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Changing governance, changing inequalities: Protected area co-management and access to forest ecosystem services: a Madagascar case study

Caroline Ward *, Lindsay Stringer, George Holmes

Sustainability Research Institute, School of Earth and Environment, University of Leeds, Leeds LS2 9JT, UK

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ABSTRACT

Access, in reference to Ecosystem services (ES), is defined as the capacity to gain benefits from the environment. There has been a global shift in natural resource governance, particularly increased co-management of protected areas (PAs). Yet there has been little research on how this change may be affecting access to ES. We aim to fill this research gap by considering: (a) what ES are considered most important, (b) what factors are important in determining whether a person can access ES, and (c) how rules and regulations regarding ES access are decided and enforced.

Qualitative and quantitative data were collected using questionnaires, focus groups and interviews with stakeholders in a case study PA in Madagascar, co-managed by local community associations (VOIs) and an NGO. Data analysis was framed around the IPBES framework and access factors.

Respondents considered provisioning services most important, but also valued cultural and regulating services. Institutions and social identity had the largest impact on access to ES. VOI members and individuals who knew VOI committee members had greater access to ES than non-members. Findings show that co-management may be shifting ES access inequalities rather than reducing them, and we outline a number of challenges relating to PA co-management.

1. Introduction

Ecosystem services (ES) are the benefits people obtain from ecosystems (Millenium Ecosystem Assessment, 2005). It is well established that ES underpin human well-being, providing material things necessary for daily life, regulating the environments we live in, and contributing towards spiritual well-being (Millenium Ecosystem Assessment, 2005). Many different frameworks have been developed to conceptualise these links, incorporating social and natural sciences, and objective and subjective measures (Agarwala et al., 2014; Díaz et al., 2015; Fisher et al., 2014; Millenium Ecosystem Assessment, 2005). Yet, there continue to be debates about how best to measure the links between the natural environment and human well-being, especially because these relationships are dynamic. One factor frequently missing from these frameworks is an understanding of what may affect access to ES, as people are only able to realise ES benefits if they can access them. It is important to understand this in order to better evaluate environmental management interventions and their impacts on human wellbeing. This paper addresses this research gap.

Access, in reference to ES, can be defined as the capacity to gain benefits from the environment (Ribot and Peluso, 2003). The degree to which any individual benefits from ecosystems will depend on a complex range of mechanisms shaping access, including social relationships, institutions, capabilities, property rights and various capitals (Table 1). Daw et al. (2016: 11) identify access as key to "*the ability of people to benefit from [ES], whether or not that ability is realised*". Increasing stocks or quality of an ES will therefore have little effect on the well-being of people living nearby if they do not have access mechanisms to benefit from it (Daw et al., 2011). Conceptualising the unequal distributions of benefits has an established history within the social sciences. For example, Sen's (1981) entitlements approach to the analysis of famines showed that people may still experience famine when food is available, due to social, economic and institutional mechanisms affecting their access. Leach et al. (1999) highlight the importance of endowments, the rights and resources individuals have, and entitlements, the means to use a resource. There has been limited application of these frameworks to ES access, but previous studies have illustrated that social and institutional

* Corresponding author.
E-mail address: eecwa@leeds.ac.uk (C. Ward).

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Table 1
A summary of factors affecting access to ES (adapted from Ribot and Peluso, 2003) and relating to IPBES framework (Díaz et al., 2015).

Factor	Definition	Relation to IPBES framework	Relation to ES
Institutions	Laws, customs, conventions and authorities Access can be affected by both formal (e.g. laws) and informal (e.g. social custom) rules Access may be affected by laws denoting property ownership, permits and licenses	Institutions and governance (socio-political)	Ownership of land, paying for permits and local customs can all affect access to ES In the case of joint resource management, forest rights are sometimes not fully transferred to local people, allowing other agents greater control over allocating access
Physical assets	Technology, capital, markets and labour Physical ability to access resources may require tools, infrastructure, financial capital, access to markets and labour	Anthropogenic assets (built, human, financial) Institutions and governance (technological)	Many provisioning services cannot be extracted without the use of tools Financial capital may be required to buy permits or legal rights to access
Social identity and relationships	Identity, relationships and power Access is often affected by an individual's social identity (e.g. gender, age etc.), status within society (e.g. community leaders, village chiefs) and relationships with others. All mechanisms of access are forms of social relations	Anthropogenic assets (social, financial, human) Institutions and governance (socio-political)	Relationships with PA managers or committee members may allow easier access and more leniency towards rule breaking or the opposite for some groups
Knowledge	Direct knowledge relating to access (i.e. how, where, what), and also perceived knowledge status e.g. expert status, can give privileged access to resources, or authority to control resource-use	Anthropogenic assets (human) Institutions and governance (cultural)	Knowledge of where a particular provisioning service may be found (e.g. medicinal plants) Within strict PAs 'experts' or researchers may only be allowed access

mechanisms, alongside knowledge, were more important than economic or rights-based mechanisms in determining access (Hicks and Cinner, 2014). This has led to calls for increased incorporation of social data relating to ES, to improve understanding of how people use and value ES (Dawson and Martin, 2015). Addressing such calls is particularly important given trends towards increasing areas under conservation protection and the development of new mechanisms for their governance.

Protected areas (PAs) are a popular way to conserve ES and constitute "*. . .a socially constructed set of rules that. . . allocate access to and use of natural resources among stakeholders*" (Mascia and Claus, 2009: 17). By definition, PAs will affect ES access for local communities. This change in access may be positive or negative, and may be felt differently by different groups within communities (Schreckenberg et al., 2010). Often there are trade-offs between different services, resource-use objectives and societal goals, current and future generations, and between different beneficiaries (McShane et al., 2011). In developing countries this can lead to local livelihood costs, which may not be distributed equally, while the benefits are shared globally or at least at supra-livelihood scales (Oldekop et al., 2016). At the same time, at international level the Aichi targets not only aim to increase protected area coverage, but also to ensure these are "*equitably managed*" (CBD and UNEP, 2010).

