

ARTICLE

<http://dx.doi.org/10.4314/mcd.v9i1.7>

Towards a more adaptive co-management of natural resources – increasing social-ecological resilience in southeast Madagascar

Gemma Holloway and Samm Short

Correspondence:

Gemma Holloway

Azafady

Madagascar.

E-mail: gemmaholloway@gmail.com

ABSTRACT

Situated on the southeast coast of Madagascar, Sainte Luce is a fishing village bordering some of the country's last remaining littoral forests. Characterised by a combination of extreme poverty, the presence of highly-prized natural resources and feeble institutional structures, it is argued that Sainte Luce typifies contexts of social and ecological vulnerability found across Madagascar. The presence of the international mining giant, Rio Tinto, and the company's role in managing a protected area bordering Sainte Luce, adds a complex dimension to this already highly vulnerable social-ecological context. Setting the case study within the context of recent natural resource management policies in Madagascar, the paper aims to highlight the need for innovative governance structures which match the complexity and dynamism of social-ecological systems such as that of Sainte Luce. We describe the approach taken by a local/international NGO partnership, Azafady, to build social and ecological resilience through a process of participatory and adaptive environmental action planning. The approach draws on concepts from adaptive co-management, which highlights the interdependence of human and natural systems and focuses on innovative institutional arrangements, social learning and cross-scale collaboration to manage the complexity and uncertainty of such systems. We examine the ways in which this approach has contributed to increasing social and ecological resilience in Sainte Luce and consider how progress made to date can be sustained and scaled up to wider geographical areas.

RÉSUMÉ

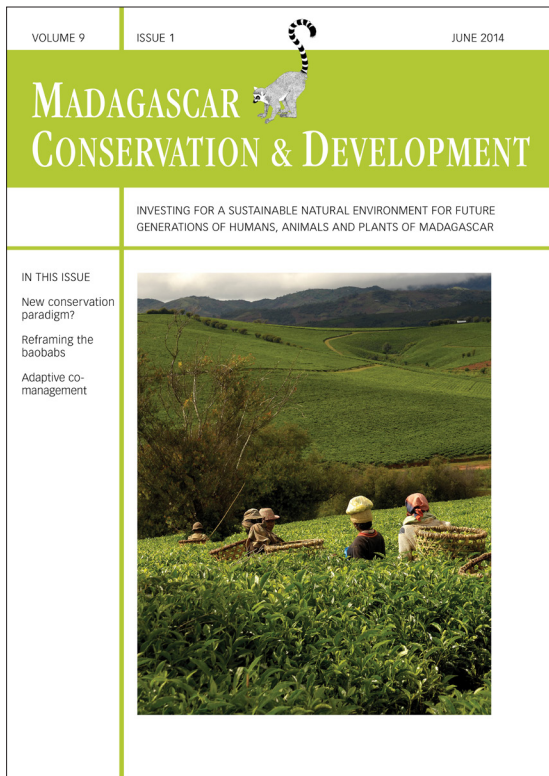
Situé sur la côte sud-est de Madagascar, Sainte Luce est un village de pêcheurs bordé par quelques-unes des dernières forêts littorales du pays. Une extrême pauvreté des populations villageoises associée à des ressources naturelles prisées et des structures institutionnelles fragiles caractérisent Sainte Luce qui est ainsi analysé dans un contexte typique de vulnérabilité sociale et écologique, rencontré ailleurs sur l'ensemble de la Grande Île. La présence du géant international de l'exploitation minière, Rio Tinto, et le rôle de cette entreprise dans la gestion d'une aire protégée limitrophe de Sainte Luce ajoute une dimension complexe à une situation socio-écologique déjà vulnérable.

L'exemple de Sainte Luce abordé ici sert à souligner la nécessité de considérer des structures de gestion innovantes

qui répondent à la complexité et au dynamisme des systèmes socio-écologiques sous de multiples pressions exogènes et endogènes. L'étude de cas est considéré dans le cadre de la récente politique environnementale de Madagascar, qui a pour objectif de promouvoir l'implication des populations locales dans la gestion des ressources naturelles, en transmettant les droits de gestion aux groupes d'utilisateurs dénommés les COBA pour Communautés de base. Cependant, l'extension des accords de co-gestion incluant des tiers, comme des sociétés minières et des ONG internationales, a eu tendance à écarter les intérêts communautaires et, dans la plupart des cas, n'a pas réussi à promouvoir une appropriation des ressources par la population locale.

Nous décrivons ici une approche adoptée par l'ONG Azafady, un partenariat local et international, pour renforcer les résiliences sociale et écologique à Sainte Luce par un processus de planification d'actions environnementales, adaptatives et participatives. La démarche s'appuie sur les concepts de co-gestion adaptative qui met en évidence l'interdépendance des systèmes humains et naturels. Elle se concentre également sur des dispositifs institutionnels novateurs, sur l'adaptation sociale ainsi qu'une collaboration multilatérale pour gérer la complexité et l'incertitude de ces systèmes. Afin d'établir et de maintenir l'appropriation de la communauté au cours du processus de gestion adaptative, l'approche a consisté à inverser les tendances historiques de mise en œuvre du sommet vers la base ou top-down d'un projet, en privilégiant une participation réelle et conséquente des populations locales. Les structures institutionnelles existantes ont été incorporées dans le nouveau modèle, tandis que de nouvelles structures ont servi à créer un cadre institutionnel plus résilient et plus adaptatif.

Nous examinons comment cette approche, avec sa base conceptuelle de co-gestion adaptative, a contribué à renforcer la résilience sociale et écologique de Sainte Luce. En tenant compte des difficultés rencontrées, de la nécessité de maintenir les progrès réalisés et de la possibilité de reproduire ce concept à une échelle géographique plus vaste, nous montrons comment l'expérience de Sainte Luce peut servir à d'autres organisations qui essaient de promouvoir la gestion environnementale durable avec des paramètres dynamiques et complexes ailleurs à Madagascar, voire au-delà.



Madagascar Conservation & Development is the journal of Indian Ocean e-Ink. It is produced under the responsibility of this institution. The views expressed in contributions to MCD are solely those of the authors and not those of the journal editors or the publisher.

