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Protected area co-management and perceived livelihood impacts

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ABSTRACT

Creation of protected areas to conserve biodiversity can have both positive and negative impacts, with impacts unequally distributed within local communities. A global shift towards local community involvement in protected area governance and co-management has aimed to reduce costs of protected area establishment and their uneven distribution. Yet, there is mixed evidence to support whether such initiatives are succeeding. Here, a protected area in Madagascar is used as a case study to explore how co-management governance processes impact upon livelihood strategies and outcomes, and how these impacts are distributed within and between villages.

Focus groups, interviews and questionnaires were conducted in 2015/16 with households surrounding a protected area, co-managed by local community associations and a national NGO. Data analysis was framed around the Sustainable Livelihoods Framework.

The majority of respondents perceived negative livelihood outcomes, and impacts were unevenly distributed between social groups. Respondents were more likely to report negative livelihood outcomes if they were from remote villages, poorer households and reliant on provisioning ecosystem services before protected area establishment. Qualitative data showed that the main drivers of this were protected area-related rules and regulations restricting forest activities. Drivers of improved livelihood outcomes were training and materials improving agricultural yields and increased community cohesion. Although co-managed protected areas may be overall more effective in meeting biological and socio-economic goals than protected areas of other governance types, the evidence here suggests that governance processes can lead to local perceptions of inequity.

1. Introduction

Protected areas (PAs) are one of the most frequently used conservation strategies, but remain contentious due to their negative impacts on local communities (Holmes and Brockington, 2012; Pullin et al., 2013) and mixed evidence on their ability to conserve species and habitats (Eklund and Cabeza, 2017; Geldmann et al., 2013). A global shift towards co-management and community involvement in PA governance and management, has in part, aimed to reduce local costs of PAs and provide more equitable management (Berkes, 2009). Yet there is mixed evidence as to whether this new form of governance is meeting its aims. In this study, we explore how co-management governance processes impact upon local livelihoods and how these impacts are distributed within and between local communities.

There is no universally agreed definition of co-management, but generally it refers to shared authority and decision making between parties, often local communities and the government or NGOs (Berkes, 2010). IUCN categorises these PAs as shared governance, and defines this as where a governmental agency and other stakeholders, such as local/indigenous communities that depend on the area culturally or for their livelihoods share power and responsibility to make and enforce decisions (Borrini-Feyerabend et al., 2012). It is clear that this may encompass both governance and management, and although these terms are often used interchangeably in the literature it is important to distinguish between them. Governance refers to who holds the power, authority and responsibilities, whereas management refers to resources, plans and actions (Lockwood, 2010; Lyver et al., 2014; Borrini-Feyerabend et al., 2012).

Signatories to the Convention on Biological Diversity (CBD) and Aichi Targets have agreed to not only increase PA coverage by 2020, but also to ensure that PAs are managed equitably (CBD and UNEP, 2010). Equity broadly refers to "the fair or just treatment of individuals or groups" (Law et al., 2017: 4). Co-managed PAs may offer a more equitable method of establishing and running PAs, as they provide opportunities to reduce local costs or provide benefits via the potential to tailor rules to local conditions, increase regulatory compliance, improve collaboration, and lead to greater stakeholder engagement and empowerment (Ayers et al., 2017; Carlsson and Berkes, 2005; Berkes,

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2009). Challenges of implementing co-management include institutional barriers, engaging all relevant stakeholders, conflict throughout planning processes and equity issues relating to collective decisions or unequal distribution of benefits (Kocho-Schellenberg and Berkes, 2015; Manzoor Rashid et al., 2013; Trimble Nunez et al., 2013). Successful co-management arrangements often require time to develop institutional networks and trust between them (Berkes, 2017). Existing research shows that co-managed PAs are more likely to provide socio-economic benefits than other governance-types, but this varies (Oldekop et al., 2016). Positive outcomes are more likely for PAs allowing sustainable-use, empowering local people, reducing inequalities and providing cultural and livelihood benefits (De Vente et al., 2016; Oldekop et al., 2016). But also, co-management may be more efficient in areas where there is resource control (for example forestry or fisheries) where it can improve data quality, reducing overcapitalisation, promoting economic development, ensuring more equitably allocation decisions, sharing power and reducing conflict (Ayers et al., 2017; Gurney et al., 2016).

A key part of many PA co-management approaches is the participation of local communities in PA governance or management. Participation can range from a brief consultation before PA establishment to full participation in daily management decision-making (Sterling et al., 2017; Reed, 2008; De Vente et al., 2016), yet this is all grouped under community participation. Involving local communities in conservation interventions, particularly PAs, has been well documented in the academic literature. Advantages are similar to those given to co-management and include: greater evidence base and diversity of views to improve decision making; increased trust between stakeholders; and increased support for interventions. Disadvantages include: risk of elite capture and dominance; potential for conflict between stakeholder groups; and increased time needed for decision-making (Ward et al., 2017; Sterling et al., 2017; De Vente et al., 2016; Reed, 2008). However, a recent review of the literature concluded that there are still many aspects of participation which are poorly understood and studies could be improved by incorporating qualitative data (Sterling et al., 2017).

Existing studies have analysed how the benefits and costs of PA establishment are distributed (e.g. Foerster et al., 2011; Franks et al., 2014; Gurney et al., 2015), but few have explicitly linked this to the governance processes causing these impacts. As community involvement in PA governance becomes more widespread, we need to understand whether and how it is meeting the aim of improving PA-related equity within particular country settings. To explore this, in this paper we focus on Madagascar, which has seen a strong shift towards co-management of PAs, presenting a useful case study to explore how co-management governance processes play out in reality.

In 2003, President Marc Ravalomanana of Madagascar announced the 'Durban Vision', which aimed to establish a new network of PAs across Madagascar (Virah-Sawmy et al., 2014). These PAs differ from the existing state-run network of strictly protected National Parks in two main ways. Firstly, the new PAs would be co-managed by a 'promotor' (usually an NGO) and local community associations (locally known as VOIs); and secondly, the new PAs would contain sustainable resource-use areas alongside more strictly managed no-take zones (Gardner et al., 2013). The VOIs act as a mechanism for local community members to have a say in PA governance and management, from establishment through to daily management decisions. The creation of this new PA network followed both instrumental (increased PA coverage without stretching the limited Malagasy government resources) and moral (involving local communities to reduce PA-related costs and potentially even provide benefits) drivers. Studies of this new PA governance have so far found mixed results in terms of meeting these aims (Ward et al., 2017; Corson, 2012, 2014; Virah-Sawmy et al., 2014).

