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Environmental justice and biodiversity
conservation, an application to mangrove
management in Madagascar

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Abstract

In the context of Protected Areas (PAs) extension and increased management delegation to Local Communities (LCs), finding ways to understand the underlying factors affecting their success or failure is key to ensure biodiversity conservation. The functioning of these initiatives are usually analysed through either an Ostrom framework of socio-ecological systems (SESs) or through environmental justice lens. We here argue that a comprehensive context analysis should rely on the two theories combined. This study focuses on management transfers of mangroves to LCs in the Menabe region, southwest Madagascar in a successful conservation initiative. Interviews conducted in nine villages revealed both positive and negative justice dimensions and management outcomes. They include, for instance, distributive justice (ie., provision of greater material resources) and procedural justice aspects (ie., improve administrative efficiency), recognition of traditional knowledge, and enabling conditions (ie., environmental awareness, legal certainty). Overall, it appeared that those management transfers proved relatively efficient in conserving the resource, contributed to women's emancipation and were quite well supported by LCs, facing the consequences of climate change. They even appeared as favoring social resilience.

Keywords: Protected Area, Marine Protected Area, Commons, Conservation, equity, environmental justice, social-ecological ecosystem.

1 Introduction

Assessing the underlying factors affecting the effectiveness of Protected Areas (PAs) is a major issue, in a context of political encouragement for their expansion worldwide (Zhang et al., 2020), in particular Marine Protected Areas (MPAs) (Campbell & Gray, 2019). In fact, the post-2020 global biodiversity framework of the Convention on Biological Diversity (CBD) sets the objective to protect at least 30% of the concerned land and sea areas by 2030 (CBD, 2020). However, the poor efficiency of many PAs is pointed at, a feeling encouraged by the global decline in biodiversity, but also by the often poor relevance of the desired targets (Pressey et al., 2015). Biodiversity assessments through remarkable species targets is often preferred (Gatiso et al., 2022). Besides, cost-efficiency approaches to conservation measures have been developed in Europe (Wätzold & Schwerdtner, 2005) and developing countries (Birner & Wittmer, 2004). In parallel, social impact assessments have been advocated for (N. Jones et al., 2017).

More comprehensive assessments, accounting for social, economic and biodiversity progress, are rarer (Bull et al., 2015).

The question remains as to how to assess the reasons of this low efficiency. In this context of political enthusiasm about PA extension, it is essential to ensure that they are equitably managed at the local level (Campbell & Gray, 2019; McGinnis & Ostrom, 2014; Xie et al., 2019). In fact, we contend, similar to (Gatiso et al., 2022), that PA effectiveness assessments should focus not only on biodiversity data but also on their management aspects and the mitigation of threats to biodiversity.

Assessing a PA governance requires looking at ways power and responsibilities are exercised through an analysis of the structures, decision-making processes, local traditions and stakeholders' involvement (Fromont et al., 2022; Graham et al., 2003; Lockwood, 2010). PAs governance types have evolved over the last few years, moving from centralized types of governance, perceived as unfair, "illegitimate, ineffective and undemocratic" (Bulkeley & Mol, 2003) to governance structures greater implying the local population (Borrini-Feyerabend et al., 2006; Gardner et al., 2018). The participation of local actors to policy planning has been described as an emerging phenomenon aimed at fighting the legitimacy issue pointed at since the 1960's (Chilvers & Kearnes, 2015; Hofer & Kaufmann, 2023). In fact, "people-centered governance", based on strong cooperation between actors, the development of common narratives and empowerment is one of the success factor of conservation initiatives (Koch et al., 2023; Oldekop et al., 2016; Tauli-Corpuz et al., 2020). Besides, previous research showed that the issuing of management plans in parallel to the implementation of PAs contributes to greater conservation gains, thanks to a qualitative enhancement of this management (West et al., 2022).

Conservation initiatives have sparked many critics in general (Blanc-Pamard & Fauroux, 2004; Rakotonarivo et al., 2023; Schlosberg, 2004; Sikor et al., 2014), pointing at the recurring disrespect of the local communities' (LCs) rights inside protected areas, and, in particular, the Natural Resources Management Transfer Contracts (CTGRN¹) in Madagascar (Blanc-Pamard, 2012; Ferguson et al., 2014; Hockley & Andriamarivololona, 2007). In fact, sanctuarization of natural spaces at the expense of the LCs' uses might create conflicts (Liu et al., 2010). However, embedded in larger conflicts, those involving LCs in remote areas are often forgotten (Tauli-Corpuz et al., 2020). The local population is sometimes considered as the cause of biodiversity loss rather than a key actor to its conservation. For instance, the discrepancy between the national and international visions and the LCs'

¹ *Contrats de Transfert de Gestion des Ressources Naturelles.*

perspective on the ways conservation should be conducted was observed many times and called the "justice gap" (Martin et al., 2016). Similarly, "green colonialism" describes a situation where international actors (NGOs, etc) create a protected area eventually benefiting foreign tourism and to which LCs have no longer access (Blanc & Morrison, 2022; Low, 1999). Numerous examples exist in sub-Saharan Africa (BenYishay et al., 2017) and Madagascar (Marie et al., 2009). As a result, deprived from access to the natural resource, the population nurtures feelings of injustice (Campbell & Gray, 2019; Schreckenberget al., 2016).

This call for equity (Campbell & Gray, 2019; McGinnis & Ostrom, 2014; Xie et al., 2019) has been translated into international agreements and statements, especially, in 2010, in the Aichi Biodiversity Target 11 which stipulates that "communities should be fully engaged in governing and managing protected areas according to their rights, knowledge, capacities and institutions should equitably share in the benefits arising from protected areas and should not bear inequitable costs" (SCBD, 2021). Nevertheless, assessing the effectiveness and equity of PAs management is difficult as it requires time-consuming context-level analysis (Moreaux et al., 2018; Zafra-Calvo et al., 2017). Multiple tools and frameworks addressing equity in different terms are already available (Dawson et al., 2018; Schreckenberget al., 2016).

This study is based on a field study conducted in the Protected Area of Menabe Antimena (APMA) which overlaps an MPA, the Tsihibirina mangroves (a RAMSAR site), in the Menabe region, western Madagascar. The country hosts about 2% of the world mangroves (T. Jones et al., 2016). However, despite the Durban declaration (2003) and the establishment of many PAs, the loss of these irreplaceable ecosystems continues at a rapid pace. We decided to study the mangrove region covered by this PA as, on one hand, it is one of the first established PAs in Madagascar - and thus served as a model (Bidou et al., 2008) - and, on the other hand, for its apparent success regarding mangrove conservation. The Menabe-Antima area, already studied in Sommerville et al., 2010 and Brimont and Karsenty, 2015, hosts about 7% of the total area covered by mangroves in Madagascar (MEDD, 2014, 2022).

Thanks to the results of this qualitative field survey, we identified the adequacy and the inconsistencies with the Ostrom's design principles of effective management of a common pool resource (CPR). In the context of delegated management, the social-ecological system (SES) framework allows to analyze the relationships between actors, to reveal inconsistencies and positive outcomes. Additionally, a more detailed analysis, using the four sub-systems defined by Agrawal, 2001, based

on previous works of the Ostrom school of thoughts, sheds light on more specific items, related, for instance, to the external environment impacts. Then, this study is complemented by socio-historical and anthropological insights so as to produce an environmental justice analysis (Furman et al., 2023). In fact, as in He et al., 2021, we argue that taking the considerations of justice into account contributes to understand the functioning of a delegated management of natural resource. Doing so, this study is in line with the growing need for approaches better including considerations from the political, economic and social spheres in the assessment of PAs (Francks et al., 2016; Ikeme, 2003; McDermott et al., 2013; Moreaux et al., 2018; Timko & Satterfield, 2008).

This article is structured as follow: a first part presents the analytical framework (I), followed by a presentation of the case study and methodology used (II). The investigation results - in particular thanks to the Ostromian analysis frameworks - are presented in a third part (III), before environmental justice considerations (IV). A last part (V) contains a discussion about policy recommendations and concludes.

Main broad themes addressed: socio-ecological systems, governance, conservation finance, climate change impacts, inter-generational and intra-generational justice.

2 Local Communities management of open-access natural resource: from Ostrom to environmental justice

Commons correspond to a certain type of economic good that include open access natural resources. Preventing their over-exploitation requires setting up sustainable management systems including LCs (Hardin, 1968). It often implies creating property rights for LCs on a specific natural resource. Recognised as the main legitimate users of a resources, they are designated responsible for their protection. Protected areas and common resource management approaches were theorised in the 1980's. They were progressively implemented in many countries from the 1990's, based on the so-called Ostromian approach (Brosius et al., 1998; Ostrom, 2009, 2007).

Inspired by the interview structure used by the WWF², we started this study with an analysis of the eight "core design principles" of an SES defined by Elinor Ostrom and formulated in Cox et al., 2010; Ostrom and Cox, 2010; Wilson et al., 2013 and originally in Ostrom, 1990. De-

²World Wildlife Fund for Nature, international NGO.

defined as principles, they are collective choice arrangements that ensure the effective protection of CPR. In fact, they allow to minimize the costs associated with the protection of a given open-access natural resource by local actors (as compared to the benefits). It is a framework that can be extended to any other shared goals requiring cooperation within a group of people (Wilson et al., 2013), as in the health sector (Robert et al., 2021).

Principle	Description
Principle 1	Clearly defined boundaries. <i>The resource and the entitled people must be clearly defined.</i>
Principle 2	Proportional equivalence between benefits and costs. <i>The resource management rules must be consistent with the local environment context and the objectives of the entitled people.</i>
Principle 3	Collective-choice arrangements. <i>The entitled people must participate in the elaboration and the modification of the management rules.</i>
Principle 4	Monitoring. <i>Agents implementing these rules must be responsible towards (act under the responsibility of) the entitled people.</i>
Principle 5	Graduated sanction. <i>A graduated system of sanctions in case of rule violation must exist.</i>
Principle 6	Conflict resolution mechanisms. <i>The system must include an easy and rapid access to local authorities able to settle potential conflicts.</i>
Principle 7	Minimal recognition of rights to organize. <i>Superior authorities (states) must acknowledge the local authorities' rights to manage resources, thereby guaranteeing the subsidiarity principle.</i>
Principle 8	For groups that are part of larger social systems, there must be appropriate coordination among relevant groups. <i>For larger common resource, nested management devices can be designed.</i>

Table 1: Ostrom's eight core design principles, based on Wilson et al., 2013

Complementary approaches developed in the 2000's addressed the natural resources and governance system in a broader way. In particular, Agrawal, 2001 defined a set of "enabling sustainable conditions" related to four elements and their relationships, namely 1) the resource system 2) the managing community characteristics, 3) the institutional arrangements and 4) the external environment (stable legal framework, financial aid, technology, etc.). Those conditions are presented in Table 2. Concerning the relationships between the resource and group characteristics, there must be an overlap between the user group residential and resource locations, a high levels of dependency by group members on the resource system, a fair allocation of benefits from common resources, a low levels of user demand and a gradual change in demand levels. Finally, regarding the relationships between the resource system and the institutional arrangements, harvest restrictions must be consistent with the regeneration capacity of the resource.