All the Issues and articles are freely available at <http://www.journalmcd.com>



Contact Journal MCD
info@journalmcd.net for general inquiries regarding MCD
funding@journalmcd.net to support the journal

Madagascar Conservation & Development
 Institute and Museum of Anthropology
 University of Zurich
 Winterthurerstrasse 190
 CH-8057 Zurich
 Switzerland

io@i

Indian Ocean e-Ink
 Promoting African Publishing and Education
www.ioeink.com

 MISSOURI BOTANICAL GARDEN

Missouri Botanical Garden (MBG)
 Madagascar Research and Conservation Program
 BP 3391
 Antananarivo, 101, Madagascar

INTRODUCTION

Madagascar is one of the poorest countries in the world. More than 80% of the population lives below the poverty line of \$1.25 a day and the country ranks 151 out of 186 in the UNDP Human Development Index (UNDP 2013). Access to trade and development opportunities is severely limited, particularly following sanctions imposed by the international community as a result of the 2009 political crisis and subsequent ongoing instability. For the majority of the population, livelihoods rely heavily on natural resources, however a rapidly expanding population, decreasing access to land, recurrent food security crises and the impacts of climate change all render this reliance increasingly unstable (Raik 2007, Harris 2011, World Bank 2013).

Decisions around resource use are embedded not only in need but also in culture, history and politics (Kull 2002, Raik 2007). The complex relationship between rural Malagasy communities and their environments has long created a dilemma for the country's leaders and policy-makers (Kull 2002, Horning 2008). As one of the world's top biodiversity hotspots (Myers et al. 2000, Ganzhorn et al. 2001), Madagascar faces increasing pressure from the international community to preserve its natural heritage, particularly the biodiversity harboured in its formerly abundant but ever-diminishing forests (Marcus and Kull 1999, Corson 2011). However, in spite of vast amounts of donor funds being channelled into Madagascar's environmental sector since the mid-1980s, the challenge of slowing the trend of environmental degradation has not been met (Horning 2008, 2012) and this contributes to a situation of increasing ecological and social vulnerability across the country.

NATURAL RESOURCE MANAGEMENT POLICY IN MADAGASCAR. Launched in 1991 and funded by the World Bank, one of the aims of Madagascar's 15-year long National Environmental Action Plan (NEAP) was to create the institutional infrastructure through which all future environmental policies would be implemented (Hanson 2012). Following the first phase of the NEAP, in which highly centralised, 'needs-based' integrated conservation-development programmes failed to make the link between peoples' lives and their environment, the second phase (1997–2003) saw a move towards 'community-based natural resource management' (Marcus and Kull 1999, Raik 2007, Hanson 2012). During this period measures were introduced which were designed to transfer management rights to local communities with the aim of fostering a greater sense of ownership of natural resources (Fritz-Vietta et al. 2009). The legislation through which these mechanisms were developed forms the basis of the legal infrastructure created to facilitate the transfer of management responsibilities to local communities.

The initial policy, GELOSE (*Gestion Locale Sécurisée*), introduced in 1996, is applicable to forests, marine and pastoral territories and includes legislation designed to grant communities limited tenure security (Antona et al. 2004). In reality, the tenure element proved costly and delayed the transfer process, and consequently the rights transferred are primarily usage and exclusion rights rather than ownership (Pollini and Lassoie 2011). In response to criticisms of the complexity of GELOSE, a new mechanism, GCF (*Gestion Contractualisée des Forêts*), was implemented in 2001 specifically for forest management (Fritz-Vietta et al. 2009, Rajaspera et al. 2011). GCF arrangements require the establishment of a voluntary association of community members, called a *Communauté de Base* or COBA,

which is open to all village residents and designed to be a fee-paying user group (Hockley and Andriamarivololona 2007, Pollini and Lassoie 2011). A contract is signed between the COBA and the decentralised state forestry or fisheries service (and also the Commune in the case of GELOSE) for an initial period of three years, and can include objectives and responsibilities which are conservation-oriented, production-oriented or, in many cases, a combination of the two (Hockley and Andriamarivololona 2007).

Following former President Ravalomanana's Durban Declaration to triple the size of protected areas in Madagascar, the third and final phase of the NEAP (2004–2008), focused on establishing management arrangements to accommodate this massive increase (Norris 2006, Raik 2007). The aim was to increase protected areas from 1.7 to 6 million ha in five years and by the end of 2010 the figure had reached 9.4 million ha (Horning 2008, Corson 2011). This increase necessitated a review of management systems at the local level, leading to the development of co-management arrangements between the government, local communities and third parties with an interest in conservation, including non-governmental organisations (NGOs) and private sector actors (Corson 2011, Rajaspera et al. 2011). Whilst third party actors, particularly NGOs, had played a role throughout the implementation of the NEAP with varying motivations, agendas and results (Raik and Decker 2007, Pollini and Lassoie 2011, Hanson 2012), the promotion of non-state involvement in protected area management opened the gates for private actors to pursue their own interests in forest management and thus community interests continued to be side-lined (Horning 2008, Corson 2011, Seagle 2012).

ADAPTIVE CO - MANAGEMENT. Academics, policy-makers and resource managers have, in the last twenty years, come to recognise what indigenous communities have known for millennia – that human societies are embedded in ecological systems and that they are therefore mutually dependent (Folke et al. 2002, Adger 2006). Linked to this recognition is the now widely acknowledged fact that natural and social systems are dynamic, complex and unpredictable (Folke 2006).

The dynamic and uncertain nature of social-ecological systems in the face of pressures such as climate change, population growth and changing access to land and resources requires new and innovative governance structures. Throughout the 1990s and 2000s, various approaches were developed and advocated in academic and policy circles to address this need to manage dynamic ecosystems. These included collaborative management (Conley and Moote 2003, Plummer and Fitzgibbon 2004), adaptive management (Plummer 2009) and ecosystems management (Grumbine 1994).