This study is conceptually designed around the Sustainable Livelihoods Framework (Fig. 1) to explore PA-related benefits and costs, and how they interact with co-management governance processes. The Sustainable Livelihoods Framework has had wide application in development disciplines, and some use within conservation (Bennett, 2010). Weaknesses of the framework include limited consideration of political aspects and wider contexts, and a top-down approach to identifying livelihood assets (de Haan and Zoomers, 2005). We argue that it provides a useful framework as it takes a holistic view of livelihoods, incorporates governance processes and is easy to look at different social groups, making it ideal for investigating the links between PA co-management and perceived livelihood impacts. By enabling local households to define important livelihood assets we ensure that the methodology is not dominated by a top down approach. The Sustainable Livelihoods Framework defines a livelihood as the "means, activities, capabilities, assets and entitlements by which people build a living", and can be applied to explore how a certain event or 'shock' can lead to different livelihood outcomes (DFID, 1999). In this case, we define PA establishment as a 'shock', due to a potential change in access to natural resources and change of rules prohibiting certain livelihood activities (Ward et al., 2018). The framework has previously been applied to investigate impacts of forestry co-management (Chinangwa et al., 2016), marine PAs (Bennett and Dearden, 2014) and was used to design the Social Assessment of Protected Areas framework (Schreckenberg et al., 2010). The present study differs from these, by explicitly exploring the links between governance processes, changes in livelihoods and the distribution of these. The framework also allows investigation of different aspects of livelihoods or human well-being, which have not been frequently covered in the conservation literature, such as social and human aspects.

2. Methodology

2.1. Study site

The case study PA, Mangabe Forest, is located in Eastern Madagascar, and forms part of the Eastern tropical forest belt. This area is of high conservation priority due to significant levels of biodiversity and increasing human pressures from mining, shifting agriculture, locally known as 'tavy' and illegal rosewood trade (Poudyal et al., 2016). Madagascar is also ethnically diverse, including 18 groups with shared ancestry, institutional arrangements, livelihood activities, taboos or '*fadys*', and generally tied to specific geographical areas (Scales, 2014; Randrianja and Ellis, 2009). The local population in Mangabe are of Bezanozano ethnicity. The Bezanozano have strong cultural links to the forest including creating tombs inside sacred areas, and considering hunting or eating Indri (*Indri indri*) *fady*, as they believe them to represent their ancestors. The majority of the population are subsistence farmers, relying on shifting agriculture and collecting forest products for subsistence use and trade (pers. comm. NGO staff).

Mangabe PA was established in 2008 to protect globally important populations of the critically endangered indri lemur (*Indri indri*), and the critically endangered golden mantella frog (*Mantella aurantiaca*). The PA consists of a core zone, which is strictly protected, and sustainable use areas. Local communities are allowed to access and use natural resources from sustainable use areas, but only for subsistence use. Common activities include firewood collection, collecting medicinal plants, collecting honey and hunting game species. Certain livelihood activities are restricted throughout the PA including goldmining, hunting lemur species, collecting animals to sell and commercial logging. Mangabe PA forms part of the 'Durban Vision' network of PAs, and is co-managed by a national NGO and 10 local community associations (VOIs). VOIs may be based on existing institutions or created by the co-management partner, and consist of a committee and members. All local community members over the age of 18 are eligible to join the VOI, and the committee is voted in by members. VOI members have regular meetings to discuss aspects of PA management and governance. NGO staff are not always present at these meetings, in which case a report of the meeting is sent by the VOI president or other

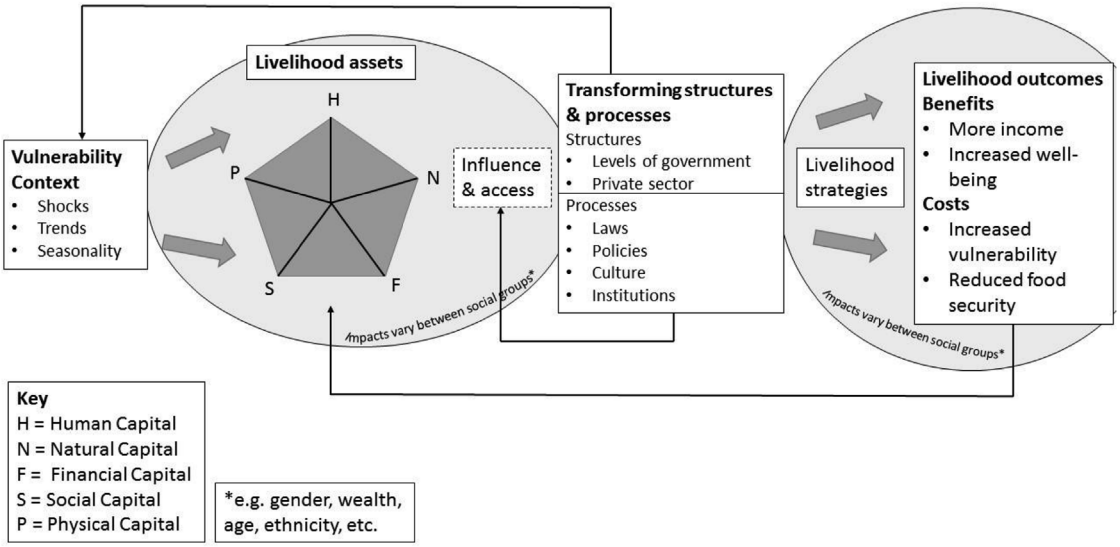

Fig. 1. Sustainable Livelihoods Framework.
Adapted to show how it can be applied to understand impact distribution between different social groups (adapted from DFID, 1999).

committee meeting. Previous research has shown that households perceive high costs and limited benefits to joining the VOI in this case study PA, and that there is confusion regarding the rules for VOI members and non-members to access forest resources (Ward et al., 2017, 2018).

2.2. Data collection and sampling strategy

Three villages or VOIs were selected for this study (Table 1), each of which had similar access to the forest (1 h walking along a mud footpath) and had similar VOI establishment processes (i.e. in each of the sample villages the VOI was established by the NGO). Distance to forest was assumed as proxy for use of and reliance on natural resources (Newton et al., 2016), and similar VOI establishment processes allowed data on governance processes to be comparable (pers. comm. NGO staff). Villages 1 and 3 were similar distances to towns and markets but village 2 was more remote (Table 1). Although this was assumed to impact local livelihoods, there were not three villages at similar distances.

Data collection took a mixed-methods approach, comprising: (1) Semi-structured interviews, (2) village focus groups, and (3) household questionnaires. This research was part of a broader study that also focused on co-management governance, participation and ecosystem service access (Ward et al., 2017, 2018). Research design was informed by the Sustainable Livelihoods Framework and included both qualitative and quantitative methods to ensure both depth and breadth of information (Bennett et al., 2017, Table 2; Table 3). Data collection was conducted in September–December 2015 and May–July 2016 by the lead author with the help of trained local translators and research assistants. Ethical approval was sought from the University board before data collection began.

Table 2
Summary of questionnaire data collected.

