape and concentrated in the southeastern corner outside of the protected area and in the northern region of the protected area. Tall vegetation and short vegetation dominate the southeastern portion of the outside of the protected area and in the northern section of the protected area. Forest cover is found almost exclusively within the protected area, particularly closer to the interior.

Figure 15

Land cover classification result



The overall accuracy of the classification was 85.78% with a Kappa Coefficient of .8031. The confusion matrix for the six land cover classes is shown in Table 6 with the producer's and user's accuracies for each class. Forest land cover has the highest accuracy with around 97% Producer's and 95% User's accuracies. This class is the most critical to understanding the landscape and as such its high accuracy indicates a robust display of forest cover. The model was less effective in differentiating between tall and short vegetation, as vegetation regrowth is continuous and thus designation as 'short' versus 'tall' is more difficult for plots that are closer to the 2-meter division. Regrowing plots may have a mix of vegetation, including some short agriculture as well as secondary succession trees or crop trees, making it difficult to assign to one class or the other. However, despite this, User's accuracy for short vegetation was still about 81% and about 76% for tall vegetation. The overall user's accuracy for vegetation classes was about 90%. There was considerable confusion between built and exposed land cover,

which may be due to the relatively small amount of built material (largely tin house roofs) interspersed with bare walking paths which may have a similar spectral signature. However, the most relevant part of the model is to understand vegetation dynamics, thus it is most important to see that the three non-vegetation classes (built, exposed, and water) were rarely confused with the vegetation classes.

Table 6

Confusion Matrix with producer's and user's accuracies

	Forest	**Short Vegetation**	**Tall Vegetation**	**Built**	**Exposed**	**Water**	**Total**
Forest	688	0	23	0	0	0	711
Short Vegetation	0	199	27	4	6	6	242
Tall Vegetation	36	19	171	0	0	0	226
Built	1	11	0	51	35	5	103
Exposed	0	9	0	14	91	1	115
Water	0	8	3	10	3	134	158
Total	725	246	224	79	135	146	1,555

Table 7

Accuracy assessments for the remote sensing land cover classification

Class	**Producer's Accuracy**	**User's Accuracy**
Forest	96.77 %	94.90 %
Short Vegetation	82.23 %	80.89 %
Tall Vegetation	75.66 %	76.34 %
Built	49.51 %	64.56 %
Exposed	79.13 %	67.41 %
Water	84.8 %	91.78 %
		Overall Accuracy: 85.78 %

Situating this map in the context of the zoning model discussed by the WWF official, VOI board focus group and *Polisin'ala* focus group, the black line labeled 'COMATSA Sud' represents the beginning of the fourth zone of strict protection and complete prohibition of resource use. In theory, within this boundary should be entirely forest cover as it is the protected area and specifically the strictly protected zone. However, there is a significant amount of short vegetation and tall vegetation within the protected area, especially towards the edges. This analysis will focus on the southeast border of the protected area as this was the location of field data collection, but the same trends in land cover can also be observed in the northern section of the protected area as well.

I suggest that forest should constitute 90% of the land cover within the protected area with allowance for forest gaps, rivers, rock formations, and other natural features within forests that may result in a non-forest cover in a classification. However, within a 1-kilometer buffer towards the interior of the protected area, forest constitutes only 35% of the land cover as described in Table 8. Instead, short vegetation constitutes 23% of the 1 km buffer into the protected area and tall vegetation constitutes 40%, dominating the edge of the protected area and indicating that the forest has receded.

Table 8

Land Cover within a 1 Kilometer Buffer Towards the Interior of the Protected Area

Class	Area (square meters)	Percentage
Forest	8,941,675	35.03%
Short Vegetation	5,908,051	23.14%
Tall Vegetation	1,0285,332	40.29%
Built	70,751	0.28%
Exposed	46,459	0.18%
Water	274,138	1.07%

The protected area management system thus clearly is not effectively preserving forest cover, as a significant portion of the protected area is no longer forested and there is scant forest cover outside of the protected area, in the exterior zones that should be forested in theory.

Multiple sources indicate that there has been a general trend of deforestation over time, resulting in a gradual decrease in forest cover in the area. At the beginning of our research season, we conducted an open community meeting to understand some key community history and establish a framework for our research. At this meeting with about 50 members of the community present, there was a clear narrative about forest cover decreasing over time in this region. People reflected on the founding of the village around 1922; in this era, all of the mountains surrounding the village were covered with forests that were full of valuable, hardwood trees which are now rare. Making a testament to the size of trees at this time, one person described that “big houses could be finished with a single tree.” Until the early 1990s, the prevailing community narrative depicted the forest as significantly larger and more expansive: “There was still forest all around us, there were wild pigs right around us here. We didn’t have to go far for forest resources.” However, “by around 2000, the forest was already disappearing,” and people increasingly turned to forest products as a source of income. Furthermore, the community attributed the reduction in rainfall and depletion of rivers to forest cover decline: “When the forest was still extensive, we had plenty of water. Now, streams are running dry because the forest is being destroyed.”

All five of the *Polisin’ala* members echoed this trend of decreasing forest cover over time: “We clearly see that the forest is disappearing, because of forest clearing and people farming on the hills.” One *Polisin’ala* described how certain parts of the river used to require a boat to cross but can now be crossed on foot to illustrate how rivers have shrunk as a result of forest destruction. Another *Polisin’ala* described that shorter vegetation has encroached into the protected area, another said that forest clearing has become extremely pronounced due to high vanilla prices incentivizing people to clear land for vanilla cultivation, and another described how the forest is “becoming further away,” compared to the past. The last *Polisin’ala* described how, when he was a child, the forest began much further downstream than now, not far from the village. Many community members echoed these themes in their interviews as well, shown by the 93% of people who reported that timber is becoming more difficult to find, and the 63% who offered unprompted that the forest is receding, the ‘trees are getting further away.’ Timber workers particularly describe how much further they now must go to harvest timber than they used to:

> “I remember when I needed timber to build my kitchen, the forest was very near. I went to the forest in the morning and I returned in time to eat lunch at my house. But now, if people go to the forest, they leave home even earlier in the morning and they do not come home until 5 or 6 pm.”

Lastly, the WWF official really emphasized the trend of deforestation, saying that it is a major problem in the region and the rate of deforestation is even increasing.

In summary, this land cover classification with over 94% accuracy for forest cover shows that there is scant forest remaining outside of the protected area and that the large majority of the 1-kilometer southeastern edge of the protected area has been deforested already (65% (16.58 km^2) is already deforested). Though this specific analysis only classifies the current landscape as of 2023, the interview data clearly reports that areas were once forested and have been undergoing deforestation. As such, the COMATSA Sud does not effectively preserve forest cover, and the implications of the spatial distribution of land cover types will be further explained in the next section.