Another approach to emerge from this search for sustainable management systems was adaptive co-management (ACM). The focus of much attention in the literature, its novelty comes from combining the iterative, learning dimension of adaptive management, and the linking, cooperative dimension of collaborative or co-management (Olsson et al. 2004, Plummer 2009). In adaptive management, resource managers take a flexible approach, treating policies and management activities as experiments, monitoring ecological feedbacks, learning from these and adapting management accordingly (Plummer and Armitage 2007, Huitema et al. 2009). Co-management stresses the importance of sharing responsibility and power, usually at different institutional scales and, in contrast to adap-

tive management, acknowledges the social challenges involved in resource management (Plummer 2009). The merging of the two concepts creates a distinct approach which represents a potentially important “innovation in natural resource governance under conditions of change, uncertainty and complexity” (Plummer and Armitage 2007: 3).

ACM shares much conceptual common ground with theories of resilience and its antonym, vulnerability. Resilience describes the capacity of a system to absorb shocks while maintaining function, the capacity to self-organise and the degree to which a system is able to learn and adapt (Carpenter et al. 2001). Vulnerability is the inverse of resilience and is used to describe systems in which resilience has been eroded (Folke et al. 2002, Adger 2006). Whilst the concept of resilience originated in ecological circles (Holling 1986, 2001), the resilience approach evolved, notably through the work of scholars at the Resilience Alliance, to incorporate the integrated concept of humans-in-nature (Folke et al. 2002, Folke 2006). With its focus on adaptation, learning, self-organisation and collaboration, ACM is a way of managing for resilience by creating systems of governance that have the potential to strengthen capacity to deal with uncertainty and change (Olsson et al. 2004, Walker et al. 2004).

Although developed along different theoretical lines, in practical terms, the convergence of ACM with resilience and vulnerability concepts highlights the relevance of ACM in development contexts, in which notions of vulnerability are likely to be familiar to practitioners from sustainable livelihoods approaches and where more recently, ideas of resilience in the context of climate adaptation have gained currency. With a few notable exceptions, however, (e.g., the work of CIFOR; cf. Colfer 2005, Diaw et al. 2009), documented experience of ACM has largely come from the global north (Folke et al. 2002, Olsson et al. 2004, Armitage et al. 2009). It seems likely that this is due both to the more readily available access in the north to scientific data collection methods which can feed into ecological monitoring and to more established, strongly linked cross-scale institutional structures. Such practical limitations, however, should not prevent resource managers in developing countries from using the approach as a conceptual framework on which to base management strategies. Indeed, the ACM approaches being applied in developing countries including Indonesia, Nepal, Zimbabwe and Cameroon (CIFOR 2008) highlight its potential as an effective governance model in contexts where populations are often highly dependent on natural resources and where multiple factors – economic, political, social, environmental and climatic – contribute to the degradation of such resources. There are also precedents of the approach being applied in different forms in Madagascar in both marine and forest settings. (e.g., Wollenberg et al. 2000, Cinner et al. 2012). Although it is difficult to judge the degree to which ACM has strengthened resilience in such contexts, the evidence suggests that it is a promising, if challenging, approach which can help to bring stakeholders together to understand the various pressures on natural resources and to adapt management of them accordingly. In the face of growing interest from commercial and industrial actors in Madagascar’s land- and seascapes, governance structures which prioritise multi-stakeholder collaboration and adaptation are increasingly necessary to minimise and mitigate occurrence of

irreversible and negative changes in such environments and the inevitable knock-on effects for local communities.

This article discusses the case of Sainte Luce, a fishing village on the southeast coast of Madagascar bordering some of the last remaining littoral forests in the country. Characterised by a combination of extreme poverty, the presence of highly-prized natural resources and feeble institutional structures, Sainte Luce typifies the vulnerability of social-ecological systems across Madagascar. The presence of the mining company Rio Tinto/QMM, which has plans to exploit the area for ilmenite and which plays a central role in forest management, adds a complex dimension to this situation, with its present and future impact on ecological and social structures representing a key driver of vulnerability in the area. The article outlines the approach taken by a local/international NGO partnership, Azafady, to build the resilience of the community and its surrounding ecosystems through a process of participatory and adaptive environmental planning and management. The approach draws on concepts from adaptive co-management, which sees human and natural systems as interdependent and focuses on innovative institutional arrangements, social learning and cross-scale collaboration in order to manage the uncertainty and complexity of such systems.

CONTEXT

LIVELIHOODS. Sainte Luce lies 50 km north of Fort Dauphin on the southeast coast of Madagascar. Comprising three hamlets, Manafiafy, Ampanasatomboky and Ambandrika, the *fokontany* (or village) has a population of approximately 2,000 people and is situated administratively within the rural Commune of Mahatalaky. Sainte Luce is regionally renowned for its rich natural heritage; its situation in a natural rocky harbour makes it a prime fishing location and accounts for the fact that it is the main source of lobster exports in the Fort Dauphin area (Sabatini et al. 2007). The village also borders some of the most intact fragments of the Ambatoatsignana littoral forest which provides surrounding communities with timber, firewood, materials for fishing equipment, food, medicinal plants and cattle pasture. In addition to its marine and forest resources, Sainte Luce contains river, estuary, mangrove and swamp habitats, each providing a wealth of ecosystem goods and services on which local people depend for subsistence and income.

Livelihoods strategies in Sainte Luce are predominantly based on marine fishing, with most households supplementing this with weaving, using a local reed called *mahampy* (*Lepironia mucronata*) and subsistence farming – predominantly cassava along with pineapples, sweet potatoes, pumpkin and beans. Other livelihoods activities include river fishing, casual labour, selling firewood, selling timber, and selling cooked fish and snacks. Although livelihood strategies are reasonably well-diversified (according to a survey conducted by Azafady in December 2011, households pursue an average of 6.04 livelihood activities), the majority of household income is derived from fishing, notably lobster fishing, and most households are strongly dependent on the presence of two international lobster exporting companies, Martin Pêcheur and Madapêche. Formal sector opportunities exist but are limited. Twelve percent of households have at least one member in formal employment, with the main employers being Martin Pêcheur, Azafady, a luxury eco-hotel and the mining company QMM.