Various interventions have been introduced in order to recognise the unequal distribution of costs and benefits of maintaining ES. Once such response is shared governance or the co-management of PAs, where the power, responsibility, decision-making and enforcement is shared between the state and other non-state actors, including NGOs, local communities and private companies (Berkes, 2010; Borrini-Feyerabend et al., 2012). Co-managed PAs aim to provide both socio-economic and ecological benefits. Frequently, local communities are involved as a partner in co-management in order to increase their representation, empower marginalised groups, increase trust, and promote social learning. Overall, evidence suggests that co-managed PAs are more likely to reduce costs and provide benefits for local communities than other governance approaches (Oldekop et al., 2016; Persha and Andersson, 2014). Yet, not all co-managed PAs have succeeded in meeting these aims (Persha and Andersson, 2014). This study adds to the evidence base in this area by examining which forest ES are considered most important by local communities in Madagascar, what factors are important in determining ES access, and how rules and regulations regarding ES access are decided and enforced. As local participation in governance increases, it is important that we understand how aspects of governance may impact people's access to ES, and whether this is equitable for those living nearby.

1.1. Conceptual framework

Conceptualising the links between the natural world and human well-being is crucial to improve environmental management whilst understanding the impacts this may have on local communities. This is particularly the case for the world's poorest, whose well-being is often most depending on ES, and where the impact of environmental change is often differentiated not only across age, livelihood, and gender, but also across culture and socio-economic status (Dawson and Martin, 2015).

There have been many different frameworks designed to outline the relationships between the natural world and human well-being, drawing upon environmental sciences, economics, psychology, sociology, and anthropology (e.g. Díaz et al., 2015; Millenium Ecosystem Assessment, 2005). Due to the complexities and dynamics of these relationships, new frameworks are constantly emerging as our understanding changes. Existing frameworks have been extensively reviewed within the literature, with critiques focussing on: a need for an interdisciplinary approach, integration of subjective and objective dimensions of well-being, equal inclusion of all ES categories (particularly cultural), integration of the diversity of values given to ES and consideration of ecosystem 'disservices', which have negative impacts on human well-being (Agarwala et al., 2014; Fisher et al., 2014; Pascual et al., 2017).

One of the more recent frameworks to emerge is from the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES; Fig. 1). IPBES was established in 2012 as an independent intergovernmental body open to all member countries of the United Nations (UN), with the goal of "*strengthening the science-policy interface for the conservation and sustainable-use of biodiversity, long term human well-being and sustainable development*" (IPBES Secretariat, 2017). The IPBES framework was constructed through

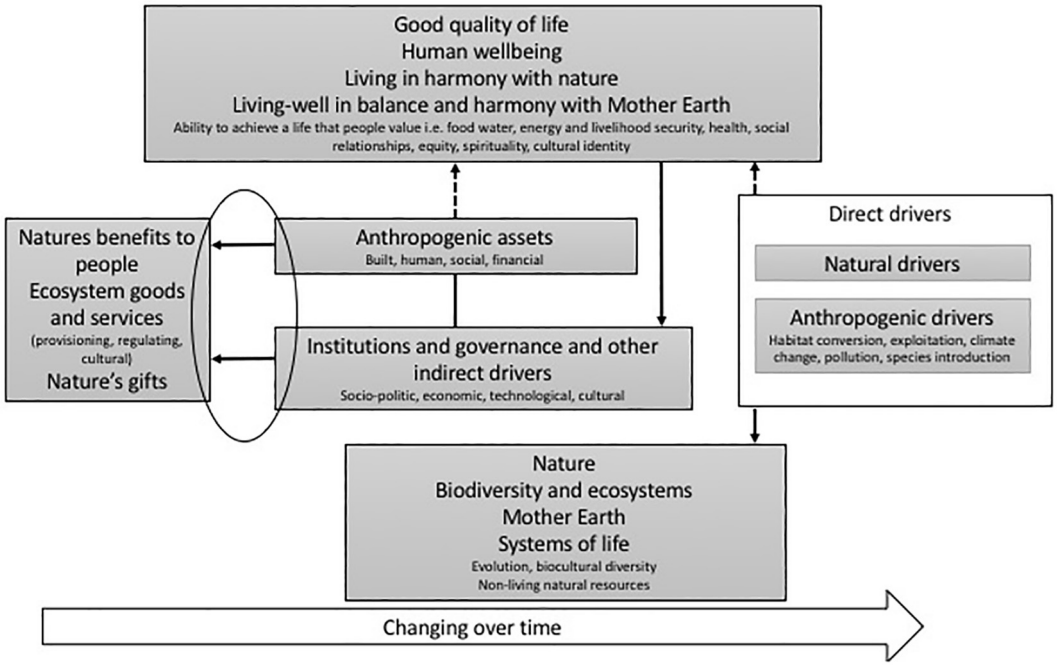

Fig. 1. IPBES conceptual framework (adapted from Díaz et al., 2015): the circle highlights the section where access to ES could be incorporated and the focus of this study.

multidisciplinary workshops involving diverse stakeholders, knowledge systems and countries, and defines how ES link to human well-being, what is driving changes in ES and how this may impact human well-being (Díaz et al., 2015). It will be used to inform future policy recommendations from the IPBES findings, yet due to its relatively recent release, it has had few real-world applications.

By diversifying those involved in framework construction, IPBES aimed to meet critiques of previous frameworks which lacked interdisciplinary approaches to understanding both ES and human well-being. It has been particularly praised for its approach to understanding the diversity of values given to ecosystem services, with some suggestions of reclassifying ES to 'natures contributions to people' in order to incorporate aspects of nature which cannot be valued or easily classified (Pascual et al., 2017; Tengö et al., 2016). However, while the framework includes anthropogenic assets, institutions and governance systems, it does not make clear the link between these and other factors and how they may affect an individual's ability to access ES, i.e. to realise the potential benefits from the environment. This is a repeated critique of many frameworks, as discussed in Section 1.

For this study, we attempt to target these critiques and combine Ribot and Peluso's access factors (Table 1) with a section of the IPBES framework (Fig. 2). This allows us to explore which factors are important in determining ES access in PA co-management.