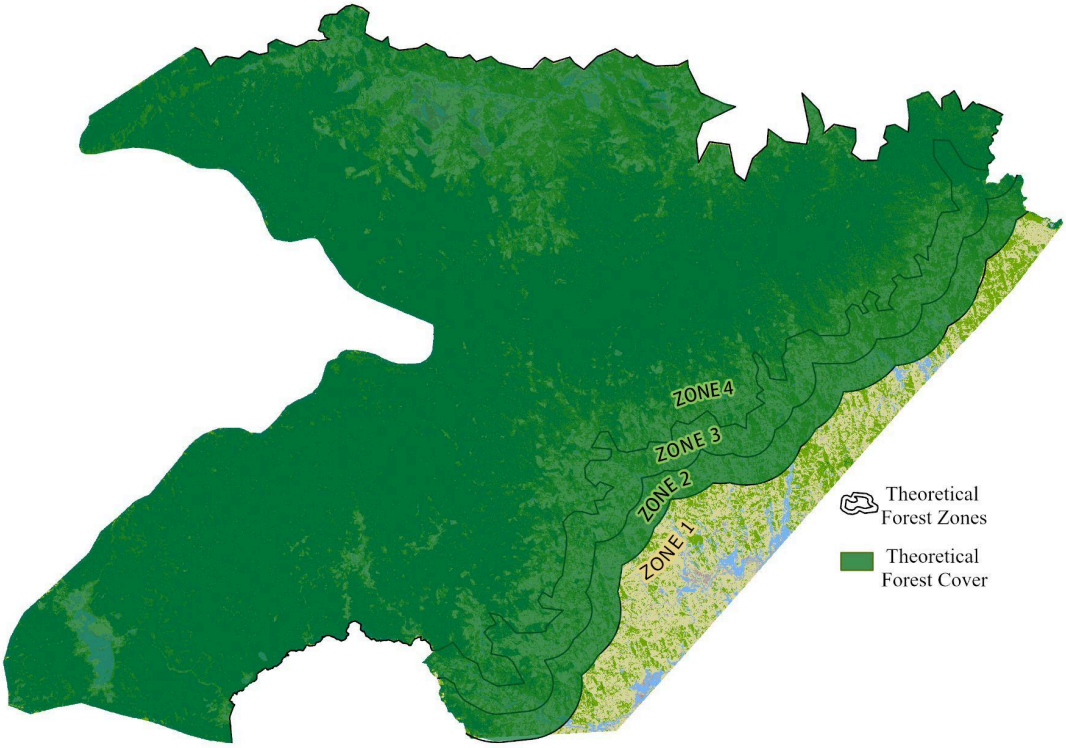
5.4 Incongruence Between Management Model and Local Reality

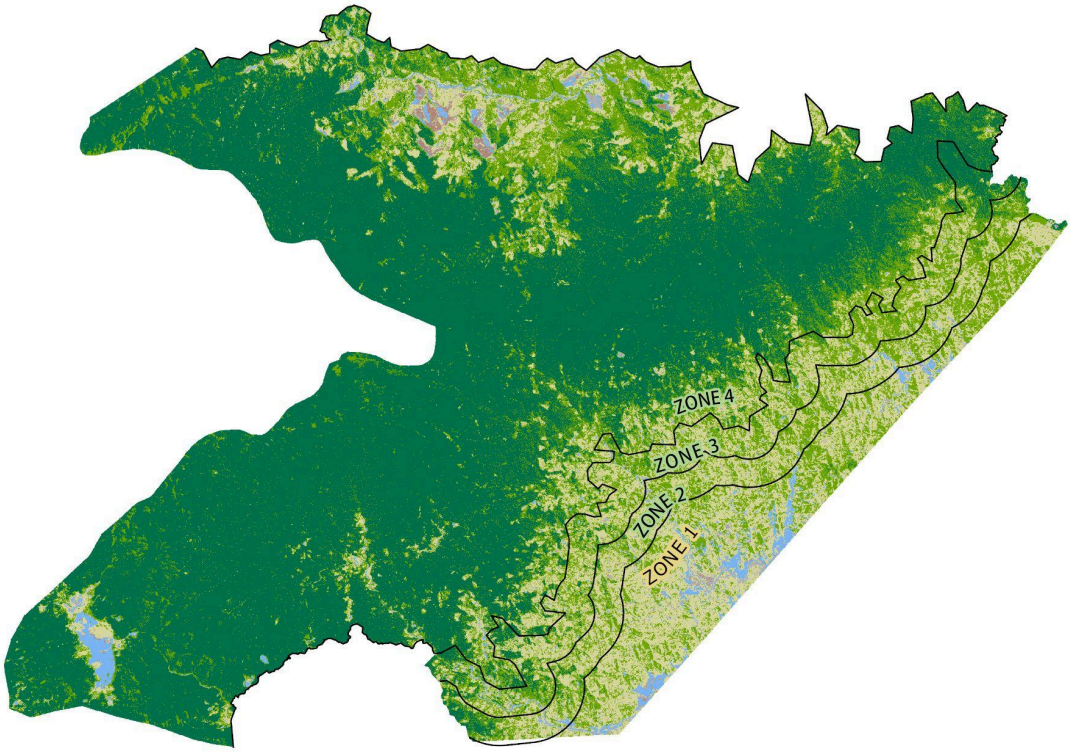
Having addressed the two-part research question and finding that the protected area management system does not effectively provide for the community or preserve forest cover, this section will address a major discrepancy between the management model and the reality of land cover distribution that may be a driving factor in the system's failure.

First, it is important to consider the conceptual model for the forest zones, as drawn and detailed by the WWF official, VOI board focus group, and *Polisin'ala* focus group. This model consists of four zones, with increasingly strict laws about resource use and particularly timber, culminating in the untouchable *ala fady* (the Malagasy phrase for 'forbidden forest,' referred to in this paper as the 'protected area'). This system rests upon the existence of two forested zones, zones 2 and 3, in which community members may legally take timber and other resources with a permit. Figure 16 shows a theoretical map of land cover according to this model, with forested buffer zones outside of the protected area. However, as revealed by the remote sensing analysis, there is scant forest remaining outside of the fourth zone; it is largely agricultural and fallow land.

Figure 16

Theoretical forest cover versus true forest cover


ZONE 4
ZONE 3
ZONE 2
ZONE 1
Theoretical Forest Zones
Theoretical Forest Cover



These buffers as shown in the map, however, are entirely speculative as there is no evidence on the ground to show for them, and local people had no idea where these zones actually fall on the landscape. During the *Polisin'ala* focus group, when asked about the zoning structure of the forest, the group drew the same tiered model as the WWF official. However, when asked about the implementation of this model, they said:

> "This structure is not respected. This drawing does not exist. This is the truth. Even the *ala fady* sign itself is in the middle of a vanilla farm. When we go further inside the *ala fady*, we find farm fields and houses. It means that to describe the forest as this drawing would be to hide the real situation. It would be a lie."

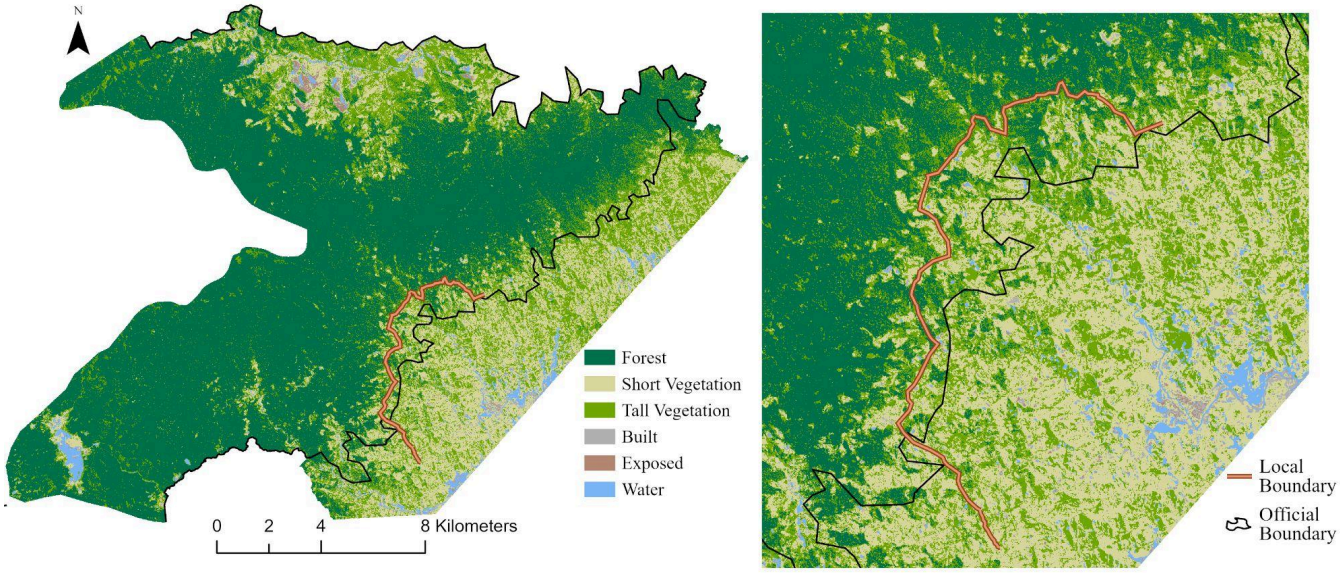
As such, zones 2 and 3, the critical zones that should be forested and a place for legal forest resource use, are no longer forested and have no true existence on the ground. This is supported by the WWF official as well, who explained that “there are no zones left where there is good forest. People are only given permits to cut in zone 2 or zone 3, but there are no trees left in these zones.” Instead, these zones are full of agricultural land that has been claimed by people and is critical to their livelihoods.

