

A longitudinal governance analysis of a locally managed marine area: Ankobohobo wetland small-scale mud crab fishery, Madagascar

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ABSTRACT

Small-scale fisheries are a cornerstone of coastal livelihoods throughout Madagascar, providing income, nutrition, and a way of life to over half a million people. Due to limited state capacity, community-based management of marine resources has proliferated, with locally-managed marine areas (LMMAs) becoming a major avenue for coastal resource governance in Madagascar. Though case studies of LMMAs exist, little research has tracked their effectiveness over time. In 2016, the Marine Protected Areas Governance (MPAG) framework was used to critically assess the governance of the Ankobohobo wetland's mud crab fishery: the first analysis of a fishery produced using the framework. This study revisits Ankobohobo using the same methodology three years later, representing the first longitudinal application of the framework. Overall, participants throughout the fishery revealed a lack of progress towards management goals and emphasized the vulnerability of the governance model to external drivers of change. Despite substantial efforts from fishers and fishing associations to secure sustainable crab fishing, progress is hindered by an absence of support from the state or NGOs. Persistent challenges include intensified mangrove logging, declining crab stocks, increased fishing effort, and entrenched poverty. These are driven by factors beyond the communities' control: global markets, population growth, migration, and a lack of viable, income-generating activities. These findings emphasise that a purely bottom-up, community-led approach cannot address external drivers. Effective governance requires a diversity of actors and incentives combining bottom-up and top-down approaches. The absence of this in Ankobohobo explains the lack of progress in the three years between these assessments.

1. Introduction

In Madagascar, many coastal communities rely directly on marine resources for sustenance and livelihoods [1,2]. Over 500,000 Malagasy citizens are involved in the fisheries and seafood sector, with the majority participating in small-scale fisheries (SSF) [2,3]. Typical of low-income countries, limited alternative economic activities intensifies reliance on marine resources [4]. Reportedly, overexploitation has resulted in a decline of fishery stocks throughout the country [1,5]. The loss or degradation of key ecosystems, (e.g. coastal mangroves) further threatens SSFs and communities [6,7]. However, due to low state capacity and limited funding, the management and governance of SSF and coastal ecosystems are often left to local actors, with limited state involvement [8,9].

In Madagascar, locally managed marine areas (LMMAs) have emerged as one potential solution to address the limited state capacity for the management of coastal ecosystems and SSFs [10]. The LMMMA model seeks to establish community-based natural resource management (CBNRM) in marine settings, with governance driven by the involvement, collaboration, support, and knowledge of local communities [11–13]. This bottom-up mode of governance is increasingly widespread in contexts where state-capacity for top-down regulation is limited [14]. Since 2004, LMMAs have proliferated, with 178 LMMAs now covering 4.36% of Madagascar's exclusive economic zone (EEZ) [10,15,16]. Almost all LMMAs contain SSFs, and are supported by MIHARI (*Militantana HAREna and Ranomasina avy eny Ifotony*/'marine resource management at the local level') a network of LMMAs, which supports and advocates for fishers and coastal communities [10,17–19].

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Numerous LMMAs in the MIHARI network have achieved legitimised co-management under Madagascar's Protected Area System (SAPM, No. 848–05) [20], whilst others are more organic initiatives with little or no external support. Many LMMAs codify management measures through the use of a *dina*, a customary system of law [21]. Since 1996, *dina* have been incorporated into national law, meaning that where ratified they can be enforced by the state [22], which is an option employed in some LMMAs [23].

However, LMMAs can face significant challenges in fulfilling management goals, particularly with regards to sustainable fishing and marine conservation [8,23]. This puts many LMMAs at risk of becoming “paper parks,” whereby coverage goals appear to be met, but governance is actually neither effective nor equitable [24,25]; a challenge encountered in marine protected areas (MPAs) globally [24,26,27]. Persistent issues in Madagascar's LMMAs include: limited tangible local benefits from fishery restrictions; insufficient consultation with local actors; low compliance with regulations; and high levels of poverty [23, 28–30]. Limited livelihood opportunities result in increased fishing effort and natural resource extraction [31–33]. Despite some moderate successes, LMMAs in the south-west Indian Ocean region (SWIO) identify common and sometimes insurmountable challenges, including; changes in supply chains; incursion by outsiders; weak enforcement; financial instability; population growth; insufficient participation; and a lack of capacity [23,29,34,35]. This capacity gap may be largest in LMMAs that lack strong, or any, partnerships with third parties (e.g. NGOs) [23]. The absence of state support exacerbates these challenges, with local managers operating without a wider supportive framework and vulnerable to external threats beyond their capacity to address [26, 35,36].

A case-study example of these challenges was provided by the Ankobohobo small-scale crab fishery, which underwent a Marine Protected Areas Governance (MPAG) analysis using data collected in 2016 and 2017 [37] and can be considered a LMMMA. The MPAG framework was originally developed as a structured, empirical tool to assess the effectiveness and equity of MPAs [38] and was subsequently adapted to be applied to fisheries [26,37,39]. The MPAG framework is based on the coevolutionary theory that neither top-down nor bottom-up modes of governance alone confer effectiveness to a governance structure. Rather, a combination of both, alongside market mechanisms, may build resilience within the governance of a given MPA. By utilizing a diversity of incentives from legal, economic, communication, knowledge and participatory categories, a given management unit, or in this case, SSF, will be able to achieve management objectives [38].

The original MPAG assessment of the Ankobohobo LMMMA in 2016 [37] found that the small-scale crab fishery faced significant threats from the effects of market forces and migration, with the demand for charcoal, timber, and crab negatively impacting the mangrove habitat and crab stock on which the fishery depends. Three nascent fishing associations were managing portions of the fishery, with notable management measures including fishery-wide gear restrictions and community-led efforts to restore areas of degraded mangroves. However, governance effectiveness was limited. The incentives employed were not adequate to address threats, with many incentives identified as in need of introducing or strengthening. Fishers were found to be under-represented in local natural resource management institutions, and a lack of co-ordination between existing fisher-led initiatives undermined effectiveness at the scale of the fishery and mangrove ecosystem. A key barrier was the lack of external support, especially from the state, a finding which has been made elsewhere and emphasised by the MIHARI network [23,40,41].

The problems as identified in Ankobohobo, reminiscent of challenges faced by LMMAs nationally, necessitate a critical examination of the limits of the LMMMA model, with particular attention to barriers to achievement of equitable and effective sustainable resource use, and the potential constraints created by employing a predominantly bottom-up governance approach. Given the widespread and recurrent nature of the

challenges identified in Ankobohobo and other LMMAs, it is critical to understand how actors respond and governance evolves over time. This study revisits the Ankobohobo LMMMA three years later, providing the first longitudinal application of the MPAG framework. Such longitudinal evaluations may provide crucial insights to develop and sustain effective and equitable governance structures.

2. Methods

2.1. MPAG framework

This case study used the MPAG framework, an applied governance analysis framework which provides a standardised structure and empirical approach to critically analyse the governance of MPAs [26, 38]. This methodology was used in the original assessment [37]. The application of the MPAG framework, its underlying theoretical framework, strengths and limitations are extensively discussed by Jones and Long [26]. In brief, the framework collects and analyses primary and secondary data to provide a holistic and critical account arranged under the following headings: *Context, Objectives, Drivers/Conflicts, Governance framework/approach, Incentives, Effectiveness, and Cross-cutting issues*. A key element is the identification of which of 36 possible incentives, from five categories (economic, legal, communication-based, knowledge-based, or participatory) are employed in the governance structure of a given protected area and how they interact. Crucially, it also seeks to identify which incentives require strengthening or introduction in order to address the threats or impacts and assigns an effectiveness score (on a scale of 1–5) based on the extent to which the drivers or threats are addressed and the objectives are met. The MPAG framework rejects idealised models of governance that implicitly promote ‘bottom-up’ or ‘top-down’ approaches. Instead, the MPAG framework is based on a realist coevolutionary model of governance that recognises that in any context effective governance is necessarily and combination of both ‘bottom-up’ and ‘top-down’ approaches, where resilience is achieved through a diversity of actors and the coevolution of the incentives they collectively employ. The framework has been applied to over 50 case studies [26], which supports direct comparisons and is oriented towards providing actionable findings for communities, NGOs and the state. Inevitably, this approach has its limitations, which are discussed elsewhere (see Long and Jones, 2021 [26], and Bennett, 2015 [42]), and include: the positionality and interpretation of the researcher(s); and challenges of assessing effectiveness with a single indicator. Whilst no analytical framework or its underlying theory is perfect, the strength of employing MPAG approach here is that its structure and methodology are repeatable, allowing direct comparison with the previous study [37], supporting a rare examination of how the governance of a LMMMA has changed over time.