Core element		Enabling sustainable criteria
Resource system characteristics		Small size
		Well-defined boundaries
		Low level of mobility
		Possibilities of storage of benefits from the resource
		Predictability
Group characteristics		Small size
		Clearly defined boundaries
		Shared norms
		Past successful experience - social capital
		Appropriate leadership - young, familiar with changing external environment, connected to local traditional elite
		Interdependence among group members
		Heterogeneity of endowments, homogeneity of identities and interests
		Low levels of poverty
Institutional arrangements		Rules are simple and easy to understand
		Locally devised access and management rules
		Ease in enforcement of rules
		Graduated sanctions
		Availability of low cost adjudication
		Accountability of monitors and other officials to users
External environment	Technology	low cost exclusion technology
		Time for adaptation to new technologies related to the commons
		Low levels of articulation with external markets
		Gradual change in articulation with external markets
		Central government should not undermine local authorities
	State	Supporting external sanctioning institutions
		Appropriate level of external aid to compensate local users for conservation activities
		Nested levels of appropriation, provision, enforcement, governance

Table 2: Enabling sustainable elements and criteria, based on Agrawal, 2001

However, CPR management approaches have been criticised mainly for ignoring the socio-historical aspects of the analysed systems (Forsyth & Johnson, 2014). In particular, the notion of trust in local leaders and community institutions is essential (He et al., 2021; Xie et al., 2019) and is largely based on perceived equity outcomes. Therefore, we choose here to go beyond this Ostromian framework and use its results to suggest an environmental justice analysis of the delegated management. Assessing the effectiveness of the PA through an environmental justice lens is a rather new approach which we find essential to design policy recommendations (He et al., 2021; Tauli-Corpuz et al., 2020).

Environmental justice and equity approaches have been increasingly used to address context-specific cases. Both approaches have

converged since the 1990's, bringing together analysis of intra and inter-generational justice issues and environmental harm distribution (Dawson et al., 2018). The environmental justice perspective is a social justice approach which focuses on ways people are unevenly exposed to environmental risks, depending on their social status, race, gender, etc. It also questions issues related to their access to natural resources and environmental services (Le Meur & Rodary, 2022; Low, 1999). Previous studies showed that accounting for human-environment interactions eventually fosters ecological outcomes and support conservation goals (Ban et al., 2013; Cetas & Yasué, 2016; Klein et al., 2015; Moreaux et al., 2018; Oldekop et al., 2016).

Environmental justice is often analysed through three interrelated dimensions: procedural, distribution and recognition (Schlosberg, 2004; Sikor et al., 2014; Walker & Day, 2012) to which a fourth dimension (revealing the interdependence between the three others) was added, the enabling conditions or capabilities (Schlosberg, 2007). Detailed definitions of the following concepts can be found in McDermott et al., 2013 and Schlosberg, 2007. Procedural justice refers to power relations, formal and informal rules, and the decision-making process. An example is the approach used by Gustavsson et al., 2014 about local management of an MPA in Zanzibar, Tanzania. Regarding distributive justice, it concerns the distribution of material and non-material gains and costs (Walker, 2012; Walker & Day, 2012). In the present case, it points at the consequences of the management agreement, from financial and material viewpoints especially. Thirdly, recognition is a notion referring to how much cultural values of the concerned social groups are taken into consideration and respected (Chan et al., 2012; Fraser & Honneth, 2003; Martin et al., 2016). In fact, the importance of traditional knowledge and practices for biodiversity conservation has been demonstrated, for instance in Kala, 2011 and in McCarthy et al., 2018. The enabling conditions, also called "contextual justice and capabilities" (McDermott et al., 2013; Nussbaum et al., 1993), question the existence of conditions enabling a specific group to exercise its rights. "Capabilities" are, for individuals, the capacities to "fully function in their chosen lives (...) to pursue the lives they value." McDermott et al., 2013 For instance, literacy capability is a condition to reading or information and available time are some conditions to participatory parity (Szablowski, 2010). Initiated by Agrawal, 2001, the approach has been further developed in the equity frameworks developed in McDermott et al., 2013 and Pascual et al., 2014 for Payments for Ecosystem Services (PES) schemes, and in Francks et al., 2016 and Schreckenberget al., 2016 for PAs. Thus, it is a broader concept which concerns aspects such as access to education, the availability of trans-

lations in local dialects, level of articulation with external markets, etc. It has not been many times applied yet although, in our sense, it provides a better understanding of the contextual aspects.

We argue that addressing those four dimensions of environmental justice will contribute to understand the success of this mangrove conservation initiative. Previous studies conducted in the region focusing on environmental justice dimensions (Brimont & Karsenty, 2015; Brimont & Leroy, 2018; Desbureaux et al., 2015; Sommerville et al., 2010) and in other parts of Madagascar (Bidaud et al., 2016) contributed to inform this study. In addition, we applied the following indicator frameworks (see Table 3) elaborated by Francks et al., 2016; Schreckenberget al., 2016 who defined a set of twenty criteria.

Env. justice dimension	Criteria
Distributive	<ul style="list-style-type: none"> Identification and assessment of costs, benefits and risks and their distribution and trade-offs Effective mitigation of any costs to LCs Benefits shared among relevant actors according to one or more of the following criteria: <ol style="list-style-type: none"> 1. Equally between relevant actors or 2. According to contribution to conservation, costs incurred, recognized rights and/or the priority of the poorest Benefits to present generations do not compromise benefits to future generations
Procedural	<ul style="list-style-type: none"> Full and effective participation of all relevant actors Clearly defined and agreed responsibilities of actors Accountability for actions and inactions Access to justice, including an effective dispute-resolution system Transparency supported by timely access to relevant information in appropriate forms Free, prior and informed consent for actions that may affect the property rights of IP and LCs
Recognition	<ul style="list-style-type: none"> Respect for human rights Respect for statutory and customary property rights Respect for the rights of Indigenous People, women and marginalized groups Respect of different identities, values, knowledge systems and institutions Respect of all relevant actors and their diverse interests, capacities, and powers to influence No discrimination by age, ethnic origin, language, gender, class, and beliefs
Enabling conditions	<ul style="list-style-type: none"> Legal, political and social recognition of all protected area governance types Relevant actors have awareness and capacity to achieve recognition and participate effectively Alignment of statutory and customary laws and norms An adaptive and learning approach

Table 3: Environmental justice dimensions and criteria, based on Francks et al., 2016.

3 Case study presentation

3.1 Madagascar

In Madagascar as well as in other parts of the world, natural resources and biodiversity are declining, mainly due to anthropogenic pressures (Butchart et al., 2010), threatening the population’s well-being (Cardinale et al., 2012; Janssens et al., 2022). In fact, in subtropical developing countries, the poorest are often greatly dependent on access to natural resources for their own survival. In fact, they provide fundamental Ecosystem Services (ES) related to food provision and water filtration (Dasgupta, 2001; Daw et al., 2011; IPBES, 2019). In Madagascar, the CBD country profile evaluates to more than 18 million people or at least 70% of the total population depending on natural resources to cover their subsistence needs³.

Although Madagascar is considered as a hotspot of biodiversity (Ralimanana et al., 2022), especially for its numerous endemic species (lemurs, orchids, etc.), it has been suffering from deforestation for many decades: it is estimated that Madagascar has lost about 25% of its tree cover since 2000 (about 4.85 million hectares) (Suzzi-Simmons, 2023). Some major causes of this biodiversity loss are land use change for rice production and timber collection. In rural areas, the phenomenon is visible through slash-and-burn agriculture (*tavy*) (Kull, 2000; Suzzi-Simmons, 2023). A 3% yearly population growth and lack of public investments in infrastructures and education⁴ contributed to worsen the situation (Razafindrakoto et al., 2017). However, such practices are complex to be addressed as, among the country’s 29 million inhabitants, 80% live with less than 2 EUR per day (about 8,000 Ariary (AR), based on the 2022 exchange rate) and the majority directly depends on agriculture for its living⁵. Moreover, it combines with a weak rule of law resulting in massive deforestation caused by illegal logging, intensive mineral exploitation and land grabbing for extensive agriculture practices by private international companies.

In spite of their exceptionally-rich ecosystem status, mangroves are also concerned and threatened in Madagascar where they represent 2% of the world’s mangroves (T. Jones et al., 2016). In fact, according to the Global Mangrove Watch, mangrove cover lost reached 50.77 km² between 1996 and 2020⁶.

³<https://www.cbd.int/countries/profile/?country=mg>

⁴The very low access to education impacts the Human Capital Index (HCI) (it reaches only 0.4% (2020) (scale 0-1) (World Bank, 2023)).

⁵<https://data.worldbank.org/country/madagascar>

⁶<https://www.globalmangrovewatch.org>

To address the biodiversity loss issue, the Malagasy state has made several commitments since the 1990's at the national and international levels. In particular, it implemented PAs based on CPR management, after the adoption of the 2003 "Durban vision" aiming at tripling the size of PAs (up to 6 million ha or 10% of the national surface area) (MEDD, 2014) and the ratification of the CBD, therefore abiding by the Aichi Target 11. Nowadays, Madagascar counts 123 PAs, including 13 mixed PAs (covering marine and coastal ecosystems) (SCBD, 2021). In this context, it transferred the management of numerous natural PAs to LCs. International NGOs and international cooperation agencies were in charged of creating and temporarily managing the protected zones until the signing of management contracts with LCs (CTGRN). Those are regulated under the GELOSE law⁷ and the 2001 GCF decree⁸ (Blanc-Pamard, 2012; Brimont & Karsenty, 2015).