It has been proven that the buffer zones are largely theoretical concepts, with no tangible existence through spatial boundaries or through forest cover. I found that even the fourth zone, which should have the most strict protection with a total prohibition of resource use, is largely a conceptual idea as well without substantive spatial delineation.

The remote sensing analysis already showed that the edge of the protected area (the fourth zone) is largely cleared, indicating that the official boundary is not being enforced. However, there might have been substantial difference between the online shapefile and the local understanding of the location of the boundary. To investigate this possibility, I traversed and georeferenced the entire length of the protected area boundary in the jurisdiction of the study village, led by a local guide and *Polisin’ala*. Figure 17 shows the path of the protected area boundary according to local guidance versus the official protected area shapefile. Overall, the locally defined boundary follows a similar pattern as the official one, but it aligns more closely with forest cover on the landscape (though deviating considerably from this trend in the southern portion of the boundary). This difference further indicates a discrepancy between the official model and the local system. Regardless of the specific boundary of the fourth zone, however, the lack of available forest outside of the strict protected area poses the largest problem in the incongruence between model and reality.

Figure 17

Local protected area boundary versus official protected area boundary



Furthermore, while undertaking this journey over the course of three days, I looked for indications of the commencement of the protected area. Over the entire boundary, I only saw one sign that read '*Ala Fady*.' The guide indicated that there had been at least two other signs previously, but that they had been destroyed or moved by members of the community. There were no other indications of changing boundaries, including no tree markings, physical boundaries, fire-break-like clearings, or other. Most often, we were walking between farmlands, with one of them technically crossing the line into the 'protected area.'

The interview data supports the conclusion that even the protected area boundary is largely a conceptual idea rather than a tangible or distinct boundary over which resource use regulations change. As one *Polisin'ala* summarized: "That's why people go inside the *ala fady* and build houses and create farmland; they don't know where the boundary of the *ala fady* begins." Another *Polisin'ala* said: "The ala fady is not really defined. People who have cleared forest in the *ala fady* seem to be disobedient, but it's really just because there is no clear boundary." The VOI board focus group noted as well that people from the community do not know the boundary of the protected area and that the current signs are insufficient to delineate it. Local forest managers generally emphasized that their greatest desire for improving management is to have a distinct boundary to mark the protected area so that it is made known to the community.

This lack of spatial delineation and lack of real buffer zones means that the timber permit system is deeply flawed. Because the outside zones lack forest and these are the only legal

zones for timber extraction, people take timber from the protected area. As reported in section 5.2, the *Polisin'ala* estimated that 74% of people do not have a permit. However, even for the 26% who do have a permit, that permit should technically be for taking timber in zone 2 or zone 3, not in the protected area. As such, it is impossible to give people legal permits, making the system broken from the start. One *Polisin'ala* described: "It is impossible to get a permit for the *ala fady*. When people get a permit, they indicate a place outside of the *ala fady*, but when they arrive they sneak into the *ala fady* and take timber."

Given this massive incongruence between the theoretical management model and the reality on the ground, the local forest management association is tasked with enforcing rules based on a landscape that does not exist. This 'paper park,' or rather 'paper CBNRM,' then leaves managers and the local community in a precarious situation, with community members depending on illegal forest use for livelihood sustenance and local forest managers charged with prohibiting this critical source of income. Furthermore, with the Malagasy word for the protected area being *ala fady,* meaning 'forbidden forest,' land that has undergone land cover change may no longer resonate with the local community as continually being the '*ala fady*.' Once the land has been converted to scrubby grass or 6-inch tall bean cultivation, it would be detached and impractical to refer to this land as the 'forbidden forest' with local people. It is possible that once the land has been converted from forest to farmland, it is perceived as no longer belonging to the special protected land class of 'protected area.' This is in opposition to creating a line on the ground beyond which the land itself is protected, regardless of what land type covers it.

The question then arises, what to do about the zoning system and the already converted land? Should people be removed from their land? Should the boundary be moved, or a more drastic reformation of the system be enacted? Currently, there is no success for the management system. It is not being implemented in the way it was designed to. However, to enforce it and actually implement timber regulations would be to deprive people of much-needed income in a poverty-stricken area, and to actually implement land-use rules in the buffer zones 2 and 3 and the edge of the protected area by removing people from their farmland would have catastrophic consequences for people's livelihoods and survival.

5.5 Reforming the Management System

The final question of the research is to investigate the possibility of a reformed system, aimed at more thoroughly fulfilling the key pillars of CBNRM by jointly addressing community livelihood needs and ecosystem preservation. To address this question, I gave the 30 randomly selected community members a hypothetical situation, in which they receive some form of livelihood benefit in exchange for more thoroughly managing the forest. In this hypothetical scenario, the community still has some access to forest resources, but it is much more regulated and people must actually abide by the regulations as set by the VOI. I asked the community members if they would be amenable to this agreement, and 93% said yes. 100% of *Polisin'ala* said that it would be a good idea and a good forest management strategy (Table 9). I asked community members which type of livelihood benefit would be most important to receive from the VOI association in the village from the following four options: community infrastructure (roads, bridges), community education (school buildings, materials, fees), direct payments, or livelihood trainings (animal husbandry, gardening, improved rice and vanilla farming, etc). As shown in Table 10 and Figure 18, the most common choice for preferred benefit from the VOI was 53% for livelihood trainings, with 26% for education following, 7% for infrastructure, 7% for direct payments, and 7% for another benefit. I then asked which kind of benefit community members would like to receive from an outside entity or organization such as the WWF or the government. In this case, 33% of community members would prefer infrastructure, while 27% would prefer education, 20% would prefer direct payments, and 20% would prefer livelihood trainings. Figure 18 displays these preferences and differences between the benefits that community members would like to see from the VOI versus from outside entities. Figure 19 displays these results cumulatively across both questions (as though each respondent may vote twice, given the same options).