2.2. Data collection

Primary data were collected in June–July 2019 within the Ankobohobo LMMMA, in the Mariarano rural commune of the Boeny region, northwest Madagascar (Fig. 1). This study included the seven locations from the original assessment; Andriamandroro, Antsena, Antafiamahagandra, Antafiameva, Antanandava, Bekobany, and Mariarano; as well as one new location; Antsakoambezo.

Semi-structured interviews and focus groups were used to collect primary data for actors representing different constituencies (Table 1). For interviews, constituency codes followed by sequential number (e.g. CF1) are used to attribute findings hereafter.

Semi-structured interviews ($n = 36$), lasting 30–50 minutes, were conducted to gain insights into individuals' experiences with, and perceptions of, governance within Ankobohobo (Table 2). Interviews utilised open-ended questions to engage stakeholders in a dialogue [45], providing a flexible method to explore established themes [46]. Focus groups ($n = 5$, 3–10 participants, FG1 to FG5) provided a comfortable

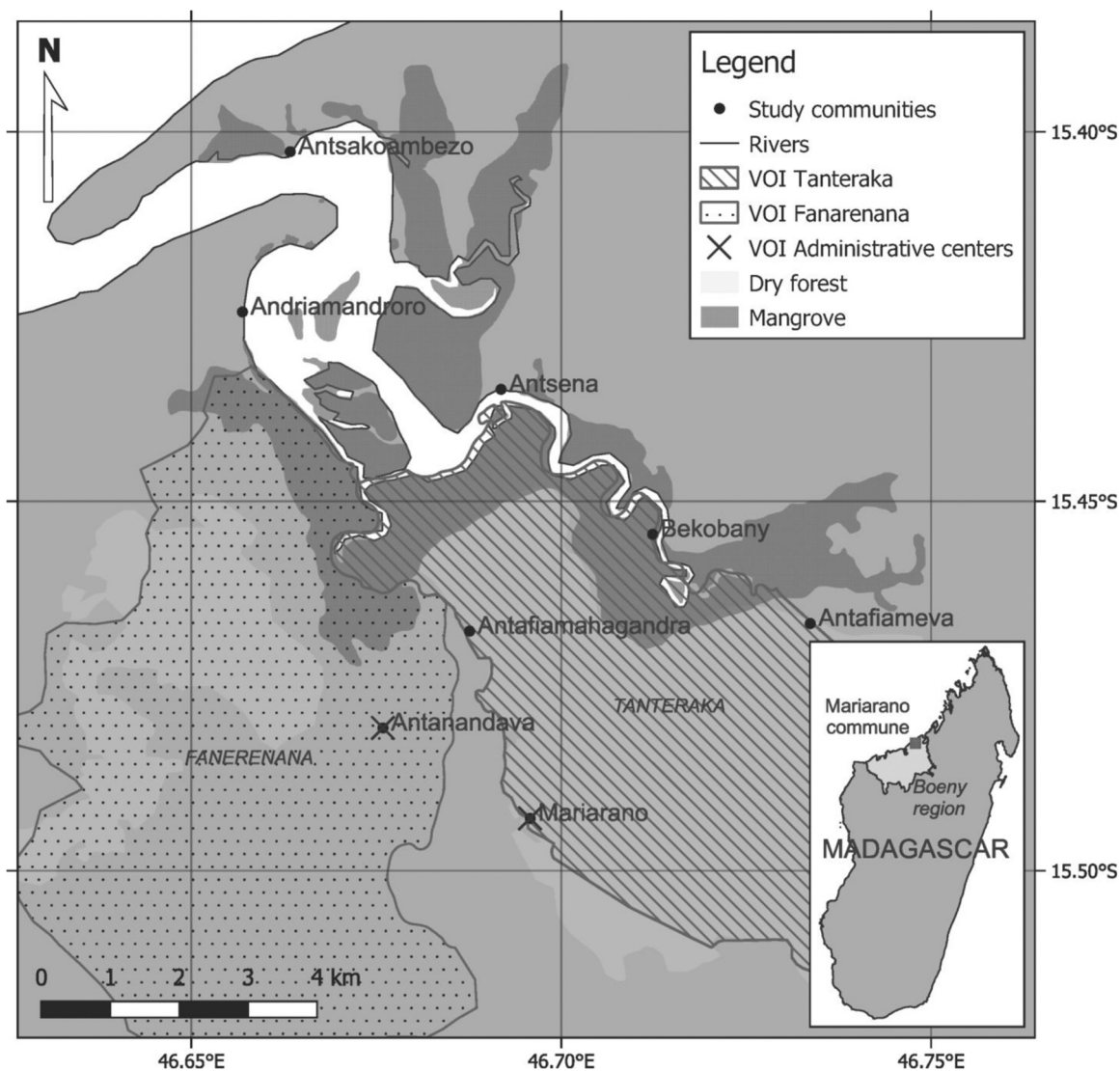


Fig. 1. Study area within Mariarano commune, Boeny region, northwest Madagascar. The Vondron'Olona Ifotony (VOI) Tanteraka and VOI Fanarenana areas of management responsibility are indicated as determined from georeferenced management transfer documents. Mangrove extent from Spalding et al. 2010 [43]. Coastline from Sayre et al. 2018 [44].

Table 1
Interview and focus group constituencies, showing the code used for attribution and number of participants.

Constituency	Code	Number of participants		
		Interviews	Focus group	All
Crab collector	CC	7		7
Crab fisher	CF	19	21	40
Fishing association leader	FA	2		2
NGO	N	1	2	3
Community member	OA	3		3
Public figure	P	2	2	4
Vondron'Olana Ifotony (VOI)	V	2		2
ALL		36	25	61

setting for discussion and allowed for wider involvement in a time-limited study (Table 2). Initial participants were identified and contacted upon arrival at the study site based on the findings of Long et al. [37]. Additional interviewees were identified at the recommendation of local guides, community members, and via snowball sampling [45,47]. Total participants in both individual semi-structured interviews and focus groups numbered 61 (Table 1).

Table 2
Number of interviews and focus groups disaggregated by community, with focus group size and composition detailed.

Fokontany	Community	Interviews	Focus group		
			ID	Size	Composition
Mariarano	Mariarano	7	FG5	3	NGO (2), public Fig. (1)
		8	FG1	3	Crab fishers
		2			
		9			
		3	FG2	10	Crab fishers (9), public Fig. (1)
Marosakoa	Antanandava	1			
	Andriamandroro	2	FG3	6	Crab fishers
	Antsakoambezo	4	FG4	3	Crab fishers
ALL		36	5	25	

Interviews and focus groups were conducted in Malagasy and were translated to English for functional equivalence by a researcher with extensive experience working with rural communities. Interviews and focus groups began with introductions and an explanation of study intentions, and were only recorded with explicit informed verbal consent from participants. If a participant did not wish to be recorded, notes were taken throughout the interview instead, again with explicit verbal consent. Responses were anonymised and attributed using codes (Tables 1 and 2). Study design was informed by context specific socio-economic monitoring guidelines for the Western Indian Ocean [48] and followed UCL's research ethics requirements.

