Forest Conservation in Madagascar: Past, Present, and Future

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"*Ny lasa tsy anenenana fa ahombiazana ny ho avy*" (the past is not to be regretted but to inform the future). Malagasy proverb.

Introduction

Almost every article about Madagascar's biodiversity starts with a list of superlatives reflecting the country's status as one of the world's 'hottest' biodiversity hotspots (Ganzhorn et al. 2001). However, when thinking about conservation of that biodiversity, many other extremes are also relevant. Madagascar is one of the poorest countries in the world (World Bank 2019), with a higher proportion of people living in extreme poverty than almost anywhere on the planet (Roser and Ortiz-Ospina 2019) and widespread food insecurity (Rakotomanana et al. 2017). This fact affects all aspects of conservation on the island. Madagascar is also one of the highest recipients of biodiversity-related aid (Miller et al. 2013; Waeber et al. 2016). It was one of the first southern hemisphere countries to introduce laws facilitating community-based natural resource management (Rasolofoson et al. 2017), and it has undergone one of the most comprehensive recent expansions of its protected area network in the world (Goodman et al. 2018). So many challenges and so many opportunities.

At this critical time for the future of Madagascar's biodiversity (Jones et al. 2019a), we first review the past: touching upon conservation from pre- to post-colonial periods before focusing on the period which most dramatically shaped the country's current conservation-related institutions and policies (1984-2009). Next the present: we examine evidence for the effectiveness (or otherwise) of the main approaches to forest conservation on the island. We look in detail at how conservation has conceptualized the link between environment and development in Madagascar, the impact of measures by conservationists to transform rural livelihoods, and the effectiveness of protected areas, community-based natural resources management, and the environmental impact assessment legislation. Finally, we look to the future and consider how pressures on Madagascar's biodiversity, and the conservation community's responses, are evolving and need to evolve.

This is, of course, hugely ambitious. We are attempting to cover a significant chunk of history for a diverse mini-continent. We bring in literature from anthropology, political ecology, economics, and conservation science. We can only hope to do this incompletely. We focus on forest conservation partly because such a high proportion of Madagascar's biodiversity is found in forests (Goodman and Benstead 2005), but also because other contributions in this book cover conservation issues faced by specific taxonomic groups.

Conservation Past

The Pre-colonial Context of Conservation in Madagascar

The livelihoods of Malagasy people have always been varied; with, for example, livestock herding dominant in the dry south and west, and fishing in coastal areas (Dewar 2014). Where there is forest, people use shifting or swidden agriculture (known as *tavy* in the Central Highlands and the east, *jinja* in the north, and *hatsake* in the south and west: hereafter *tavy*; Figure 1a) to meet their subsistence needs. The ancestors of the current Malagasy ethnic groups would have developed institutions to manage the natural resources on which they depended (Ostrom 1990). Perhaps we can see vestiges of how these institutions may have looked in some aspects of the *fady* (Malagasy taboos and social norms; Jones et al. 2008), and *dina* (locally imposed regulations; Rakotoson and Tanner 2006; Andriamalala and Gardner 2010), which contribute to traditional natural resource management today. However, these institutions would have been highly variable across the island and are poorly documented (Kull 2014). Like others, we therefore skip over the first millennia of natural resource management in Madagascar to consider the beginning of top-down rules, which emerged during the Merina royal dynasty.

At the end of the 18th century, the first king who attempted to unite Madagascar (Andrianampoinimerina; 1745-1810) introduced some of the earliest documented rules concerning the conservation of natural resources in the Afro-Malagasy Region (Scales 2014a). Presented using the magnificent Malagasy oral tradition of *kabary*, these were written down by missionaries in the 1860s and 1870s (Callet 1878, quoted and translated in Langrand and Rene de Roland 2018). Andrianampoinimerina clearly considered the forest as a public good whose products could be used by the poor. "Here is the forest, a patrimony not susceptible of division among the subjects. It is there that the orphans, the widows and all the unfortunate will come and seek their means of existence, as without the forest they would have no resources to sell". He expressly banned forest clearance except for making charcoal to support metalwork and this exploitation was only to be conducted at forest edges (Langrand and Rene de Roland 2018). Subsequent Malagasy royals (particularly King Radama II; 1829-1863, and Queen Ranavalona II; 1829-1883) further developed and formalized laws controlling the clearance of forest land, introducing the state ownership of forests which remains the default to this day (Pollini 2011; Raik 2007). The focus of these rules was retaining access to precious hardwoods for royal and state-approved uses. While these rules purported to apply to the whole island, in reality the Merina dynasty had limited control outside lands of the Imerina and Betsileo ethnic groups (the Central Highlands) certainly until the mid-19th century (Brown 2000; Randrianja and Ellis 2009). Other leaders outside of Imerina presumably had their own systems of natural resource management which are less well known.

The Colonial and Immediate Post-colonial Period

France formally annexed Madagascar in 1896. Following growing awareness of the economic value of forests in French colonies, Madagascar's forest service, the Département des Eaux et Forêts, grew rapidly in the early part of the 20th century (Langrand and Rene de Roland 2018). A major focus of the authorities was on limiting traditional shifting agriculture and the use of fire, while extracting valuable timber and promoting cash crops for export (Jarosz 1993; Kull 2004; Scales 2014b). The Département des Eaux et Forêts (DEF) were also responsible for planting and managing large tracks of exotic eucalyptus and pine plantations to provide timber and fuel wood to support building projects and the energy needs of the two French-built railways (Olson 1984).

Colonial scientists and naturalists believed that Madagascar had been entirely forested before the arrival of humans (McConnell and Kull 2014). Paleo-ecological studies of pollen records, and analysis of the species found in Madagascar's grassland communities, has now shown beyond doubt that grasslands of the Central Highlands pre-existed human settlement (Dewar 2014; Vorontsova et al. 2016). They are therefore not entirely anthropocentric. Such misunderstanding of how much forest

existed ‘originally’, and the relatively limited attention given to the role of logging and commercial plantations during the colonial period, has resulted in overemphasis on the role of *tavy* in the narrative of Madagascar’s deforestation (Jarosz 1993; Scales 2011; McConnell and Kull 2014).