Table 9

General community openness to a reformed management scheme

Finding	**Respondent**	**Percent**
Would agree to following and enforcing a more robust forest management scheme with a complementary livelihood benefit	Community Members	93 %

Would agree to following and enforcing a more robust forest management scheme with a complementary livelihood benefit	*Polisin'ala*	100%

Table 10

Livelihood benefit preferences in the hypothetical scheme

Community Members' preferred benefit coming from the VOI
Infrastructure……7%
Education……..26%
Direct Payments……..7%
Livelihood Trainings……53%
Other……..7%

Community Members' preferred benefit coming from an outside entity (WWF, government, etc)
Infrastructure……33%
Education…….27%
Direct Payments……..20%
Livelihood Trainings……20%
Other……..0%

Cumulative preferred benefit from VOI and outside entity (WWF, government, etc)
Infrastructure……20%
Education……..27%
Direct Payments……..13%
Livelihood Trainings……37%
Other……..3%

Figure 18

Preferred Benefits from the VOI Forest Association and Outside Entities

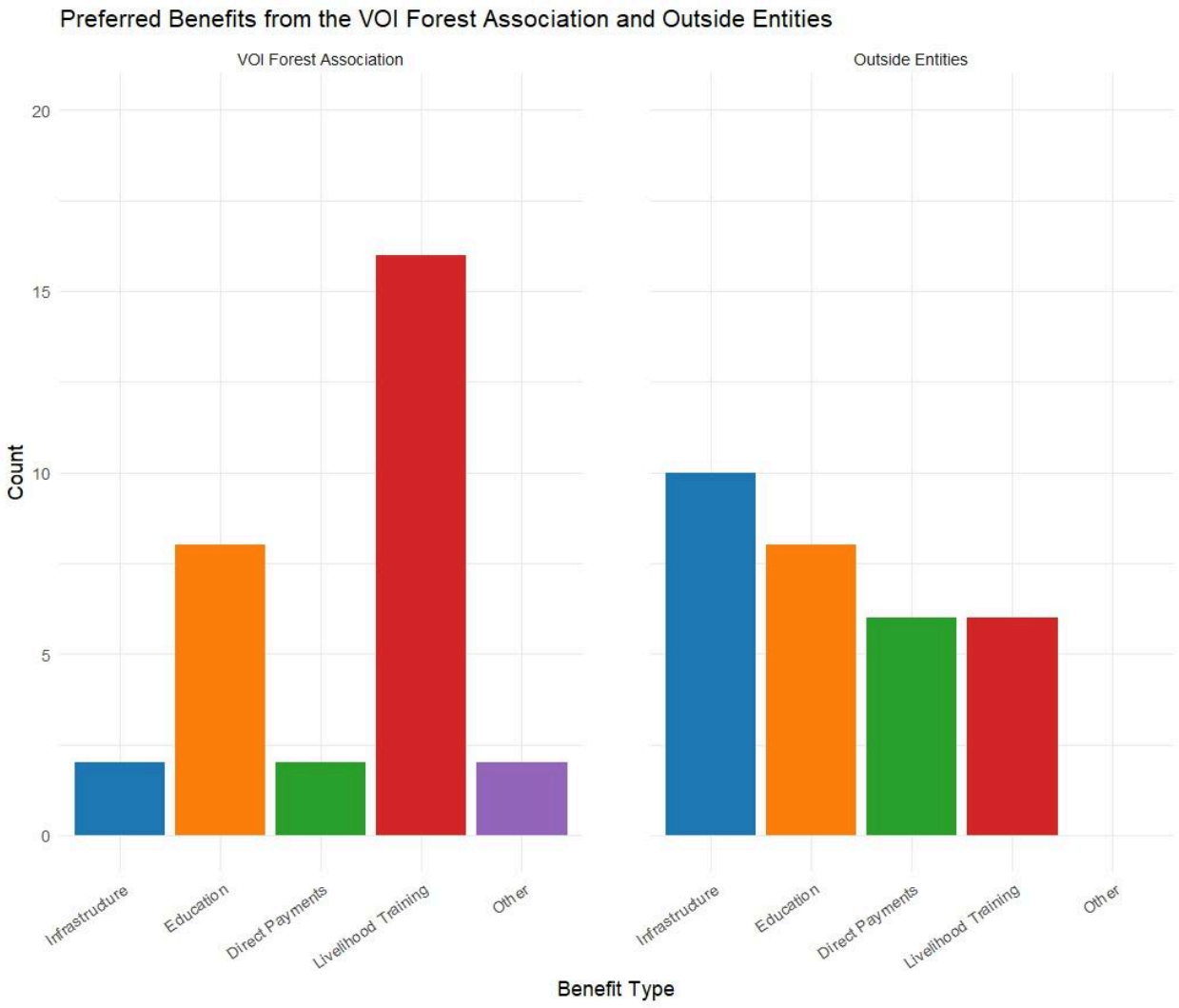
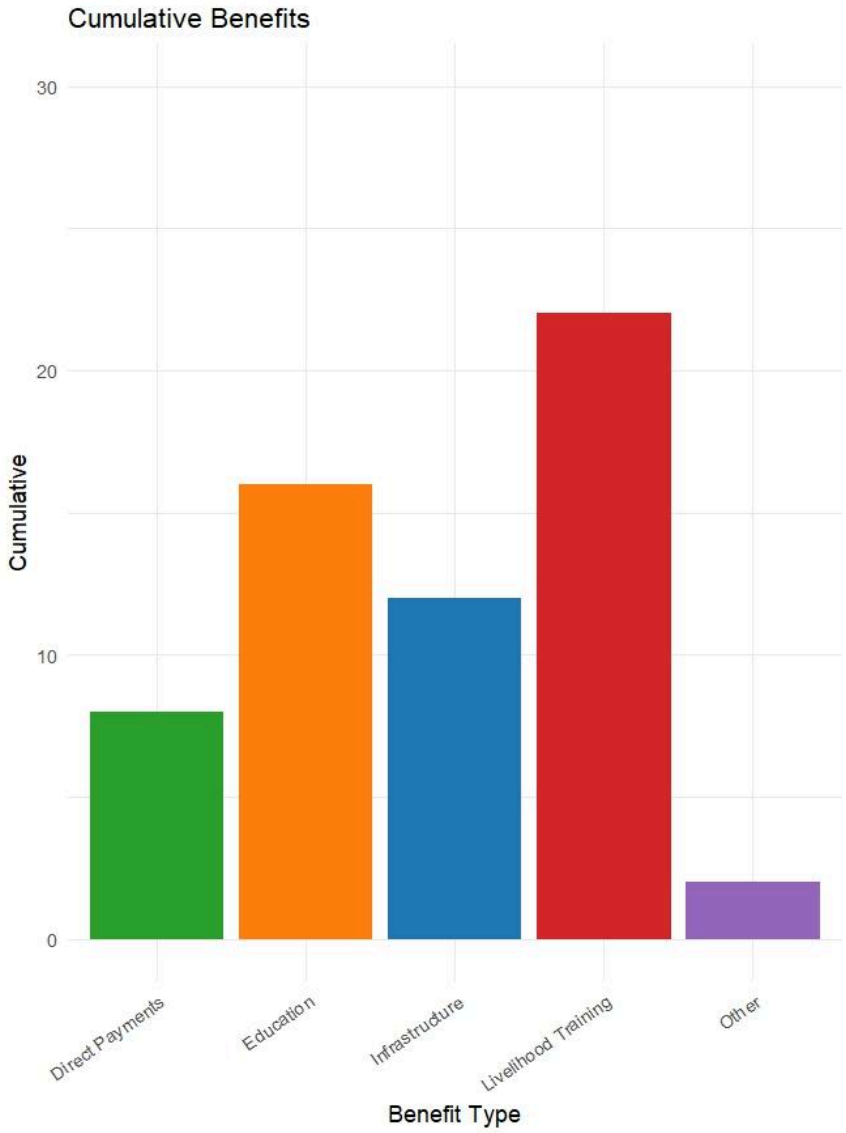


Figure 19

Cumulative Preferred Benefits from VOI Association and Outside Entities



The cumulatively most popular choice was livelihood trainings. A few reasons are as follows:

> “If we are trained about animal husbandry, I am confident that we will be able to provide for ourselves. If I choose direct payments, the money will run out. But if you know how to farm animals, you know how to consistently make money for your livelihood.”