Secondary data were obtained from: administrative documents from the Mariarano *fokontany* (smallest administrative district in Madagascar) and greater Mahajanga II district; the Mariarano Commune Plan, Malagasy national fisheries legislation, local fishing association (FA) documents, and local management transfer agreements.

For each interview, notes and/or transcripts were summarised in interview reports, following protocol established by Jones [38]. Reports were then 'open-coded,' with emergent common themes and issues noted throughout all reports and grouped together to produce key issue documents. Information in documents was also clustered accordingly. Issue documents then served as the raw material for analysis via the MPAG framework, informing each key section: (a) context, both country and local; (b) governance framework/approach; (c) drivers and conflicts; (d) incentives used; (e) effectiveness; (f) cross-cutting issues, and (g) incentives in need of strengthening or introducing (see [26] for further details on the MPAG framework).

3. Context

The study site is in the Ankobohobo wetlands, encompassed within the *fokontany*s of Mariarano and Marosakoa in the Boeny region, northwest Madagascar. The area hosts significant biodiversity, including the Critically Endangered Madagascar fish-eagle (*Haliaeetus vociferoides*) and the Critically Endangered Coquerel's sifaka (*Propithecus coquereli*) [49,50]. The Ankobohobo wetlands include an estimated 2330 ha of mangroves, one of the largest remaining intact mangrove ecosystems in the region [7]. The villages included in the original and present study are located amongst the wetlands, and within a savanna, dry forest, and agricultural matrix.

Little difference in the national, regional, and local context was identified between the original assessment (2016) and the present longitudinal study (2019). Decreases were recorded in the Human Development Index (HDI), in which Madagascar fell from 158 out of 188 countries in 2016–164 in 2019 [51]. GDP growth rate and state capacity remained relatively consistent at 4.2% and -0.74 on a range of -2.50 – 2.50 , respectively (formerly 4.1% in 2016 and -0.72 in 2015) [52,53]. The rate of population growth remains high, particularly within the Boeny region, where populations have risen from 391,100 to nearly 931,200 between 1993 and 2018 [54]. The original study noted that within the *fokontany*s of Mariarano and Marosakoa, birth rates and in-migration were especially high, with the population growing at approximately 5.6% per year [37], with no updated figures available in 2019.

In combination with low state capacity and rapid population growth, target communities have been described as facing significant barriers to development, a finding affirmed by the original assessment and in 2019 [37,55]. A study completed in 2015 uncovered that nearly 90% of households in the villages of Mariarano and Antanandava were considered impoverished according to the Multidimensional Poverty Index [55,56]. Notably, these two villages are significantly less isolated than villages located farther in the wetlands, including Bekobany, Antsakoambezo, Antafiamahagandra, and Andriamandrora.

Livelihoods, as reported in Long et al. [37], are primarily within agriculture, pastoralism, and fishing, with many households employing multiple livelihoods for income. Notably, mangrove harvest was also

found to be an important economic activity in the original assessment and remained so in the current assessment, with uses for mangroves including timber, charcoal, medicine, and *pirogue* construction (Table 3). Timber sale in particular is a lucrative activity, with timber loggers reporting cutting six to eight trees per day and earning 15,000–20,000 MGA (US\$ 4.22–5.63) for a large beam (Table 4).

The crab fishery is male-dominated, and is a primary livelihood for the majority of study participants. The main target species of the fishery is mud crab, *Scylla serrata*, known locally as *drakaka*. Types of gear used remain consistent with Long et al. [37]. Gear used varies between seasons, with some fishers utilising the *fangavitra* and *soaky* (hooked staff and net, respectively), during the wet seasons when crabs are more active and easier to fish on foot [CF5; FG1]. However, as seen in the initial study, the *treko* (passive, bottom-fixed crab pot made of woven vines and/or palm fronds) and *garigary* (passive, baited, circular lift-net) remain the most widely used gear, as reported by 70% of crab fishers interviewed. The use of *garigary* has been endorsed by MIHARI and NGO Blue Ventures as a low-impact fishing gear [57]; conversely, the *treko* had been banned in multiple villages due to its reportedly indiscriminate catch. Contrary to the original study, *treko* use is no longer confined to solely Antafiamahagandra and Antsena, but is reportedly used by fishers in five of the seven villages, gaining popularity due to its ability to catch a large volume of crabs with comparatively less effort. Only Antsakoambezo and Bekobany have no reported use of the *treko*.

Fishing effort is spatially continuous throughout the Ankobohobo LMMA, with villages' fishing grounds overlapping and no formal territorial boundaries. Study participants' anecdotal reports of past catch differ significantly from reported current catch, with fishers reporting catches from the 1990 s to early 2000 s that were over double their current catch. Additionally, 90% of fishers interviewed perceive a decline in crab populations over time, with many attributing this change to mangrove destruction and more fishers coming to the area, increasing overall fishing effort. 75% of fishers interviewed also reported switching from low-volume gear such as *fangavitra* and *soaky* to higher-volume techniques including the *treko* and *garigary* due to crabs becoming harder to catch over time. These findings are consistent with data in Long et al. [37], where fishers reported marked decreases in catch over time.

Crabs are primarily sold to local and regional collectors, consistent with findings in 2016, with some local subsistence and consumption occurring for undersized crabs. Prices for crab remain consistent between the two study periods, with reported prices ranging from 2500 to 3000 MGA (US\$0.71–0.85) per kilogram, which rose sharply from approximately 500 MGF¹ (US\$0.08) in the early 2000 s. Collectors preferentially sell to Chinese export companies, which pay 7000 - 8000

Table 3

Local and scientific names of harvested mangrove species, with reported primary uses of each species. Data obtained from interviews and Israel-Meyer [56]. 'Export' refers to movement out of the harvest area to the regional capital for sale.

Local name	Scientific name	Primary use
Afiaty	<i>Avicennia marina</i>	Pirogue/medicine
Farafaky	<i>Sonneratia alba</i>	Pirogue/large boats
Honkolahy	<i>Rhizophora mucronata</i>	Timber/export
Honkovavy	<i>Cerriops tagal</i>	Timber/export
Lovinjy	<i>Lumnitzera racemosa</i>	Local building
Moromoray	<i>Heritiera littoralis</i>	Local building
Sarigavo	<i>Xylocarpus granatum</i>	Charcoal/export
Tsitologny	<i>Bruguiera gymnorrhiza</i>	Timber/export

¹ Madagascar ariary (MGA) replaced the Malagasy franc (MGF) as the official currency of Madagascar in 2005. The price in USD is therefore estimated off the average exchange rate of MGF to USD from 2001 to 2005.

Table 4

Reported prices for commonly-sold mangrove products, with average local price and average price when sold in commercial capital Mahajanga. Data obtained from interviews.

Type	Diameter (cm)	Length (m)	Local price (MGA)	Mahajanga price (MGA)
Beam (large)	20	2–3	-	15,000–20,000
Beam (medium)	18	2–3	6000	12,000
Pole (long)	7	2	3000	6000
Charcoal bag	-	-	3000–4000	6000–8000

MGA (US\$1.99–2.27) per kilogram for live crabs. Post-harvest loss is not stated as a major issue, with collectors able to sell dead crabs to vendors in the regional capital of Mahajanga.

4. Objectives

As reported in Long et al. [37], the Ankobohobo LMMA is not a formalised LMMA with explicitly defined management objectives. Rather, as a fishery, it can be assumed that the implicit goal of fishery, and indeed all fisheries, is the catch of target species and to sustain this activity through time [37]. The study identified various local agreements, management frameworks, and governance documents with stated objectives, which while not specific to the fishery, related to natural resource governance in the study area. These objectives are outlined in Table 5 by governing body.

5. Drivers / conflicts

Identified drivers and conflicts remained consistent between Long et al. [37] and this study. Specifically, two main drivers were identified: i) increasing effort, driven by population growth, migration, and market demand; and ii) habitat loss.