Variable		Village 1	Village 2	Village 3	Total
VOI membership	Member	45	62	26	133
	Non-member	35	17	32	84
Gender	Male	58	63	39	160
	Female	22	16	19	57
Ethnicity	Bezanozano	75	77	50	202
	Other	5	2	8	15

Focus groups were conducted in each village. They consisted of 8–10 participants, and were split into VOI members and non-members due to concerns of conflict and power inequalities between these groups (pers. comm. village elders). Participants were identified by speaking to village presidents, elders and VOI committee members. Focus group discussions covered topics relating to livelihood assets and strategies. Two focus groups were conducted in villages 1 and 3, but due to logistical constraints it was only possible to conduct one in village 2.

Interviews were conducted in all case-study villages with key stakeholders, such as village presidents, elders and VOI committee members, to gain in-depth information relating to PA governance processes and livelihoods. Sampling followed a snowball approach, and 34 interviews were completed in total (village 1 = 12, village 2 = 9, village 3 = 13). Interview data aimed to cover each section of the Sustainable Livelihoods Framework and topics covered included PA co-management governance processes, livelihood activities and perceived changes since PA establishment. 12 interviews were also conducted with NGO employees, local government officials and other relevant stakeholders to gain general understanding of the Durban Vision PA network.

Household questionnaires (Table 2) aimed to collect information

Table 1
Summary of village selection criteria.

Village	Distance from nearest town (hours walking)	Distance from forest (hours walking along mud footpath)	VOI establishment process	VOI participation level (according to NGO)
1	2–3	1	NGO & local community	Medium
2	4–5	1	NGO & local community	Low
3	2–3	1	NGO & local community	High
Justification	These were the most similar of the 10 villages surrounding the PA	Likely to be a proxy for forest resource reliance (assuming access to town/markets)	Likely to be an important factor in how VOIs function. Kept constant for comparison between VOIs	Differences are useful for investigating factors related to VOI participation

Table 3
Methods used to address different parts of the Sustainable Livelihoods Framework.

Framework section	Livelihood assets	Influence and access	Transforming processes and structures	Livelihood strategies	Livelihood outcomes
Methods	Indicators identified for each capital in interviews (n = 34) and focus groups (n = 5) based on what was perceived to be most important Data collected on each indicator using questionnaires (n = 217)	Interviews (n = 34)	Interviews (n = 34)	Livelihood activities free-listing in focus groups (n = 5) Data collected using questionnaires (n = 217)	Interviews (n = 34) and questionnaires (n = 217)
Data collected	Likert-type scale questions for each indicator	Respondents were asked about access to each of the livelihood capitals, with a particular focus on access to the forest and how this varies between groups	Respondents were asked about informal and formal rules regarding forest access, different institutions and how they impacted forest access and how this related to livelihoods	Main and other livelihood activities identified from list (process repeated for subsistence and income generating activities)	In interviews respondents discussed how they perceived their lives had changed
Perceived change measurement	For each indicator response to increased, decreased, no change (averaged out for each capital)	Respondents were asked these questions about the situation currently and 10 years ago (before PA establishment)	Respondents were asked these questions about the situation currently and 10 years ago (before PA establishment)	Respondents asked about livelihood activities now (2015–2016) and 10 years ago (2005–2006)	In questionnaires respondents were asked whether they perceived their lives to have improved, got worse or stayed the same

Table 4
Indicators used to measure livelihood capitals and perceived changes since PA co-management.

Livelihood capitals	Indicators	Score
Natural	Provisioning ecosystem service access and use	Count
	Fields owned	Score (0–3)
	Rice harvest	Number of months (0–12)
Financial	Access to bank	Score (0–1)
	Money for emergencies	Score (0–1)
	Ability to earn income	Score (0–1)
	Zebu ownership	Count
Physical	Distance to nearest town	Score (1–7)
	Asset ownership (motorbike, plough, bicycle)	Count
	House structure	Score (0–2)
Social	Participation in community work	Score (0–5)
	Helping others with emergencies	Score (0–5)
	Others helping you in emergencies	Score (0–5)
Human	Doctor visits	Score (0–4)
	Years in education	Score (0–4)

from a larger sample size within each village (Newing et al., 2011). Questionnaires (n = 217) were conducted with the head of household, this included 57 female heads of households. There was no census information available for the villages, and we were unable to create a complete sampling frame. To make sure our sample was as representative as possible given these constraints, every 2nd household in each village was selected. It was also ensured that all remote village areas had been sampled by checking with village presidents and elders. Questionnaires included both open-ended and closed questions, and covered socio-economic information, co-management governance processes, provisioning forest ecosystem service use, livelihood activities, livelihood capital indicators, livelihood outcomes, and how these were perceived to have changed since PA establishment. Questionnaire design was informed by interview and focus group data. Livelihood capitals were assessed using 2–3 indicators for each capital (Table 4), which had been identified and verified in semi-structured interviews and focus groups. Scores were designed to be comparable (i.e. a higher score for 'doctor visits' corresponded to fewer 'doctor visits')

2.3. Analysis

Interviews and qualitative responses from questionnaires were transcribed and coded into themes in NVIVO (QSR, 2012). Themes were organised under the various components of the Sustainable Livelihoods Framework: livelihood assets, influence and access, transforming processes and structures, livelihood strategies and livelihood outcomes.

Quantitative data were analysed in R (R Core Team, 2013). Livelihood capital scores were calculated using a Principal Component Analysis on indicators for each factor, following the methodology used to calculate Material Style of Life (Cinner et al., 2010). Chi squared statistical tests were used to test for perceived changes in livelihood capitals and activities since PA co-management had been established. In order to explore the distribution of impacts within and between communities, social groups were chosen as informed by interview and focus group data. These included village, VOI membership, gender, household wealth, ethnicity and age. After initial data exploration, ethnicity was removed as a factor, as all non-Bezanozano respondents (n = 15) had moved into the area after the PA had been established and therefore it would not be possible to compare livelihood changes since PA establishment between ethnicities. Age was also removed due to extreme uneven sample sizes of different age groups making comparisons unreliable. Chi squared statistical tests were used to test for differences between the remaining groups.

In order to explore distribution of livelihood outcomes, an ordinal

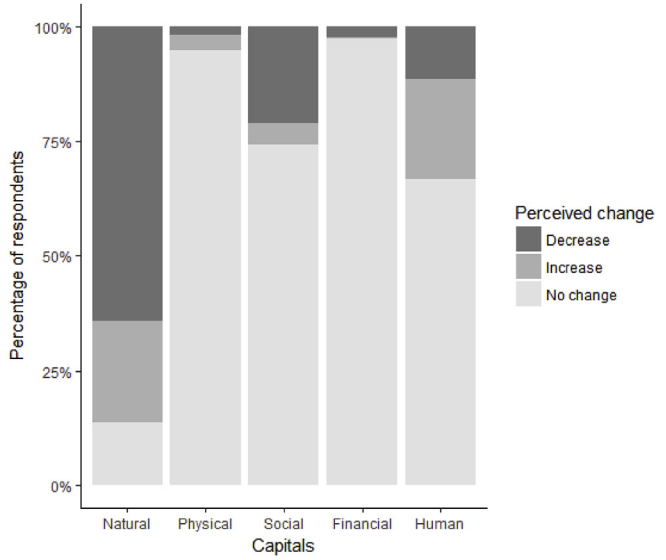

Fig. 2. Perceived changes in livelihood capitals.

logistic regression model was run in R using the MASS package (Venables and Ripley, 2002; UCLA: Statistical Consulting Group, 2017). This consisted of an ordinal outcome variable with three potential responses: declined, no change, improved; and predictor variables: village, gender, wealth, VOI membership, provisioning ecosystem service use now and before PA establishment.