> “I really want to receive training about rice cultivation because that’s what our livelihoods depend on. If we receive training about vanilla, but then the vanilla price is low, vanilla is not edible. So if I receive training about rice cultivation, I will have food and money thanks to the rice.”

> “I choose trainings about farming poultry and fish. Because money is rare, and when I do not have money, I will have meat to sell and to eat.”

> “Last year, there was a training about compost, and it was really beneficial. I planted vegetables and they grew well and very fast thanks to the compost. This is why there should be trainings about farming.”

The second most cumulatively popular choice was education. A few explanations are as follows:

> “Because, *fianarana no lova tsara indrindra* [Malagasy proverb: education is the best heritage]. Many things can be learned at school. I won’t be learning, but I only think about my children, and I want my children to be successful in school so that they can have successful livelihoods one day.”

> “People in the countryside have to pay the school fees almost every time [a responsibility that should be covered by the government]. I would like it if the schools are well-supported, so we don’t have to spend money on that.”

> “I would choose school funding, because we struggle to send kids to school here. There is no good school. We pay expensive school fees, we pay 2 *daba* of rice per kid. If they paid the salary of the teacher, we could save our money.”

> “I have empathy for the teachers because they are treated badly. When it’s time to pay school fees, there is a conflict between parents and schoolteachers…teachers worry that they may not receive money and rice. Teachers don’t have another job, but they don’t receive the payment they should.”

The third most cumulatively popular choice was infrastructure. A few reasons are as follows:

> “The bridge construction is way too big a project for local people to achieve. We struggle to cross the river during the rainy season, when the river water level rises. This means we cannot transport goods, and children can’t cross the river to reach the school. ”

> “A hospital in this village is needed. When someone is sick, we have to bring them to another village for the hospital. Even if the person could be cured, sometimes they die on the way to the hospital because it’s so far.”

> “It is the duty of the government to bring development to local people, to build roads and bridges.”

The fourth choice, slightly less popular than infrastructure, was direct payments. As one person explained:

> “These organizations should give money to each household. Because of poverty, because of our struggles. Everyone can decide what they want to do with their money once they get it, whether buying food, raising livestock, or something else.”

When asked why they would agree with this reformed management scheme, people gave varying answers. One person said:

> “I agree not to go to the *ala fady* if I receive livelihood trainings, because my livelihood won’t be dependent on the forest. And I think trainings are really more efficient than taking timber in the forest…I could make more money from this than from making timber.”

Another person, a timber worker themselves, said “Yes, I would agree, if I were trained. Because I would have work in the village through farming and animal husbandry, and the work can support my livelihood.” Another said, “For me, that is a good idea. Because if things are left to anarchy, it is not good. The forest will last a long time if there are rules to govern it.” In general, community members described that with another source of income and livelihood support, they would be amenable to a more regulated system of forest management.

Though it may seem surprising that even timber workers expressed agreement to leave this source of income, several people explained that harvesting timber is extremely difficult and not a desirable way of making money.

> “I agree [with the reform proposition]. If there is something to replace the forest and I can support my livelihood that way, I will not go to the forest because it’s very far, and we don’t know if we will live or die when we go to the forest.”

> “People are stressed thinking about their livelihoods, people are tired of working in the forest. Even though you work hard, your work doesn’t produce enough to satisfy you.”

> “It is because of lacking money that people go to the forest. I hope that no one is happy to be bitten by leeches. It’s because they have no money, they have to find another way to support their livelihood.”

> “Timber workers will agree. It is hard to traverse the mountains often. Truly hard. If they have another form of work, it is not hard to stop them from going to the forest. Because why would we put our bodies through that difficulty to go there? Why would they put their body through such difficulty to go to the forest if there’s something better here to support their livelihood?”

The theme that timber working is arduous and undesirable further supports the conclusion that forest resource use is driven by economic need and that with alternative sources of income, people would agree to abide by forest regulations.

This investigation into a potential way to reform the management system suggests that positive change is quite possible and even appealing to the large majority of the community. This finding supports re-thinking this system of management in a way that incorporates community support as a key component.

As put by one community member:

> “They really should do this [livelihood trainings]. If you block water in one place but you don’t dig a different canal, the water will break the blockage. Like that, if you block the

road for people, you should create another road for them to use. If you block access to the forest, you should create another source of income."

6. Discussion

Drivers of Land Change Theory

This thesis has focused on an analysis of the management system for this particular protected area, including land cover change and suggestions about the drivers of forest use. Based on my results, as well as informal conversations, observations, and insights over 5 months spent living in this community, I hypothesize that the following dynamics are together driving overall land cover change and especially deforestation: the vanilla economy, the timber economy, geophysical characteristics, agricultural systems, and population density.

Vanilla is an important part of the system, as its price seems to have a large impact on the local economy. As reported by interviewees during my interviews, the vanilla price can range from a reported 200,000 ariary per kilogram (at an unspecified time in the past) to the current reported price of around 5,0000 ariary per kilogram. Residents of the village complained that the price of vanilla was so cheap this year that they might as well have grown potatoes instead, and it would have been a similar income per kilogram. Though not every household in the village farmed vanilla, the majority did. It is considered one of the more valuable and strong financial investments to make, albeit a bit risky. One farmer described his vanilla field 'like his wife,' as he tends to and dutifully takes care of it every day. However, vanilla cultivation can also be quite risky, as vanilla is easily infected by *Fusarium spp.* fungus, which can ruin the crop. Furthermore, vanilla theft is a huge problem, with many farmers building a small shelter that will be their primary dwelling in the weeks leading up to the harvest and sale of vanilla. In this way, farmers can protect their vanilla, especially from thieves during the night. People have been killed over vanilla in this area, and I witnessed an event of the community gathering together to ostensibly apprehend and possibly kill a thief that had been encountered in the vanilla fields one night. The date of the sale of vanilla, typically occurring during August, is a date set by the government on which the 'vanilla market is opened.' In 2022, this date occurred on August 14th (Poulos, 2023). During this time, 'middlemen' arrive to the village typically on motorcycles, to buy the farmers' vanilla and resell it in larger regional cities. The minimum price is also supposedly dictated by the government.

When a farmer wants to plant vanilla, it is best to do so in a semi-shaded environment on rich soil, but these conditions can be difficult to find in the packed, rarely forested agricultural area in this region. Furthermore, vanilla typically takes 3-5 years from being planted to begin producing vanilla beans that can be sold, so there is a time investment and lag before profit can be made from the crop. In this village, a 2023 study found that there are five main problems with vanilla farming: “(1) disease or insect infestation of the plants, (2) vanilla theft, (3) price fluctuation, (4) getting taken advantage of by vanilla buyers; and (5) climate change” (Poulos, 2023).