French botanists stationed in Madagascar noted the unusual flora and started arguing for protection of the various phytogeographic domains from the early 20th century (Saboureau 1946; Langrand and Rene de Roland 2018). The Parc Botanique de Tsimbazaza was created in 1925 for the scientific study Madagascar’s flora, and the country’s first 10 nature reserves followed soon afterwards. More widely, the colonial administration perpetuated and expanded state control of Madagascar’s forests with a strong focus on ensuring access to valuable natural resources (Montagne and Ramamonjisoa 2006). The early protected areas were put under the management of the DEF. For a time, the department was well-resourced and included highly trained and professional foresters; talking to rural people with memories of life in the 1950s it is clear that the *ben’ny ala* (forest guards) were generally well respected. However, in the post-colonial period the DEF was progressively starved of funds (Corson 2016) and its capacity to manage forest resources collapsed.

The year after becoming an independent nation in 1960, Madagascar joined the World Conservation Union (IUCN). In 1972 they sent a high-level delegation to the United Nations environment conference where the vice president of Madagascar made a forward-looking speech highlighting the need to reconcile conservation and sustainable use of natural resources (Repoblika Malagasy 1972). From 1975 Didier Ratsiraka’s socialist government, with its policy of ‘non-alignment’ with western powers and emphatic rejection of French neo-colonialism (Brown 2000), took power and actively encouraged rural people to clear forest to create farmland. A favorite slogan, repeated by the president in his own version of Mao’s Little Red Book (Ratsiraka 1975), was “*Mamokatra, mamokatra, mamokatra hatrany*” (Produce, produce, produce continually). There was little progress in terms of environmental institutions or policy development until the mid-1980s.

The Beginning of Modern Conservation in Madagascar (1984-2009)

At the start of the 1980s, Madagascar’s economy was in a very poor state and Ratsiraka’s government was forced to turn to the International Monetary Fund for urgent debt relief (Brown 2000). At the time, lack of capacity in the DEF, had created a *de facto* open access situation in much of Madagascar’s forests (Raik 2007); although it is important to note that customary management persisted in certain areas of the island (Rabesahala Horning 2005). Forests (both those inside and outside the very limited protected areas of that period) were being lost rapidly (Eklund et al. 2016; Vieilledent et al. 2018). As the country underwent economic reform (forced by the terms of the International Monetary Fund deal), there was growing donor interest in Madagascar (Rabesahala Horning 2008; Kull 2014; Corson 2016). The United States Agency for International Development (USAID), for example, set up its mission in 1984. Particularly influential in galvanizing the donors was an international conference attended by Prince Philip (then president of WWF) which was held in Madagascar in 1985 (Jolly 2015). The next 25 years saw rapid change in Madagascar’s environmental institutions and policies, strongly influenced by donor requirements (Corson 2016).

The National Environment Action Plan: From the mid-1980s, the World Bank started encouraging African nations to adopt formal environmental action plans in recognition of the importance of both the environment and economic policies to sustainable development (Mercier 2009). Madagascar’s National Environment Action Plan (NEAP), one of the first in Africa (Greve et al. 1995), was agreed in 1988 and signed into law in 1990 (Figure 2). This ambitious, multi-donor program of support was planned to last

15 years and bring in US$100s of millions to transform environmental management on the island (Corson 2016).

The NEAP had three major phases. The first (1991-1996) established key national institutions for environmental management such as the Office National pour l'Environnement (ONE) and developed the newly formed Association National pour la Gestion des Aires Protégées (ANGAP, now called Madagascar National Parks). ANGAP was created as a parastatal organization, outside the direct control of the government, to take over the management of protected areas from DEF (Kull 2014). The 1st phase of the NEAP also set up and supported new protected areas through Integrated Conservation and Development Programs (ICDPs). Reviews of these ICDP projects suggested the development approaches had been poorly targeted and delivered limited conservation benefit. There was also growing awareness of how much of Madagascar's biodiversity remained outside protected areas and that protected areas alone might be too small to ensure the survival of key species (Freudenberger 2010). This resulted in a shift to focus on wider landscapes; the 'eco-regional' approach. The second and third phases of the NEAP (1997-2003 and 2003-2008) supported the development of the legal frameworks allowing co-management of natural resources with local communities, and the national law requiring environmental impact assessment and impact mitigation for new developments (Figure 2).

The Durban Vision and Rapid Expansion of Madagascar's Protected Area Network: Madagascar's protected area system, with a particular emphasis on terrestrial sites, had gradually increased during the first two phases of the NEAP. However in 2003, the former President Marc Ravalomanana dramatically announced at the World Parks Congress in Durban, that the national government would more than triple the country's terrestrial protected area network from approximately 3% of the territory to approximately 10% (Figure 2). The announcement mobilized substantial additional international donor support (Corson 2016). Malagasy and international conservation scientists pulled together the best available biodiversity data to inform the design of this new protected area network (Kremen et al. 2008). By 2008, a substantial proportion of the planned sites had received temporary protected status, although it took another seven years for this status for be formalized (Ranivo Rakotoson and Razafimahatratra 2018). Protected areas established before 2003 were state managed through the parastatal ANGAP (now Madagascar National Parks). However, the years following the Durban Vision saw a re-writing of the protected areas code to permit a range of different organizations, ranging from non-governmental organizations, universities, and even mining companies to act as the legal manager of new protected areas (Gardner et al. 2018).

The Introduction of Community-based Natural Resource Management: A string of Malagasy legislation from that which was established in pre-colonial times, through the colonial period, and unbroken till the late 1990s, enforced the state as the only legitimate manager of forests (Raik 2007). However, during the 1980s and 1990s there was growing realization around the world that state ownership of forests, especially in the context of weak and poorly resourced forest services, could result in a de facto open access situation and rapid overexploitation (Ostrom 1990; Rabesahala Horning 2005). Community-Based Natural Resource Management (also known as co-management) was proposed as a way for communities to take greater responsibility for their natural resources (Montagne and Ramamonjisoa 2006). Two procedures for co-management were put in place on the island to transfer some degree of management authority to local groups: Gestion Locale Sécurisée (known as GELOSE) in 1996, and Gestion Contractualisée des Forêts (GCF) in 2001 (Figure 2). These legal structures, some of the first in the Afro-Malagasy Region, were intended to deliver environmental benefits while supporting local livelihoods (Ramiarantsoa et al. 2012; Ferguson et al. 2014).