SOCIAL-ECOLOGICAL SYSTEMS. It is argued here that social-ecological systems in Sainte Luce are characterised by uncertainty and change. This is in part due to the presence of the mining company, QMM, compounded by pressure on ecosystems from factors including growing populations, migration, and commercial exploitation of resources without sustainable management systems in place. QMM's presence in Sainte Luce, even in the pre-mining phase, has triggered social tensions linked to concerns over loss of land and forests and indications of the future environmental impact have already been felt in the clearing of areas of forest to conduct soil testing (President of Sainte Luce COBA, pers. comm.). The potential for these tensions to be exacerbated when mining commences can be seen in communities affected by QMM's operations to date, particularly in relation to issues around compensation and access to resources (ALT and Panos 2009). In addition to this, it is likely that there will be significant environmental impacts on the forest, land and waterways, meaning that social-ecological systems will be subject to increasing levels of perturbation. This high level of uncertainty and vulnerability underscores the need for an innovative and flexible governance structure with the capacity to build the resilience of social-ecological systems to withstand future shocks and stresses. In addition to flexibility, an effective governance structure would also need to incorporate the multiple interests of local, commercial and government stakeholders likely to continue exerting pressure on local resources in the lead-up to the start of mining operations.

The Ambatoatsignana forests are of extreme conservation importance, being some of the last remaining fragments of littoral forest in Madagascar and sheltering an extremely rich diversity of flora and fauna much of which is nationally or regionally endemic (Ganzhorn et al. 2001, Ingram et al. 2005, Lowry et al. 2008). The eastern littoral forests are amongst Madagascar's most threatened ecosystems and are home to numerous IUCN Red List species including the Critically Endangered geckos *Phelsuma antanosy* and *Matoatoa spannringi*, the Endangered endemic palm *Dypsis saintelucei* and the Vulnerable collared brown lemur *Eulemur collaris* (IUCN 2013). These high levels of endemism contributed to the decision of the Malagasy authorities to include the forests within the country's network of protected areas (Ramasinoro 2010).

Initiated in 2000, the process of creating a new, 1,365 ha protected area (*Nouvelle Aire Protégée* NAP) in the Ambatoatsignana forest zone was led by QMM (Ramasinoro 2010). The creation of the new protected area served both to fulfil an objective set out in the regional development plan to increase the number of conservation zones and helped QMM to meet a commitment to the Malagasy state to create three protected areas prior to starting exploitation (Ramasinoro 2010). The NAP stretches over three Communes (Mahatalaky, Mandromodromotra and labakoho) and is comprised of conservation zones, community usages zones and a privately owned habitation zone (*zone d'occupation contrôlée*) (Ramasinoro 2010). The usage zones are managed by a network of 11 COBAs, each of whom has signed a GCF agreement granting them usage and management rights within their designated forest area. Each COBA has its own *dina*, a set of rules developed through the management transfer process detailing usage rights, responsibilities and penalties for management of its particular usage zone. The processes of elaborating these *dina* were facilitated

by Azafady and by QMM (for different COBAs) in the late 1990s and early 2000s, prior to the forest's inclusion in the network of new protected areas (NAP).

The creation of the NAP required certain areas of forest to be designated as 'core conservation zones' (Ramasinoro 2010). These comprise a 690 ha section across three forest fragments in which community usage is prohibited, except for harvesting of dead wood, medicinal plants, vines and *amboja*, the juvenile of the palm *Dypsis scottiana*, used to make lobster pots. The conservation zones are managed by FIMPIA, a *Comité de Gestion* (COGE), whose members include the heads of the 11 COBAs and *fokontany* contained within the NAP. A new *dina* known as a *Dina Be* was developed between the FIMPIA and QMM to regulate the management of the conservation zones. Whilst QMM continued to provide financial support to the FIMPIA throughout the 2000s, a lack of transparency, notably amongst the executive committee, a body of elite community members, meant this support did not filter down to COBAs for on the ground management activities.

According to research conducted by Azafady from January to April 2012, community members in Sainte Luce viewed both the COBA and FIMPIA with some level of mistrust, with both institutions having a widespread reputation for corruption. In the case of FIMPIA, this was exacerbated by a lack of clarity over its specific role, its relationship to the COBA and its historical links with QMM (Azafady unpub. data). Power within forest management was thus seen to lie in the hands of a small group of elites and QMM. Management of marine resources in Sainte Luce, in contrast, does not fall under the authority of the COBA and FIMPIA as both the GCF agreement and the NAP cover only forest and marsh resources. Instead, marine resources are managed by a local *dina*, a locally agreed set of rules and associated penalties which, though not part of an official management structure, can be legally ratified by state authorities, with this being seen as a way to increase observance by non-community members. At the time of Azafady's research, the marine *dina* had not been ratified and, in the context of focus group discussions, the local population expressed their dissatisfaction with the existing management system in which rules were enforced sporadically and inconsistently. This weak management structure was perceived by the community as playing a major role in the decline of lobster and fish stocks which fishermen claimed to have observed in recent years and there was thus strong motivation amongst the community to address this.

While existing management structures such as the COBA and *dina* were recognised as being legally and culturally important respectively, the history of these structures highlighted a lack of flexibility and authority to respond to an increasingly dynamic social-ecological context. The need for a more adaptive and collaborative model of governance was therefore identified as a priority by the community and Azafady, with the aim of complementing pre-existing management structures.

In response, Azafady developed and secured funding for Project Miaro – an 18 month project which aimed to research the complex interdependence of people and the environment particular to Sainte Luce and to support the community to engage in a process of participatory action planning, with the goal of creating an empowered community group active and able to communicate with existing decision-makers, including the COBA, FIMPIA and QMM. The project aimed to secure greater

involvement by the community in natural resource management decisions and actions, and to establish a flexible management structure that was accepted and approved by the community and external stakeholders and could complement the more rigid COBA and *dina*.

THE QMM PROJECT. QIT Madagascar Minerals (QMM) is a partnership between the international mining company Rio Tinto and the Government of Madagascar. The company started exploration activities in 1986 and in 1998 attained legal authorisation for a plan to extract ilmenite, a titanium oxide, from three sites in the Fort Dauphin area: Mandena, Sainte Luce and Petriky (Smith et al. 2012). Production at the first site, Mandena, started in 2009 and exploitation activities are due to be conducted sequentially at the three sites over a period of 40 years (Rio Tinto 2013). Preliminary steps for the development of the second site, Sainte Luce, began in 2012. However, following a strategic business decision taken in early 2013 to temporarily withdraw development teams, timeframes remain unknown; recommencement will depend on market demand for ilmenite and the company's internal investment strategy. Whilst such uncertainty is unsettling for communities who will potentially be impacted by future mining, the deferral of the second phase offers opportunities for lessons learnt about social and environmental strategies at Mandena to be consolidated. Efforts to minimise the ecological impacts of mining are being informed by the company's high profile strategy to have a 'net positive impact on biodiversity' (Rio Tinto 2008). This includes a provision for 624ha (of the total 6,000ha targeted for exploitation) to be set aside for conservation, in addition to around 2,400ha to be designated as 'biodiversity offset' sites to compensate for non-negotiable losses of biodiversity (Rio Tinto 2008, Temple et al. 2012).