The yearly price for vanilla is extremely volatile, with farmers in this village describing as well that despite the minimum price set by the government, the price that local farmers can actually get from middlemen is typically lower (Poulos, 2023), and the price ranged from around 80,000 ariary in the mid-2000s, lowering to 3,000 ariary per kilogram in 2007, but up to 170,000 ariary per kilogram in 2017, to an all-time high of 200,000 ariary in 2019, and then dropping again by 2022. In 2022, the price was said to be 75,000 per kg for green vanilla as set by the government, but the price that people could actually earn was around 40,000-50,000 ariary per kg (Poulos, 2023). If farmers wait and cure the vanilla until it turns brown, the vanilla can be sold for a higher price. However, waiting for the vanilla to cure means a longer time of keeping the vanilla, a higher chance of theft, and a chance of rot and decay of the crop. This overall volatility of vanilla prices makes it difficult to stabilize finances and may leave many farmers expecting a significant income that cannot actually be depended upon.

In my interviews, some people raised the idea that the profitability of vanilla may drive forest destruction, as people may clear tracts of forest land in order to cultivate vanilla, especially if the price has been high and people expect to be able to eventually make a big profit. Even if people clear land to plant vanilla in a year the price is high, however, there is no guarantee that the price will remain high for the 3-5 years it will take until the plant begins producing beans. Some people worry that villagers’ livelihoods are overly dependent on vanilla. As the WWF official put it, “Is the people’s mindset destroyed by vanilla? Nothing else besides vanilla can make money?” The price of vanilla furthermore can affect the prices of other commodities. For example, several people in my interviews described that when the vanilla price was high, timber prices would be high as well (around 15,000 - 20,000 ariary per plank), but now with the vanilla price being very low, timber prices are low as well around 5,000 ariary per plank. Vanilla, in summary, plays a large role in the local economy and its price can affect the general prices in the village, but price volatility and overall risk in farming this cash crop can easily produce financial insecurity for people in the village. However, it was hypothesized that

high vanilla prices may incentivize forest clearing, but that low vanilla prices may drive timber extraction. Thus the role of vanilla seems to be very important in forest use dynamics.

Based on my results and personal observations, timber seems to be a major source of income for people in the village, and timber extraction is largely driven by poverty. Selective timber harvesting seems to occur throughout the forest, more driven by the specific location of valuable hardwood trees than anything else. The yearly cycle of livelihood thriving and struggling, resulting in the 'crisis' from January to April, also affects timber use with an increase in timber use during the crisis. Selective timber harvest does thin the forest a bit, but does not in and of itself produce widespread forest cover loss. It may, however, begin to open areas to be cleared for agriculture in the future. Furthermore, *Polisin'ala* theorized that, as people are entering the protected area for timber harvesting, they come across other land that they realize has suitable site characteristics for farming, which they will then want to clear for their own agriculture.

The forested parts of the protected area are by and large on mountainous terrain, more difficult for farming. The places that were cleared for farming tended to have certain characteristics that made them more suitable. These characteristics include more gradual slopes or flat areas rather than steep slopes, proximity to rivers, and underlying soil rather than rock. The area near the village is the last area where large water-fed rice cultivation can be found, and from this point towards the mountainous protected area, the elevation rises and the terrain increasingly becomes more hilled and mountainous. Agriculture is generally more difficult on such terrain; however, it should also be noted that soil quality seems to be much higher in the forested area and that several interviewees reported decreasing fertility in their farmland near the village. Thus, timber extraction and geophysical characteristics are important dimensions of forest conversion as well.

Another dynamic important to land cover change is food production and agricultural land, which is closely related to population density. A particularly insightful informant described that a somewhat unique characteristic of this village was that people really depend on buying their food, as opposed to growing it themselves, because there are so few fertile farmlands available. As such, people have a constant need for cash, and will potentially face food insecurity without it. This need for cash may thus drive both timber extraction more immediately, and investing in cash crops like vanilla. Rice production is considered particularly critical for feeding oneself and one's family, as this is the basis of every meal in traditional Malagasy culture and is typically more valued as a crop than others, such as vegetables or fruits. Related, the population density in this region is very high. As my results show, 83% of interviewees said that their land was not

sufficient and 97% described that it is getting more difficult to access land over time, as there is very little farmland left available to be used or bought. A common trend in the interviewees as well was describing either that one's personal family was growing quickly, or that the general village population was growing quickly. This combined high population density, growing population, and serious scarcity of available farmland are important factors in driving forest destruction as well, as people need land not only for cash crop production but also for staple food crop production.

These combined factors together suggest that land cover change and particularly forest conversion is driven by complex and interrelated dynamics, but that notably lacking is the presence of immediate commercial or government intervention. The nature of land change dynamics here, driven by individuals and the situation in which they find themselves, further suggests that support to ameliorate the livelihood situation in this village coupled with education and local agency in establishing forest use regulations could be impactful for preserving forest cover.

Research Implications

My research has important implications for the larger debates about natural resources management and the approaches of human inclusive versus human exclusive approaches. In this system, there is an attempt at community-based management by creating local forest associations to manage timber extraction and patrol the protected areas. However, the system lacks the critical dimension of an economic benefit. I argue that this creates a semi-CBNRM system and the shortcomings of the system may be significantly improved by more intentionally creating an economic benefit for local communities. The ultimate misalignment between the theoretical model and the reality of the landscape closely resembles problems from other CBNRM projects (Garner, 2018; Chisanga, 2016; . Similarly to the paper by Dressler et al. (2010), discussed in chapter two, this system involves a CBNRM project that isn't meeting community needs, fitting into the "global pre-packaged solution to local problems" that proves ineffective. This leaves local managers tasked with the difficult undertaking of forest protection, relying on punitive measures (fines and arrests) without any incentives for forest protection for the local community, in a region with high levels of food insecurity and poverty. Given this context, it is not surprising that this semi-CBNRM system is struggling to succeed.

Furthermore, given the scant remaining forest left outside of the zone 4 protected area, the system has somewhat devolved into a de facto park system. The resource allowance for this zone is complete prohibition, much like a park. This lack of access should be offset by the availability of forest resource access in the preceding zones; however, as I have shown in this study, these zones are more of a theoretical concept than a reality. There is little forest remaining outside of the zone 4 protected area, leaving local people few options for legal forest resource use.

Based on these findings, I suggest that steps must be taken to help rectify the management system for this protected area. While some, such as Terborgh and Van Schaik (2002), argue that human concerns including development must be separated from concerns about conservation and ecosystems, I argue that they must be addressed jointly. In my study, the management model has turned into one that attempts to shun people and prioritize forest preservation over human needs (through the exclusionary zone 4). However, with this study, I have shown that there are significant shortcomings in this system, both from the perspective of preservationism, i.e. illegal forest resource use is occurring, and from the perspective of human needs and well-being, i.e. livelihoods are not supported through the system. Instead, I argue that this management system needs reform to more effectively and ethically fulfill its goals.

In reforming this management system, it is critical to re-think the zoning structure of the forest. I suggest that these borders should be analyzed, including assessing if they are necessary to begin with, what purpose they serve, how to delineate them, and how to hold people accountable to them. I suggest that this process should be decided primarily by the local community, as they are the people who will most be affected by the outcome, but with the participation of the WWF and the national government as well. This process could be accomplished through external mediation.

My results show that the community is overwhelmingly in support of a reformed management system, on the critical condition that this system inherently involves a significant livelihood benefit for the community. Given food insecurity and poverty in the village, it is unrealistic and unethical to restrict access to an important resource without an alternative form of support. One of the main questions to address with forest management is how the community wants to balance immediate economic needs and long-term benefits (ecosystem services, resource use) from forest protection, a question that should be up to the community to answer. Furthermore, a large consideration in a reformed management system is accountability. A current problem that was often mentioned in the interviews was that of ‘outsiders’ using forest resources and particularly clearing large tracts of forest land for agriculture. In some cases,

these outsiders had permits from other places to do so, suggesting corruption and mismanagement at higher levels, as this should not be possible. The ability to determine who is entitled to access forest resources is critical to incentivizing collective management and longer-term collective benefit.