Throughout Madagascar, there is net migration to coastal areas in search of economic opportunity, which is likely to increase as the effects of climate change intensify [62–64]. Concurrently, the increase in the value of fishery products, as seen in Ankobohobo with the arrival of the high-paying Chinese export companies, attracts migrants and itinerant fishers pursuing the perceived lucrative livelihood [FG2]. Combined with high rates of population growth (see Context), fishing effort in the area has increased, giving rise to concerns of over-exploitation and increased reliance on additional unsustainable livelihoods such as mangrove logging.

Habitat loss is also widespread in Ankobohobo, as detailed in Long et al. [37] and reported by the majority of actors interviewed [61]. Mangroves serve as important nursery and primary habitat for mud crabs [65,66], with mangrove deforestation and degradation likely to have serious adverse effects on crab populations. 80% of study participants who perceived a decline in crab catch attributed it to pervasive and intensified mangrove deforestation.

Despite widespread knowledge regarding the adverse effects of logging, the practice is observed frequently in the area and acknowledged by multiple participants as a necessity during the National Closed Season for crab fishing (NCS). Low barriers to entry, little chance of retribution, and reliable markets for charcoal and timber in the regional capital Mahajanga contributed to uptake of this illicit activity.

These driving forces create a positive feedback loop, whereby increasing numbers of local, migrant, and itinerant fishers increase overall fishing effort to unsustainable levels, crab stocks decline, reliance on logging increases, crab habitat is destroyed and degraded, and fishery stocks decrease further. This leads to a coupled downward trend in crab stocks and the mangrove habitats that support them, as well as a downward trend in catch-per-unit-effort and the well-being of people that rely on crab fishing and mangrove cutting for their livelihoods (Fig. 2).

Table 5

Objectives of governing bodies in Ankobohobo. Information from GIZ [58]; Andrianasolo & Razafindramasy [59]; Antsakoambezo Fishing Association [60]; VOI (Vondron'Olana Ifotony/'community body,' the local natural resource management group supported by the German development agency GIZ and conferred management rights from the State) Tanteraka [61]; [FA1].

Governing body	Conservation and/or fishery objectives	Operational objectives
Mariarano Rural Commune ^a	Provide future generations with a quality living environment; ensure basic needs for current and future inhabitants Preserve & restore mangroves for crab habitat, climate change regulation, and ecological balance	Cease mangrove logging Restore and protect 1.25 km ^b of mangroves VOI(s) manage and monitor the area
Antsakoambezo Fishing Association	Enable association members to improve livelihoods and avoid poverty Foster community solidarity, unite fishers, preserve community heritage Protect benefits of natural resources for the community	Maintain use of traditional fishing practices Limit outside users' access to the fishery
Bekobany Fishing Association	Unite fisher[s] with the same purpose Maintain crab populations	Ban the use of <i>treko</i> Improve the fishery, e.g., through mangrove replantation
Andriamandroro Fishing Association ^b	Maintain crab and finfish populations Solidarity and collaboration regarding fishing grounds	Do not allow migrant fishers to fish near village Follow NCS and other national regulations
VOI Tanteraka	Conservation and sustainable use of Ankatsabe forest and mangroves, so that future generations may profit from them Enable forests to meet daily needs of community members and improve their income	Use patrols, signs, and awareness-raising to increase compliance with regulations Discipline offenders Replant cleared forest, and protect degraded forest from further destruction Develop alternative livelihood activities for the community Do not crab fish in areas of degraded mangroves
VOI Fanarenana	Secure and sustainably develop natural resources for public use	Train forest police and guides to monitor forest Reforest in degraded areas

^a The Rural Commune Development plan presents broad goals for the entire commune; only objectives applicable to the Ankobohobo Wetlands are included.

^b Andriamandroro Fishing Association has no formal written contract, but members reported the indicated strategic and operational objectives.

6. Governance framework/approach

As described in the original assessment, the fishery is governed primarily on a bottom-up basis by local communities, with most implementation and decision making in the fishery delegated to local users in line with national fisheries policy and natural resource management agreements [37,38]. A detailed description of the governance structure

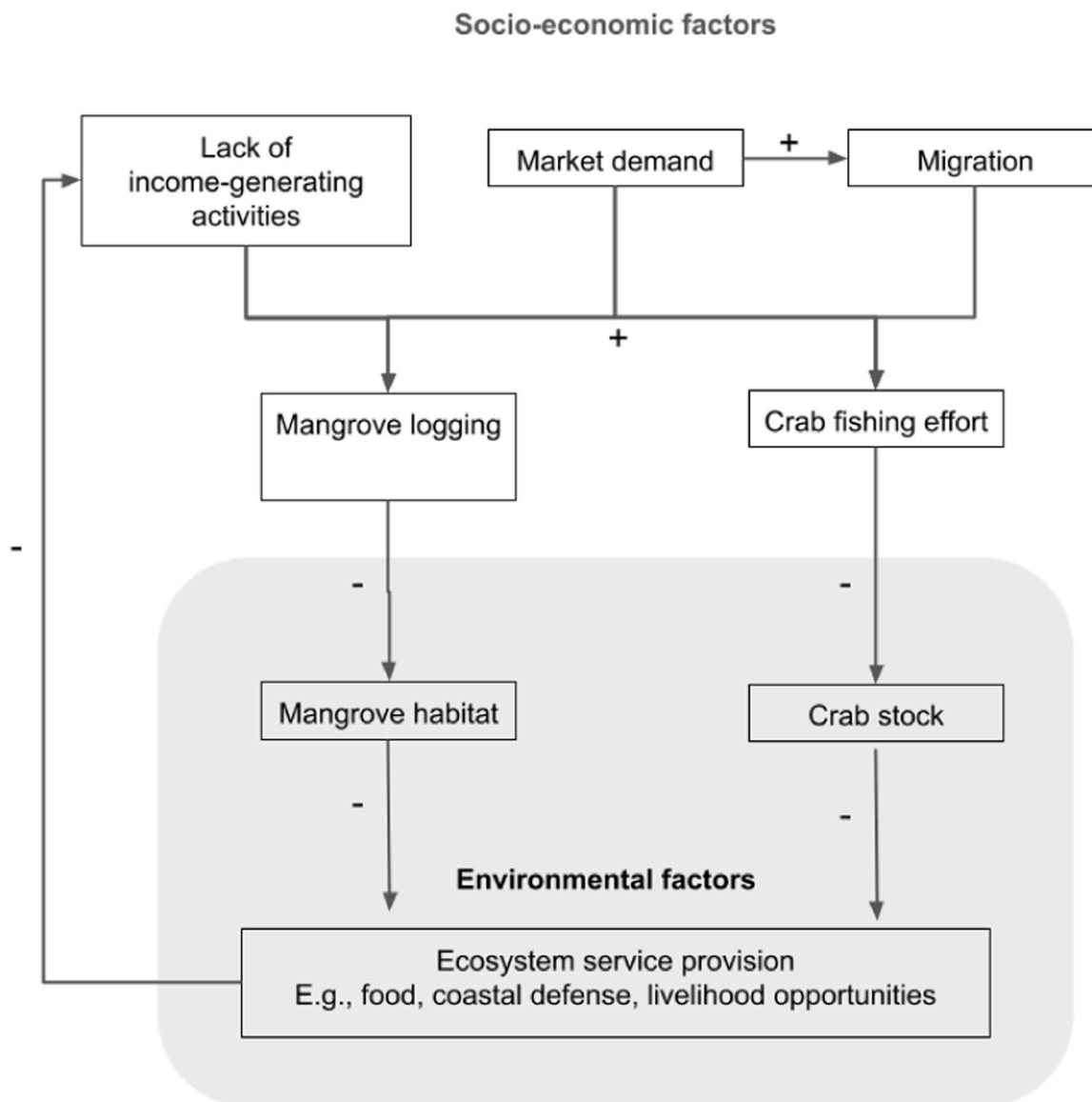


Fig. 2. Social-ecological feedback loop of the Ankobohobo LMMA. + and - represent positive and negative relationships between each component.

can be found in Long et al. [37], and is summarised in Fig. 3. Key differences to the governance structure arising since the original assessment are identified below.