Having had a presence in the area since 1989, conducting extensive research contributing to its biodiversity strategy, and in the absence of alternative organisations with the technical and financial capacity to take on the task, QMM's involvement in the creation of the Ambatoatsignana NAP seems to have been regarded as a *fait accompli*, despite some internal recognition of the obvious conflicts of interest given that the company's plans to mine in the area will involve the destruction of a significant, but as yet undefined, amount of forest (Vincelette et al. 2007, J.-B. Ramanamanjato, pers. comm.). Whilst overall authority for the management of the NAP officially lies with the regional forestry ministry (*Direction Régionale de l'Environnement et des Forêts* or DREF), QMM has joint responsibility with DREF in "scientific and socio-economic aspects and in engaging communities in the elaboration and application of the *dina* (rules)" (Ramasinoro 2010: 8). In reality, QMM's position as financial patron as well as official 'promoter' of the Ambatoatsignana NAP, combined with the severely limited resources and capacity of the regional forestry authorities, has created a situation in which the mining company effectively has *carte blanche* in virtually all matters relating to forest management. This has been facilitated by the company's continued financial support of the NAP management committee, FIMPIA. This situation gives the company great leeway to determine the forest areas which will be used as biodiversity offsets. At the time of writing the company's designated offset sites at Sainte Luce are within existing avoidance zones, however, if deemed strategically necessary, QMM's well-established position of authority within forest manage-

ment in the area gives it the freedom to select new sites. This would inevitably further reduce community access to vital forest resources in order for QMM to implement the conservation measures required to deliver targeted offset results.

DRIVERS OF VULNERABILITY. Following Kaspersen et al. (1995) and Adger (2000), we define vulnerability as the propensity of social or ecological systems to suffer harm from external stresses and perturbations, such as environmental variability or social, economic or political upheaval. The three key drivers of social-ecological vulnerability described below were identified on the basis of participatory research conducted during 2012 and Azafady's ongoing engagement with the community of Sainte Luce.

Whilst efforts to minimise the environmental impacts of the forthcoming mine have been made, as the company itself acknowledges, it is inevitable that some negative effects will occur (Rio Tinto 2008, Temple et al. 2012). The complexity of these impacts makes a comprehensive analysis extremely challenging. The balance of evidence suggests, however, that whilst the impacts are not purely negative, QMM's presence in Sainte Luce represents a potential key driver of vulnerability. It should, nonetheless, be noted that the impact of the conservation zone has contributed to the preservation of certain species sheltered therein including the Critically Endangered palms *Dypsis saintelucei* and *Beccariophoenix madagascariensis* and four species of lemur. This is due to regular patrols by a QMM-supported agent and also probably to the frequent presence of QMM and Azafady researchers. In spite of the inconvenience caused by the prohibition of access to this section of forest, according to data collected by Azafady through focus groups and interviews, the positive conservation outcomes seem to be valued by the community who recognise that the lack of an effective forest management system prior to QMM's arrival was threatening the availability of resources for future generations. However, poor village-level communication throughout the various stages of the establishment of the NAP and its accompanying restricted access rules, together with low levels of community participation in subsequent forest management, have resulted in a severely diminished sense of ownership of the forests amongst the community. This has been driven by a widely-held perception amongst local people that the *vazaha* (foreign) company has removed access to what is rightly theirs, an idea which is strongly bound up with the Malagasy idea of *tompon-tany* – not only 'masters of the land' in the literal sense, but also indicating a connection to the ancestors through the land (Evers 2005, Sandy 2006, von Heland and Folke 2014). As one focus group participant commented: "In the protected areas, we cannot cultivate the fields made by and used by our forefathers". However, discontent is also linked to the declining availability of cultivable land which the protected area has exacerbated. According to another focus group participant: "We are not allowed to farm in the protected area. The land we are cultivating now is becoming infertile but we cannot move onto new areas".

Access restrictions in the conservation zones have contributed to an increase in exploitation activities in the less-managed usage zones (Azafady, unpub. data). QMM's increased support to the Ambatoatsignana COBAs since mid-2012 has helped to address this, however independent assessments (Bezanson et al. 2012, Olegario et al. 2012), echoing Azafady's findings,

highlight the need for improved stakeholder collaboration and improved village-level communication of both forest management and mining plans, in order to improve governance and minimise the already evident negative social and ecological impacts.

The second driver of social-ecological vulnerability is the strong dependence of the community on lobster fishing. Fishing is the primary source of income for 79% of households in Sainte Luce and, of these households, virtually all fish for lobster (Azafady unpub. data). Fishermen report that lobster stocks have been declining gradually but in the last ten years have seen a more rapid decline. Whilst there are no recent, comprehensive population data available, the fishermen's reports correspond with studies conducted in the early 2000s in the Fort Dauphin area (Bautil 2002 and Sylvestre 2005, in Sabatini et al. 2007). These studies found that unsustainable practices such as the removal of juveniles and gravid females and the use of masks and snorkels, as well as increasing numbers of lobster fishermen, had led to a significant decline in catch per unit effort. Sabatini et al. (2007: 299) conclude that lobster populations in the Fort Dauphin area could crash within a decade and "may already be beyond recovery". Whilst QMM has been criticised for overstating such fatalistic perspectives, emphasising the lack of effective environmental management in order to support the case for mining (e.g., Ingram et al. 2005, Seagle 2012) it is argued that such negative ecological assessments highlight the need for action, a sentiment strongly reflected by the community from the start of Azafady's engagement through Project Miaro. Data collected by Azafady in August 2013 suggest that lobster accounts for around 30% of fishing households' combined income and food requirement. Therefore, in addition to the consequences of overfishing on a single species, the decline of lobster populations in Sainte Luce increases the vulnerability of households who rely heavily on the income generated from lobster sales to support their livelihoods.