Figure 1. **A**) *Tavy* on the edge of Zahamena National Park. **B**) and **C**) Malagasy people have always used products collected from the forest (including building and roofing materials and food such as freshwater crayfish). **D**) Payment for Ecosystem Services Schemes, where users of hydro-electricity or operators of dams pay upstream farmers to maintain forest and reduce siltation, may contribute in future to funding forest conservation in Madagascar. **E**) Micro-development interventions such as improved bean cultivation can be popular and bring benefits but have tended not to result in significant transformation of farming systems. **F**) Functioning ecosystems can provide benefits; *Mormopterus jugularis*, Peter's Wrinkle-lipped Bat, predates pests of rice fields. **G**) Communities in the west of Madagascar are exploring the potential of working with international cosmetic companies interested in baobab fruits; a potentially high-value product allowing them to benefit from the endemic trees. (Photos A, C, and D by J. P. G. Jones, B and G by Madagasikara Voakajy, E by M. Poudyal, and F by Adrià López-Baucells.)

Conservation Present

In 2009, Madagascar underwent a major political crisis due to an undemocratic change of government. Many donors left the country. USAID took this opportunity to conduct a retrospective exploring what had, or had not, been achieved since they set up their mission on the island in 1984. This fascinating document (Freudenberger 2010), has a subdued tone:

"…*As we step back after 25 years, honesty compels us to conclude that the environmental crisis in Madagascar is far more acute now than it was at the outset of* [the first phase of NEAP]".

If one was to simply compare before and after, one might conclude that conservation on the island over the last few decades has failed. At the start of the NEAP, Madagascar had 11 million ha of forest. This has since reduced substantially and by 2014 nearly 50% of remaining forest was within 100 m of the forest edge (Vieilledent et al. 2018). However, the appropriate comparison is what might have occurred if conservation efforts had not been made. This is of course is inherently unknowable (Baylis et al. 2016) but there are a growing number of robust impact evaluations of Malagasy conservation efforts (Eklund et al. 2016; Rasolofoson et al. 2015, 2018a) which formally attempt to estimate the counterfactual. In this section we consider different (overlapping) aspects of Madagascar's current conservation approaches and use the best available evidence to evaluate the impacts.

Assumptions about the Relationship between Poverty and Conservation

It has long been accepted that biodiversity loss and poverty are linked problems, but the nature of the relationship between these policy realms is complex and uncertain (Adams et al. 2004; Roe et al. 2019). Madagascar's biodiversity is a priceless national heritage. It also plays a key role in attracting international and national tourists and donor support (Corson 2016), and provides important national ecosystem services (Wendland et al. 2010). In these ways, conservation can contribute to poverty alleviation at the national scale (Jones et al. 2019a). There are also clear local benefits from conservation. For example, communities recognize the role of forests in hazard mitigation such as reducing sediment flow after heavy rain (Dave et al. 2017) and providing valued products such as wild foods during times of famine (Figures 1b and c; Noromiarilanto et al. 2016). There is also empirical evidence that children with access to forests have more diverse diets and suffer less from micronutrient deficiency than otherwise similar children (Golden et al. 2011; Rasolofoson et al. 2018b). Healthy ecosystems can provide valuable pest control services (Figure 1f; Kemp et al. 2019) and contribute to water availability for consumption, agriculture and hydropower (Neugarten et al. 2016).

However, while it is true that forest conservation brings local benefits, this does not mean that conservation will inevitably contribute to poverty alleviation at the local scale. Unfortunately 'win-wins' (happy alignment of the interests of forest-edge communities and the national and international conservation communities) have not generally been borne out in practice (Serpantié et al. 2007; Freudenberger 2010; Pollini 2011). For example, conservationists tend to see *tavy* as an unsustainable and therefore inherently irrational agricultural practice, meaning both farmers and the environment would benefit from a change. But this flexible, low-input system is well adapted to the conditions faced by forest-edge farmers (Freudenberger and Freudenberger 2002; Scales 2014b), and is often the only real option open to them to ensure their food security. By preventing local people expanding their agricultural lands through *tavy*, or prohibiting charcoal burning and hunting, forest conservation can bring genuine local costs (Ramamonjisoa and Rabemananjara 2012; Poudyal et al. 2018), as well as benefits. These costs are often disproportionately borne by some of the poorest. As a man from the eastern moist evergreen forests put it in an interview with one of us (Rakotonarivo 2016):

> "*Land [accessed through forest clearance] is the most valuable inheritance you can leave to your children… I am grieving that people are put in jail because they are making a living from the forestlands which are Zanahary's* [God's] *creation, not the government's property*".

This quote captures the hardship caused by enforcing severe penalties for land clearance, without providing alternatives. Recognition that there is a moral obligation for conservation to avoid making poor people poorer was formalized in the revision of the protected area code in 2015, but implementation of these social safeguards is lacking (Poudyal et al. 2018).

Some see poverty as a critical constraint on conservation, meaning conservation must consider poverty alleviation, if only for pragmatic reasons (Adams et al. 2004). There is a clear rational for this in Madagascar where a significant proportion of land clearance is driven by poor people's need to achieve food security. However, it does not necessarily follow that conservation will inevitably be achieved if poverty is reduced. Among poor rural farmers, a small increase in available resources may result in an increase, not a decrease, in their ability to clear land (Freudenberger and Freudenberger 2002; Llopis et al. 2019). Also, it is often not the poorest who hunt wildlife (Jenkins et al. 2011; see Golden et al., p. xx), or engage in illegal exploitation of precious wood (Randriamalala and Liu 2010; Wilmé et al. 2020). Together, these observations all mean that interventions which successfully raise incomes, while desperately needed, cannot be relied upon to reduce pressure on the environment.

Efforts by Conservationists to Transform Rural Livelihoods

The evocative descriptions of *tavy* written in 1661 by the French governor Etienne de Flacourt (quoted in Jarosz 1993) are perfectly familiar to anyone who spends time in the villages of Madagascar's eastern forests. This illustrates just how little agricultural practices at the forest frontier have changed in centuries, despite the long antipathy towards this agricultural system by the authorities (Kull 2004). Throughout the last 35 years, conservationists (and projects funded with conservation as the ultimate objective) have implemented a range of interventions aimed at encouraging a shift away from *tavy* towards more intensive production systems.