Nevertheless, the efficiency of those measures can be questioned as deforestation continues at an alarming rate (Gardner et al., 2018).

3.2 Historical and legal background

In Madagascar, most lands belong to the private domain of the state or are untitled⁹ (Ferguson et al., 2014). In practice, they have been de facto exploited and managed by villages or lineages for generations (Bidou et al., 2008). Despite the country's legal framework supposed to support land securitization and local management of lands and resources (Teyssier, 2010), local populations' poor understanding of their own rights tends to weaken the system (Andrianirina Ratsialonana et al., 2011; Ferguson et al., 2014).

The GELOSE law (1996) was meant to recognize the customary rights of LCs through a contract between the land owner (the state), the municipality and the *Vondron Olona Ifotony* (VOI), a legal ad hoc local institution (Brimont & Karsenty, 2015), locally described as an "association". Through this contract, the resource management is officially delegated to the LC, helped by an environmental mediator. The management transfer is renewable and lasts three years (WWF & CN-FEREF, 2014).

Alongside the conservation policies of the 1990's, an administrative reform was implemented in order to better involve the local populations in the decision-making process thanks to a power decentralization process. In 1994, cities with extended powers were created, followed by 22

⁷Local and Secured Management law (*loi sur la Gestion Localisée Sécurisée*).

⁸Contractualized Forests Management decree (*Décret de Gestion Contractualisée des Forêts*).

⁹The state-ownership presumption abolished in 2005 (Ferguson et al., 2014).

regions in 2004 and land offices in charge of decentralised land management. The municipality is the important decision-making body, particularly concerning the receipt of funding and coordination with the national level and international donors. Inter-municipal public bodies (Organisme public intercommunal, OPCI) deal with the remaining issues (Bidou et al., 2008). Lastly, the region coordinates the implementation of national public policies.

Schematically, in accordance with the principles enacted by UNESCO¹⁰ in 1974, PAs are divided into several (often three) types of zones, namely a "core" zone, a usage zone and a buffer or intermediate zone (Batisse, 1997; UNESCO, 1974; Xu et al., 2016). In the present case, this last zone often corresponds to an area of restoration conducted by the local populations, in compensation for their own uses. The management system is ruled by the villagers where the VOI is responsible for organizing the patrolling and defining the rules to be applied, for instance in terms of exploitation and restoration of the mangroves, as well as the sanctions (see Figure 1).

The "soft conservation" approach used (as opposed to a "fortress conservation approach") means that the resource is not sanctuarized but can be exploited - sustainably - by the local population. The approach is also "incentive-based" (approach developed since the 1980's) as measures are implemented so as to offset the costs associated with the ban imposed on natural resource uses (Brockington et al., 2008; Charnley, 2023).

¹⁰United Nations Educational, Scientific and Cultural Organization.

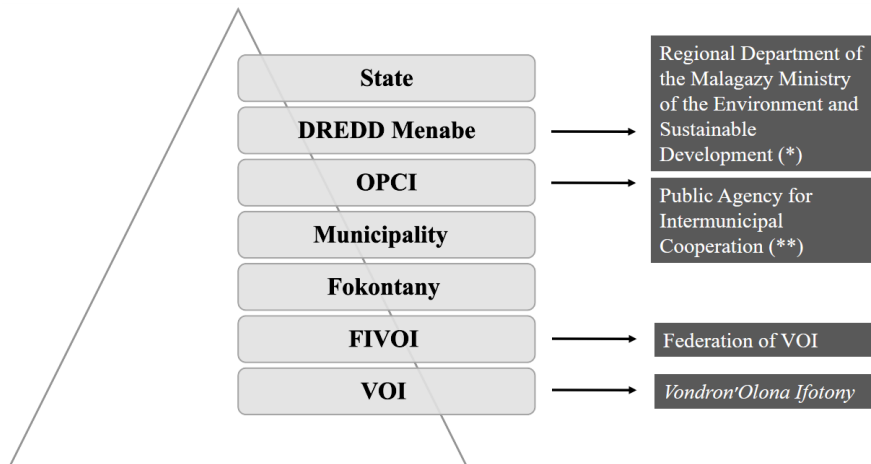


Figure 1: Administrative hierarchy. In practice, the administrative hierarchy is organized as follows: several VOIs refer to the FIVOI, which itself is under the authority of a *fokontany*. Since the Menabe mangroves are managed according to the GELOSE process, they are subject to the authority of the municipality and/or the OPCI.

In the APMA, an Orientation and Monitoring Committee (COS) produces reports for the decision-making committee, made up of state authorities (DREDD) which transmits its decisions to the executive committee. The latter is made up of unit managers (CNFEREF, etc.), technical partners (NGOs such as WWF, Durrell, etc.) and LCs (VOI), depending on the area concerned. It obtains information from local OPCIs.

(*) *Direction Régionale de l'Environnement et du Développement Durable* (**) *Organisme Public de Coopération Intercommunale*

3.3 Case study and methods

3.3.1 Local investigations

This study focuses on mangrove LCs' management in the Menabe region, Western Madagascar. It is a IUCN¹¹ category V, covering 13,947 ha of mangroves out of a total cover of 210,000 ha (which includes 68,974 ha of core area, 141,126 ha of buffer area). The Menabe region is famous for its tourist attractions: the Baobab alley and Tsingy de Bemaraha, both welcoming about 30,000 tourists annually (WWF & CNFEREF, 2014).

Officially created in 2015, the APMA covers the Menabe region, formerly known as the kingdom of Menabe (coord. 19°38' ; 20°15'). It is located 25 km north to Morondava, the region's capital, and bounded to the north by the Tsiribihina river, to the east by the Anketrevo and Mandroatsy savannahs and the Bevoay rice-growing area, and to the south by the Tandila and Morondava rivers (MEDD, 2014, 2022).

¹¹International Union for Conservation of Nature.

About 37 446 people live in the area¹², with a low population density of 7 to 70 inhabitants per km² and 5 people per household. Administratively, the PA is made of two districts, namely Morondava and Belon'i Tsiribihina, 6 municipalities and 39 *fokontany* (MEDD, 2014, 2022).

The objectives of the management plans are "to encourage a fruitful coordination between LCs and authorities", through the empowerment of the local population (management rules designed in a participatory manner), the establishment of a monitoring system and "the rational management of natural resources while ensuring the socio-economic life of households that already live inside or near the forest". Biodiversity preservation is expressively cited as a management objective so as to ensure "the sustainability of ecological functions and the maintenance of ecosystem productivity, (...) processes necessary for the well-being of LCs as well as for the sustainable use of natural resources." (MEDD, 2022).

This study is based on the assessment of quantitative and qualitative data. Especially, it is informed by the results of semi-directive interviews, partly based on the WWF evaluation follow-up guide. In addition, we used management plans for the period 2014-2019 and 2022-2027 provided by the CNFEREF (MEDD, 2014, 2022). Analysis contained in internal reporting documents provided by WWF were also used: the Final report TGRN WWF CNFEREF (WWF & CNFEREF, 2014), the Evaluation report 2015-2019 of the Management Plan conducted by an external NGO, Acting for Communities and Trees (ACT, 2021) and the Monitoring and Evaluation report 2023 conducted by the NGO Fanamby (Fanamby, 2023).

Departing from Morondava in May 2022, qualitative interviews were conducted in nine villages (hamlets) with the local WWF team (see Figure 2): Bevava (V1), Lapotaly (V2), Andramasay (V3), Ambakivao (V4), Soarano sur Mer (V5), Antsakoamaliniky (V6), Tsimandrafoza (V7), Kaday (V8) - stopover at Belo sur Tsiribihina - and Kivalo (V9), before a return to Morondava. In particular, the *fokontany* of Soarano and Kivalo are the two extreme limits (north and south respectively) of the APMA.

¹²Estimate based on the last census (Toisième Recensement Général de la Population et de l'Habitat (RGPH-3), 2018), INSTAT Madagascar.

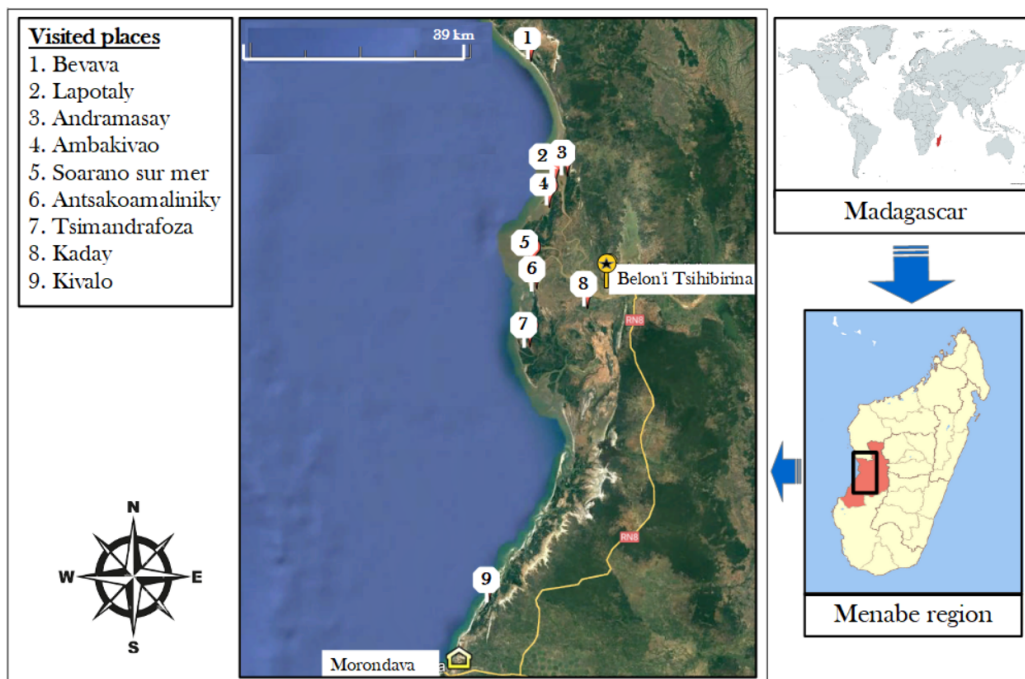


Figure 2: Map of visited sites, Menabe region, Madagascar. The area studied here is managed according to the management plan MEDD, 2022. Notably, this area includes the MPA of Tsihibirina mangroves.