6.1. State

In 2019, the Ministry of Agriculture and the Ministry of Fisheries and Aquatic Resources (MPRH) merged, creating the Ministry of Agriculture, Livestock, and Fisheries (MAEP). MAEP goals are to promote economic growth, food security, and rural livelihoods [67]. MAEP was undergoing reorganization and task delegation to regional sub-branches at the time of study, which were severely understaffed [4]. The Ankobohobo LMMA falls within the jurisdiction of the Mahajanga regional directorate of MAEP (Mahajanga DRMAEP). Fisheries surveillance is the responsibility of the Centre de Surveillance des Peches de Madagascar (CSP, Surveillance Centre for Fisheries of Madagascar), which is responsible for monitoring and enforcement, but to-date focusses mainly on larger-scale industrial fisheries such as shrimp and tuna [68]. No substantial efforts have been made to monitor or enforce SSF regulations, especially in rural areas [2,68].

6.2. Local terrestrial and aquatic resource governance framework

Locally, management of dry deciduous forest and portions of the Ankobohobo wetlands fall under GELOSE (*Gestion Locale Sécurisée*/‘Secured local management;’ Law 96–025) management transfers, a legal framework created in 1996 by the Malagasy government, which transfers some natural resource management rights from the state to local users [69]. In the dry forest and Ankobohobo, management is split between two bodies, referred to as VOI (*Vondron’Olana Ifotony*/‘community body’) Tanteraka and VOI Fanarenana. VOI Tanteraka, was formed in 2001 and formally recognized in 2012, and is responsible for Ankatsabe forest and 7.13 km² of mangroves. VOI Fanarenana, was established in 2013 and governs Analabe forest and 3.90 km² of mangroves [55]; [V2]. Concurrent with national policy, the two GELOSE contracts were initially drawn up, with the facilitation and support Gesellschaft für Internationale Zusammenarbeit (GIZ), a German development agency. These contracts are initially valid for a period of three years, after which the state assesses adherence to national conservation and development goals [70]. VOI Tanteraka passed its three-year assessment in 2015, and VOI Fanarenana in 2016 [P4; V2]. Upon successful assessment, the contracts were renewed for 10 years,

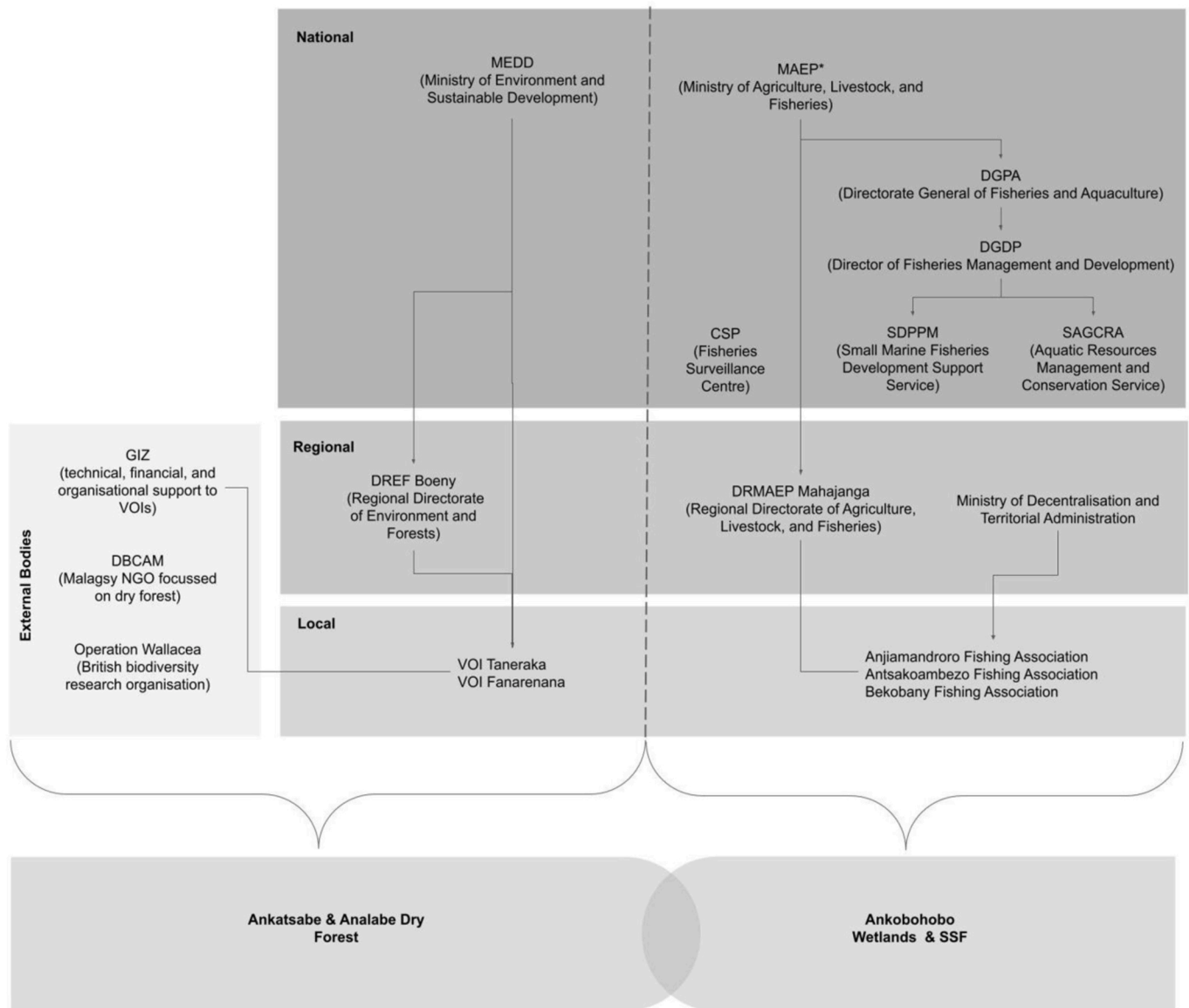


Fig. 3. Management structure of the study area, with mangrove forest falling at the interface of dry forest and wetlands. Info from MAEP (2019a). *MAEP was formerly Ministry of Marine Resources and Fisheries (MRHP) and now re-named Ministry of Fisheries and Blue Economy (MPEB). External bodies include Deutsche Gesellschaft für Internationale Zusammenarbeit /German Agency for International Cooperation (GIZ) and Development and Biodiversity Conservation Action for Madagascar (DBCAM).

with the potential to be renewed indefinitely after a second assessment [71]. VOI Fanarenana is considered one of the most successful VOIs in the Mahajanga II district, with high rates of compliance and community involvement [56]. VOI Taneraka has faced significant challenges as *Mariarano* grows, with a prominent authority expressing doubt that it would pass its 10-year assessment due to the proliferation of logging in the dry forest [P4].

Two conservation and development NGOs were identified as being active in the study area: GIZ and Development and Biodiversity Conservation Action for Madagascar (DBCAM). DBCAM is a Malagasy Conservation NGO operating throughout the region, promoting supplementary livelihoods including fruit tree planting. Further, Operation Wallacea, a British biodiversity research organisation, has conducted biodiversity surveys and monitoring in the area since 2010. Operation Wallacea partners with DBCAM and are generally present in the area for two months per year. Operation Wallacea, GIZ, and DBCAM work primarily in the terrestrial forest.

Currently, three community fishing associations exist in Bekobany,

Andriamandroro, and Antsakoambezo. Notably, the fishing association in Antsena reported in Long et al. [37] has dissolved, and an additional fishing association has been included, in the new study site of Antsakoambezo. The three existing fishing associations differ in their structure, objectives, and status, with Bekobany and Antsakoambezo being the most well-established (Table 6).