Initial efforts focused on increasing productivity in irrigated rice fields in the belief that this would reduce forest clearance for *tavy*. This was based on rather simplistic assumptions. For example, the much promoted System of Rice Intensification (SRI) could increase yields on small plots (Stoop et al. 2002), but because it required high labor inputs and the need to closely control water levels, take up was disappointing (Moser and Barrett 2003). Another issue was that many of the farmers clearing forest did not have access to irrigated land; they needed technologies to maintain fertility and increase production on their *tavy* fields. A range of approaches were taken to address this including promoting soil fertility through composting, planting cover crops, and using perennial grasses such as vetiver (*Vetiveria*, Poaceae) to support irrigated terraces on steep slopes (Freudenberger and Freudenberger 2002).

Throughout the years of the NEAP, and in the decade since it ended, conservation projects have also widely promoted alternative livelihoods such as fish farming, honey production or producing essential oils. While these alternative livelihood approaches brought some successes (Bidaud et al. 2017; Harvey et al. 2018; Poudyal et al. 2018), and they may have been important to legitimize the presence of conservation organizations working in an area, large-scale agricultural transformation did not generally occur and their results were often disappointing (Laney and Turner 2015; Rakotonarivo et al. 2017).

There are many explanations for the lack of widespread success of these conservation-funded investments intended to transform local farming systems (Figure 1e). Firstly, land tenure issues are an important constraint on farmer's ability to invest in the land they farm. Many farmers borrow or rent land and even those who do enjoy customary ownership may hesitate to invest due to uncertainties in tenure (Aubert et al. 2013; Burnod et al. 2014). Secondly, labor constraints (Tucker 2007), and the inability of poor Malagasy farmers to take the risk of investing in new approaches (Rakotonarivo et al. 2018), may have been underestimated. Thirdly, the poor state of rural infrastructure (especially for transport and irrigation) has consistently limited the potential of micro-development projects to lead to large-scale change (Freudenberger 2010). Finally, and perhaps most important, while many projects have been large in absolute dollar terms, the amount available for interventions at the forest frontier, where 1000s of widely dispersed households needed to be reached (Jolly 2015; Poudyal et al. 2016), was actually quite small. Perhaps it is not surprising that many schemes did not deliver what was hoped for.

The US$100 million Projet Agriculture Durable par une Approche Paysage (co-funded by the World Bank, the Agence Française de Développement, and the Global Environment Facility) aims to increase agricultural productivity in connection with sustainable management of natural resources (Agence Française de Développement 2017; World Bank 2017). The project documents suggest that replacing unsustainable *tavy* with agro-forestry will provide a '*win-win in the sense that they will benefit both the landholders themselves and environmental service users'*. This positive wording rather glosses over the failures stretching back to colonial time of attempts to prevent this practice, and ignores the reasons that this remains such a popular agricultural system in rural Madagascar. However, the project does directly address some of the limitations of earlier interventions, for example by investing in irrigation infrastructure and working on land tenure issues. There seems to be increasing recognition that sustainable transformation of agriculture in Madagascar is likely to require investment and collaboration across a range of sectors. This is very positive and greatly needed. Successful conservation in Madagascar will be impossible without sustainable agricultural development.