We identified six groups of actors (see Figure 3) committed to cooperate in the management of mangroves.

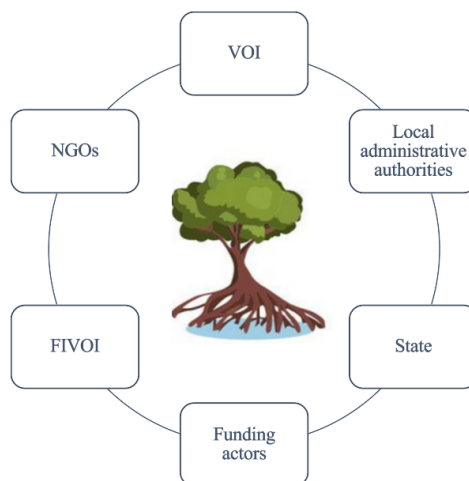


Figure 3: Key actors in mangrove conservation.

3.3.2 The Sakalava vezo

Most of the villagers encountered were part of the Sakalava people, the descents of the XIXth century Sakalava kingdom (Graeber, 1997; Lombard, 1988). Sakalavas are a sociocultural group of people that used to be very powerful, especially in the XVIIth century, as opposed to the Merinas (Razafindrakoto et al., 2017). In particular, they are part of the Sakalava vezo as they mostly live from fishing - as opposed to the Sakalava masikoro living from livestock breeding and agriculture (MEDD, 2014). Some immigration waves from the South (Antanosy and Antandroy in the 1940's, then the Betsileo in the 1975-1980's) took place and modified the inland population but not much the coast's (MEDD, 2014). In the region, two other cultural groups are identified: the Mahafaly and Antesaka.

Until recently, nature has been considered as an unlimited resource due to a low population density, a rapid regeneration of forests, little effort required for cultivation on silt, etc. (Fauroux, 1997). Houses are built in wood because it is a living material, as opposed to rock, usually more appropriate for graves (local guide; Goedefroit and Lombard, 2007). As described in "The Sakalava house" by Feeley-Harnik, 1980, houses are small and organized around a central sleeping room. Meetings and meals take place on the floor on a mat. Sometimes, in notables' houses, one finds a supplementary room for cooking and a sheltered outdoor space for meetings.

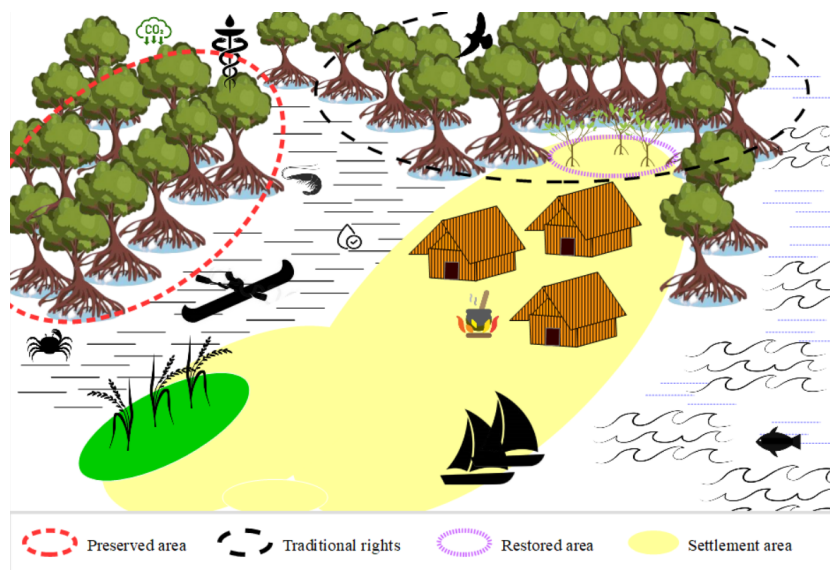
In fact, mangrove forest is a place of worship and burial. For instance, depending on their severity, diseases are healed by the *ombiasy* (healer) thanks to its knowledge of the *hasana* (seeds) and prayers to the spirits (Lombard, 1973). This "great cultural importance" is recognized in the management plans.

In practice, during the interviews, meetings were organized in circle, sometimes under the tamarind, with visitors usually invited to seat on a mat (Lombard, 1976), men and women seating separately. Women are often assigned to the meal preparation (mostly rice and fish). Numerous children were present with the older taking care of the younger ones.

3.3.3 Direct and indirect uses of mangrove

The ES provided by mangroves are numerous for the coastal populations (see Figure 4). Notably, trees provide timber which allow to build houses and cook; the fish nursery service allows to fish crabs and coastal fishes; the water, filtered by the mangrove roots, is used for cooking and washing; the vegetation provides freshness and reg-

ulates climate locally; the mangrove allows coastline protection from flooding (resulting from natural hazards or sea level rise); carbon being sequestered in trees, roots and leaves, mangroves contribute to the regulation of the global climate.



Ecosystem service type	Ecosystem services		Local impact / human well-being
Supply services	• Materials and fibres		• Security (housing)
	• Biomass (energy)		• Energy
	• Drinking water • Medicine plants		• Human health
	• Wild animal protein source		• Subsistence mean: fishing • Local food security
Regulation services	• CO2 storage		• Climate regulation
	• Habitat, shelter, nursery		• Subsistence mean: livestock farming
	• Soil quality maintenance		• Subsistence mean: agriculture
	• Water quality maintenance		• Human health
	• Erosion control • Flooding regulation		• Protection against natural hazards
Cultural services	• Symbol • Leisures • Knowledge, education		• Cultural identity • Tourism revenues

Figure 4: Local area definitions, ecosystem services and their impact on human well-being. The contract (CTRGN) terms specify that LCs are empowered to implement their own rules, related to the three areas, a *(direct) used area* where they can extract - sustainably - the resource, a *hard core area* which they must protect thanks to regular patrolling, and a *restored area* where replanting of mangroves is conducted by the villagers themselves. A fourth area, usually near the shore and outside the forest, corresponds to the *settlement area*. The table shows the correspondence between ecosystem services and their impacts on human well-being.

3.3.4 Ecological aspects

As part of the western ecoregion of Madagascar, the APMA comprises three habitat types, including mangroves but also a dry forest and lake ecosystems (Lakes Bedo and Kimanaomby)(MEDD, 2014, 2022). The mangrove area exhibits a typical vegetation of the Western Indian Ocean region with *Rhizophora mucronata* and *Ceriops tagal* as the most encountered specie, besides less abundant species such as *Heritiera littoralis* and *Sonneratia alba*, and *Lumnitzera racemosa*. This ecosystem hosts about 36 species belonging to 11 families. In particular, they provide roots and birdhouses for water birds especially for the listed endemic and threatened species "Bernier's Teal (*Anas bernieri*), Humblot's Heron (*Ardea humbloti*), Madagascar Sacred Ibis (*Threskiornis bernieri*), Madagascar plover (*Charadrius thoracicus*) and fruit bats (*Pteropus rufus*) (MEDD, 2022). However, a global population decrease has been observed (a 20% decrease for *Threskiornis bernieri*), resulting from rice paddy fields expansion, hunting, egg collection and nest destruction (ACT, 2021).

At the regional level, despite the creation of the APMA, the area is threatened by a very quick deforestation, especially its dry forest part. Mangroves is a threatened habitat and ecosystem too but to a lesser extent, especially due to hunting and tree clearing, besides selective cuts and eggs collection of protected bird species. It is estimated that about 9% were lost between 2015 and 2020 (or 548 ha), with a yearly deforestation rate of 2% (ACT, 2021; MEDD, 2014)¹³. However, this deforestation is considered as a "controlled" one.

4 Results

4.1 Local Communities at the front-line of biodiversity conservation

Investigations revealed that up-to-date management plans and LCs' commitments are the main drivers of this mangrove conservation success.

LCs' commitments consist mainly in mangrove protection and restoration. They commit to two activities, namely the protection of mangrove (the "conservation" aspect) via regular patrolling operations in the "(hard) core" zone and the control of the respect of timber cutting rights, and the restoration of specifically targeted areas. They also

¹³During the same period, dry forest lost about 16,165 ha (i.e. an annual deforestation rate of - 4.5%). (MEDD, 2022).

participate in the decision-making process concerning the area management. The management transfer is thus called the PA's "green belt" (NGO interview).

Regarding timber cutting rights, they vary from one village to another and can be free, charged or prohibited. In any case, wood products cannot be transported but must be used locally (MEDD, 2022). Their role is to act as a deterrent, reflecting the scarcity of the resource and preventing over-exploitation. Here they are set at a quite low level so as to ensure that members actually pay (and thus contribute to finance the VOI). Depending on the VOI, a house (which necessitates about 120 mangrove trees) is worth about between 5,000 AR for VOI members and 10,000 AR for non-members. In V9, cutting rights reach 10,000 AR and 20,000 AR, respectively.

LCs also monitor the conservation area thanks to trained patrollers (*polisin'ala*), usually operating in small teams. In V7, a typical patrollers' routine is to carrying out surveillance four times a month, or twice in the northern part and twice in the southern part of the core area. Beyond the loss of income generated by the PA establishment, the time spent by the patrollers can be estimated in monetary terms (see Figure 10 in Appendix section 7.3).

Lastly, replanting operations are conducted by villagers and organized by VOI, with the help of NGOs. These operations are mixed and children participate.