The Antsakoambezo fishing association represents a wider range of fishers, including those targeting crab, shrimp, finfish, and sea cucumber. Additionally, cognizant of differential financial status within the village, fishers partake in a monthly day-long fishing outing in lieu of monetary membership fees, the profits of which are placed in a fund and used for members experiencing financial hardship.

Each fishing association has established fishery regulations in the form of *dinas*, which largely align with national law whilst incorporating local regulations, as described in Table 7.

Table 6
Fishing association information. Information from interviews and focus groups.

Village	Date(s) active	# Members	Membership fee	Change from original MPAG assessment
Andriamandroro	2015-present	36	1,000MGA/month	Defunct; members plan to dissolve association because badges do not work in Mahajanga/contain inaccuracies; President has left [FG3]
Antsakoambezo	2014-present	40	1 days' worth of fishing/month	Functional; not included in original assessment
Antsena	2015-2018	30	-	Dissolved due to badges being rejected in Mahajanga and general frustration amongst members [P3]
Bekobany	2014-present	35	1,000MGA + 500 MGA/month	Functional; continues to await official legal status with documents submitted to DRRHP in 2014

7. Effectiveness

7.1. Analysis of incentives

The longitudinal analysis highlighted the stagnant nature of governance within Ankobohobo LMMA. Many of the incentives identified in the original assessment as in need of strengthening or introduction (see Long et al. [37], Table 6) remain weak or absent. The incentives as identified are described through a longitudinal lens (Table 8).

When first examined in 2016 by Long et al. [37], the Ankobohobo LMMA received the overall effectiveness score of one, 'some impacts beginning to be slightly addressed,' on a scale from zero, 'no impacts addressed' to five, 'all impacts...completely addressed' [38]. Three years later little has changed, with governance remaining ineffective. The governance framework continues to fail to support the objectives of fishing associations, fishers, or VOIs. As reported here, the perception is that CPUE continues to decline, whilst restrictions against mangrove logging remain ineffective due to widespread and perhaps increasing non-compliance. Concurrently, overarching drivers of overfishing such as migration, population growth, and poverty have not been addressed at a local level; problems that continue to undermine sustainable natural resource governance throughout Madagascar [8,23,73]. Ultimately, governance effectiveness within Ankobohobo retains the score of one, as governance fundamentally has not been able to address drivers of this

Table 7
Laws and rules applicable to the SSF, as outlined by fishing associations and the national government.

Entity	Rules					
	NCS [†]	MLS ^{††}	No gravid females	No treko	No mangrove harvest	Other
MAEP	✓	11 cm	✓		✓	No soft-shell crabs
Andriamandroro Fishing Association	✓	10 cm		✓		No migrant fishers can stay in the village
Antsakoambezo Fishing Association	✓	11 cm		✓		
Antsena Fishing Association *	✓	12 cm	✓		✓	
Bekobany Fishing Association		12 cm		✓		
MEPP		n/a			✓	No live timber harvest

*Antsena Fishing Association has dissolved, but many fishers reportedly still adhere to the rules

[†]National Closed Season,

^{††} Minimum Landing Size, measured at crab carapace width

downward spiral of decline (Fig. 2) and has not improved from the original assessment. This is reminiscent of a common theme in CBNRM, whereby local efforts alone are not adequate to address external drivers and conflicts.

8. Cross-cutting issues: a longitudinal perspective

The application of the MPAG framework to re-assess the governance of this SSF finds no evidence of progress in the intervening three years. The inability of local actors within Ankobohobo to address key drivers of decline is exacerbated by cross-cutting issues that remained consistent between the two study periods. If anything, frustration has led to a further weakening of a governance system unable to adequately address threats. Whilst three years might be considered a relatively short period, there is no evidence here that the situation will improve given more time, without material changes to the governance framework.

Such findings reveal, and indeed support, the core argument discussed in Jones [38] and as observed in numerous case studies throughout the SWIO: that bottom-up governance alone cannot achieve conservation and management goals, especially in the face of local challenges and larger-scale external drivers and conflicts [19,35,36]. As over 28 MPAG case studies have highlighted, effective governance is dependent on a diversity of incentives, implemented by a diversity of actors (communities, state, NGOs, etc.) [26,74]. Only co-evolved governance frameworks combining top-down and bottom-up approaches can achieve resilient, effective, and equitable governance. This study supports these prior findings which are echoed in the wider literature [36,38,75,76].

The recurrent themes discussed below identify key shortcomings of the LMMA approach as a primarily bottom-up, locally-led management approach, which in the absence of a supportive structure and key incentives cannot address major drivers of decline.

8.1. Participation

Numerous critiques exist of the CBNRM model in Madagascar in the form of GELOSE management transfers, particularly with regards to the prevalence of elite capture and the supplantation of traditional community hierarchies and governance structures with new governance processes or otherwise neo-colonial management structures [14, 77–80]. As GELOSE transfers are nearly always facilitated by NGOs, effectiveness may be undermined by conflicting perceptions of valid land use [78]. This was seen in Ankobohobo, where the goals of the NGOs and other non-state actors (GIZ, Operation Wallacea and DBCAM) were focussed on biodiversity conservation and research, particularly in the Ankatsabe and Analabe dry forests. Conversely, the objectives identified by the Antsakoambezo, Bekobany, and Andriamandroro fishing associations emphasize not only sustainable resource extraction, but also improving livelihoods; alleviating poverty; providing for future generations; maintaining cultural practices; and promoting solidarity and collaboration within fishing associations and communities. This is

Table 8

Incentives as assessed in the original assessment and in the current study, with direction of change and accompanying details (incentive iX numbers based on MPAG framework of i1-i36 incentives Jones and Long [26]).