The third main driver of vulnerability in Sainte Luce is the impact of the changing demographic structure of the area. Whilst Sainte Luce has historically had a higher presence of *vazaha* than other villages as a result of transport links, trade and tourism opportunities, the last three decades have seen the arrival of the mining company and the ensuing establishment of the conservation zone as well as a number of land acquisitions by *vazaha*, all of which have put pressure on land and forest access. This has forced local people to change the ways they use resources, for example not being able to graze cattle through privately-owned or protected areas of the forest, and reducing fallow periods due to land shortage, putting additional strain on the available resources. Exacerbating this situation is the steady increase in migrants arriving from both coastal and inland communities in search of livelihood opportunities in Sainte Luce – in Azafady's 2011 demographic survey, 45% of respondents reported being not native to Sainte Luce. This has both increased resource demand and contributed to a decline in traditional governance structures since, according to Azafady's research, many migrants are perceived by the indigenous community as not recognising local resource governance rules. This perception applies both to observance of the forest rules or *dina* and, even more divisively, to the local taboo against using diving equipment to catch lobster and the use of fishing nets in the harbour area. The increased pressure on natural resources

due to migration and changing access rights, combined with a decline in *dina* observance by both native and non-native residents, has contributed both to social discord and to ecological degradation.

Whilst other anthropogenic or environmental drivers that affect the vulnerability of socio-ecological systems certainly exist, for example climate change (Hannah et al. 2008), the three described above present the most significant and immediate factors which threaten to erode the resilience of social and natural systems around Sainte Luce.

APPROACH

As the recent history of natural resource governance in Madagascar (Marcus and Kull 1999, Raik 2007, Hanson 2012) and other developing countries (Colchester 1994, Agrawal and Ribot 1999, Ribot 2002) has shown, externally imposed solutions to environmental problems rarely succeed in meeting communities' needs and expectations. For this reason, Azafady adopted a participatory approach to facilitate its support to the community of Sainte Luce to improve natural resource management. The approach centred on providing opportunities for the community to analyse the current situation and to explore options for addressing the perceived issues and, later in the project, participatory monitoring would be key to reinforcing community ownership of natural resources. The initial phase of the project consisted of a participatory community assessment, focusing on aspects of natural resource use and management, livelihoods, decision-making structures, culture and history. During this phase, a range of participatory rural appraisal methods was used including community mapping, transect walks, seasonal calendars, Venn diagrams, wealth ranking and matrix scoring. These visible and tangible tools allowed local people to share ideas and to visualise the complex dimensions of their existence and interactions with the environment. The assessment was conducted over a period of four months (January to April 2012) in order to allow a broad range of community members to contribute to the discussions and enabling those who have historically been excluded from public forums, particularly women and the elderly, to participate. This period of co-inquiry served to build a shared understanding of the social and environmental status quo and the key concerns of local people but also, through the use of appropriate tools, attitudes and behaviours, facilitated the building of trust between Azafady and the community, a key factor in the later success of the project, as described below.

Azafady held a series of community feedback meetings at which the key findings of the participatory research were presented and the way forward was discussed with the community. People from all levels of the social hierarchy were encouraged to attend and participants included some prominent decision-makers but also, in general, lower status groups such as women, youth and migrants. Although anxiety about the anticipated loss of land and resources such as *mahampy* due to mining activity was expressed, these were seen as future issues with more concern being expressed for the existing and increasing loss of vital livelihood resources, notably lobster and fish, *mahampy* and forest species. The main causes of decline of these resources were cited as "selfish, unthinking behaviour", such as lack of control of fires used for pasture regeneration and non-traditional practices such as use of diving equipment for lobster fishing.

Given this acute concern about the declining availability of resources, sharpened by uncertainty about the impact of future mining activity on the environment (and consequently on livelihoods), a joint decision was taken by Azafady and the community to develop an environmental action plan in order to address the key issues faced by the community. A committee would be established to develop the action plan, to coordinate all community natural resource management efforts and to act as a point of contact for external stakeholders with an interest in natural resource use or management. Named the Miaro Committee, the group would be comprised of an equal representation of five people from each hamlet, include a gender ratio of three men to two women (locally determined as appropriate) and contain representatives of all existing environmental-oriented community groups including the COBA and fishermen's associations. These criteria were decided upon by the community and a well-publicised and well-attended community meeting, facilitated by Azafady, ensured that the process of proposing and electing the committee members was transparent and democratic and not dominated by elites.

The community action plan was elaborated by the Miaro Committee over a series of meetings facilitated by Azafady. The plan included activities to improve the overall management of natural resources, for example ways to enforce the forest and marine *dina* and the clearing of firebreaks, as well as ideas to reduce pressure on existing resources, for example the creation of a community nursery, the extension and management of an afforestation site, the cultivation and sustainable management of a *mahampy* reed bed and the development of alternative sources of income such as ecotourism guiding.

Prior to starting to elaborate the plan, the committee had reviewed and analysed existing management structures and aimed to align the activities in the plan with these or, where necessary and feasible, to amend them. This latter was the case for the marine *dina* which, since not linked to a management transfer, are not bound by the legal restrictions associated with GCF contracts. This meant that the Miaro Committee could spearhead efforts to amend the *dina* through a community-led process in order to respond to widespread concerns about declining lobster stocks. In the case of forest management, the presence of the Sainte Luce *Chef* COBA on the Miaro Committee helped to ensure that the Miaro plan complemented the existing COBA management plan. However, the committee faced challenges when the implementation of ideas for updating or introducing new rules for forest management was constrained by the existing COBA management plan or the *Dina Be*, changes to which must follow set legal procedures. These challenges were, to some extent, addressed by the fact that the *Chef* COBA and the rest of the committee were able to raise their ideas for amending the *dina* directly with QMM (who oversees the process of revising the *Dina Be*) and other COBAs at the stakeholder platform described below. In this sense, the Miaro Committee serves a crucial bridging function between the community and external decision-makers, representing a wide range of ideas and concerns, and with the backing of village authorities, local and regional government authorities and QMM. Though it could be argued that the COBA could and perhaps should play this role, in Sainte Luce, Azafady's participatory research concluded that a new body with the ability to more accurately represent community interests across all natural resources and with no

history with or links to QMM, would be better placed to serve this function.