2. Materials and methods

2.1. Study area

Madagascar presents a "classic conservation and environmental management conundrum" (Scales, 2014: xx), as one of the world's least developed countries (UNEP, 2013), yet also classed as a biodiversity hotspot with over 80% of species endemic to the island (Goodman and Benstead, 2005; Myers et al., 2000). 80% of the population are rural and rely on a combination of subsistence farming

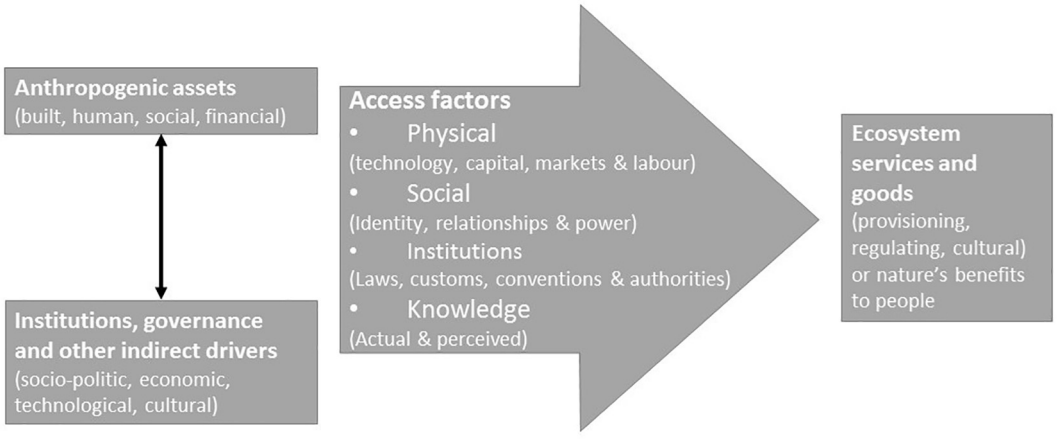

Fig. 2. Combining Ribot and Peluso (2003) access factors with the IPBES conceptual framework to explore what may impact individuals' or households' ability to access and use ES.

and non-timber forest products (NTFPs) for their livelihoods, illustrating the importance of provisioning ES (Randrianarivony et al., 2016). The slash and burn agriculture system, known as *tavy*, is regarded as the country's main driver of deforestation (Waeber et al., 2016). At low population densities *tavy* may be sustainable, but population growth, from 5 million in 1960 to 24 million in 2015 (World Bank, 2016), means that reducing this practice is now considered a priority by many conservation organisations (Scales, 2014). A key strategy has been to establish a new network of PAs, aiming not only to increase PA coverage and increase connectivity between existing PAs, but also to allow communities to continue accessing forest resources sustainably as they move towards alternative livelihoods (Gardner, 2014). These new PAs are co-managed by local associations (locally known as VOIs) and a non-state partner (promoter). VOIs provide a mechanism for individuals to participate in PA governance, from establishment through to daily management decisions. VOIs may be established by the promoter or based on existing village associations, and consist of a committee and members. Anyone in the community is eligible to join and the committee is elected by the members. A number of concerns surrounding the legitimacy, true levels of local participation, elite capture and lack of promised compensation have been raised within the academic literature (Corson, 2014, 2012; Virah-Sawmy et al., 2014; Ward et al., 2017). Yet few studies explore how this new approach to managing PAs in Madagascar affects access to ES. Consequently, we are limited in our understanding of whether these new PAs are meeting their aims. As co-management of PAs increases globally, Madagascar offers an important case through which to explore how this governance approach plays out in reality.

This study focusses on one of these newly established PAs, Mangabe Forest, located in eastern Madagascar and co-managed by 10 VOIs and a national NGO. The eastern forest corridor belt in Madagascar is made up of a number of PAs, which are recognised as extremely important for conserving Madagascar's biodiversity but are under pressure from expansion of agricultural land, illegal logging and artisanal mining (Poudyal et al., 2016). In particular, Mangabe Forest contains 60% of the remaining population of the locally endemic and critically endangered golden mantella (*Mantella aurantiaca*), and important populations of endemic and critically endangered lemur species indri (*Indri indri*) and diademed sifaka (*Propithecus diadema*) (Pers. comm. NGO staff).

2.2. Data collection methods and sampling strategy

Three data collection methods were used: (1) village focus groups, (2) semi-structured interviews, and (3) household questionnaires. Data were collected in September–December 2015 and April–July 2016 (Table 2). Ethical approval was granted by relevant bodies before data collection began.

Three study villages were selected due to their similar distances from forests (1 h walking), variations in VOI participation and similar VOI establishment processes (pers. comm. NGO staff; Table 2–2). Distance from forest was considered likely to affect frequency of forest access and reliance on forest resources, and therefore kept as similar as possible between villages.

Focus groups (FG) discussed ES and disservices (benefits and costs) from the forest, and varying importance of each (Appendix B). Purposive sampling did not aim to be fully representative of each village, but to gain a wide range of opinions. After consultation with village members, FGs were divided into members and non-members due to concerns of conflict between these groups. Participants were identified during village introductions, with each FG consisting of 8–10 participants. FGs were facilitated by research assistants with input from the lead author if needed. Discussions were recorded and written into summaries by the lead author and research assistants. 5 FGs were conducted (Table 2).

Interviews aimed to discuss in-depth topics relating to PA governance, ES use and access and the rules or laws related to this (Appendix C). Sampling aimed to gain a wide range of views, and allowed us to speak to individuals living further away from village centres who may not have been able to participate in FGs. VOI and village presidents were interviewed first, and further interview participants identified via snowball sampling to give a total n = 34. We aimed to interview an equal number of VOI members and non-members, although found that there were many more VOI members living in villages than non-members and therefore our total sample size for members and non-members follows this distribution (Table 2). Interviews were conducted with the assistance of a translator. Interviews were also conducted with 2 NGO staff members, in order to gain background understanding on the rules relating to ES access and use.