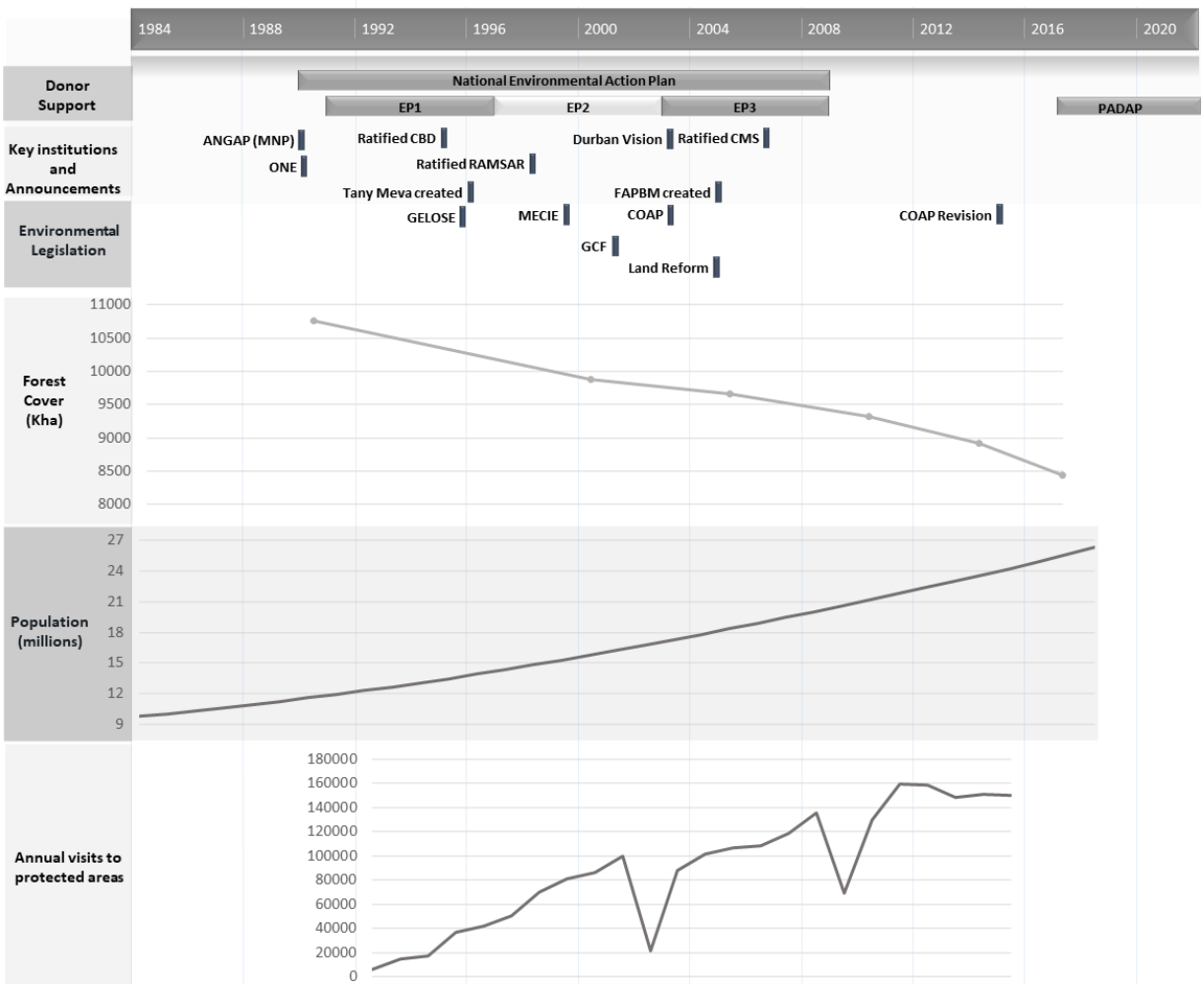

Figure 2. A timeline showing key events related to conservation in Madagascar over the last 35 years. Data on forest cover comes from Vieilledent et al. (2018), data on population comes from World Bank (2019), data on annual visits to protected areas comes from Goodman et al. (2018). ANGAP: Association Nationale pour la Gestion des Aires Protégées (MNP: Madagascar National Parks); CBD: Convention of Biological Diversity; COAP: Codes des Aires Protégées de Madagascar; EP1, 2 3: the 1st, 2nd, and 3rd phases of the National Environmental Action Plan; GCF: Gestion Contractualisée des Forêts; GELOSE: Gestion Locale Sécurisée; MECIE: Mise en Compatibilité des Investissements avec l'Environnement; PADAP: Projet Agriculture Durable par une Approche Paysage.

The State of Madagascar's Protected Area Network

Madagascar's current protected area system, remarkably representative of the nation's world-renowned biodiversity (Goodman et al. 2018), is a priceless national treasure (Randrianandianina et al. 2003; Ramangason 2018). The 144 protected areas (as of 2020; Vyawahare 2020), including sites representing principally terrestrial or marine ecosystems, represent the full spectrum of management from IUCN category I to VI (Gardner et al. 2018; Goodman et al. 2018).

Madagascar's protected areas face many pressures (Jones et al. 2019b). Some suffer from sporadic exploitation of precious hardwoods (Wilmé et al. 2020), hunting of wildlife for bushmeat (Razafimanahaka et al. 2012; Brook et al. 2019) or gold and gem mining (Cabeza et al. 2019). Large-scale land clearance to produce cash crops (Filou 2019), charcoal production (Gardner et al. 2016), as well as continued degradation driven by small-scale subsistence agriculture (Desbureaux and Damania 2018) are also important threats.

Despite these pressures, protected areas in Madagascar have tended to effectively slow forest loss. Protected areas tend to be located in areas subject to lower deforestation pressures than unprotected forests; this bias needs to be accounted for when evaluating the impact of protected areas. Such robust analysis has shown that in all three major forest biomes of Madagascar (humid, dry deciduous, and spiny), protected areas have slowed deforestation, at least up to 2010 (Eklund et al. 2016). A different analysis using a similar approach has suggested that post-2010 protected areas have also slowed deforestation, but only in dry years when pressures on forests are highest (Desbureaux and Damania 2018).

Since the early days of the NEAP, tourism has been at the heart of plans for funding protected areas in Madagascar (Méral et al. 2011). Tourism can play an important role in generating jobs and support for conservation (Ormsby and Mannle 2006); although this is far from universal (Cameron 2017). However, although visits to protected areas have increased (Figure 2), and park entrance fees were substantially raised in 2015, park receipts still contribute relatively little to the running costs of Madagascar National Parks (Goodman et al. 2018). Tourism revenue can also be extremely fickle. Past political crises have crashed tourist numbers and international press coverage of a violent incident involving a tourist rapidly results in cancellations. The Fondation pour les Aires Protégées et la Biodiversité de Madagascar (FAPBM) was established in 2005 as a national foundation to provide sustainable financing for Madagascar's protected areas. It is endowed with more than 70 million USD (as of 2018) but available funding has not kept pace with protected area expansion (Gardner et al. 2018) and currently FAPBM's annual income provides less than 10% of the current management costs of the network (Jones et al. 2019a).

Since the mid-1990s, there has been criticism that protected areas in Madagascar have brought local costs without providing adequate support to impoverished local communities (Peters 1998; Harper 2002; Jolly 2015). While there are examples of Madagascar National Parks and other conservation actors, working well with communities to develop small-scale development projects (Aymoz et al. 2013; Ormsby and Mannle 2006), this problem remains today. The new protected areas created under the Durban Vision were subject to stringent rules driven by the World Bank social safeguards, supposedly guaranteeing compensation to anyone suffering from economic displacement. However, detailed research carried out in the Ankeniheny-Zahamena Corridor (eastern moist evergreen forests) revealed that such compensation tended to benefit the better off and those less affected by conservation rules (Poudyal et al. 2016). While benefits from conservation may of course come in future, this work shows that and that overall none of the 6000-odd affected households were fully compensated according to the World Bank rules (Poudyal et al. 2018). Studies in other new protected areas in Madagascar have drawn similar conclusions (Brimont et al. 2015; Ward et al. 2018).

These findings pose difficult challenges for those concerned with the future of Madagascar's protected areas. The network is vital to biodiversity conservation in the country. However, despite their immeasurable national and global value, as yet mechanisms do not appear to have been found to fully ensure their effective, and critically their equitable, conservation (Hockley et al. 2018).

Success and Failure of Community Based Natural Resource Management

By 2014, 15% of Madagascar's natural forests were under co-management (Rasolofoson et al. 2017) and the vast majority of the post-Durban Vision protected areas involve some degree of co-management with local communities over at least part of their area (Toillier et al. 2011a; Gardner et al. 2018). The rationale behind co-management is that devolution of rights to make management decisions and capture benefits from natural resources will result in more sustainable management. However, the extent to

which co-management has resulted in any substantial devolution of rights to rural people in Madagascar has been debated (Kull 2004). Some have suggested that instead of devolving real power, co-management aimed simply to co-opt community efforts to further the agenda of the conservation organizations (Pollini et al. 2014). This argument suggests that despite the justification for the approach being framed in terms of the now familiar concept of 'win-wins' (i.e. benefits for both the environment and local people), the rules tended to result in limited benefit to be had by local communities.

There has been extensive debate in the literature about the extent to which the community-groups to which management authority is devolved (usually called VOI; *Vondron Olona Ifotony*) do indeed represent local community interests and what the most effective and appropriate structure should be. The relevant laws, somewhat surprisingly, do not require that the VOI is representative (Pollini et al. 2014; Rabemananjara et al. 2016). In this way, co-management can in practice support the privatization of natural resources management, rather than its decentralization (Pollini et al. 2014). There are many examples of VOI being controlled by local elites for their own private benefit (Hockley and Andriamarovololona 2007; Pollini and Lassoie 2011).