3. Results

Results are framed around the Sustainable Livelihoods Framework, where establishment of the PA is considered to be a 'shock' as listed in the vulnerability context.

3.1. Livelihood impacts

Across all respondents, physical, social and financial capitals were perceived to have remained stable since PA establishment, natural capital to have decreased and human capital to have increased (Fig. 2). Natural capital was measured through provisioning ecosystem service access, number of fields owned and rice harvest. Interview responses stated that the perceived decrease was mostly due to new restrictions on forest-resource use e.g.: "*now that we can't access the forest, life is harder*" (village 2, male, VOI member). Human capital was measured via access to education level and number of doctor visits. Interview responses stated that since the PA had been established there were now more local primary schools and fewer issues with health, but this was not linked to PA governance: "*we have repaired the school, and now we have a teacher too*" (village 3, female, VOI member); "*our health is better now than it was*" (village 1, male, VOI member).

Across all respondents, there were perceived changes in income-generating livelihood activities (Fig. 3). Forest-based activities were perceived to have decreased (particularly collecting honey, cutting wood and goldmining), whereas agriculture and farming were perceived to have increased since PA establishment. There were no significant changes in subsistence activities. Interview responses stated that new rules meant that many forest-based livelihood activities had been prohibited: "*We're not allowed to sell wood from the forest*" (village 3, female, VOI non-member); "*before there were no restrictions related to the forest, but now there are lots of regulations*" (village 2, male VOI member); "*our income has decreased because of the prohibition of mining*" (village 3, female, VOI member). This had led to more people to try to earn an income from agriculture or farming: "*people have less ways to earn an income and so more people do agriculture now*" (village 1, male, VOI member). Other responses stated that training and provision of materials from the NGO had increased harvests and encouraged people to switch to agriculture and farming: "*we have had training for better agricultural techniques*" (village 2, male, VOI member); "*now the forest is protected we don't do timber logging, so we learn to grow rice and other crops*" (village 1, male, VOI member).

Collecting honey ($x^2 = 11.3$, df = 1, $p < 0.001$), cutting wood ($x^2 = 28.0$, df = 1, $p < 0.001$) and goldmining ($x^2 = 42.3$, df = 1, $p < 0.001$) were perceived to have significantly decreased as income-generating activities. Agriculture and farming were perceived to have increased as income generating activities but these differences were not significant ($x^2 = 1.45$, df = 1, $p > 0.05$; $x^2 = 0.469$, df = 1, $p > 0.05$). There were no significant changes for subsistence activities.

Across all respondents, 53% stated that life had 'got worse' or declined since PA co-management, 28% that it had improved and the remainder that there had been no change(Fig. 4). Qualitative data illustrated that respondents related declining livelihood outcomes to a lack of income-generating options, a change in weather meaning less rain for rice fields, increased conflict within villages and a decline in *herana* (*Cyperus latifolius*) required for weaving products: "*we still have problems with the rainfall being too low*" (Village 2, male, VOI member), "*apart from the protection of the forest, I now have no way of making an income*" (village 2, male, VOI member). Respondents linked the lack of income-generating options to the new rules and regulations relating to PA co-management: "*our lives haven't gone well since the forest was protected, because now we can't go to the forest to cut and sell trees. And we used to hunt the lemurs too, but we can't now. The rice we grow isn't enough, maybe if we had* funding *from [the NGO] to help us develop things would be better*" (village 1, male, VOI member). The shift from forest-based livelihoods to agriculture and farming listed above, was also blamed for the decline in *herana*: "*the area for the plants we need for weaving to grow has decreased as it's been converted to rice fields*" (village 3, male, VOI member). Increased conflict within villages was linked to establishment of the VOI and rules relating to PA co-management: "*the problem is that there is constantly animosity between VOI members and non-members*" (village 3, male, VOI member); "*the problem is that we have lots of arguments with non-members, because the rules are so strict and stop people from doing tavy so some people hate us for that*" (village 2, male, VOI member), although it should be noted that this did not appear to have affected social capital overall (see Fig. 4).

Interview responses relating to improving livelihoods discussed enhanced village cohesion, training to improve agriculture and farming yields and jobs with the NGO: "*things are improving slowly through training and* [the NGO] *gave us some different grains to try growing*" (village 2, male, VOI member); "*now we have more cohesion in the community, so we can all work together and build important things like the school*" (village 1, female, VOI member); "*the offers for work have increased because MV and the VOI need people to lead meetings, so now I have more money for food and other things*" (village 3, female, VOI member). Conflicting with the results shown above, improved village cohesion was related to the establishment of the VOI for PA co-management: "*cohesion in the community is better because of the VOI*" (village 3, male, VOI member); "[the VOI] *makes work easy because members help each other*" (village 1, male, VOI member).

3.2. Distribution of livelihood impacts

The livelihood impacts listed above mask any inequalities experienced between social groups within communities. To understand these, we have looked at differences between villages, VOI members and non-members, gender and wealth. Perceived changes in livelihood capitals, activities and outcomes all differed between these social groups (Supplementary material).

The ordinal logistic model results showed that village, wealth and ecosystem service use before PA establishment were significant predictors in livelihood outcomes. Respondents in village 2 and 3, from