Questionnaires aimed to sample a larger proportion of the population for a more representative set of views. Census information was unavailable, as there are few records on the location and size of communities in rural Madagascar, making it difficult to develop a rigorous sampling frame. We aimed to collect a representative set of views for each village. Households were randomly selected, by choosing every 2nd household. Permission was requested to interview head-of-households (as defined by the household). If they declined to participate, or were not available, we moved onto the next household. Discussions with village presidents and elders confirmed that all remote areas of the village had been sampled. Ordinal and categorical questions relating to socio-economic indicators and ES use, and open-ended questions about access to ES were included (Appendix D). 217 questionnaires were completed (Table 2). Questionnaires were conducted in Malagasy by research assistants from the University of Antananarivo. Material Style of Life (MSL) was used as a proxy for wealth, and calculated for each household based on locally appropriate household structure and possessions (Appendix D). MSL is a widely used, useful and robust indicator of wealth in developing countries (see Cinner et al., 2010, for more detail). The MSL score was calculated using a principal component analysis (PCA) on all variables and items with low factor loadings were removed (Cinner et al., 2010). Questionnaires were piloted in the villages to test for clarity and length before data collection began. As no modifications were needed, pilot data were included in the final sample.

2.3. Data analysis

T-tests using R (R Core Team, 2013) were used to measure differences between demographics, socio-economic characteristics

Table 2
Summary of data collected.

	Village 1		Village 2		Village 3		Total
	VOI members	VOI non-members	VOI members	VOI non-members	VOI members	VOI non-members	
Focus groups	1	1	1	–	1	1	5
Interviews	7	5	7	2	7	6	34
Questionnaires	45	35	62	18	27	35	220

and number of ES accessed. Proportions were used when comparing between different groups (such as VOI members and non-members) due to unequal sample sizes. Transcribed interviews and questionnaire responses were analysed using NVIVO software version 10 (QSR, 2012) to identify answers relating to ES use, factors affecting access and rules relating to ES access. Qualitative analysis was conducted in several stages of reading, coding, comparing to quantitative data and recoding. Responses were classified by ES category and access mechanisms included within the access framework presented in Fig. 2 (Newing, 2010). In order to understand which factors (listed in Fig. 2) had the greatest impact on ES access, we compiled evidence from qualitative and quantitative methods. From this combined data, it was possible to draw out which factors had the greatest impact.

3. Results

3.1. What ES are most important or used most frequently?

In FG discussions, respondents considered provisioning services such as wood for fuel, building and tools, to be the most important benefits from the forest (Table 3). Rainfall, a regulating service, was also considered important in two of the three study villages. Data from interviews and questionnaires highlighted perceived links between the forest, air or water quality and rainfall: "*the forest makes the air clean and helps our health*" (Village 1, female, VOI non-member) and "*The forest helps to clean the air, give water and rain*" (Village 2, male, VOI member). Cultural services were mentioned infrequently (28/220), but considered the importance of forest existing for future generations: "*there will still be forest for future generations*" (Village 2, male, VOI member), aesthetic aspects: "*the forest is beautiful to see*" (Village 1, male, VOI non-member), the value of wildlife: "*I like to see the wildlife*" (Village 3, male, VOI member), and the importance of local beliefs related to the forest: *"the forest is the home of our ancestors, so we must respect the fadys. It is fady to wear rings or earrings in the forest and to speak foolishly*" (Village 3, VOI member).

Questionnaire data on provisioning services showed that ES used most frequently (Fig. 3) were fuelwood (23.0%), wood/plants for construction (13.4%) and fish (7.8%). ES use varied between villages and village 2 had the highest proportional use of all ES categories (Fig. 3). Fuelwood use was consistently high across all three villages.

3.2. What factors are important in defining whether a person has access to provisioning ES?

Results are summarised following the access factors defined in Table 1. Table 4 explains in detail how and why each access factor affects ES access, and Fig. 4 depicts how these findings relate to the conceptual framework. The paragraphs below summarise these findings. Overall institutions and social identity appeared to have the greatest impact on ES access.

Table 3
Village selection criteria.

Village	Distance from nearest town (hours walking)	Distance from forest (hours walking)	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

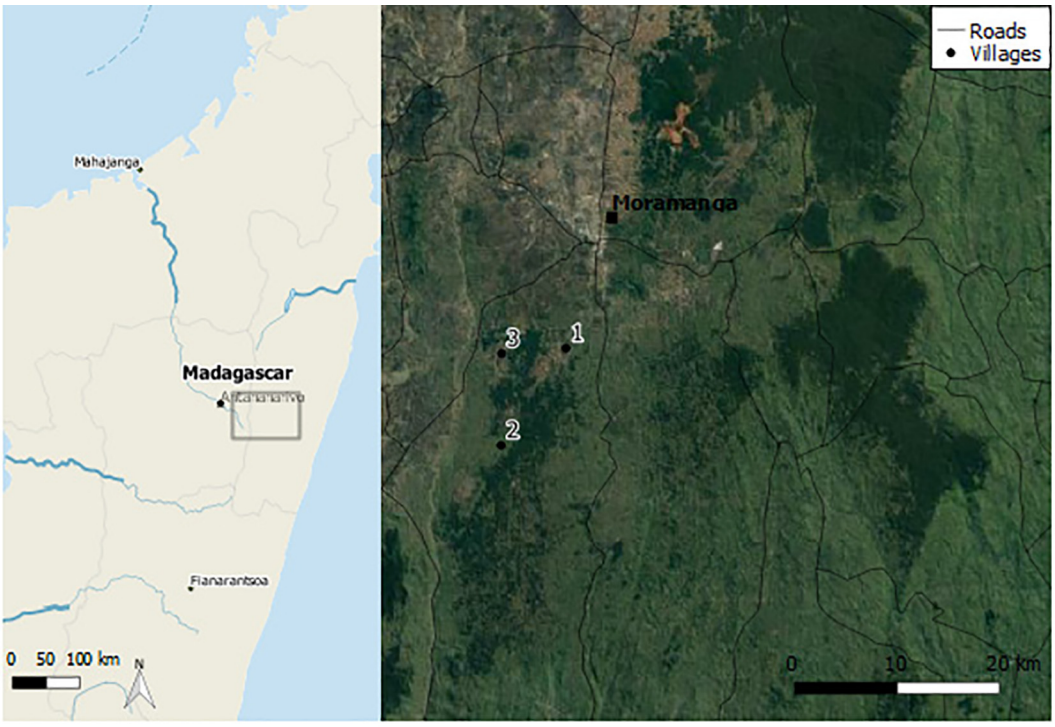

Fig. 3. Map showing case study village locations.