I strongly discourage, however, the interpretation of these results to be a doubling-down on the official rules and the official zones, even more strictly enforcing a park model. This approach would be unrealistic and logistically difficult to employ, and have catastrophic effects on local livelihoods in a way that could only be considered immoral and inhumane. My findings support an ongoing movement to include people in the decision-making and implementation process of natural resources management. This study comes after decades of CBNRM and sustainable development projects that have begun to strive towards this goal. The NGO and governmental actors who have been involved in implementing the management system of the COMATSA Sud protected area have taken an important step in working towards ethical and effective management, and my findings offer solutions for improving the system collaboratively. My findings also support the importance of understanding local intricacies and maintaining a locally-grounded approach to management. As with many other CBNRM projects around the world, a disconnect has formed between the local understanding of reality and the overarching national and international levels. Reconciling these differences across scale will help pave the path forward for ecosystems and local communities both in Madagascar and in the world at large.

7. Conclusion

In summary, I found that the system of VOI association management in this region began in the early 2000s, based on a spatial forest zoning model with increasingly strict resource use rules and culminating in the ‘untouchable’ protected area. The management system itself does not provide any economic benefit for the local community, but direct use of the forest is important for the community, particularly for timber extraction but also handicraft materials and traditional medicine. Income from timber extraction is especially important for supporting local livelihoods through economic difficulties, such as the ‘crisis’ season of the year and years when the vanilla price is low. The problem is that this timber use is largely occurring in the fourth zone, and thus is technically illegal. The management system is not preserving forest cover either; the remote sensing analysis shows that zone 2 and 3 are almost completely deforested and that even within the ‘untouchable’ zone 4, within 1 km of the southeastern

boundary is only 35% forested. Comparing the theoretical zoning model and corresponding resource use allocations with the reality that the only remaining forest occurs almost exclusively in the fourth zone, I argue that there is a serious incongruence that is resulting in an effective management system. However, the community would be open to a more robust system of forest management on the condition that it involves a significant livelihood benefit to offset potential decreased access to forest resources.

This research has important implications for wildlife conservation, protected area management, and rural development in this specific location and more broadly. The COMATSA Sud forest is rich in biodiversity itself, has not been fully inventoried yet, and is a corridor connecting three other major reserves in the area. Habitat loss is one of the main driving factors in threatening species, and forest cover in this area is thus extremely important for the biodiversity in the forest. To actually protect the habitat of these species, however, we must focus on management. We must especially focus on human-landscape dynamics, as local people are and should be the primary managers of this land, and larger economic and political forces have trapped the region in poverty and food insecurity. Conservation must more broadly consider the context in which biodiversity exists and the power dynamics that have determined who has the agency and privilege to make decisions regarding natural resources. Furthermore, protected areas across the world rely on potentially outdated systems. My findings suggest that an effective approach to this problem would be to restructure these systems based on the current reality, community input, and the prioritization of people's livelihoods as much as wildlife conservation. With different priorities for land use between local, national, and international scales, as well as between interest groups such as conservation organizations, industry, and local resource users, innovative and collaborative approaches are more important than ever. This thesis aims to cut across disciplines and scales to produce insights about the human, ecosystem, and landscape dimensions in this complex system that are stronger and more impactful for the influence of the other. The problems and solutions identified herein clarify a promising path forward for ethical and effective natural resources management in a world that will only increasingly require such nuanced, conscious, and collaborative solutions.

References

Armstrong, & Goodman. (2022). Forest and Grassland Ecology. In S. M. Goodman (Ed.), *The New Natural History of Madagascar* (pp. 101). Princeton University Press.

Beier, P., & Noss, R. F. (1998). Do Habitat Corridors Provide Connectivity? *Conservation Biology, 12*(6), 1241-1252. https://macalester.on.worldcat.org/oclc/9981873455

Bertrand, A., Rabesahala Horning, N., & Montagne, P. (2009). Gestion communautaire ou préservation des ressources renouvelables: Histoire inachevée d'une évolution majeure de la politique environnementale à Madagascar. *La Revue Électronique En Sciences De L'environnement, 9*(3)

Brandon, K., Redford, K. H., Sanderson, S. E., Brandon, K., Redford, K. H., Sanderson, S. E., & Nature Conservancy. (1998). *Parks in peril: people, politics, and protected areas*. Island Press.

Campbell, G. R. (2004). Madagascar: Merina Kingdom, Nineteenth Century. *Encyclopedia of African History* (). Routledge.

Central Intelligence Agency. (2024, Jan 17,). *Madagascar.* The World Factbook. https://www.cia.gov/the-world-factbook/countries/madagascar/

Chisanga, A. (2016). *What explains success and failure in Community Based Natural Resource Management? A comparison of Botswana and Zambia* (Masters).

Christoph Schwitzer, Russell A. Mittermeier, Anthony B. Rylands, Lucy A. Taylor, Federica Chiozza, Elizabeth A. Williamson, Janette Wallis and Fay E. Clark, Schwitzer, C., Mittermeier, R. A., Rylands, A. B., Taylor, L. A., Chiozza, F., Williamson, E. A., Wallis, J., & Clark, F. E.

(2014). *Primates in Peril: The World's 25 Most Endangered Primates 2012–2014.* (). Arlington, VA:

COMATSA Sud. Protected Areas Madagascar. Retrieved Jan 30, 2024, from https://protectedareas.mg/landscape/show/97

Cooke, A., Wells, S., Oates, J., Bouchet, P., Gilchrist, H., Leadbeater, A., Goucgh, C. L. A., Rasoloniriana, R., Randrianjafimanana, T., Jones, T. G., Aigrette, L., Ratefinjanahary, I., & Ravelonjatovo, J. (2022). MARINE AND COASTAL BIODIVERSITY AND CONSERVATION. In S. M. Goodman (Ed.), *The New Natural History of Madagascar* (). Princeton University Press.

Cronon, W. (1996). The Trouble with Wilderness: Or, Getting Back to the Wrong Nature. *Environmental History, 1*(1), 7-28.

Dressler, W., Buscher, B., Schoon, M., Brockington, D., Hayes, T., Kull, C. A., McCarthy, J., & Shrestha, K. (2010). From hope to crisis and back again? A critical history of the global CBNRM narrative. *Environmental Conservation, 37*(1), 5-15. https://macalester.on.worldcat.org/oclc/9980099153

Fayad, D. (2023, June). *Food Insecurity and Climate Shocks in Madagascar.* IMF ELibrary. https://www.elibrary.imf.org/view/journals/018/2023/037/article-A001-en.xml#:~:text=1.,one%20million%20in%20three%20months.

Ganzhorn, J. U., Lowry, P. P., Schatz, G. E., & Sommer, S. (2001). The biodiversity of Madagascar: one of the world's hottest hotspots on its way out. *Oryx, 35*(4), 346-348. https://10.1046/j.1365-3008.2001.00201.x

Garner, K. (2012). *CBNRM in Botswana: The Failure of CBNRM for the Indigenous San, the Village of Xai Xai and the Wildlife of Botswana* http://hdl.handle.net/10214/4053

Glew, L., Hudson, M. D., & Osborne, P. E. (2010). *Evaluating the effectiveness of community-based conservation in northern Kenya: a report to The Nature Conservancy.* ().