Category	Incentive	Need at Original Assessment	Change	Details
Economic	i2 Assigning property rights	Strengthen	Unchanged	Fishers remain underrepresented in VOIs which are focussed on terrestrial resources (i.e., the dry forests rather than the mangrove ecosystem) and have no jurisdiction over fisheries. Fishing association establishment does not confer tenure on property agreements [72].
	i3 Reducing the leakage of benefits	Strengthen	Unchanged	Financial benefits to fishing association members remain limited due to an inability to gain preferential access to markets/fishing territory over non-fishing association competitors, or to negotiate prices with collectors [FG2; FG3]. Post-harvest actors continue to hold disproportionate power and receive a greater proportion of management benefits than the users who implement them.
	i4 Promoting profitable and sustainable fishing and tourism	Needed	Improved	All fishing associations have requirements in place promoting sustainable fishing. Two fishing associations banned <i>treko</i> use and require compliance with NCS, while all fishing associations require compliance with MLS [CF14; FG2; FG4; P1]. All fishers displayed a strong desire to restore mangrove habitat, with mangrove restoration well-established amongst a majority of villages. All participants in fishing associations and VOIs reported replanting in the past 3 years, with an estimated total of 15,000 – 40,000 seeds planted per year [CF12; FG3; FG4] [37]. However, the scale and rapidity of deforestation is strongly suspected to outpace restoration efforts, and anecdotal evidence suggests logging is more widespread than in previous years. Reactive measures will ultimately not rectify habitat loss without proactive governance approaches to slow or halt deforestation.
	i6 Promoting diversified and supplementary livelihoods	Strengthen	Worsened	Existing livelihoods do not provide sufficient opportunities or financial benefit, resulting in high fishing effort and mangrove exploitation [37]. Mangrove exploitation has become more prolific throughout the wetland, becoming common during crab fishing season in addition to NCS, as crab fishing alone reportedly no longer generates sufficient income [CF9; CF14; FG2]. Fishers reported high reliance on producing timber and charcoal products in the absence of external financial or technical support to trial supplementary livelihoods [FA2; CF14; V2]. Livelihoods promoted by GIZ and DBCAM, including working as guides for biodiversity surveys with Operation Wallacea and planting fruit tree plots, were revealed to have limited, if any, impact on fishing communities, focusing instead on terrestrial forest users [P3; V1].
	i10 Provision of NGO, private sector and user fee funding	Adequate	Unchanged	Funding initiatives for environmental and livelihood programmes are concentrated in terrestrial areas where VOIs operate [N2; P4]. Campsite user fees are paid to VOIs, which do not translate to benefits to fishing communities [V2].
Communication	i11 Raising awareness	Strengthen	Unchanged	No current awareness-raising of ecosystem services or biodiversity exists in either the terrestrial or mangrove forest for the general public. Operation Wallacea shares scientific findings directly with the VOI but this is not disseminated throughout villages [P3]. The majority of fishers reported either not knowing about GIZ, DBCAM, and Operation Wallacea at all, or hearing about them but not about their purpose or function.
	i12 Promoting recognition of benefits	Not employed	Needed	Though the majority of crab fishers identified mangrove deforestation as having a negative impact on crab populations, the link between other regulations (MLS, ban on landing gravid females) and fishery sustainability was less widely recognised. Many of fishers did not perceive gear restrictions or MLS as beneficial to crab populations [CF16; FA1]. Such sentiments were amplified amongst villages lacking a fishing association.
	i13 Promoting recognition of regulations and restrictions	Strengthen	Unchanged	Continued limited knowledge of national fisheries regulations as well as VOI and local restrictions [FA2; FG3; FA1]. Some information on national regulations is spread through radio and through word of mouth in isolated villages.
Knowledge	i14 Promoting collective learning	Strengthen	Unchanged	There is a lack of respect for and recognition of each other's knowledge between researchers and fishers [N1; P3]. Knowledge sharing is limited between researchers and VOI, with a focus on biodiversity and not on collaboration or livelihoods. Participatory monitoring of the fishery is needed but unlikely without support.
	i16 Independent advice and arbitration	Needed	Remains absent	Ankobohobo LMMA lacks external sources of advice and support, with SSF management guided by fishing association values and national legislation but without access to expertise regarding evidence-based decision making or support for contextualized management approaches [FG3; P3].
Legal	i18 Capacity for enforcement	Needed	Remains absent	Fishers were frustrated with the lack of state support/enforcement of fishing and timber regulations [FA2], recognizing that peer enforcement is insufficient to regulate destructive practices and that avenues for escalation are non-existent. VOI members and community leaders also struggle to enforce logging rules, reporting being threatened with violence whilst trying to stop active loggers [FG3; OA3; V1]. As stated by locals, 'We've seen people from Mahajanga cutting mangrove trees, but when the VOI reports it to the Ministry, no one is arrested, no one is fined, and no one comes here to enforce it' [OA3].
	i19 Penalties for deterrence	Strengthen	Improved	Ratified <i>dina</i> and national legislation outline penalties for fishery and forestry infractions. Fines exist for breaking <i>dina</i> , such as payment of 1 zebu, 1 bag of salt, and 1 sack of rice for harvesting a live mangrove tree [CF6]. National fines

(continued on next page)

Table 8 (continued)

Category	Incentive	Need at Original Assessment	Change	Details
	i20 Protection from incoming users	Needed	Remains absent	exist for prohibitions on logging (up to 400,000 MGA) [CF1]. However, these penalties are seldom applied or enforced. Fishing association effectiveness continues to be undermined through incursions by non-members and interlopers [FG3]. As expressed in one focus group, '... Other fishermen are coming here and use the area freely...taking crabs and using the treko. We are not allowed to catch crabs less than 11 cm, but the people using the treko do. This isn't fair for us' [FG3]. Fishing associations have little ability to negotiate for exclusive access, particularly with regards to migrants and seasonal fishers [CF11; P3].
	i21 Attaching conditions to use and property rights, decentralisation, etc.	Adequate	Unchanged	Both VOIs have management rights over their respective forests with the understanding that if they fail to meet national regulations for sustainable resource use, their contracts could be terminated [P4; V2], though the potential for recourse to this is limited given the evident lack of effectiveness in promoting sustainable crab fisheries and mangrove harvesting.
	i22 Cross-jurisdictional coordination	Strengthen	Worsened	Little to no coordination of management efforts exist between VOIs, fishing associations, and research organisations, especially within the wetland [CC6; FA2; CF14; FG3; P3; V1]. Lack of support and cooperation between fishers and representative bodies in the area, including mayors, has resulted in growing frustrations and feelings of disempowerment amongst fishers [FG3; OA3; P1; V1].
Participation	i27 Rules for participation	Strengthen	Unchanged	Better representation of fishers and fisher interests in VOI is required. Both financial burden and difficulty in reaching meetings were given as reasons fishers chose not to join [CC6; CF8; FG1; FG2].
	i28 Establishing collaborative platforms	Strengthen	Unchanged	Better coordination between communities, fishing associations, and stakeholders is needed. No evidence was found or reported indicating the LMMA is a member of the MIHARI network.
	i31 Decentralising responsibilities	Adequate	Unchanged	VOIs Fanarenana and Tanteraka have been formally designated as responsible for management of dry forest and mangrove resources with the technical and financial support of GIZ [55]; [N2].
	i32 Peer enforcement	Strengthen	Worsened	Fishing associations and VOIs rely on peer enforcement of traditional <i>dina</i> but lack support from government authorities. Further, several participants noted that <i>dina</i> infractions were mainly out of severe financial need and were uncomfortable at the prospect of reporting someone in such a situation; with mangrove degradation proliferating and crab fishing becoming less viable, this financial need and associated hesitancy to report peers grew [CF5; CF9; FG2]. Back-up state enforcement capacity and avenues for escalation are needed, alongside consideration of the ethics and feasibility of peer enforcement in situations of extreme need, and social and community cohesion.
	i33 Building trust and the capacity for cooperation	Not employed	Needed	Wetland villages sometimes view researchers and outside NGOs with an air of distrust as they are often unaware of researchers' intentions; limited researcher – community cooperation and interaction exacerbate mistrust [FA1]. Collaboration between communities was minimal/non-existent due to lack of respect between various populations and conflicts regarding fishing regulations [CF14; FA2; FG3].
	i34 Building linkages between relevant authorities and user representatives	Needed	Remains absent	Disconnection and inadequate communication between MAEP and fishers, and between MEPP and the VOI/forest users result in few linkages or opportunities to strengthen management.
	i35 Building on local customs	Adequate	Unchanged	The incorporation of <i>dina</i> into management builds upon local practices. Andriamandroro and Antsakoambezo promote traditional gear use both as a way to maintain custom whilst limiting harmful fishing practices [FG3; FG4].

evidenced by sentiments expressed in interviews and formalised in management documents [60]. This forward-facing mind-set and the community-oriented nature of management goals aligns with other sites in Madagascar, where communities' priorities lay with ensuring the wellbeing of future generations [81]. LMMAs and MPAs with conservation as a primary goal, written by external actors and overshadowing more pressing community values, are likely to face significant challenges, and cause conflicts within the system [14,23,71,82]. Such NGOs and research communities, especially those with access to power and influence within a management unit, must consider who their research serves and whether it champions the values of those affected by intervention.

Not only were conservation-centric views championed above local values, but many community members were excluded, indirectly, from participation at any level other than fishing associations. As evidenced in Ankobohobo over both study periods, many fishers and marginalised groups lacked the capacity to join VOIs and as such were not involved in creating the legislation that governed them, particularly as it pertained to management of the mangroves.

These issues relating to participation and the lack of alignment between the objectives of local communities and NGOs has persisted from the original assessment. No evidence was found of efforts to address this in the intervening years, despite being identified as a priority.