Table 4
FG responses to the question: "what are the most important benefits you get from the forest?" These are used to indicate perceived ES importance. Answers focussed mostly on provisioning services but also included regulating and cultural services (P = provisioning service, R = regulating service, C = cultural services).

Relative importance of ES	Village 1		Village 2	Village 3	
	VOI members	VOI non-members	VOI members	VOI members	VOI non-members
1	Wood/plants for construction (P)	Fuelwood (P)	Rainfall (for rice agriculture) (R)	Rainfall (for rice agriculture) (R)	Fuelwood (P)
2	Honey (P)	Wood/plants/for construction (P)	Medicinal plants (P)	Wood/plants for construction (P)	Rainfall (for rice agriculture) (R)
3	Animals for hunting (P)	Honey (P)	Honey (P)	Fuelwood (P)	Wood/plants for construction (P)
4		Fish (P)	Wood/plants for construction (P)	Number of animals in the forest (C)	

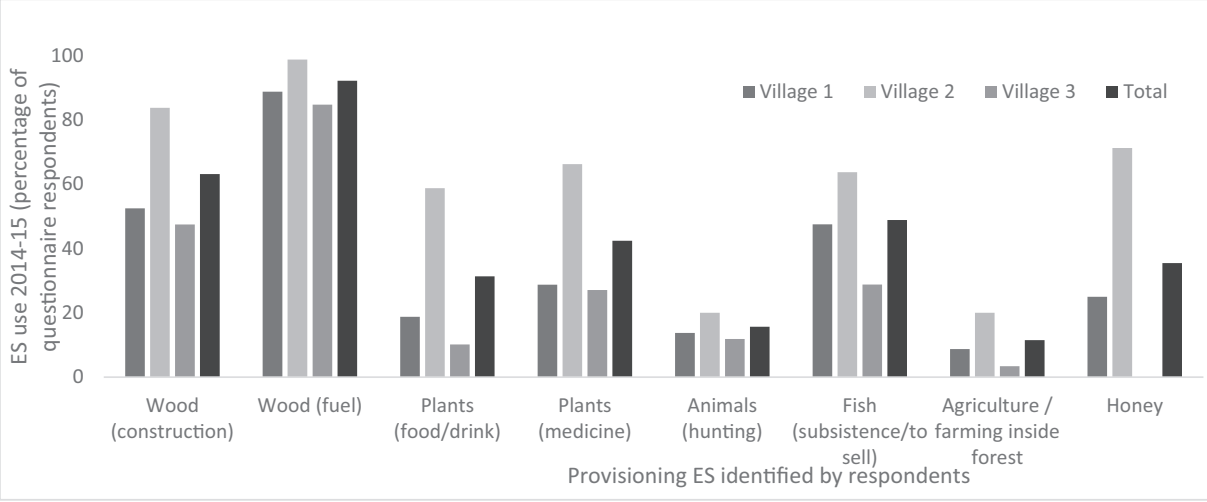

Fig. 4. Percentage of respondents (total and per village) using provisioning ES from 2014 to 15.

3.2.1. Institutions

VOI members had fewer barriers to accessing ES including fewer restrictions via rules/laws. 17/34 interview respondents stated that there were significant differences in forest access rules for members and non-members. However, explanations of these differences varied, including no forest access for non-members, permission required by non-members, and payment required for access (see Table 4). Questionnaire responses showed that VOI members were more likely to be accessing a wider range of provisioning ES ($t = 5.57$, d.f. = 210, $p \leq 0.001$; Fig. 6). VOI membership also related to knowledge and social identity (Fig. 5).

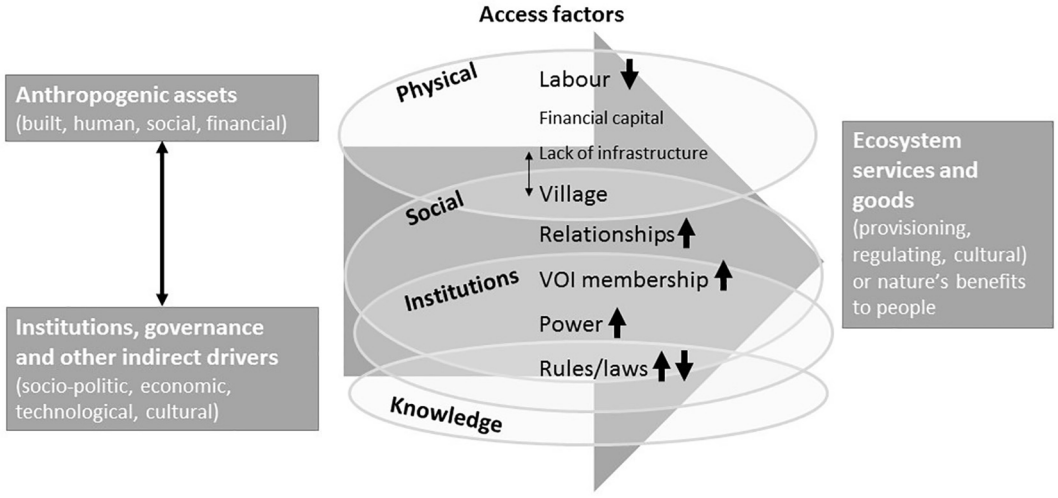

Fig. 5. Summary of access factors impacting ES access and their direction. This figure shows an expanded version of Fig. 2, indicating the results of the study. The access factors have been expanded to indicate what was most important in each factor identified in Fig. 2, following the results from Table 5. The arrows illustrate whether factors increase or decrease access to ES, utilising the evidence summarised in Table 5. Factors without arrows showed no obvious effect on access. Note that there was evidence that knowledge of rules and laws both increased and decreased access (see Table 5). Factors overlap as there were many linkages between them.