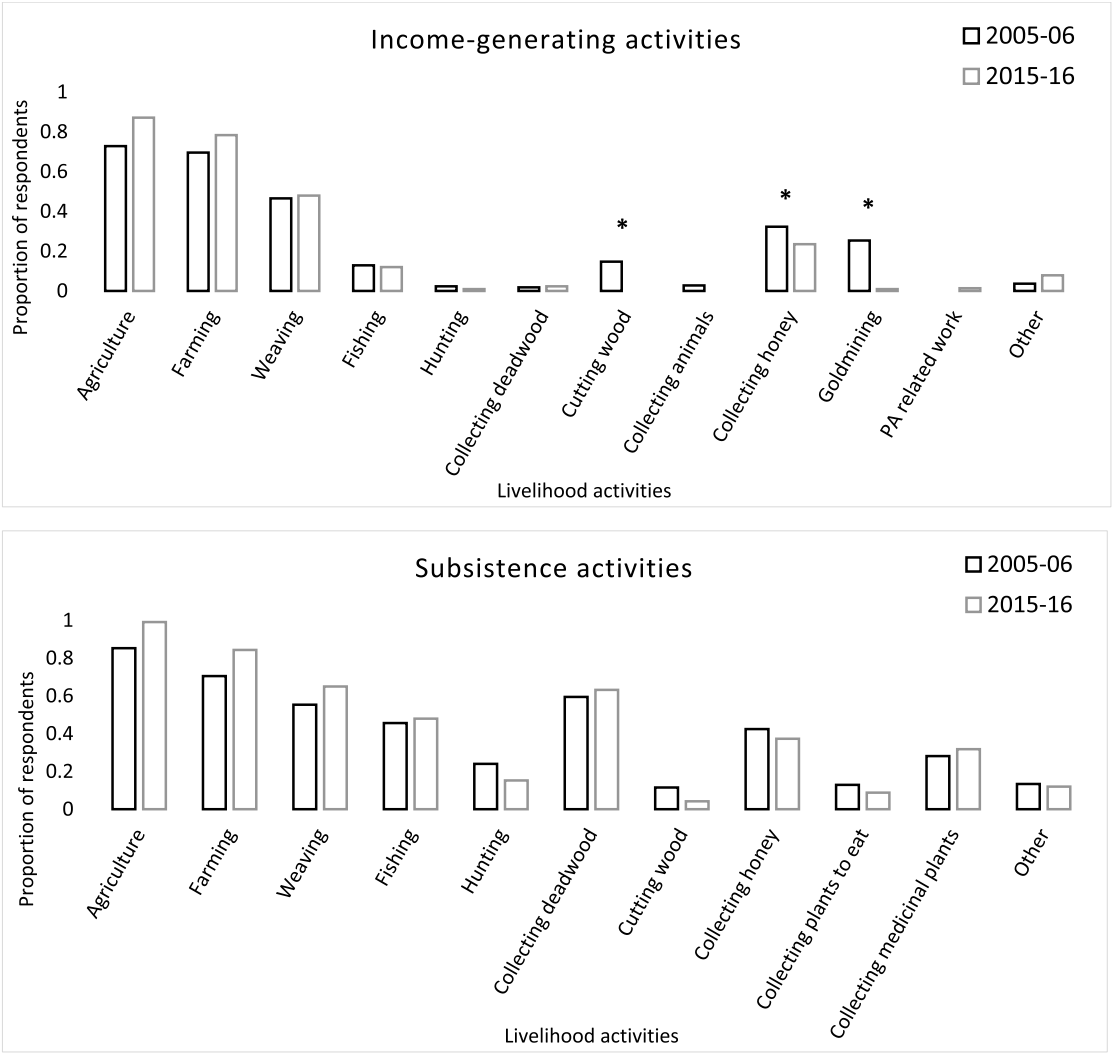

Fig. 3. Proportion of respondents undertaking income generating and subsistence livelihood activities now (2015–16) and before PA establishment (2005–06). * shows significant changes.

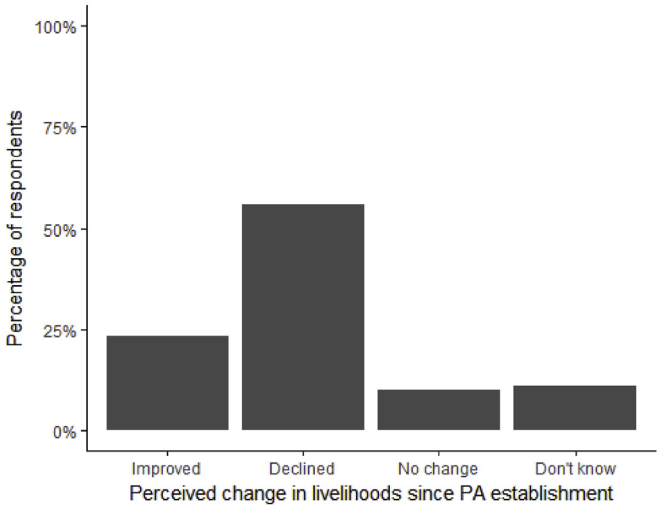

Fig. 4. Perceived change in livelihood outcomes since PA establishment.

poorer households and who used a higher number of ecosystem services before PA established were significantly more likely to state that life had "got worse" since PA establishment.

3.2.1. Villages

Village 2 perceived a significantly greater decrease in natural capital ($x^2 = 10.5$, df = 4, $p < 0.05$) and increase in human capital ($x^2 = 14.8$, df = 4, $p < 0.01$). The natural capital indicator includes data from provisioning ecosystem service use (Table 4), and previous work has shown that village 2 was more reliant on these than the other two villages (Ward et al., 2018), so the new PA rules may have had a larger impact. Interview responses from this village focus on the loss of forest access: "*it's forbidden now to take things from the forest and everyone suffers*" (village 2, male, VOI member); "*people are wary to go into the forest now*" (village 2, male, VOI member); "*the area we can go in the forest is limited now*" (village 2, male, VOI member). Village 2 had established their own primary school with a teacher since the PA had been established, although interview responses stated that this had not been due to input from the NGO. This demonstrates the challenges in disaggregating the impacts of the PA from those associated with wider development processes.

Village 3 perceived a significantly greater decrease in social capital ($x^2 = 23.8$, df = 4, $p < 0.001$). Conflict between VOI members and non-members, villagers and 'outsiders' and village members and the NGO, were mentioned in interviews from across all villages, but were particularly an issue in village 3: "*there are problems from other people who don't agree with the VOI because it stops them from hunting lemurs and doing tavy, so it causes animosity between groups*" (village 3, male, VOI

Table 5
Summary of ordinal logistic model results. Negative Values indicate variables predicting a negative livelihood outcome (i.e. these groups of respondents were more likely to state that life had got worse), positive Values indicate variables predicting positive livelihood outcomes (i.e. these groups of respondents were more likely to state that life had got better).

Predictor variables	Value	Standard Error	t value	p value
Village 2	−1.371	0.442	−3.099	0.002***
Village 3	−1.052	0.440	−2.390	0.017*
Female	0.391	0.386	1.012	0.311
Wealth Score	0.334	0.129	2.504	0.012*
VOI Non-member	−0.271	0.364	−0.744	0.457
Provisioning ecosystem service use now	−0.001	0.109	−0.009	0.993
Provisioning ecosystem service use 10yrs	−0.290	0.069	−4.192	0.000***
Declined|No change	−1.562	0.494	−3.165	0.002
No change|Improved	−1.896	0.485	−1.849	0.064

*p < 0.05, **p < 0.01, ***p < 0.001.

member); "*people hate the VOI members because we don't have a solution to them not being able to hunt anymore*" (village 3, male, VOI member); "*the VOI creates conflict between members and non-members*" (village 3, male, VOI member).

Villages 2 and 3 reported decreases in forest-related income-generating activities (Fig. 3). Villages 1 and 3 reported greater increases in agriculture, farming, and PA-related work, although these were not significant. Similar to the differences observed with livelihood capitals, this underscores the greater reliance of households in village 2 on forest-based livelihoods before the PA was established. It also shows that the shift towards agriculture and farming is not necessarily affecting those who are having to cope with the greatest decrease in forest-related activities. Respondents in villages 2 and 3 reported greater decreases in forest-related subsistence activities compared to village 1 (Fig. 3).