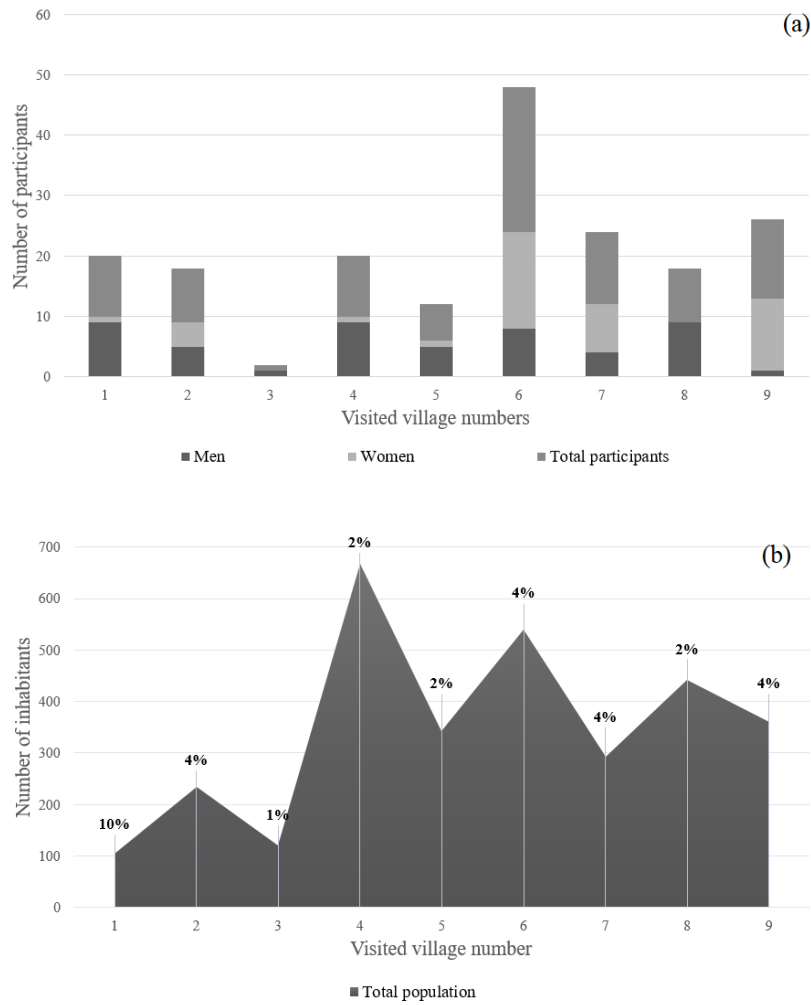


Figure 5: (a) Village participants to meetings with the WWF. On average, about ten people attended the meetings organized with the NGO. Mostly men were present, except in villages V6, V7 and V9. The reasons given were fishing day and bad communication about the meeting day. (b) Fokontany population (incl. children) and participation to meetings. Between 1 and 4% of the population participated to the meeting as VOI members, except for V1 (10%). Most VOI members were present, which means that VOI members represent a very small share of the total population.

Based on interviews, we concluded that about three thirds of the LCs' involvement (in terms of time) concerned conservation, against one third for restoration of the mangroves.

4.2 Need to build capacity to manage tense usage conflicts

A better controlled deforestation would require greater resources to face tense usage conflicts. On the ground, VOIs seem to be a kind of "bulwark" against strong threats. However, numerous issues concerning usage conflicts between the multiple stakeholders were pointed at during the interviews and confirmed by NGO members. For instance, regarding fishing activities, competition between local and industrial fisheries have been mentioned, besides conflicts created by salt exploitation activities.

"Everyone dispersed" (a villager in V3).

Tensions surrounding resources are such that safety issues are sometimes a major concern for patrollers. In V3, following a wave of violence (including murders) involving foreigners poaching in the mangroves, the village split in two. Only two years later did the rebuilding started (2020-2021). In fact, it appeared that local villagers are not armed to defend themselves in front of poachers. Even industrial poaching is common knowledge (for example, the exploitation of crabs by a Chinese company) but goes unpunished.

Further, during interviews, climate change consequences were regularly notified. For instance, in V2, villagers complaint about a change in the calendar of cultures and harvests. Moving coastlines and the impact of weather changes on agriculture (salt entries...) were pointed out in many instances: changing seasons, difficulties of cultivating rice with a rising sea level (salted waters), changes of culture locations. Others (V1) asked for a weather station to better organize fishing activities. In village V4, coastline setback (500 meters) caused progressive population displacement towards the inlands (see Figure 6).



Figure 6: Climate change impacts: village relocation in Ambakivao, Menabe, Madagascar. Sea level rise impacts villages and conducts to relocation. From top to bottom: Ambakivao (V4) in 2004, 2013 and 2023. Source: Google Earth pro.

Threats to mangrove ecosystems continue to be observed with, by order of importance, tree clearing (for land-use change), hunting, selective cutting and egg and chick collection. In particular, observers note the continuing use of *tarikaky* (forbidden nets made of mosquito nets) for fishing represent a great threat to channel (*tan-drano*) sedimentation. Additional disturbance is caused by lighting used for crab hunting (*tara-jiro*) and the intensification of salt exploitation activ-

ities while lanyards allow illegal products transport throughout the mangroves. Over-fishing may be an issue in some places (ie., V9) due to industrial fishing. Lastly, destructive behavior against tourists and armed vandalism were pointed at during interviews (ie., V7).

Nonetheless, the mangrove deforestation pace has been described as a "controlled" one (MEDD, 2022) as threats control to mangrove ecosystems has been quite improved since 2015 (ACT, 2021).

The PA establishment led to revenue losses for the local population who can no longer exploit the forest trees nor the fauna (hunting products). In line with the incentive-based conservation approach, to encourage LCs and mitigate poverty, numerous economic activities are supported, also called Income Generating Activities (IGAs). They include support to local agriculture (especially peanuts and lentils) and training in improved breeding technique (ducks, etc.), ecotourism, local artcraft, beekeeping, fish trade, etc.. Although elaborated based on discussions during participatory workshops at the *fokontany* level, it is estimated that about 75% of the Project Affected Population (PAP) did not receive any compensation for cutting right restrictions (MEDD, 2022). In fact, encouraged by NGO partners, they target very specific groups (VOI, women associations, young associations etc.).

4.3 Assessment of the eight principles for local natural resource governance

An analysis of the questionnaire and interview results through the lens of the governance framework developed by Ostrom revealed that only two principles (3 and 7) were fully respected.

In fact, according to principle 3, *the rights holders must participate in the development and modification of management rules*. In the present case, although the functioning is not based on co-management, the management transfer is based on closed cooperation between locals and the state authorities. Besides, it can be argued that via the CTGRN, the VOIs of the villages concerned are responsible for managing the resource of which they depend: rational exploitation for uses other than commercial, replanting to ensure the restoration of the mangroves. It validates the principle 7 stating that *higher authorities (state) must recognize the right of local authorities to self-manage resources, thus guaranteeing the subsidiarity principle*.

However, most of the other principles are not entirely respected. First, the delays observed in the drawing up and transmission of the maps to LCs de facto imposes a top-down relationship between the state authorities and the villagers. Trust is a fundamental aspect in the success of management transfers. However, corruption and admin-

istrative delays contribute to fueling mistrust towards the decision-making authorities. It can thus be asserted that principle 1 is not well respected.

Most of the time, local regulations apply, called *dinam-pokontany* (are dina) in V6 and V5 or *diman-pokolona* (village dina) in V4 and V1, in addition to specific rules for mangroves, or other local rules (V2: a fine of 5,000 AR is applied for not attending the meetings, V1: curfew, etc). Nevertheless, despite LCs' strict commitment to preserve the mangrove resource and its ecosystem, IGAs do not compensate them fully from the economic loss they suffer as a result of imposed regulations. Therefore, principle 2 is not validated.

Regarding principle 4, observations revealed that, at the VOI level, the sanction system is essentially based on the existence of close interpersonal relations between few villagers. Beyond that, there are multiple levels of authority and rules. In fact, the sanction system relies on the traditional hierarchy of authority. The "notable" (olders, richers, responsible persons) are called in the event of a conflict. Then, if the conflict remains unsolved, the conflict is brought before the FIVOI who decides eventually. In practice, the decisions are taken either by the *fokontany* and its chief (V5, V6, V9) or by the General Assembly of the *fokontany* (all the VOI members).

Although many conflicts are solved thanks to the dina of Menabe, the sanction system depends on each specific VOI's management rules. For example, in villages 6 and 8, there is no automatic sanction in case of unauthorized harvesting of mangrove wood (discussion is preferred). Conversely, in other villages, a strong financial penalty is applied (usually 10,000 AR). In most cases, discussion and reasoning of the culprits is preferred over sanction. Thus, principle 5 is not validated here.

An assessment of principle 6 leads to the conclusion that, at the local level, the system effectively allows rapid access to conflict resolution. However, for conflicts that cannot be solved locally, because of reduced communication means and of great physical distances between the villages, the FIVOI, the *fokontany* and the referent commune, resolution often takes time.

Regarding principle 8, communication between villages is encouraged by NGOs through reforestation and training, but cooperation between them remains scarce and often inefficient or inappropriate (ACT, 2021). In fact, efforts are conducted to strengthen communities' relationships and for the authorities to provide more detailed management documents (MEDD, 2014, 2022).

4.4 Facilitating sustainable conditions

A more comprehensive Ostromian analysis of the present context leads us to adopt the framework defined by Agrawal, 2001. Table 5 in Appendix section 7.1 presents the results derived from the contextual analysis. Figure 7 below helps conclude on the weaker points in the present case study, namely the state’s involvement in the resource management, the remoteness of those communities (hence the difficulties to adopt the appropriate technologies) and the low predictability of the concerned resource, the mangrove. However, both the group characteristics (small size, internal leadership), together with the institutional setting and the low integration to external markets (Chhatre & Agrawal, 2008) contribute to this conservation success.

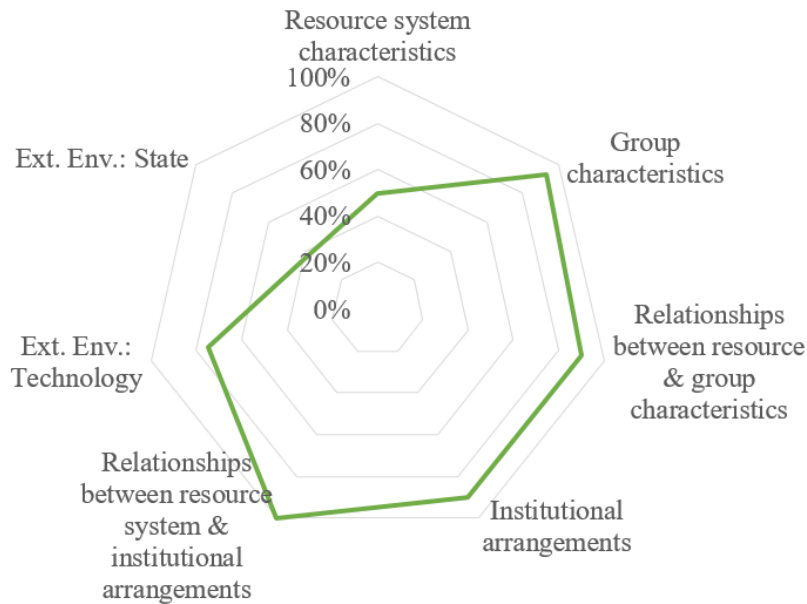


Figure 7: Radar plot for Ostromian approach. The figure displays the radar plot obtained from the results described in Table 5 in Appendix section 7.1.