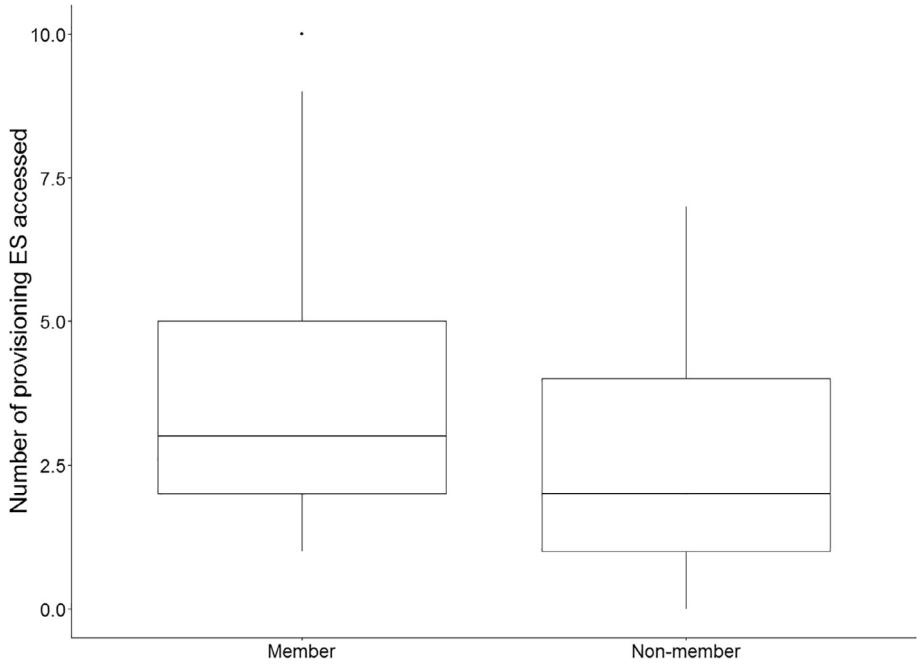

Fig. 6. Mean and interquartile range of provisioning ES accessed by VOI members and non-members: on average, VOI members were accessing a significantly wider range of provisioning ES (see Fig. 4; $t = 5.57$, d.f. = 210, $p < 0.001$).

3.2.2. Physical

Physical factors had less of an impact on ES access. Lack of infrastructure was discussed as an issue relating to transporting forest resources to towns or markets, but only by a minority of respondents and is unrelated to PA co-management. The NGO involved in PA co-management has been encouraging households to increase rice cultivation. A few respondents (7/34) stated that this left them with less time to travel into the forest. A minority of respondents (7/34) stated that non-members had to pay to access forest resources, but questionnaire data gave no statistically significant relationship between household wealth and provisioning ES use ($t = -1.75$, d.f. = 210, $p < 0.08$).

3.2.3. Social identity

Provisioning ES use varied between villages, with village 2 having the highest use of all categories (Fig. 4). This was also the only village where FG discussions on ES importance mentioned medicinal plants, and many questionnaire respondents (50/80) stated there were a lack of possible income-earning livelihood activities, and life had become more difficult: "*There are less activities to earn money due to the regulations*" (village 2, male, VOI member). This village is located the furthest from roads and markets via a mud path, which could explain the higher reliance on provisioning ES compared to the other two villages.

VOI members were more likely to know VOI committee members or patrollers, which respondents stated would both make it easier for them to get permissions to access the forest, and be less likely they would be reported if caught breaking rules (Table 4). Power could be gained through VOI membership or being a VOI committee member, to give greater access to ES or more involvement in deciding the rules of forest access or punishments for breaking the rules.

3.2.4. Knowledge

VOI members were more likely to know the rules surrounding ES use than non-members. However, other respondents suggested that punishments for breaking rules might be more lenient for non-members (Table 4).

3.2.5. Overlaps

The results highlight the overlaps and relationships between factors in the analytical framework (Fig. 4). VOI membership was incorporated by both social identity and institutions, and also related strongly to knowledge, as VOI members had greater knowledge of rules/laws relating to ES access.

3.3. How are rules/regulations surrounding ES access decided and enforced?

Interview respondents gave a variety of answers about who was involved in decision making related to ES access. This included: the VOI (4/28), VOI committee (1/28), VOI president (6/28) NGO (5/28), government (2/28), a combination of all four (5/28) or not knowing (5/28). For example: *"there was a meeting between [the NGO], the local people and the forest ministry, and we all decided together*" (village 3, male, VOI member), *"[the NGO] told us where we can get trees from and where we can't*" (village 2, male, VOI member) and *"the president tells us where we can get resources from and what times of year we can fish and hunt*" (village 1, male, VOI non-member).

Responses suggested that the enforcement of these rules is complex, as VOI committee members are employed as forest patrollers but lack any power to arrest rule breakers. Some interview respondents highlighted issues with enforcing rules including: lack of regular payment for patrol work; lack of power to arrest rule-breakers; lack of materials needed for patrolling; and that the process for reporting rule-breakers was convoluted and rarely successful. For example: *"We lack materials and we need them, as a patroller we need materials like cameras to get proof that people have broken the rules... Sometimes if people are caught then there is no proof and it is just our word against them, so sometimes they win... even if they are put in jail it's not for very long, only 1 or 2 months... Also we need a telephone because sometimes when we catch people breaking rules they threaten us so we need to be able to call the* [police] *or people around to come and help us...*" (Village 1, male, VOI member).

Other interview responses focussed on the social and political issues with potentially reporting rule-breakers from their own

Table 5
Summary of factors affecting ES access.