The overriding aim was not to produce a 'donor-friendly' plan but to use the process of identifying key concerns and corresponding actions to address these, to build the group's capacity in teamwork, decision-making and analytical skills, core skills that would enable them to implement dynamic and responsive activities on an ongoing basis. Once the committee had finished elaborating the action plan, meetings were held to enable the village head and the rest of the community to provide their input into the plan. This was a vital step in ensuring community validation and ownership of the plan and it also provided opportunities for highly inclusive discussion and debate about environmental concerns and potential solutions.

A stakeholder platform was established comprising village, Communal and Regional ministry representatives, QMM, the lobster company Martin Pêcheur and the eco-hotel, Miaro Committee members and community representatives from surrounding villages who rely on the natural resources around Sainte Luce. Prior to the first meeting, Azafady consulted with each stakeholder individually in order to explain the aim of the platform – to provide a forum for meaningful communication between all natural resource stakeholders, including, notably, community members. In convening all stakeholders to engage in discussion over mutual and divergent interests in resources, the intention was to create opportunities to recognise the importance of collaborating and sharing responsibility. With the exception of the annual meeting of FIMPIA and its advisors, which in past years has not always taken place, the Miaro platform is the first forum to exist in which village representatives can engage with other resource users and managers and have a voice in decision making.

Miaro Committee members presented their action plan at a stakeholder platform meeting in December 2012 and received the support and encouragement of the authorities to execute the planned activities. The implementation of the plan started in January 2013, funded by Azafady, and a participatory monitoring system was integrated within the initiative to strengthen community ownership of resources and to motivate the community to continue engaging in resource management activities. A simplified monitoring framework aimed to capture both positive and negative changes in the environment and to build a shared understanding of these changes through group analysis with the Miaro Committee and then with the wider community. The framework does not focus only on monitoring the activities in the Miaro action plan since this would allow for too limited an analysis, but rather looks broadly at all environmental changes in the Sainte Luce area and uses analysis of these changes to determine priority actions. Monitoring takes place biannually and the information generated is presented at stakeholder platform meetings with the aim of communicating to external stakeholders key areas of concern and progress and thus facilitating focused discussions on actions which can be taken, collaboratively or by individual stakeholder groups, to improve resource management.

DISCUSSION

In spite of its picture postcard appeal, Sainte Luce's ecosystems are deteriorating at an alarming rate. Pressure from population growth, immigration, climate change, and unsustainable

practices such as commercial logging and the use of diving equipment in lobster fishing, are causing changes in the natural environment which raise questions about its ability to sustain the local population into the future (Ingram et al. 2005, Consiglio et al. 2006, Hannah et al. 2008, Hogg et al. 2013). As is the case elsewhere in Madagascar (Evers et al. 2013, von Heland and Folke 2014), socioeconomic processes and norms in Sainte Luce are strongly interlinked with surrounding ecosystems. For most households, the sea, the land and the forest are the cornerstones of their livelihoods, providing for their daily income and subsistence needs as well as having important cultural significance. Focus groups conducted by Azafady revealed, for example, that *mahampy* is the most highly valued land-based natural resource, according to both men and women, since it is customary to use it as a shroud for corpses and no other material has the same significance. "It is important in death as well as in life", according to one community member. The links between nature and society for people in Sainte Luce go far beyond a mere practical dependence. As a vast body of literature shows, there are intrinsic connections between Malagasy people and the land, mediated through complex ancestral traditions, which are highly distinct from the prevailing dichotomised conception of human and natural systems (Middleton 1999, Hanson 2007, Andrianirina et al. 2011, Evers et al. 2013).

The linking of social and ecological systems inherent in ACM offered a useful conceptual reference for an approach to improving environmental governance in Sainte Luce. Whilst it is too early to assess whether any lasting changes will result from the initiative, a management model based on ACM principles, and emerging from the community's own reflections on the integrated nature of their lives and the environment, was seen to offer the flexibility and inclusiveness which the pre-existing resource management model had lacked. The approach's focus on participatory monitoring and regular, structured reflection, also offered a way for communities to better understand the impact of both usage and management activities on ecosystems, and to better respond to potential negative impacts caused by unsustainable harvesting practices, natural or climatic forces or future mining activity.

With reference to the latter, it could be argued that the social and environmental impacts of the future QMM operation are likely to be so significant that they will result in fundamental changes of a negative nature to both ecosystems and social structures. In other words, the mine will cause changes that undermine any potential increase in resilience that the ACM governance model has brought about. Indeed, critics of ACM have suggested that a key weakness of the approach lies in its failure to take account of the broader economic context, including extractive industry projects which, by their nature, decrease resilience and lead to ecological and institutional collapse (Nadasdy 2007). This criticism, however, is not pertinent in the Sainte Luce case since consideration of the broader economic and political environment was precisely one of the reasons that ACM, with its focus on collaboration, adaptation and learning, was seen as a useful conceptual framework for the approach taken. ACM takes as its starting point the uncertainty of the future and it is this element which makes it particularly relevant to contexts such as Sainte Luce. Although we can speculate about the impacts of the mine by looking at precedents, the precise nature of these impacts, including when and where they

will be felt, remain uncertain and therefore adaptability is key. Moreover, the 'collaboration' element of ACM was seen as vital if attempts were to be made to shift the balance of power out of the hands of QMM and elite community members and into the hands of a more representative group who, though lacking the legal standing of the COBA or QMM in management structures, acquired some level of authority through having the respect and buy-in of both community members and external stakeholders.

Azafady therefore sought to create the conditions which would promote community ownership and allow a more collaborative and adaptive governance to emerge. Three key elements of ACM theory were particularly instructive in supporting this process: (i) the emergence of multiple and innovative institutions; (ii) monitoring, learning and adaptive management, and (iii) cross-scale collaboration and trust building. The remainder of this section examines the ways in which these elements in particular aimed to bring about a shift towards more resilient social-ecological systems in Sainte Luce.