5 Analysis: stakeholders’ relationships, environmental justice issues

We now investigate whether the four dimensions of environmental justice defined above are respected.

5.1 Distributive justice issues

5.1.1 Insufficient management resources: too much decentralization? Financing conservation as a distributive justice issue.

According to most interviews and management documents, the resources attributed to the VOI are insufficient to face the actual necessary needs.

Villagers blame the state and NGOs for not supporting them enough and letting them bear most of the management costs. For instance, there is a recurring claim among villages to support the build up of a technical house for the VOIs' specific activities. Besides, regarding conservation activities, the interviews revealed that poachers and authors of illegal cuts were heavily armed and violent (V3, V7), and corrupted members of the army were seen (V1). Villagers thus complained that they could rarely apply the timber cutting right rules to outsiders. In fact, there is a high level of insecurity along the coast, especially in V5 and V7. In 2022, out of the 584 surveillance missions planned in the entire PA, 357 were carried out, 13 by the patrollers (*OPJs*), during which 2,605 offences were declared and reported and only 22 fined (Fanamby, 2023).

Despite being the first programmed expenditure item, there is a lack of funding for monitoring activities since no NGO wants to contribute to any military intervention¹⁴. This issue is a great concern for all actors as it represents a security issue for goods and people in the PA (MEDD, 2022).

Globally, Tauli-Corpuz et al., 2020 found that personal investments in conservation (via private savings or labor time) reach about 15-23% of the total amount spent by the other actors (governments, donors, foundations, NGOs) (or between EUR 2.94 billion and 4.26 billion). In Madagascar, this distributive justice issue was already highlighted in Brimont and Karsenty, 2015. Here, private investments in conservation made by LCs through labor time is great. For instance, in V5, restoration and conservation "costs" can be approximated to about 950 Euros (see Figure 10).

Some PES schemes used to take place in the region, of which the impacts were analysed in Brimont and Karsenty, 2015; Sommerville et al., 2010 and Brimont and Leroy, 2018 but most of them stopped while creating disappointment (Louvain in Delta city). In fact, as pointed out by Hockley and Andriamarivololona, 2007, providing PES linked to CTRGN would probably be perceived as justified by the

¹⁴According to a Government Official (GO).

local population, who would then have a better understanding of the positive externalities resulting from conservation activities.

5.1.2 Women's role and status

Distributive justice also refers to the treatment of minorities and future generations. From an intra-generational justice viewpoint, it is important to take the role of women into account when evaluating the functioning of community management (Lebel et al., 2006). More precisely, the question is whether the community management of mangroves challenges the traditional distribution of gender-based assigned roles. In the present case, some progress have been observed regarding their emancipation. In fact, women, through the creation of associations, seem to assert themselves in the management of community affairs thanks to the new opportunities opened up by the diversification of economic activities. According to a Government Official (GO), there is in fact an appropriation by women of the mangrove protection issue, who seem to spontaneously create women's associations. These associations are dedicated to mangrove protection and restoration or to the management of IGAs which contribute to their emancipation from their traditional roles.

Studying the evolution of daily and economic activities among women in the Masikoro region (further south, west coast), Fauroux, 1986 showed that the traditional activities of women included more preferably crafts (weaving, basketry) than land cultivation (with low added value compared to breeding for men). Following the 1980s "cotton boom", gender relations were questioned thanks to new economic activities: women were looking for economic independence through personal fields cultivation (Fiéloux, 1990). Nowadays, activities such as rearing of turkeys, goats, pigs, as well as sewing have mostly been carried out by women (Fiéloux, 1990) and continue to be supported by NGOs. Here, such specific activities include dry fish trade (V2) or wood artcraft (V9), beekeeping (V8) and poultry rearing. In fact, ecotourism is greatly invested by women: in V9 for instance, about 200 foreigners used to be welcomed per day (before the 2020-2021 COVID crisis).

More generally, women often introduce social change in rural villages (Fiéloux, 1990). Thus, we come to a similar conclusion as Brimont and Leroy, 2018 regarding their role: thanks to the gain of management powers, they appear "on the public action stage" (Lascoumes & Le Galès, 2018). This can be explained by the fact that the definition of local policies, using an hybrid knowledge (mixing scientific and local knowledge), allows local actors to increase their influence,

precisely thanks to the acquisition of new knowledge and know-how (Delvaux & Schoenaers, 2012).

However, there remains an observable gender division: most women cook or take care of the house and children while men attend the VOI meetings with the NGOs. As a general rule, VOI presidents and patrollers are men. Only in some villages do women participate actively in the meetings. Most participants as VOI members were men (VOI presidents, assistants, patrollers), except in villages V8 and V9, men having set sail (see Figure 5). In general, even though sometimes a woman may be secretary of the VOI, they mostly participated as member of a "women association". In fact, women's economic independence still depends on their marital status: single and childless, they are free to diversify their sources of income, while as wives they lose their mobility beyond the home and fields (Fiéloux, 1990) .

5.2 Procedural justice issue

5.2.1 Top down processes characterize the management transfer to LCs

Regarding the area definition process and map production, according to villagers, each specific areas were defined based on mutual agreement between the contractors. In practice, discussions between *fokontany* members, technicians and NGO members, led to the drawing of intuitive maps which were then validated at the state level (WWF & CNFEREF, 2014). However, as the CNFEREF is eventually in charge of the area definition, the methodology used is close to a legal scientific one (Cosson et al., 2017)¹⁵.

The actual introduction of official delimitation signs has only been completed since 2023, after four years of failure (according to a GO). Overall, the administrative process seems not very informative for LCs: few villages are in possession of the contract document and maps are provided with great delays.

Two villages (V1 and V9) were in possession of the contract documents, the other were waiting for a response from the authorities. This administrative slowness from the state authorities was observed in V2, V3, V5, V6, and V7 as the contracts were not delivered for months or even years.

Nevertheless, this issue is acknowledged, as stated in the MEDD, 2022. It reveals existing power asymmetries between stakeholders. It was described in Brosius et al., 1998 regarding the production of maps favoring local elites versus LCs. It was also observed in natural re-

¹⁵The latter issues opinions independently from the state authorities.

sources community-based management in Botswana (Twyman, 2000). Similarly, it results in empowerment constraint for LCs. From a very critical viewpoint and using a political ecology approach, Huff and Orengo, 2020 describe the political and historical roots of the violence at play in the imposition of territorial limits by the state (privatizations, enclosures). In fact, conflicts over resource access have very ancient historical roots. In Madagascar, forest and mangrove in particular are both reserves of value and perceived as sources of troubles (protest against the dominant elite). It thus has become, since the XVIth century, both a controlled domain of the state and a place of systematic marginalization of LCs (Huff & Orengo, 2020; Watts & Peluso, 2013).

5.2.2 Power asymmetries

Further, despite recent responsibility transfers to local organizations, recurrent conflicts between *fokontany* and VOI tend to interfere with the smooth implementation of management activities (ACT, 2021). As explained in Blanc-Pamard, 2012 there is an inherent asymmetry in the CTRGN which are often confusing for LCs, even in the words (in French, "transfert de gestion" translated to "*famindram-pitantana*" meaning "transfer of ownership"). Despite an apparent participatory framework, decisions are too often based on a top-down approach (Bidou et al., 2008). Besides, in the Menabe region, the city council, central coordination actor between external aid providers, is an unbalanced power (Bidou et al., 2008). Information sharing about the APMA to *fokontany* remains insufficient. The GELOSE process is based on a simplified approach to LCs, conceived as "homogeneous with identical individual and deploying similar strategies" (Bidou et al., 2008). As a result, some groups may be favored over others (Blanc-Pamard & Fauroux, 2004). Eventually, in the visited villages, a traditional set of regulations applies eventually to any unresolved conflicts, the dina of Menabe, of which the legitimacy has been questioned (Huff & Orengo, 2020).

5.3 Recognition

5.3.1 Traditional knowledge

Recognition of traditional knowledge and of local dialects is also key as few people - and mostly men - have access to secondary education. Mobile phones are provided to VOIs, which are both an information sharing technique and an empowerment tool for LCs. It proved efficient in other contexts (McCarthy et al., 2018). Providing translated

documents or using signs is also a way of recognizing traditional knowledge (ie., the phone explanatory note). Problems of access to phone chargers and networks were nevertheless reported.

5.3.2 Household well-being and development

The PA establishment led to revenue losses for the local population, despite IGAs. Thus, a better targeting of the PAP and their needs (MEDD, 2022) while taking into account migration waves (populations displacements) is necessary. Nonetheless, cooperation between LCs and external actors allows the acquisition of technical know-how. In fact, investments in livelihoods (Charnley, 2023) are key in the context of biodiversity conservation.

The management transfers only concern a minor cause of decline in the mangrove ecosystem, namely selective cutting. In fact, the two main causes of mangrove impoverishment are not really the main focus of these contracts, hence the importance of insisting on auxiliary measures linked to institutional and technical capacity building.

5.4 Enabling conditions - capabilities

5.4.1 Education to environment issues

The Malagasy case study highlights the importance of the enabling conditions, in particular environmental awareness through education (Rakotonarivo et al., 2023). In fact, there is often a positive correlation between adherence to protective measures and the level of education (Liu et al., 2010). According to the studied documents and interviews of NGO members, workshops aimed at increasing environmental awareness have been carried out multiple times in the area. However, the stakeholders' workshop (ACT, 2021) concluded that more initiatives were needed, especially for the resource managers (SIG and other spatial planning techniques, decision-making processes and existing regulations) and patrollers (conflict resolution techniques). In addition, to fight against illegal fishing, observers advocate for greater awareness initiatives about illegal techniques.

5.4.2 Communication between actors and stakeholders

In practice, villages tend to coordinate mostly with the above authority (FIVOI). Exchanges, organized with other communities, including outside the PA (southern Madagascar) (V4, V7, V8, V9), are perceived as very instructive and beneficial by the participants. In fact, a

better interconnection between villages and a greater communication between all the stakeholders would be very beneficial to biodiversity conservation (Koch et al., 2023).

5.4.3 Persistent gender division

Despite progress observed and described above, the persistent gender division hampers the capabilities of women to fully participate (on an equal footstep with men) to the resource management.