Respondents in villages 2 and 3 were more likely to report declining livelihoods (Table 5). As illustrated by the quotes above, respondents in village 2 reported greater impacts from new PA rules due to restrictions on forest-based livelihood activities, and village 3 due to increased intra-village conflict.

3.2.2. VOI membership

There were no significant differences in perceived changes of livelihood capitals between VOI members and non-members.

VOI members reported greater decreases in forest-related income-generating and subsistence activities and increases PA-related work (Supplementary material). These results may be due to VOI members having greater knowledge of PA-related rules than non-members, and therefore adhering to these rules, or their greater reluctance to admit rule-breaking. Previous research showed that VOI members had greater knowledge of PA-related rules (Ward et al., 2018). VOI non-members reported greater increases in agriculture and farming for income-generating and subsistence. These results show that the increase in certain livelihood activities is not necessarily able to offset loss of income from prohibited activities, and the increases in agriculture and farming are not necessarily helping the households most affected by PA restrictions. There were no significant relationships between VOI membership and livelihood outcomes (Table 5).

3.2.3. Gender

Men perceived a significantly greater decrease in social capital ($x^2 = 7.9$, df = 2, $p < 0.05$) than women. Previous research (Ward et al., 2017) has shown that men were more likely to be VOI members than women, and therefore may have been more likely to encounter any conflict relating to the VOI. In terms of livelihood activities, male respondents reported significant decreases in cutting wood ($x^2 = 25.7$, df = 1, $p < 0.001$) and goldmining ($x^2 = 36.1$, df = 1, $p < 0.001$). Female respondents perceived significant increases in collecting deadwood ($x^2 = 21.7$, df = 1, $p < 0.001$). This represents the gender divide in livelihood activities, as described in focus groups, with men doing activities inside the forest, and women focussing on activities closer to villages or houses. There were no significant relationships between gender and livelihood outcomes (Table 5).

3.2.4. Wealth

Poorer households perceived a greater decrease in natural capital ($x^2 = 14.73$, df = 4, $p < 0.001$). Previous work showed no significant difference between provisioning ecosystem service use and wealth (Ward et al., 2018). Some interview respondents mentioned losing agricultural land which had been inside the PA, which may have impacted poorer households more as they were unable to buy or access other land: "*a lot of land where we used to grow rice is not used now because it is in the protected area*" (village 3, male, VOI member). High and low wealth respondents reported significant decreases in cutting wood ($x^2 = 16.8$, df = 1, $p < 0.001$; $x^2 = 46.8$, df = 1, $p < 0.001$) and goldmining ($x^2 = 3.88$, df = 1, $p < 0.05$; $x^2 = 3.87$, df = 1, $p < 0.05$). Yet, poorer households were more likely to report declining livelihoods (Table 5), and this may be linked to the greater decrease that they perceived in natural capital. Richer households may also have been better able to cope with the livelihood impacts, by selling livestock or relying on savings.

3.3. Governance processes and livelihood impacts

From interview and questionnaire data, VOI establishment and the introduction of new rules had the greatest impact on livelihoods across communities (Fig. 5). Establishment of the VOI created new power dynamics and changed inequalities in accessing natural resources. Previous work has shown that VOI members have greater access to forest resources via reduced permit costs and relationships with committee members and patrollers (Ward et al., 2018): *"VOI members just talk to the committee to get wood, it is easy. But non-members must get permission from [the NGO] and the ministry so that they can get a permit for taking the wood"* (Village 3, male, VOI member); *"It is easier for VOI members to get access to resources and also cheaper than non-members"* (Village 1, male, VOI member).

The introduction of new rules restricted certain livelihood activities: "*we used to hunt lemurs to eat or sell. Also we used to collect red mantella to sell, and we used to let people cut trees in the forest when they paid us*". Although PA co-management is between the NGO and local communities, there are set rules and regulations from the government which have to be applied when a PA is created. These relate to the creation of core and sustainable-use zones and the activities allowed and restricted in each: "*in all of the new PAs there are two main zones, the core zone that means the strictly protected area … But in the sustainable use zone they can do their everyday life activities, like they can collect fuelwood for instance for their subsistence use*" (NGO staff).

Interview data also highlighted the existing strong culture of '*fir-asakina*' where village members will help each other in times of need or during harvest and engage in community work. Interview responses showed conflicting opinions on whether VOI establishment had strengthened or weakened these social ties: "*the VOI creates conflict between members and non-members*" (village 3, male, VOI member); "*cohesion in the community is better because of the VOI*" (village 3, male, VOI member).

The co-management NGO organised development activities such as training and materials for improved agricultural and farming techniques, to encourage households away from forest-based activities, and this was highlighted as a key benefit from the PA by local community members; "*we have had training for better agricultural techniques*" (village 2, male, VOI member). However, this has been focussed on VOI

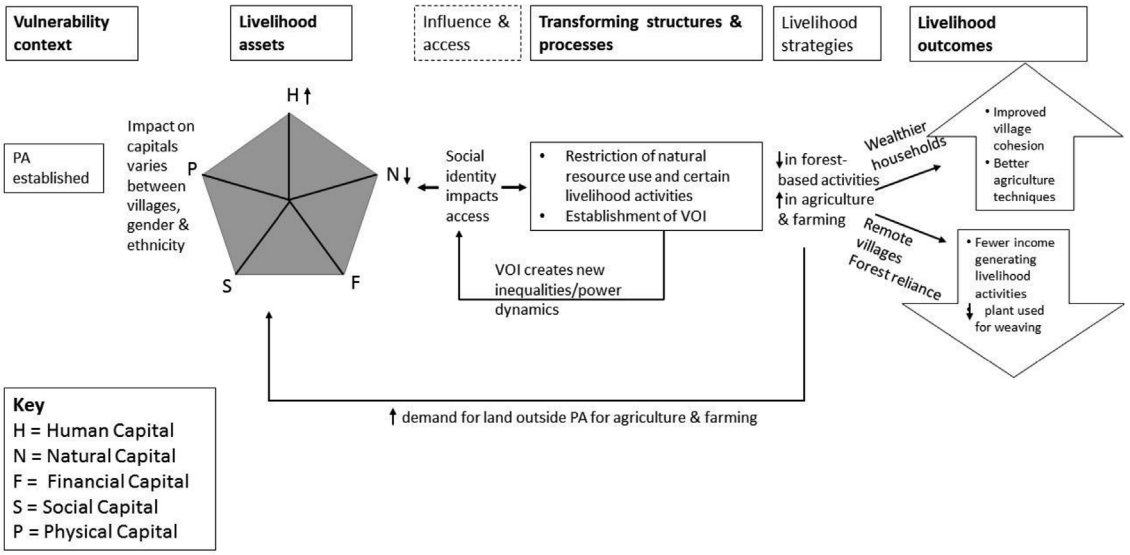

Fig. 5. Summary of results interpreted via the Sustainable Livelihoods Framework.

members: *"this is a pilot project so we start with VOI members"* (NGO staff). Some community members viewed this as not necessarily reaching those households most impacted by the PA and as a sort of favouritism from the NGO *"We haven't received any training or help, and the jobs always go to the same people"* (Village 3, male, VOI non-member).