An important question of course is whether co-management has delivered its objectives in terms of providing environmental and welfare benefits. Qualitative evaluation at seven sites in the eastern moist evergreen forests (Hockley and Andriamarovololona 2007) suggested that all VOIs had made efforts to exclude others but had often struggled, as the back-up they needed from state authorities was not forth coming. A robust counterfactual impact evaluation (comparing deforestation rates in pixels under co-management with statistically matched pixels without any form of management) suggests that between 2000 and 2010, co-management did not, on average, slow deforestation on the island (Rasolofoson et al. 2015). This result is unchanged even when the analysis is restricted to include only those sites where there was evidence of implementation on the ground (many co-management agreements, especially those using GCF legislation, were made in a rush with little local engagement and very limited training or capacity transfer). However, there was some evidence that co-managed forests where commercial logging was prohibited did have some impact in terms of reducing deforestation compared to co-management where such use was allowed and forests without co-management. A similar national-scale analysis of the impacts of community forest management on economic well-being (Rasolofoson et al. 2017) also showed no positive impacts on average, but at least was able to reject the hypothesis of substantial negative impacts.

Such national-scale analyses give a useful overview but, because they inevitably lump together co-management implemented with a varying degree of investment and care, they say little about the potential of the approach. What is certain is that many communities agreed in good faith to set up these new institutions, which they often believed would solidify their rights over their land (Rasolofoson et al. 2018a). However, in many cases they were then given little support as donor funding ended and NGO partners moved on.

Dealing with the Environmental Impacts of Development

The legal framework for requiring environmental impact assessment in Madagascar (Mise en Compatibilité des Investissements avec l'Environnement, commonly known as the MECIE decree), is considered by some to be one of the big successes from the NEAP (Freudenberger 2010). It requires large forestry or agricultural operations (Ratsialonana et al. 2011), extractive industries (Nwapi and Nliam 2018), or infrastructure projects, to undergo a scoping process overseen by the national regulator (Office National pour la Environnement or ONE), and lays out when in-depth social and environmental impact assessment and remediation measures are needed (Huff 2016). These assessments should, in

theory, provide the government with the tools to balance the needs for development investment with their commitments to protect the environment. However, implementation has been mixed. One of the challenges has been that the regulator is increasingly dependent on fees paid by developers; potentially undermining its ability to independently regulate the sector (Nwapi and Nliam 2018; Gerety 2019). Monitoring of the Environment Impact Assessment (EIA) agreements have often been lacking (Huff 2016; Bidaud et al. 2018). There is also concern that the legislation itself is not fit for purpose for tackling new and evolving industries in Madagascar. For example, the criteria which would be used under MECIE to determine whether an oil sands mining development required an EIA are not clearly linked to the likely extent of environmental impact from the proposed extraction (Nwapi and Nliam 2018; Gerety 2019). Our own observations (J. H. Razafimanahaka, unpublished data) suggests similar issues for both extraction of essential oils and the harvesting of bat guano from cave deposits. There are efforts to revise the decree to more explicitly incorporate the mitigation hierarchy and require the use of strategic environmental assessment (Jones et al. 2019a).

Conservation Future

The pressures on Madagascar's natural resources continue to grow. Just since the year 2000, the human population has nearly doubled. Some urbanization has occurred but a significant majority of Malagasy still live in rural areas (World Bank 2019). This means that the number of farmers seeking to make a living at the forest frontier has rapidly increased. While tree cover (mostly fruit trees and non-natives) is increasing in pockets of the Central Highlands (McConnell et al. 2015), a forest transition (where land-use trends change from a period of net loss to a period of net gain) is not expected at the national scale any time soon (Kull et al. 2007; Jones et al. 2018). At the same time, climate change is shifting the distribution of some forest species (Vieilledent et al. 2013), and will make life even more difficult and precarious for many rural people (Harvey et al. 2014). In this section, we highlight some of the most important areas where progress is needed if current trends in forest and biodiversity loss are to be reversed.

Without Effective Governance and Government, Conservation in Madagascar is Impossible

In Madagascar's recent history, governance issues have significantly hampered conservation efforts (Gerety 2017a; Jones et al. 2019b). Madagascar appears 105th out of 128 countries in the Rule of Law Index and performs particularly poorly on measures of corruption and criminal justice (World Justice Project 2020). Corruption, involving Madagascar's elites, has been implicated in a number of important conservation issues including illegal rosewood trafficking (Anonymous 2018) and the trade of threatened animal species (Mandimbihasina et al. 2020). Saying that improving the rule of law is vital to effective conservation in Madagascar should not be interpreted as a call for an increase in enforcement-heavy conservation strategies (Neimark 2019). Given the issues faced by the judiciary and prison system (Amnesty International 2018), a clampdown on poor farmers who break environmental laws is not what is needed. However, broader accountability, just laws, open government, and accessible justice (the four universal principles of the rule of law; World Justice Project 2020) are vital both for Madagascar's development prospects and effective conservation (Jones et al. 2019b).

Political crises associated with transfers of power have been a regular feature of Madagascar's post-colonial history (Ratsimbaharison 2017; Razafindrakoto et al. 2020). Each crisis tends to impact the stability of conservation programs. For example, both the 2003 and 2008 crises saw dramatic reductions in the number of visits to protected areas (Figure 2) affecting the resources available to Madagascar National Parks for management activities and local development projects. The political crises have also been associated with increases in illegal lemur hunting (Schwitzer et al. 2014) and

precious wood extraction (Randriamalala and Liu 2010). Madagascar, and indirectly its biodiversity, would greatly benefit from stable transitions of power.

An uncomfortable question concerns the extent to which the international community have been complicit in allowing the poor state of governance on the island to develop. By being quick to announce problematic elections as free and fair, and continuing aid programs despite failures of governance, donor governments and non-government organizations can undermine democracy (Klaas 2016).

Support from Civil Society is Vital to the Future of Conservation in Madagascar

While Madagascar's biodiversity has global value, it is first and foremost Madagascar's natural heritage-something which was too often forgotten by foreign conservationists in the early days (Jolly 1980). The influence that foreign-driven conservation programs had in Madagascar during the late 1980s and 1990s has been criticized (Freudenberger 2010). Ordinary Malagasy, especially rural people most affected by conservation policies, tended to have little or no voice and very limited influence on the government's decision-making. This is in contrast to countries such as Brazil where grass-roots activists have had significant political weight (Kull 2014). In their keenness to conserve Madagascar's precious biodiversity, donor governments and non-government organizations may have unhelpfully contributed to the idea that biodiversity is something only foreigners care about or have a say in (Kaufmann 2014; Ramiarantsoa et al. 2015; Corson 2016).