5.5 Indicator frameworks: findings summary

The radar plot below (Figure 8) shows that the scores obtained for the enabling conditions and recognition dimensions of environmental justice are quite high (75% and 85% respectively). Nevertheless, it also sheds lights on the issues mentioned earlier regarding the distributive and procedural dimensions (63% and 58%).

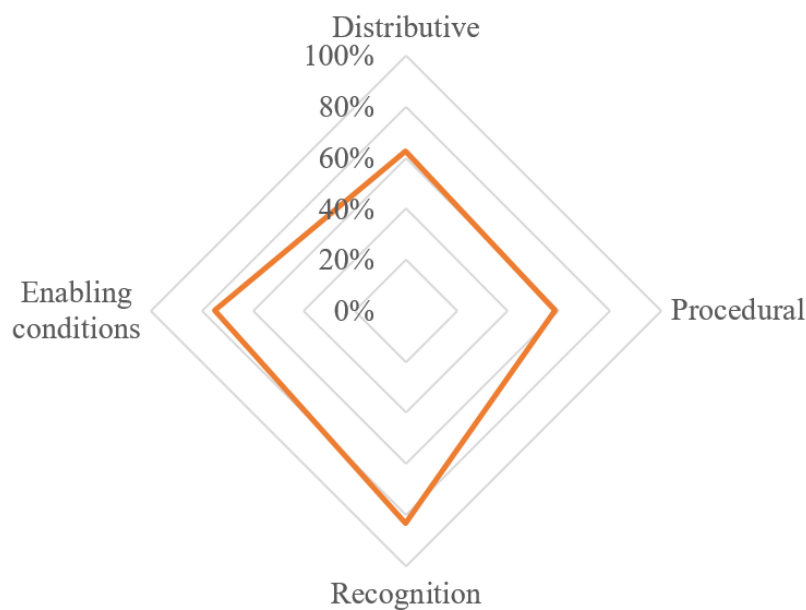


Figure 8: Radar plot for Environmental justice. The figure illustrates the results obtained and presented in Table 6 in Appendix section 7.2.

6 Discussion and conclusion

6.1 Why is it working anyway?

"Everyone contributes, women and children, on mangrove restoration days."

Overall, beyond all the justice issues highlighted above, we found that the mangrove management was effective for at least three reasons, namely: the strong rule ownership by the villagers, a strong social control supporting the management rule implementation and the pivotal role of NGOs.

Testimony by a villager: following a reforestation undertaken in 2013 (creation of the VOI in 2012), the inhabitants are now feeling the benefits, they have thus noticed an increase in rainfall, they are therefore determined to continue their efforts. Antsakoamaliniky (V6), meeting under the tamarind, administrative center of the city of Delta (2,000 inhabitants).

First, through the interviews, it appeared clearly that there is a collective recognition of the legitimacy of the applied management rules, and a strong rule ownership by the villagers. Visible depletion, acknowledged dependence towards the resource and the impressive consequences of climate change were the main justifications provided. Besides, despite the "injunction to participate" which accompanies the management transfers (Blanc-Pamard, 2012; Blanc-Pamard & Fauroux, 2004; Cooke & Kothari, 2001; Ferguson et al., 2014), many - spontaneous - participatory aspects in the decision-making (raised hands votes, conflict resolution, etc.), contribute to confirm this collective support to the rules. In fact, over the last few years, there has been a strong awareness of the value of mangroves by people for their own subsistence. This result contradicts those of Rakotonarivo et al., 2023 about forest restoration in Madagascar as the population seems aware of the hidden benefits of restoration.

Climate change affects land dynamics at the local and global levels, causing space reorganization for cultures and potential conflicts about resettlement areas (Ionesco et al., 2016). Institutional resilience of formal and informal institutions (Herrfahrtd-Pähle & Pahl-Wostl, 2012) are key to allow local land adjustments, in particular rural mobility. However, climate change is barely taken into account in management plans and no measure are taken to encourage CO2 capture (Fanamby, 2023).

"There's nothing that can't be solved by talking".

Secondly, the effective implementation of the management rules relies on social control. Villages are small and everybody knows everyone. Thus, when a conflict appears, a meeting takes place to force the offender to comply with the collectively defined rules. In V4, V8 and V9, monetary sanctions apply in case of breaching of the rules regarding timber extraction. In the other villages, as when an assigned role within the VOI is not fulfilled (for example if a patroller refuses to carry out his task), the offender is denied any responsibility within the VOI, or forced to apologize towards the community. The rule and sanction system described seem to rely on social control. In fact, in the absence of clear sanctions, it explains why the rules are respected by the villagers: in small communities especially, social control is strong. Described as the capacity of a society to regulate itself (Ross, 2009), it is a process allowing to maintain social stability by sanctioning and thwarting deviant behaviors (Parsons, 1991). This result confirms the role of group size in SESs: as a general rule, the smaller the group in charged of managing an open-access resource, the better the outcomes regarding nature conservation (Casari & Tagliapietra, 2018). This social control can be compared to the Malagazy concept of *havo* described in Fauroux, 1997. Complex phenomenon deeply rooted in the Sakalavas' spirituality, it refers in an individual to a feeling of guilt bringing bad luck after a breach of rules laid down by ancestors or *Zañahary* and which transmits through a lineage group. The vegetable world is particularly concerned with this phenomenon and must be highly respected¹⁶.

Although this system does seem to work at the *fokontany* level, it is a very different story when a conflict involves outsiders. Inter-ethnic relations are characterized by tensions about the uses of natural resources. In fact, the Sakalava *vezo* have seen their way of living historically threatened by the over-exploitation of fishery resources and land conversion to rice cultivation (to which they also contribute).

Thirdly, this conservation success clearly relies on the pivotal role of NGOs (Hearn, 1998). They are greatly involved and seem to compensate for the lack of state support. Many NGOs frequently visit the area (including USAID, WWF, Durrell, Louvain cooperation): more trusted than the state (depicted as "corrupted"), they have access to reliable information and contacts. They provide materials (canoes, miscellaneous objects) and information to the villagers (ie., the WWF guide to mangrove reforestation).

The encouragement to organize through associations, the diversi-

¹⁶To get out of the *havo*, a ceremony is organized where the ancestors are summoned by the *ombiasy* (the healer, close to a shaman) followed by a sacrifice (often of a beef whose spilled blood washes out the *havo*) (Fauroux, 1997).

fication of economic activities, the efforts led in developing education infrastructures within the communities contribute to increase their resilience, as described in Cinner et al., 2009. In short, "resilience is the ability of a social-ecological system to cope with and adapt to external social, political, or environmental disturbances (Cinner et al., 2009; Folke et al., 2002). It can be analyzed via the use of specific indicators, namely 1) flexibility (degree of dependence on natural resources for household survival), 2) capacity to organize (participation to community life, migration), 3) capacity to learn (perceptions, education level) and 4) assets (living conditions such as type of roof, quality of infrastructures) (Cinner et al., 2009).

The flexible approach to conservation implemented allows to take into account the LCs' uses and opinions through a participatory approach (Wegner, 2016). The strong ownership by LCs of the mangrove management issues results from a recognition by NGOs of their way of living, informal rules and needs. This study confirms the key importance of the NGOs' - termed "bridging organizations" - in mediating between various decision levels - both vertically between villages and the state authorities (or enterprises providing PES) and horizontally between villages (Berkes, 2009; Olsson et al., 2007; Rathwell & Peterson, 2012).

Figure 9 below summarizes the theoretical approach used in this study.

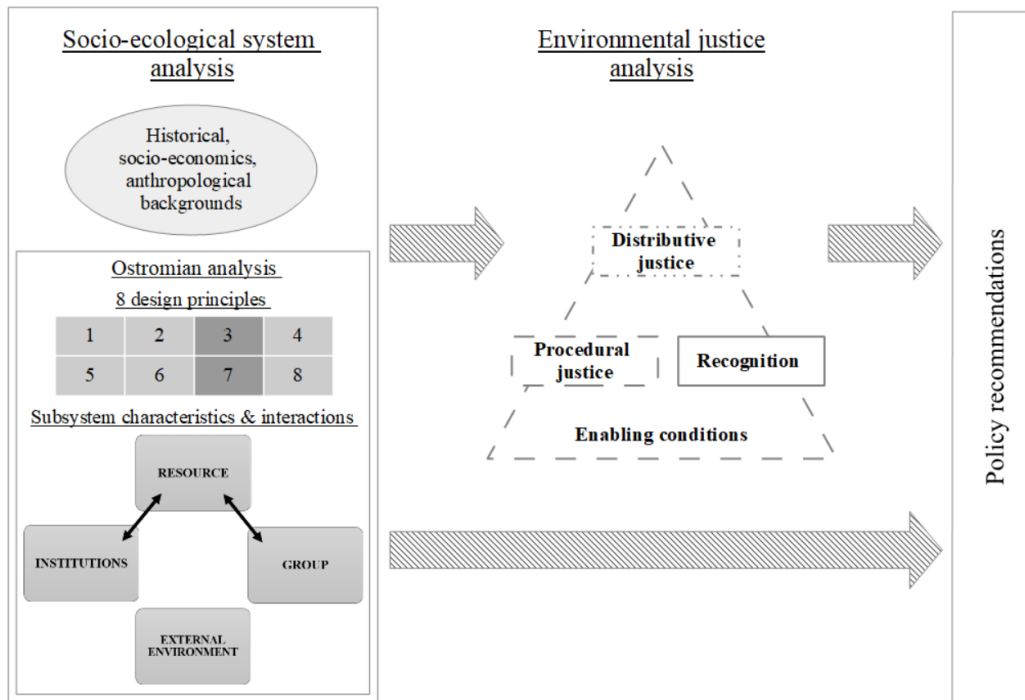


Figure 9: Theoretical framework, from Ostrom to environmental justice. The drawing presents a summary of the theoretical frameworks used, namely, within an SES analysis, an assessment of the eight design principles and of the four subsystems' characteristics, combined with historical, sociological, economics and anthropological contexts that help provide an environmental justice analysis. Policy recommendations are then formulated. Regarding the Ostrom principles, only principles 3 and 7 are fully validated. Concerning the environmental justice analysis, a solid line represents a validation (ie., recognition), as opposed to a dotted line (ie., distributive justice).