Gorelick, N., Hancher, M., Dixon, M., Ilyushchenko, S., Thau, D., & Moore, R. (2017). Google Earth Engine: Planetary-scale geospatial analysis for everyone. *Remote Sensing of Environment, 202*, 18-27. https://10.1016/j.rse.2017.06.031

Herrera, J. P. (2017). Prioritizing protected areas in Madagascar for lemur diversity using a multidimensional perspective. *Biological Conservation, 207*, 1-8. https://10.1016/j.biocon.2016.12.028

Jones, S. (2006). A political ecology of wildlife conservation in Africa. *Review of African Political Economy, 33*(109), 483. https://10.1080/03056240601000911

Kansanga, M. M., & Kpienbaareh, D. (2022). Are parks the best way to protect African wildlife? In W. Moseley, & K. M. Otiso (Eds.), *Debating African Issues: Conversations Under the Palaver Tree* (pp. 126-127). Routledge.

Khan, A., Islam, K. J., & Haque, A. B. M. M. (2023). Community-based natural resource management: an effective tool to reduce poverty and inequality? *Journal of Development Effectiveness, 0*(0), 1-16. https://10.1080/19439342.2023.2173272

Leakey, R. E., & Morell, V. (2001). *Wildlife Wars: My Fight to Save Africa's Natural Treasures*

Macekura, S. J. (2015). *Of limits and growth: the rise of global sustainable development in the twentieth century*. Cambridge University Press.

Mackenzie, J. (2005). MALAGASY. *Cassell's Peoples, Nations and Cultures* (). Cassell.

Moore, M., Townsend, M., & Oldroyd, J. (2006). Linking Human and Ecosystem Health: The Benefits of Community Involvement in Conservation Groups. *EcoHealth : Conservation*

Medicine: Human Health: Ecosystem Sustainability, 3(4), 255-261. https://10.1007/s10393-006-0070-4

Nelson, F., & Agrawal, A. (2008). Patronage or Participation? Community-based Natural Resource Management Reform in Sub-Saharan Africa. *Development and Change, 39*(4), 557-585. https://10.1111/j.1467-7660.2008.00496.x

Neumann, R. (2001). Disciplining Peasants in Tanzania: From State Violence to Self-Surveillance in Wildlife Conservation. In N. L. Peluso, & M. Watts (Eds.), *Violent Environments* (pp. 305-327). Cornell University Press.

Nuulimba, K., & Taylor, J. J. (2015). 25 years of CBNRM in Namibia: A retrospective on accomplishments, contestation and contemporary challenges. *Journal of Namibian Studies : History Politics Culture, 18*, 89-110. https://https://doi.org/10.59670/jns.v18i.110

Oates, J. F. (1999). *Myth and reality in the rain forest: how conservation strategies are failing in West Africa*. University of California Press.

Peluso, N. L., & Watts, M. (2001). *Violent Environments*. Cornell University Press.

Pemunta, N. V. (2019). Fortress conservation, wildlife legislation and the Baka Pygmies of southeast Cameroon. *GeoJournal, 84*, 1035-1055. https://doi.org/10.1007/s10708-018-9906-z

Pollini, J., Hockley, N., Muttenzer, F., & Ramamonjisoa, B. (2014). The Transfer of Natural Resource Management Rights to Local Communities . In I. R. Scales (Ed.), *Conservation and environmental management in Madagascar* ()

Poulos, M. (2023). *Supporting Women Vanilla Farmers in Madagascar: The Promise of VSLAs and Alternative Livelihoods* (Master's).

Protected Planet Report 2020. Protected Planet Report 2020. Retrieved Mar 22, 2024, from https://livereport.protectedplanet.net

Purdy, E. (2007). Madagascar. *Encyclopedia of Environment and Society* (). Sage Publications.

Rabearivony, J., Rasamoelina, M., Raveloson, J., Rakotomanana, H. V., Raselimanana, A. P., Raminosoa, N. R., & Zaonarivelo, J. R. (2015). Roles of a forest corridor between Marojejy, Anjanaharibe- Sud and Tsaratanana protected areas, northern Madagascar, in maintaining endemic and threatened Malagasy taxa. *Madagascar Conservation & Development, 10*(2), 85. https://10.4314/mcd.v10i2.7

Radachowsky, J., Ramos, V. H., McNab, R., Baur, E. H., & Kazakov, N. (2012). Forest concessions in the Maya Biosphere Reserve, Guatemala: A decade later. *Forest Ecology and Management, 268*, 18-28. https://10.1016/j.foreco.2011.08.043

Raik, D. (2009). Forest Management in Madagascar: An Historical Overview. *Madagascar Conservation & Development, 2*(1)

Raven, P. H. (2022). Foreword. In Steven M. Goodman (Ed.), *The New Natural History of Madagascar* (pp. xiv). Princeton University Press.

Rolston, H. (1998). Saving Nature, Feeding People, and the Foundations of Ethics. *Environmental Values, 7*(3), 349-357. https://10.1177/096327199800700307

Ross, P. H., Patel, E., Ferguson, B., Ravelijaona, N. R., Raoloniana, G. I., Wampole, E., Gerber, B. D., & Farris, Z. J. (2020). Assessment of the threatened carnivore community in the recently expanded rainforest protected area Anjanaharibe-Sud Special Reserve, Madagascar.*43*, 89-98. https://10.3354/esr01055

Scales, I. R. (2014). *Conservation and environmental management in Madagascar*. Routledge.

Schwitzer, Mittermeier, Johnson, Donati, Irwin, Peacock, Ratsimbazafy, Razafindramanana, Louis, Chikhi, Colquhoun, Tinsman, Dolch, LaFleur, Nash, Patel, Randrianambinina, Rasolofoharivelo, & Wright. (2014). Averting Lemur Extinctions amid Madagascar's Political Crisis. *Science, 343*(6173), 842-843. https://10.1126/science.1245783

Shackleton, S., Campbell, B., Wollenberg, E., & Edmunds, D. (2002). *Devolution and CommunityBased Natural Resource Management: Creating Space for Local People to Participate and Benefit.* (). https://dlc.dlib.indiana.edu/dlc/handle/10535/3646

Terborgh, J. (1999). *Requiem for nature*. Island Press.

Terborgh, J., Van Schaik, C., Davenport, L., & Rao, M. (2002). *Making parks work : strategies for preserving tropical nature*. Island Press.

The World Bank. (2024, Jan 10). *The World Bank in Madagascar: Overview.* World Bank. Retrieved Jan 22, 2024, from https://www.worldbank.org/en/country/madagascar/overview

Toillier, A., Lardon, S., & Herve, D. (2008). An environmental governance support tool: community-based forest management contracts (Madagascar). *International Journal of Sustainable Development, 11*(2-4), 187.

USAID. *What is CBNRM?* (n.d.). https://pdf.usaid.gov/pdf_docs/pa00jrv1.pdf

Vences, M., Wollenberg, K. C., Vieites, D. R., & Lees, D. C. (2009). Madagascar as a model region of species diversification. *Trends in Ecology & Evolution, 24*(8), 456-465. https://10.1016/j.tree.2009.03.011

Vieilledent, G., Grinand, C., Rakotomalala, F. A., Ranaivosoa, R., Rakotoarijaona, J., Allnutt, T. F., & Achard, F. (2018). Combining global tree cover loss data with historical national forest

cover maps to look at six decades of deforestation and forest fragmentation in Madagascar. *Biological Conservation, 222*, 189-197. https://10.1016/j.biocon.2018.04.008

The Wilderness Act, (1964).

Zaehringer, J., Eckert, S., & Messerli, P. (2015). Revealing Regional Deforestation Dynamics in North-Eastern Madagascar—Insights from Multi-Temporal Land Cover Change Analysis. *Land, 4*(2), 454-474. https://10.3390/land4020454