This is problematic, as conservation in Madagascar cannot succeed without support from people at all levels of society. There is progress however. Civil society groups and the independent media have become more active in environmental discourse on the island; both holding the government to account over issues such as illegal rosewood exploitation (Rakotovao and Raymond 2019), and advocating for the rights and interests of local communities (Razafindrakoto et al. 2020). There has been rapid growth of Malagasy NGOs working on conservation issues. Associations and non-government organizations such as Fanamby, Madagasikara Voakajy, GERP, and Asity manage some of Madagascar's new protected areas, while Tafo Mihavo works to give local communities a strong voice. Many have come together in the Alliance Voahary Gasy; a platform for civil society groups pushing for transparent governance of natural resources. The Critical Ecosystem Partnership Fund, which only gives grants to civil society organizations, has been a vital funder allowing the growth of this home-grown conservation sector.

A related issue has been the dominance of foreign researchers in biodiversity and conservation-related research on Madagascar (Waeber et al. 2016). This matters because research by foreigners is less likely to result in sustained impact on the ground (Gerety 2017b). Again, there is progress in this area. The high-profile Association for Tropical Biology and Conservation conference was held in Madagascar in 2019 (only the second time it has been held in the African region in its 55-year history). More than 30% of the presentations were by Malagasy students and researchers. Over 29% of contributors to this book are Malagasy; a great improvement over previous edited volumes on Malagasy biodiversity and conservation. Conservation in Madagascar urgently needs the leadership and advocacy that these people can provide.

Conservation in Madagascar Needs to Draw on More Diverse Funding

As well as needing public support, conservation needs money. Funds are required to cover the management costs of Madagascar's expanding protected area network (paying staff, monitoring, and enforcement, for example). Because conservation can bring significant local costs, substantial (and sustained) financial resources will also often be needed to compensate these costs (Poudyal et al. 2018),

or to help establish schemes which ensure conservation is a viable option locally (Brimont and Bidaud 2014). Madagascar's tax-base is largely insufficient to cover even a portion of these costs, therefore donor support is likely to be required for some time to come; but all donors are looking for an exit strategy.

Carbon finance, in particular the idea of Reducing Emissions from Deforestation and Degradation (REDD+) (see Grinand and Nourtier, p. xx), has been the big hope for providing sustainable funding for tropical forest conservation for the last 15 years (Seymor and Busch 2016). In Madagascar there have been a number of high-profile REDD+ pilot projects (Ferguson 2009). In line with global recognition that project-level forest carbon projects allow leakage (carbon emissions are displaced rather than avoided), the Malagasy Government has been moving away from scattered-individual projects, towards jurisdictional REDD+. The Malagasy Government is currently seeking funds to fully implement the first of five land-scale programs covering each forest type (Repoblikan'i Madagasikara 2018). The first covers the moist evergreen forests of the northeast and central east, incorporating the protected areas of Makira and the Ankeniheny-Zahamena Corridor (two prominent REDD+ pilots). While REDD+ can produce substantial revenue which, at least in theory, should be sufficient to compensate for local opportunity costs (Poudyal et al. 2018), research suggests that programs have often not succeeded in ensuring benefits reach remote forest-edge communities (Brimont et al. 2015; Poudyal et al. 2016). International scrutiny on the implementation of the social-safeguards associated with carbon payments is increasing. For example, public concern about a major funding proposal to the Green Climate Fund for a project in Madagascar, the Democratic Republic of Congo, and Peru (known as FP123) resulted in it being withdrawn before member governments had a chance to vote on it in 2019 (Green Climate Fund 2020). Therefore for pragmatic reasons (as well as the moral obligation that conservation should not exacerbate poverty) those involved in designing these large programs must take the issue of social safeguards seriously.

There is also interest from the Malagasy Government in other forms of payment for ecosystem services as a way to fund conservation (Figure 1d). One idea, explored sporadically over the past decade, is that those operating or benefiting from hydro-electric dams should pay upstream farmers to retain forest and thus reduce siltation (Toillier et al. 2011b). While some success has been demonstrated with small, donor-funded schemes (Cerqueira 2016), lack of willingness from the state-owned water and electricity company JIRAMA has so far prevented the development of schemes to help fund the conservation of the watersheds of major dams. As a number of new hydro-electric dams are currently in the planning stage in Madagascar (Praene et al. 2017), such a funding mechanism might be worth exploring further.

There has long been the hope that Madagascar's biodiversity holds undiscovered products with medicinal or cosmetic use, and that this value could be captured for the sake of conservation. The development of cancer drugs from the rosy periwinkle (*Catharanthus roseus*, family Apocynaceae; see Liede-Schumann, p. xx), which was known locally as a medicinal plant, has become a textbook example of the potential of bioprospecting for delivering useful products. However, although the drug company Elli Lilly netted US$100s of millions from their commercialization of this discovery, Madagascar has not received a penny (Stone 1992). Since then, both international law and what is considered best practice by industry has changed (Neimark 2012). In 2014 the Nagoya Protocol "on access to genetic resources and the fair and equitable sharing of benefits arising from their utilization" entered into force as part of the Convention on Biological Diversity (to which Madagascar is a signature country). This should put Madagascar in a better position to defend and benefit from the value of its genetic resources. However, procedures to deliver access and benefit sharing have proven difficult to implement in many countries (Hinsley and Roberts 2018), and Madagascar is no exception. Although there is interest from

commercial companies in using the protocol to deliver benefits to local communities from their extraction of, for example, baobab fruits or essential oils (Figure 1g), the legal frameworks are not yet in place to make this work as a significant source of funding for conservation.

Non-governmental organizations and associations also have an important role to play in raising funds for forest conservation in Madagascar. International conservation organizations (particularly WWF, Conservation International, and Wildlife Conservation Society) have often been able to sustain support for their conservation programs during political crises when donor governments withdrew (Corson 2016). Their ability to do this is because of their diverse funding base including private donations from members (especially in the case of WWF), private foundations, or working with companies who donate as part of the cooperate responsibility. While most such funding still comes from outside Madagascar, residents of Antananarivo have a positive willingness to pay for forest conservation (Randrianarison and Wätzold 2017). As Madagascar develops, non-governmental organizations and associations (particularly Malagasy ones) could raise a higher proportion of conservation funding from within Madagascar.