6.2 Policy recommendations

Thanks to a qualitative approach and the use of Ostromian assessment frameworks of CPR management, we could assess the four dimensions of environmental justice and draw conclusions on the way LCs are affected by the mangrove management transfers and what could be improved to foster an efficient mangrove conservation. A summary table is provided below (see Figure 4).

An assessment of the design principles of the mangroves management helped define some of the main issues at stake: the top down relationship between the state authorities and the villages, the lack of communication between stakeholders, the weakness of the sanction system in case of illegal practices. Additional results derived from the sustainable enabling conditions of the Ostromian approach highlight

the necessity to adapt to new technologies for remote communities facing a rather un-predictable resource evolution in the context of climate change. By extent, the latter issue sheds light on the importance of land ownership securitization.

Thus, procedural and distributive justice issues were identified: the lack of human and financial resources devoted to the protection of mangroves, a disconnection between PAP by conservation measures and IGAs.

Those issues are exacerbated by increased land scarcity in Madagascar and climate change, reducing the available space for local populations. Resolving these justice issues, even if major improvements are underway, would increase the effectiveness of mangrove conservation management in the APMA.

Regarding distributive justice, granting PES, as it used to be in the region (Sommerville et al., 2010), would not be the miracle solution though. Their relevance is not so clear-cut: one question is whether one should pay for practices that should have taken place anyway (intentionality issue) (Colin et al., 2023; Karsenty & Dieng, 2021), as there is a risk of undermining local institutions (Gatiso et al., 2022; Ravikumar et al., 2023).

Env. justice dimension	Positive aspects	Negative aspects	Recommended measures
Procedural	Dialogue between conservation actors in the map definitions and project implementation.	Top down processes; Lack of efficient communication and coordination between conservation actors (state-VOI- <i>fokontany</i>) and stakeholders in the long term.	Share the collected data; Update the responsibility charter to encourage effective participation and coordination of all actors; Make the <i>fokontany</i> aware of all APMA activities
Distributive	IGAs development.	IGA beneficiaries identification.	Better identification of IGA beneficiaries; Redirect part of the funding received to compensate VOIs; Provide VOI with equipment and materials; Secure external funding to APMA.
Recognition	Rites and cultural values recognized.	Untranslated documents (French, Malagazy, local dialects).	Translate all data and documents in local dialects.
Enabling conditions	Marginalized groups (women) encouraged to self-organize; Education to environment programs.	Poor access to education, low level of literacy.	Build infrastructures to provide a more efficient and inclusive education system; Capacity building: education to environmental issues; implement a behavior change program for LCs and migrants; Reinforce technical capacities to address local forest offences.

Table 4: Summary table and policy recommendations. The recommendations displayed here were informed by our study and information provided in the evaluation documents ACT, 2021; MEDD, 2014, 2022.

6.3 General conclusion

This paper contributes to the existing literature on PA management in two ways. First, it presents a case study located in the APMA Menabe Antimena, a vast area which also concerns the MPA Tsihibirina mangroves. Second, it provides an analysis framework combining an assessment of the effectiveness and environmental justice issues for a specific protected area.

Although the main threats to mangroves in the region are land clearing and poaching, the management transfers address selective cutting and reforestation. The latter activity alone, led by LCs, cannot explain the success of the conservation initiative. In particular, by drawing a parallel with the failure to protect dry forests, it can be asserted that the lack of market integration (large investments, difficult access routes) of mangroves products and the small size of the groups

managing the mangroves, contribute significantly to the preservation of the resource.

Thanks to the use of an environmental justice framework, we highlighted some of the main issues at stake regarding the four dimensions of justice, namely distributive, procedural, recognition and the enabling conditions. It appeared that enhancing this last dimension, via for instance the providing of environmental awareness workshops and appropriate training to patrollers, improving the legal security of the land ownership system, would be instrumental in insuring that the three other dimensions of justice are respected.

We conclude this study by noting that the management transfers contribute to raise awareness about the consequences of climate change among LCs and to encourage women to emancipate through the development of their own economic activities, a trend observed since the 1980's. Further, those measures may support the improvement of social resilience of the coastal communities through, for instance, incentives to develop new economic activities, so long as they are compatible with mangrove conservation.

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Additional interviews were conducted with other members of NGOs (USAID, Wildlife Conservation Society, etc).

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7 Appendix

7.1 Facilitating sustainable conditions results

Core element	Score	Validation
Resource system characteristics		50%
Small size	1	
Well-defined boundaries	0,5	
Low level of mobility	0,5	
Possibilities of storage of benefits from the resource	0	
Predictability	0,5	
Group characteristics		93%
Small size	1	
Clearly defined boundaries	1	
Shared norms	1	
Past successful experience - social capital	1	
Appropriate leadership - young, familiar with changing external environment, connected to local traditional elite	0,5	
Interdependence among group members	1	
Heterogeneity of endowments, homogeneity of identities and interests	1	
Low levels of poverty	0	
Relationships between resource & group characteristics		90%
Overlap between user group residential location and resource location	1	
High level of dependency by group members on resource system	1	
Fairness of allocation of benefits from common resources	1	
Low levels of user demand	0,5	
Gradual change in levels of demands	1	
Institutional arrangements		90%
Rules are simple and easy to understand	1	
Locally devised access and management rules	1	
Ease in enforcement of rules	0,5	
Graduated sanctions	1	
Availability of low cost adjudication	0,5	
Accountability of monitors and other officials to users	0,5	
Relationships between resource system & institutional arrangements		100%
Match restrictions on harvests to regeneration of resources	1	
External environment		56%
Ext. Env.: Technology		75%
Low cost exclusion technology	0	
Time for adaptation to new technologies related to the commons	1	
Low levels of articulation with external markets	1	
Gradual change in articulation with external markets	1	
Ext. Env.: State		38%
Central government should not undermine local authorities	0,5	
Supporting external sanctioning institutions	0	
Appropriate level of external aid to compensate local users for conservation activities	0	
Nested levels of appropriation, provision, enforcement, governance	1	

Table 5: Facilitating sustainable conditions assessment. For each condition, a score is given between 0 (No) and 1 (Yes). A validation score is then calculated.

7.2 Environmental justice dimension

Environmental justice dimension	Criteria	Score	Validation
Distributive			63%
	Identification and assessment of costs, benefits and risks and their distribution and trade-offs	0.5	
	Effective mitigation of any costs to LCs	0	
	Benefits shared among relevant actors according to one or more of the following criteria: 1. Equally between relevant actors or 2. According to contribution to conservation, costs incurred, recognized rights and/or the priority of the poorest	1	
	Benefits to present generations do not compromise benefits to future generations	1	
Procedural			58%
	Full and effective participation of all relevant actors	0.5	
	Clearly defined and agreed responsibilities of actors	1	
	Accountability for actions and inactions	0.5	
	Access to justice, including an effective dispute-resolution system	0.5	
	Transparency supported by timely access to relevant information in appropriate forms	0.5	
	Free, prior and informed consent for actions that may affect the property rights of IP and LCs	0.5	
Recognition			83%
	Respect for human rights	1	
	Respect for statutory and customary property rights	0.5	
	Respect for the rights of Indigenous People, women and marginalized groups	1	
	Respect of different identities, values, knowledge systems and institutions	1	
	Respect of all relevant actors and their diverse interests, capacities, and powers to influence	0.5	
	No discrimination by age, ethnic origin, language, gender, class, and beliefs	1	
Enabling conditions			75%
	Legal, political and social recognition of all protected area governance types	0.5	
	Relevant actors have awareness and capacity to achieve recognition and participate effectively	0.5	
	Alignment of statutory and customary laws and norms	1	
	An adaptive and learning approach	1	

Table 6: Environmental justice dimensions, criteria and their score for the mangrove conservation area in the Menabe region, Madagascar. For each condition, a score is given between 0 (No) and 1 (Yes). A validation score is then calculated.

7.3 Income loss for LCs

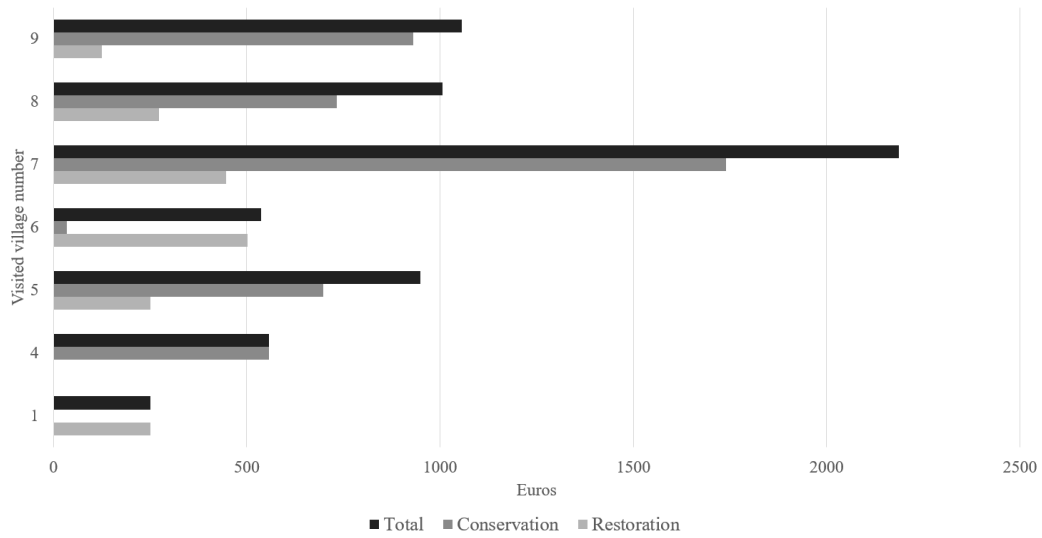


Figure 11:

The graph shows that private investments in restoration and conservation made by LCs through labor time is great, especially in V7.

The calculus is based on declarations regarding the number of workdays spent per year by villagers to either restore or protect the mangrove (conservation). For instance, in V5, restoration "costs" 3 people \times 3 days \times 12 months \times 10,000 AR = 1,080,000, and conservation actions "cost" 100 people \times 3 days \times 10,000 AR = 3,000,000. The total amounts to about 949 Euros. The maximum value recorded was in village V7 (2,186 Euros). Villages V3 and V4 were excluded due to insufficient data. Applied exchange rate Euros/AR : 1 E=4,300 AR (2022).; 1 workday revenue estimated to 10,000 AR.