Access factors		Relation to co-management	Evidence	Effect on ES access	Description
Institutions	VOI membership	VOI established as a mechanism to involve local communities in PA governance	17/34 interview respondents stated that there were differences in access between members and non-members, 9/34 stated that there were no differences, and 6 didn't know *"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) *"Non-members have to pay to cut the trees, but members don't"* (Village 1, male, VOI member) *"Non-members are not allowed to get resources from the forest"* (Village 2, male, VOI member) *"There is no difference between members and non-members"* (Village 3, male, VOI non-member) On average, VOI members accessed a significantly wider range of provisioning ES (Fig. 4; $t = 5.57$, d.f. = 210, $p < 0.001$)	Membership increases access	There were mixed responses on whether forest access was easier for VOI members or not. Interview respondents gave a variety of answers. Overall it appeared that VOI members had fewer barriers to accessing the forest and questionnaire responses indicated that VOI members were accessing a wider range of provisioning ES
	Rules/laws	The forest is now divided into a core protected area and sustainable use zone. Within the sustainable use zone only subsistence use of forest resources is allowed and certain activities are prohibited (including *tavy*, commercial logging and gold mining)	22/34 interview respondents were aware of the new rules, although their interpretations of the details varied. 12/34 did not know or incorrectly described the rules *"Now we can't do non-selective logging, slash and burn or gold mining"* (village 2, male, VOI member) *"I think people can't take what they want from the forest. There are only certain things they can take, but I don't know"* (Village 3, female, VOI non-member) *"The forest is divided into two parts: the reserve and the forest for the local community. In our part of the forest, we can get trees for households, medicinal plants, and we can hunt"* (village 2, male, VOI member) *"Now it is protected we can't get anything from the forest"* (village 3, male, VOI member) *"I don't know what we are allowed to get in the forest, I only know that we are now protecting the forest"* (village 1, female, VOI member)	Depends individual understanding of the rules and VOI membership	The majority of interview respondents were aware of the new rules. However, there were also responses stating much stricter rules and others who did not know the rules Relating to the institution access factor, there was a lot of disagreement about whether VOI members and non-members had to follow the same rules
Physical	Lack of infrastructure	–	3/34 interview respondents and 55/220 questionnaire respondents stated that lack of infrastructure caused problems reaching towns and markets *"The problem is the road, vehicles can't get here and it takes a long time for us to take things to* [the town] *to sell"* (village 3, male, VOI non-member) *"We sell* [weaving products] *in* [the town]*, but it's difficult to get them to* [the town]" (village 2, female, VOI non-member)	No effect on initial ES access Some effects on gaining further benefits from ES (e.g. poor roads make it difficult to access markets)	Villages lack infrastructure, such as roads or bridges, increasing time taken to reach the forest or to transport forest resources out for subsistence or selling. This is particularly an issue in the rainy season, when paths can become treacherous and bridges destroyed by high river levels or cyclones (however this is unrelated to PA co-management)
	Labour	Encouragement from NGO to shift livelihoods towards rice/beans agriculture to reduce forest resource reliance	7/34 interview respondents linked increased time spent on agriculture to less time available to go into the forest "*Now we do more rice and bean farming, there is less time to go into the forest"* (Village 3, male, VOI member)	Decreases access	Rice agriculture in particular is very labour intensive. This leaves less time for individuals to go into the forest, although was mentioned as an issue by only a minority of respondents
	Financial capital	-	7/34 interview respondents stated that non-members would have to pay to access forest resources	No effect	Qualitative data showed confusion over whether households have to pay fees to access resources. There was no significant relationship between

			"It is easier for VOI members to get access to resources and also cheaper than non-members" (Village 1, male, VOI member) Respondents using a wider range of provisioning ES tended to be less wealthy, but this was not a significant difference ($t = -1.75$, d.f. = 210, $p < 0.08$)		wealth and provisioning ES use
Social identity	Village	–	Village 2 had much higher reported use of provisioning services than other two villages (Fig. 3)	Likely to be affected due to differing distances to roads, towns and markets	Study villages were similar distances from the forest, but differed in distances from roads, towns and markets
	Relationships	Village members working as patrollers as part of co-management	"If we patrol and we see someone we know breaking the rules, then it sometimes creates conflict within the community" (village 2, male, VOI member) "We have to get permission from the VOI president before we cut any trees" (village 2, male, VOI member)	Relationships with VOI president and patrollers increases access	Interview responses highlighted that patrollers may not report people they know, if they see them breaking rules Some interview respondents stated that permission was needed from the VOI president to access the forest, suggesting that relationships with the VOI president may improve access
	Power	VOI committee members and patrollers gain power from establishment of VOI	"The president of the VOI is in charge of making decisions" (village 2, male, VOI member) "It depends on how seriously they break the rules. If they just cut one tree they might just get a fine (the VOI decides), but if they do slash and burn then the VOI must make a report to [the NGO] and the ministry, and the person might be sent to jail" (village 3, male, VOI member) "We often catch them, but we can't punish people, we have to send a report to the government and we don't know how the case continues after that, whether people actually get punished or not" (village 1, male, VOI member)	Being a VOI committee member or patroller increases access	Confusion over who has power to make decisions regarding ES access rules Depending which rule is broken, VOI members may lack powers of enforcement. Patrollers have to send a physical report to ministry/NGO, which may take a long time due to the distance from villages to the town
Knowledge	Rules	New rules established as part of co-management	17/21 VOI members were aware of the new rules, compared to 5/13 non-members *"The members know where in the forest they can get trees. But non-members don't know, so they have to ask"* (Village 3, male, VOI member) *"Usually it's people from outside* [who break the rules] *so they don't know what the rules are"* (village 2, male, VOI member) *"Some people don't know about the rules"* (village 1, male, VOI member) *"If they are not aware of the rules then we tell them that we are protecting the forest, and give them a second chance"* (village 1, male, VOI non-member)	Mixed	Members have greater knowledge of the rules and where they can access resources in the forest. Non-members are less aware of the rules but may therefore be given greater leniency if caught breaking the rules

communities, suggesting that it had increased conflict between people involved with the VOI and those who were not: *"people threaten us when we patrol and tell them that they can't do things in the forest*" (village 3, male, VOI member).