8.2. Ownership of fishery management

No progress was made defining management responsibility within the wetlands at the appropriate scale. Bottom-up modes of governance as led by the VOIs and the fishing associations were disjointed and incohesive, undermining community-level progress. Further, discrete management at the village level incited conflict due to spatially-continuous fishing effort [37]. A lack of solidarity between different fishing villages (i22) made governance of a shared resource particularly challenging, an important element in numerous CBNRM attempts [75, 83,84]. Consequently, management existed in discrete units where VOIs and NGOs attempted conservation with great difficulty, and fishing associations were focussed on internal wellbeing, distrusting both outside users and other villages to manage fisheries. Without coordination at the

scale of the fishery and the wetland habitat on which it depends, governance cannot adequately address the threats. Such difficulty with delineating management in marine and coastal settings is reminiscent of multiple marine protected areas in Madagascar [1,85], and conflict between user groups has been a recurring theme without clear avenues for redress.

8.3. Role of NGOs

Currently, success of other LMMAs in Madagascar is largely facilitated through involvement of NGOs, which provide technical support (i14), funding (i10), avenues for negotiation (i27), and diversified and supplementary livelihoods (i6) [11,85]. This support, often foreign, is one of the only ways in which local communities are able to access and navigate the bureaucracy of passing state-recognised *dinas* and gaining management rights [23,41]. Practitioners in Velondriake, considered to be a flagship LMA in Madagascar, emphasize this vital role of NGOs as facilitators of LMMAs, noting that success is unlikely to be reached or maintained without supplementary support [23]. For LMMAs such as Ankobohobo, which do not have access to this support, coordination and legitimacy can be nearly impossible to achieve. In Ankobohobo, Operation Wallacea and DBCAM focus on the dry forest and their activities are largely unknown by fishers. GIZ is focussed on sustainable development, but its involvement in the region is through GELOSE as a facilitator and supporter of VOIs (centred on the dry forest resources), meaning that fisheries and wetlands are somewhat peripheral. Thus, the governance of the wetlands and fishery is left with an absence of steer, coordination and technical support. Although NGOs operate locally, their objectives differ from those of fishers and their communities and so do not serve as collaborative partners to support the development of an effective LMA.

8.4. Conflict, coordination, and cooperation

The creation of fishing associations is an attempt to retain exclusive access to the fishery and enact context-specific regulations, but lack of a cohesive, fishery-wide management plan and inadequate support from regional and national authorities limits legitimacy of such associations. Addressing incursions by local and outside users is not within the capacity of fishing associations, a situation echoed in multiple LMMAs that experience a similar lack of support to address and resolve conflict [3, 23,86,87], and the absence of state-driven, top-down steer jeopardises the validity of legal structures and enforcement of regulations.

Though existing discrete management units in the form of fishing associations emphasise local desire and push for stronger governance, without a united strategy and lacking the outside technical, legal, and financial support it has not been possible to cultivate effectiveness. Delegating responsibility to local communities without providing the resources, support, or framework conferring real negotiation, implementation, and enforcement power places an impossible task on local resource users [26,36].

This situation has remained unchanged since the original assessment, which is no doubt frustrating to association members. This is demonstrated by the dissolution of the Antsena Fishing Association and likely dissolution of Andriamandro Fishing Association, which evidence the lack of external support and cross-jurisdictional coordination. Key reasons listed for frustration with, and abandonment of, the fishing association model were related to complications and dysfunction with membership cards and their legitimacy in the regional capital of Mahajanga. Despite paying membership fees and utilising the avenues available to them to manage their fishery, actors in Andriamandro, Antsena, and Bekobany all encountered various degrees of difficulty in achieving and maintaining legitimacy, or securing benefits from creating a fishing association. Additionally, the reported universal ban on *treko* in 2016 appeared completely abandoned, with the majority of fishing communities utilising the gear and numerous observations of

treko deployment recorded. This dissolution of a fishery-wide resolution further attests to the persistent struggle of communities to coordinate management efforts, and the tenuous nature of locally implemented management measures in the SSF. The situation and lack of progress in Ankobohobo demonstrates the limitations of purely bottom-up LMMAs in effectively addressing threats, ensuring sustainable resource use and meeting conservation objectives [38].

Compounding these challenges is persistent poverty and a lack of supplementary and diversified livelihoods in the region, driving many fishers and interlopers alike to resort to unsustainable mangrove extraction in order to meet basic needs. It is simply not financially viable for many to stop logging, and the current framework provides no alternatives or incentives to shift towards sustainable practices. Neither can regulations and prohibitions prevent logging; lack of enforcement by both state and local entities means that many fishers and loggers are not dissuaded from breaking national laws or local *dina*. The perceived proliferation of logging indicates an intensification of these management challenges. The governance structure lacks mechanisms to exclude rule-breakers, leaves fishers and loggers alike with few viable income streams, and cannot address the additional unrestrained pressure from migrant harvesters and interlopers.

Regardless of the drive and initiative taken by communities, as was documented throughout Ankobohobo, without creating legitimate structures within which to work, fishing associations held little power to address drivers of unsustainable natural resource use. Notably, recent promising advancements have been made, including a strategy to strengthen LMA effectiveness and autonomy put forth by MIHARI in 2022, followed by a string of management transfers focussed on marine ecosystems that same year [36,88].

9. Limitations

The period between this and the prior study was three years, and, though changes were observed in governance, many incentives also remained unchanged. A longer period between assessments would strengthen the conclusions able to be drawn about change over time, though it may lose nuance captured in shorter assessment intervals. Additionally, there are external factors that may be influencing the system, outside of those captured by the governance framework. In particular, the connections and synergies between land and marine management are not always identified within the MPAG framework, which has been applied in this study to focus on the mud crab SSF and therefore the mangrove wetland ecosystem. However, this ecosystem falls at the boundary—and according to some, within—the terrestrial management system, and an examination of the linkages between the two and how incentives specific to the terrestrial governance structure may be influencing the wetland would be beneficial. Further, positionality should be considered in any qualitative study; in this instance, the research team—HTL and QMP—had one Malagasy and one American member and inevitably brought varying experiences, viewpoints, and identities to the work. In this particular instance, multiple key informants remarked that fishers were likely more willing to speak with ‘curious *vazaha* [foreigners]’ than government officials from the capital. Regardless, consideration was given at each step in the research process regarding how positionality and identity may affect research design, data collection, interpretation, and analysis.

10. Conclusion

This study demonstrates the importance of longitudinal governance assessments within LMMAs, which are rare and has never previously been done using the MPAG framework. The initial novel application of the MPAG framework to Ankobohobo in 2016 described a largely ineffective bottom-up governance framework, which lacked the incentives required to address threats. This study finds the situation unchanged, and identifies sustained barriers to effective governance, recognising

that without external support, a purely voluntary bottom-up approach to natural resource governance cannot adequately address external threats in an LMMA. Challenges including the proliferation of mangrove logging, overfishing, and subsequent declines of crab stocks were driven by a combination of global markets, population growth, in-migration, shifting gear use, and a highly impoverished population with few supplementary avenues for financial stability. Despite commendable and significant local efforts, the lack of progress in three years demonstrates these issues cannot be addressed solely by fishers and their communities. Without support and collaboration through an integrated combination of top-down, bottom-up and economic approaches, effective management in Ankobohobo cannot be achieved. Persistent failure to achieve objectives will likely ultimately result in reduced buy-in for local management, resulting in further declines in the stock and degradation of habits with negative impacts on livelihoods and communities. This longitudinal approach moves beyond a snapshot in time, and could be applied elsewhere to identify the drivers of, or in this case barriers to, developing effective governance.

Declarations of interest

None.

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CRedit authorship contribution statement

Stephen Long: Conceptualization, Methodology, Visualization, Writing – review & editing. **Peter J.S Jones:** Conceptualization, Methodology, Supervision, Writing – review & editing. **Quinn M Parker:** Conceptualization, Data curation, Formal analysis, Investigation, Project administration, Writing – original draft. **Hoby Tsimijaly Longsoa:** Investigation, Writing – review & editing.

Data availability

The authors do not have permission to share data.

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