The Mining Boom Poses Difficult Questions for Conservationists in Madagascar

Madagascar has exceptional mineral wealth. Gold deposits are found across the island, some of the most highly valued sapphires and rubies in the world are concentrated in fluvial deposits especially in the east and south, and certain soils are rich in nickel, titanium oxide, and even rare earth metals (Cardiff and Andriamanalina 2009; Cook and Healy 2012). Large operations, such as the US$8 billion Ambatovy nickel and cobalt mine in the moist evergreen forests of the central east and the US$1 billion QMM titanium oxide mine in the littoral forests of the extreme southeast, together make a very significant contribution to Madagascar's tax base. Artisanal mining, though unquantified and poorly taxed, provides much needed income in rural areas, especially during times of drought (Lawson 2018), and employs around 500,000 people (Fritz et al. 2017). Given Madagascar's urgent need for development, it is clear the country will exploit this mineral wealth (Canavesio 2014). Many analysts agree that if trust in government were to increase (giving investors confidence), mining could rapidly increase in Madagascar. This poses challenges for conservation as many key resources are found in areas of high biodiversity (Cardiff and Andriamanalina 2009).

Ambatovy and QMM, the two most significant international mining operations in Madagascar, both made very ambitious public commitments to addressing their environmental impacts (Temple et al. 2012; von Hase et al. 2014). International best practice, and the demands of many lenders such as the International Finance Corporation (2012) require such developments to follow the mitigation hierarchy. This means they must avoid, minimize and remediate biodiversity impacts as much as possible and then offset any residual impacts to achieve at least a No Net Loss of biodiversity (Business and Biodiversity Offsets Partnership 2012). In 2004, Rio Tinto (which partially owns QMM with the Malagasy government), declared it would go beyond its regulatory requirements and achieve a Net Positive Impact on biodiversity in all its operations including QMM. Ambatovy has publicly committed to at least No Net Loss and preferably a Net Gain (von Hase et al. 2014). QMM, and to a lesser extent Ambatovy, have faced some criticism for the environmental and social impacts of their mine, and limitations of their biodiversity mitigation measures (Seagle 2012; Ferguson et al. 2014; Virah-Sawmy et al. 2014; Bidaud et al. 2017). However, conservationists putting pressure on firms such as Ambatovy and QMM face a delicate balance. Given the importance of mining to the Malagasy economy, the alternative is unlikely to be no mining, but may instead be mining by firms less open to scrutiny and potentially with much lower commitment to environmental performance.

Madagascar has been receiving increasing investment from China over the past decade (Chen and Landry 2016). This will increase following Madagascar joining the Chinese Government's massive infrastructure project, the Belt and Road Initiative, in 2017. This investment is much needed and China is also increasingly contributing development aid to Madagascar (Liu 2019). However, there has already been concern over the lack of transparency associated with a deal involving access to Madagascar's marine resources (Environmental Justice Atlas 2018), and a Chinese company given a 40 year lease to operate a gold mine in Soamahamanina (Razafindrakoto et al. 2020). Some conservationists are worried that were Madagascar's large mines to be taken over by Chinese companies (less likely to be subject to environmental and social performance standards for example), exploitation would be more environmentally damaging.

Conclusions

Writing this sweeping, bird's-eye view of conservation in Madagascar has been a sobering experience. One thing which has emerged is that on the island, as elsewhere, there has been a tendency for donors to become frustrated with an approach if the desired outcomes are not fully delivered over a short time-scale. There is constantly a search for the silver-bullet for conserving biodiversity while tackling poverty. Unfortunately, such a silver-bullet does not exist. If conservation is to be successful in Madagascar, it will need a diversity of approaches, sustainable funding, a clear voice for forest-edge communities, and much greater support from the top to the bottom of Malagasy society.

Numerous studies have criticized conservation efforts in Madagascar over the past few decades. They have pointed out that biodiversity objectives have not always been met (Freudenberger 2010; Waeber et al. 2016), that processes have often fallen short of their own stated standards of effective local participation (Jolly 2015; Hockley et al. 2018), and, most seriously, conservation measures have sometimes made life worse for rural communities (Harper 2002; Poudyal et al. 2018). However, criticism is easy. Conservation, especially in the Malagasy context of extreme poverty and food insecurity, weak governance, and a large rural population heavily dependent on natural resources, is truly difficult. Most rich countries struggle to do the right thing by their biodiversity. Expecting effective conservation which also contributes to the enormous challenge of poverty alleviation in Madagascar, is asking a lot.

We are writing this during the global lock-downs caused by coronavirus. This unprecedented global crisis will put extra pressure on Madagascar's biodiversity and make the difficult work of conservation harder (Vyawahare 2020). International tourism is on hold and unlikely to recover anytime soon. This will slash the available budget for Madagascar National Parks. There are already signs of increased pressures on protected areas (J. Eklund, unpublished data) as local incomes are reduced and people turn to the forest for resources, as they have always done in times of need. Lethargy on international markets will negatively impact the interest income from FAPBM investments and donor support for conservation in Madagascar may be at risk if governments prioritize domestic concerns in a global recession. This is an extra set of difficulties for conservation.

Despite the challenges, the experiences of the past few decades offer much to improve the chance of a positive future for conservation in Madagascar. Malagasy conservation has always had some excellent leaders (Jolly 2015), and capacity is increasing fast among a new generation (Gerety 2017b). The legal frameworks for conservation are mostly well established. New technology, such as near real-time data on forest fires, provides invaluable information which would have been unimaginable to a few years back. There is growing recognition globally of the importance of nature-based solutions to tackling the global existential threat of climate change (Seddon et al. 2020); which should result in maintained

international support for forest conservation in Madagascar. There is also much better understanding that conservation is a hugely challenging social endeavour and that to be successful it has to make sense (economically and socially) to the local population. Finally, a huge body of research can, if accessible to the right people (Rafidimanantsoa et al. 2018), inform future decisions. The very existence of innumerable unique species and habitats depend on this.

"*Tsy misy mafy tsy laitry ny zoto*" There are no difficulties which cannot be overcome by the determined. Malagasy proverb.

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