3.4. Local community perspectives compared to NGO perspectives

The sections above focus on local community perspectives of livelihood impacts and how these relate to co-management, yet it is also important to explore the NGO perspective, and how this compares to local communities, given both communities and the NGO are involved in co-management. There were two key issues from the NGO interview data relating to government involvement and issues with livelihood projects which had been planned to compensate local costs of PA establishment.

Interview data highlighted that there are many aspects of management and rules which are beyond the control of both the NGO and local communities. For example, the rules surrounding the core zones, restrictions on activities in the sustainable-use zone, and enforcement of those rules: "*The government is in charge to enforce these rules and the government is represented by the ministry of environment, ecology and forests. So the rules come from this ministry and also the application of these rules"* (NGO staff). The NGO perspectives highlight similar problems raised by local communities, and highlight issues of who is truly responsible and accountable for various aspects of PA governance and management.

Prior to establishing the PA, much of the NGO work had focussed on education: "*because the important species of Mangabe are the Indri and the golden mantella and we did lots of education about these species to the primary schools during the creation*"; and also on mapping the potential costs of PA establishment. The PA management plan included a summary of the potential impacts of PA establishment and the household groups at most risk. These groups included households depending solely on forest-related activities, high use of medicinal plants, low education levels and young households with large families. Costs were identified as prohibiting livelihood activities, and benefits were identified as pride in protecting the environment, protection for sacred forest areas and participation in livelihood projects set up by the NGO. These livelihood projects aimed to substitute potential livelihood losses from forest restriction, including poultry farming, bean cultivation, beekeeping, cassava and improved rice cultivation. Yet interviews with NGO staff showed that these projects had not yet been fully implemented and only involved VOI members, despite PA rules and regulations having been in place since 2008: "*there is lots there are still lots of efforts that still needs to be done, because these local populations before they were dependent on the natural resources, so they are requesting to better improve their livelihoods. Some of these activities started last year and also we gave training to the local populations in the 10 villages around the PA… about improved agricultural techniques, about rice, beans, maize, compost and so on*" (NGO staff). NGO staff highlighted issues with funding delays, locating the households most impacted, and a mis-match between what their projects were likely to achieve and what community members wanted: *"to get big community projects for example to maintain the roads for transporting their agricultural products and to have also some water for drinking for their health… these kind of projects are beyond our competence but we try to collaborate with other stakeholders who have a competence to do this kind of big projects"* (NGO staff). They also hoped by piloting and evaluating these projects, they could improve them in terms of funding efficiency and providing benefits for households, and that those who had received training might share this knowledge with other households: *"In the long term after these VOI members receive the* support *it's their turn to* support *the other villages to better improve their livelihoods… We are now evaluating these households who received our* support *to see what has happened after the interventions"* (NGO staff).

4. Discussion

This study provides further evidence that the costs and benefits of PA establishment are unevenly distributed within and between local communities. This is a common theme throughout the literature relating to local impacts of PA establishment (e.g. Foerster et al., 2011; Gurney et al., 2015). However, this study offers new evidence by taking an in-depth approach to explore what respondents perceive to be the cause of these impacts.

The results suggest that the current set-up of co-management in this case study PA do not allow both co-management partners to equally contribute to decision making. Respondents viewed the main causes of perceived livelihood impacts to be restrictions on certain livelihood activities and access to the forest. Yet interview data showed that both co-management partners (local communities and the NGO) were unable to participate in these decisions as these rules apply to all Durban Vision PAs in Madagascar. In essence, this leads to the PA in reality having similar impacts on the local community as a strictly managed PA would. We acknowledge that co-management arrangements often take

time to develop, yet Berkes (2017) state that long-term success often depends on the early experience of cooperation amongst stakeholders. This could be overcome by beginning to develop co-management institutions for a longer period before establishing the PA (Chuenpagdee and Jentoft, 2007), although this may conflict with short term conservation priorities of protecting species at risk of extinction.

Gardner et al. (2013) stated that Durban Vision PAs did not fully conform to the IUCN categorisation they were given (Categories V and VI) as this assumed positive relationships with natural resource use. The results from this study support this, and also suggest that the PAs do not fully fit into the IUCN shared governance category either. IUCN do differentiate between collaborative governance (where one partner has power to make decisions but must inform or consult with stakeholders), and shared governance (where various partners take decisions jointly) but note that these are both referred to as co-management (Borrini-Feyerabend et al., 2012). The case study PA could fit into collaborative governance, although these results alongside previous published work from this PA has shown evidence that not all stakeholders were fully consulted and kept informed (Ward et al., 2017, 2018). Potentially the shared governance category could be broken up to acknowledge the wide range of realities that can fall into this category. This would encourage greater consideration given to categorising PAs, as it is important to consider not only who is involved in PA governance, but also how they are involved in order to fully understand which governance type is appropriate. How stakeholder groups are involved in co-management will have the greatest impact on social and ecological outcomes.

The findings from this study have useful lessons in terms of improving co-management as an equitable approach to PA management in Madagascar and beyond. Particularly in the case of distributive equity, as we found that the benefits and costs of PA establishment were distributed unevenly and that VOI members have benefitted more from NGO livelihood projects. Remote communities, poor households and those with high forest resource reliance were more likely to report negative outcomes. Uneven participation in PA governance may allow for elite capture, thereby increasing inequitable sharing of PA-related benefits (Persha and Andersson, 2014), and previous research in this PA has shown that certain groups were more likely to participate (Ward et al., 2017). When investigating impacts of National Parks in Thailand, Sims (2010) found higher levels of inequality in communities near National Parks, and related this to elite capture of PA-related tourism benefits. There were clear differences in PA-related impacts between villages. Other studies have found similar results and suggest that this shows determinants of human well-being are highly localised and that it may not be possible to generalise this to wider spatial scales (Foerster et al., 2011; Gurney et al., 2015).

Benefits from PA co-management were identified as training or receiving materials from the co-management NGO. However, these projects had a large time-delay between PA establishment and projects being trialled and eventually rolled out to all households affected. Households with experience of past conservation interventions and unfulfilled promises will shape their willingness to engage in future conservation interventions and overall perception of conservation (Rakotonarivo et al., 2017). This shows the importance of considering the short-term costs of changing rules and access when PA is established. Establishing any benefits will take time due to a need to identify households, communicate with them and uptake of projects (Mackinnon et al., 2017; Poudyal et al., 2016).