4. Discussion

In our study, the factors most important in shaping ES access were institutions and social identity. This echoes previous findings across wider scales and within different contexts (Hicks and Cinner, 2014). Institutions are frequently highlighted as an important factor in accessing ES. Power can be exercised through formal and informal institutions, determining who may control or benefit from ES, who suffers from ecosystem disservices, which ES are considered legitimate, and whose values and perspectives are acknowledged and accounted for (Dawson and Martin, 2015; McShane et al., 2011). Previous conservation-related work in Madagascar has often highlighted the relevance of '*fadys*', a set of informal institutions which make certain behaviours taboo (Jones et al., 2008). These have been linked to the conservation of certain species (e.g. relatively low levels of bushmeat hunting (Jenkins et al., 2011) and threats to others (e.g. Goodman, 2015). This approach has received criticism for viewing 'fadys' as simplistic and static, rather than the complex, dynamic, evolving set of social norms that they are (Kaufmann, 2014). None of the interview respondents mentioned '*fadys*' in relation to accessing ES, and they were only mentioned by a few respondents in terms of cultural ES, where the forest represents a spiritual link to the ancestors. The findings in this study emphasise the role of VOIs, which take the place of formal institutions, although in some cases VOIs have been created by formalising existing informal institutions. This risks reinforcing or worsening inequalities by enabling 'elites' to have a greater say or capture more of the benefits. Virah-Sawmy et al. (2014) stated that traditional Malagasy village-level institutions tend to be dominated by older men, and basing VOIs on these risks marginalising women and migrants. This may undermine the aim of PA co-management to improve rights and natural resource access of local communities. In our study villages, VOIs were newly created with the PA establishment, yet results suggest they are potentially creating new inequalities or reinforcing existing ones. This presents a challenge for conservation interventions, where working with previously existing institutions is likely to improve the chance of success, but existing institutions may not be representative and vulnerable to elite capture. Co-management institutions need to recognise the heterogeneity within local communities, in order to ensure that all social divisions are represented within decision-making processes (Ward et al., 2017).

Social identity and relationships with VOI members and patrollers also had an important role in determining ES access in this study. It is well documented that employing local community members to patrol PAs and enforce rules, is complex. Responses in this study showing leniency to local rule-breakers are echoed in different case studies throughout Madagascar (Reuter et al., 2017; Sodikoff, 2009). Rural villages in Madagascar have a high importance placed upon *fihavanana*, familial relations, where households within villages will offer reciprocal help with sowing, harvesting and cultural activities (Sodikoff, 2009). Yet in other countries, employing local patrollers has had different impacts, increasing the likelihood of local people breaking rules (Holmes, 2013). This highlights the importance of understanding local context when designing and implementing interventions.

The results from our study illustrate the importance of forest ES to local livelihoods in this area, particularly in the village most remote from roads, towns and markets. Households were reliant on provisioning services for food, medicine, construction materials, cultural and spiritual reasons. This adds to the extensive literature showing that ES are essential from human well-being (e.g. Millenium Ecosystem Assessment, 2005; Sandhu and Sandhu, 2014). Unlike other studies, we did not find ES reliance related to wealth. Instead, it related to distance from roads, towns and markets. This is most likely to be linked to a lack of access to alternative food sources, building materials from areas outside the PA and income generating livelihood activities unrelated to the PA. Other studies have shown that where people struggle to meet multiple basic needs and few alternatives exist beyond natural resources, demand is only likely to rise for provisioning ES (Dawson and Martin, 2015). Madagascar's biodiversity is under high anthropogenic pressures, and unsustainable use of resources will also create problems for future generations. Yet, preventing resource use without offering alternatives is likely to create more resentment towards conservation than it is to reduce pressure on biodiversity. Even with continued 'sustainable-use' of ES there is still a short-term opportunity cost which needs to be explicitly recognised. If conservation interventions aim to decrease ES use, they will need to ensure that households are able to access affordable alternatives.

Cultural forest ES were mentioned in both interviews and FGs, yet the management of sustainable ES use is not necessarily set up with these in mind. Cultural ES tend to be more difficult to value and consider within environmental management as they are highly subjective, and shaped by individuals' views, needs and values (Anthem et al., 2016). Yet cultural services contribute towards human well-being in many complex ways, and also interact with other type of ES. Previous research has shown that people often perceive ES benefits in bundles, rather than as discrete individual benefits. For example provisioning services (such as fishing) offer both income (provisioning) and non-income benefits such as tradition and enjoyment (cultural services) (Hicks and Cinner, 2014). This suggests that not only do conservation interventions need to ensure that alternatives to ES are available and affordable, but also need to explore other values given to ES, to understand whether individuals would be willing to reduce their use or switch to alternatives. A recent study by Rakotonarivo et al. (2017) conducted close to the study site we worked in, highlighted that *tavy* is given important cultural value here and considered as an "identity", not just a livelihood activity to produce crops. Cleared land is also seen as an important inheritance for children and future generations. This is where studies using monetary proxies to represent ES values such as contribution to income, cost-benefit or contingent valuation may overlook the importance of non-material benefits or the crucial contribution ES make to meeting human needs. Therefore a more explicit consideration of the diversity of values and possible taboos might support improved decision making (Daw et al., 2015; Dawson and Martin, 2015).

The IPBES framework represents a relatively new method of exploring the links between ES and human well-being. It aimed to respond to critiques of previous frameworks by including perspectives from a variety of disciplines and knowledge types. Yet, it lacks inclusion of local factors which may impact upon people's abilities to access ES. We have shown in this study that local contextual factors strongly influence whether individuals are able to access ES. The IPBES framework could usefully be revised to include this aspect.

5. Conclusion

There have been a number of commitments stating that local people living close to or within forest environments, many of whom are extremely poor, should not be negatively affected by efforts to conserve forests for the global benefits they provide. By

involving local communities in PA governance, the aim is to decrease opportunity costs for local communities, whilst providing both socio-economic and biodiversity benefits. The findings from this study show that local contextual factors, particularly institutional and social identity, strongly affect access to ES, and co-management may be shifting inequalities rather than reducing them.

Findings from our study have highlighted a number of challenges related to PA co-management: (1) any reduction in ES access is likely to create a short term opportunity cost. These costs need to be explicitly recognised and livelihood interventions designed with this in mind; (2) The diversity of cultural and social values given to livelihood activities relating to ES use needs to be carefully incorporated rather than considering them as conservation or sustainability issues; (3) Community-level PA institutions need to ensure that all household types and social divisions are represented, in order to prevent worsening existing or creating new inequalities. By meeting these challenges, PA co-management will be more likely to meet its aims of providing biological and socio-economic benefits.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at https://doi.org/10.1016/j.ecoser.2018.01.014.

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