It is important to note that distributing benefits and costs equally amongst local communities will not necessarily be considered equitable by them, and deciding how conservation-related compensation should be distributed is highly complex. A study in Rwanda found that residents preferred PA-related benefits to be distributed equally, rather than directed to those most in need or who faced the highest PA-related costs (Martin et al., 2014). Although we did not assess this, other studies have shown that in Madagascar, secure land tenure and agricultural training may be more preferred compensation from conservation interventions than cash payments. In some cases financial rewards can 'crowd out' more intrinsic conservation motivations (Agrawal et al., 2015), and may not reach the target households (Poudyal et al., 2016). This highlights the importance of exploring local cultural norms, before deciding what is 'equitable', and that there is unlikely to be a 'one size fits all' approach. Dawson et al. (2017) argue that this is why promoting equity in conservation will need to take a reflexive and adaptable approach.

The findings of this study are also relevant to procedural equity, which is built on the inclusive and effective participation of all relevant actors in affairs that concern them (Schreckenberg et al., 2016). We found that community participation in governance associations did not provide any real opportunity to contribute in certain aspects of decision making, and was causing conflict in some of the villages. Local participation in PA governance is often a key part of PA co-management, yet if stakeholders feel that they are being excluded or ignored in decision-making, this can lead to mistrust and intentional rule-breaking, alongside the obvious equity implications. For example, local communities were seen killing an endangered radio-collared sifaka (*Propithecus edwardsi*) near a PA in Madagascar, in response to being excluded from an area where they had traditionally gathered forest resources (Jones et al., 2008). Co-management approaches where communities are empowered to contribute to decision-making are more likely to meet socio-economic and biological goals (Oldekop et al., 2016).

Our results show a shift in livelihood strategies, from forest-based strategies towards agriculture and farming. This is commonly pursued and promoted by NGOs and policy-makers in areas where there is high pressure on biodiversity (e.g. Freudenberger, 2010), and not just related to co-management. In this study the NGO identified it as a key strategy to reduce local costs of PA establishment. Yet it also puts greater pressure on the land outside of PAs, as more is converted to agricultural land (Ament and Cumming, 2016). Such "leakage" reduces connectivity between patches of forest, and other potentially valuable non-forest habitat types, which may have negative impacts on biodiversity (Almeida-Rocha et al., 2017). There is also an ethical aspect to this shift, as is shown in the present study, with respondents highlighting a decline in *herana* (*Cyperus latifolius*) used to weave products such as mats and bags, an activity mostly undertaken by women. If this decline continues there may be negative impacts for households reliant on weaving to generate income.

Shifting livelihoods from a range of forest-based activities to mainly agriculture, farming and weaving may also have implications for their long-term sustainability. This may be exacerbated in the future due to climate change, unpredictable seasons and increasing cyclone threat (Waeber et al., 2016). While the introduction of new varieties of crops may be more resistant to future climate changes, interventions need to align with household needs and aspirations, and fulfil the same range of functions as the original activity or activities (Wright et al., 2016). There also needs to be more consideration given to cultural implications of a livelihood shift; other studies in Madagascar have highlighted the cultural importance of *tavy*. It is seen as an identity or way of life, rather than just an agricultural method, and a way to provide for future generations: "*land … is seen as the most valuable inheritance they can leave their children*" (Rakotonarivo et al., 2017 p7).

Restricting unsustainable livelihood activities is likely to provide global benefits in the long term, such as carbon storage (Kremen et al., 2000), as well as local benefits such as catchment area protection and other locally-derived ecosystem services (Neudart et al., 2016). Yet there will always be short-term local costs which need to be stated explicitly, with compensation or alternatives provided in order to mitigate their impacts. In this study, we found that although the NGO had identified households who would be most impacted by PA establishment, planned compensation and livelihood projects had been delayed leaving those households to bear the costs of newly implemented rules. If short term costs are minimal or will lead to longer term gains, then

they may be considered more acceptable. For example, seasonal octopus fishery closures in Madagascar were considered acceptable by local communities as they only represented 15% of local fishing grounds, so the short-term cost was bearable by local households (Harris, 2006). Interventions need to be designed with short term and long-term benefits in mind. Agricultural training and introduction of new varieties of crops may increase harvests in the future, but will not compensate for loss of income or subsistence in the short term. This is an issue raised in sustainable development interventions as well. Suggested solutions have included subsidies to encourage up-take of interventions and publically-funded payment for ecosystem services schemes to acknowledge the societal benefits provided (Dallimer et al., 2016).

The Sustainable Livelihoods Framework provides a useful framework for understanding a range of impacts, including social and human factors which have historically had less attention when investigating impacts of conservation interventions (Mckinnon et al., 2016). It also enables exploration of how co-management can interact with impacts. In this study we have extended its application to enable explicit focus on differences between groups. Our study considers local perceptions of changes, rather than measured changes. Perceptions are an undervalued form of evidence in conservation science and alongside qualitative data can provide enhanced understanding of local equity concerns (Bennett, 2016; Dawson et al., 2017). However, it is also important to consider that perceptions may be unreliable in terms of the objective truth and cannot determine causation. For this study perceptions were the most appropriate evidence to look at as people are less likely to cooperate when they perceive a lack of fairness, and perceived inequity may result in attempts to resist or undermine PA rules (Hirsch et al., 2011). Perceptions of unfairness therefore lead to higher PA management costs (Pascual et al., 2014), sometimes through active resentment, such as vengeance killing of charismatic fauna (Jones et al., 2008), whereas positive perceptions of governance and social outcomes are associated with improved effectiveness (Oldekop et al., 2016; Koning et al., 2017). Quantitative large-scale studies have provided useful data, and can show whether costs and benefits are shared equally, but without in-depth studies we are unable to know whether this is considered equitable by local stakeholders, and this is crucial for both moral and instrumental reasons. We need to ensure that there are studies of both types and use the data together when measuring success of PAs and conservation interventions more generally, as well as when identifying where equity concerns need to be addressed.

5. Conclusion

Although co-managed PAs may overall be more effective in meeting biological and socio-economic goals than PAs of other governance types, this paper has presented further evidence to show that it is necessary not only to consider who is involved in PA co-management, but more importantly how they are involved. PA governance and management is a dynamic process, and the findings provide a snapshot of current perceptions. Nevertheless, there are useful lessons that can be learned from these results, these are particularly relevant for the new network of co-managed PAs in Madagascar but also globally. Careful consideration is needed as to whether these new Durban Vision PAs in Madagascar can truly be defined as co-managed when there are certain rules and regulations which local communities and NGOs are not involved in designing. The IUCN governance typology may need greater flexibility in its descriptions of how co-management partners may be involved in PA governance and management. We also presented further evidence showing that: (1) Policy-driven livelihood shifts need to take short-term and cultural implications into account. To understand what these may be, we need to take a more holistic view of what is incorporated in a livelihood; and (2) Qualitative data and in-depth studies enable us to explore perceptions of local changes associated with conservation interventions. These are vital in order to obtain a better picture of who is winning and losing out from co-managed PAs and to identify where actions need to be taken to mitigate the situation for those who bear high costs.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.jenvman.2018.09.018.

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