MULTIPLE AND INNOVATIVE INSTITUTIONS. As the lowest-level institution in a complex and bureaucratic web of forest administration, the COBA lacks organisational flexibility. Most decisions require approval by the NAP management committee (FIMPIA), the state forest administration and, in the case of Sainte Luce, QMM (as promoters of the NAP). Being so firmly embedded in Malagasy environmental legislation, there is little potential to replace the COBA with an alternative institution. However, in establishing the Miaro Committee, a complementary system was able to be implemented, which could be more adaptive to changing conditions and priorities, whilst still working within existing management structures such as the GCF.

The mandate of the Miaro Committee is different but complementary to that of the COBA. Whereas the COBA is actively involved in the day-to-day management of the forest, including issuing and checking exploitation permits, the Miaro Committee's role is to coordinate efforts to improve management across all resources including marine, forest, river and land. Most of their activities fall outside the normal remit of the COBA, for instance the establishment and maintenance of a community nursery or the piloting of a *mahampy* reed bed. While these activities *could* have been undertaken by the COBA, the existence of, and communication between, multiple, overlapping institutions has been found to build resilience through a process of shared experimentation and learning (Armitage et al. 2009, Huitema et al. 2009). The presence of the *Chef* COBA on the Miaro Committee has indeed facilitated the exchange of ideas and information, particularly in regard to *dina* enforcement and monitoring. Coordination between the two groups has also promoted transparency, serving to strengthen both institutions, as evidenced by the Sainte Luce COBA's nomination as the most effective COBA in Ambatoatsignana in a 2013 contest supported by QMM.

The ability of communities to self-organise, particularly in response to environmental problems, is an indicator of social resilience (Olsson et al. 2004, Folke 2006). A Venn diagram exercise conducted at the beginning of the participatory assessment indicated that very few community groups existed in Sainte Luce and that virtually none were active, suggesting low levels of social capital and self-organisation. During the course of Project Miaro, signs of increased self-organisation started to show. Following the community meeting at which the action

plan was presented and community environmental concerns debated, a youth group formed independently in the hamlet of Manafiafy in order to address water, sanitation and village cleanliness issues. This prompted the emergence of two other youth groups to work on similar issues across the village. The three groups have remained active, in spite of virtually non-existent financial support, and in addition to pursuing their own aims, have worked with the Miaro Committee in the implementation of activities such as maintenance of the afforestation site and firebreak clearance. Whilst it is hard to conclusively connect the emergence of these groups to Miaro activities and meetings, some community members did see a link between the two. As one member of a youth association commented, "The meetings which Azafady held helped us to think about the problems in our community and gave us the motivation to want to solve these problems ourselves so we set up this association".

Another example of self-organisation is the formation of a sea commission, comprised of 15 respected fishermen, which emerged in response to a need highlighted by the Miaro Committee and other community members to review and strengthen the enforcement of the marine *dina*. With the backing of the community, they have worked with the Miaro Committee on reviewing the *dina*, attaining ratification and developing systems to ensure that the rules are respected by community members and outsiders alike.

In this way, the focus on attaining genuine and broad-based participation and the facilitation of community analysis, debate and decision-making, has helped to foster an environment conducive to self-organisation and the emergence of innovative institutions. The community's concern for resource sustainability, their dissatisfaction with existing resource management structures and a willingness to address these issues helped to create the conditions for such mobilisation to take place. This is a key strength of this type of ACM approach. In contrast to government-led blueprint models such as the GCF or GELOSE management transfers, it allows for a strong element of community input and the emergence of institutions which are better suited to the local social and environmental situation. It is too early to assess whether the new institutional arrangement in Sainte Luce will be sustainable. It does, however, hold some promise for the future since groups have demonstrated an ability to learn from each other and to be adaptive to changing conditions and priorities – both key indicators of resilience and sustainability.

MONITORING, LEARNING AND ADAPTIVE MANAGEMENT.

In ACM, ecological feedbacks are monitored so that policies and management activities can be adapted to accommodate environmental changes (Armitage et al. 2009, Plummer 2009). Monitoring allows such changes to be observed and responded to before ecological thresholds are passed (Olsson et al. 2004). In addition to the adaptation function that monitoring serves, the increase in understanding of ecosystem dynamics that comes with communities conducting their own monitoring can serve to reinforce motivation to use and manage the resource more sustainably.

Within Project Miaro, the environmental action plan aimed to highlight current priorities and to initiate community action. Following ACM principles, the plan was not intended to be fixed, but rather is subject to change over time according to ecological feedbacks as well as to changing community priorities. Moni-

toring of the plan was therefore seen as essential not only to enable the community to assess and react to environmental changes but also to facilitate social learning about the causes of changes in natural resources and thus to promote a sense of community ownership.

Monitoring takes place within a Miaro Committee meeting and involves brainstorming of all positive and negative changes that have taken place in each resource, followed up by discussion and analysis of the means of verification (i.e., how we know there has been a change) and the causes and effects of the changes. In discussing the means of verification, the committee has been able to refer to two separate sets of participatory monitoring data. The first is forest monitoring conducted by the COBA, with the assistance of a QMM-appointed forestry technician. The second is lobster catch data collected by two community members appointed by the parastatal research body, *Unité de Recherche Langoustière* (URL), with whom the community and Azafady have collaborated to improve the sustainability of the lobster fisheries. Azafady is building the committee's capacity to keep records, for example, of nursery and afforestation site activities, which will also feed into monitoring analysis. However, in a community in which people interact very closely with their environment, hard data is not always necessary – simple observational monitoring can be sufficient if it is discussed and agreed upon.

This monitoring framework is a far cry from the advanced, often scientific, monitoring systems which are in place in northern ACM contexts. Indeed additional scientific monitoring, particularly of the forest and marine ecosystems, could help to verify community observations and support management decisions, and would certainly serve to strengthen the adaptive co-management structure. As such, steps are currently being taken by Azafady to develop scientific monitoring systems which are aligned with community priorities. However, the monitoring approach adopted thus far, with its focus on collective learning through group analysis and the sharing of results with the wider community and stakeholders, has been notably effective in building a shared understanding of resource dynamics and in informing changes to planned activities such as the increase in marine management initiatives following widespread concern for declining in lobster stocks. Both these elements are central to ACM arrangements and have been shown to contribute to adaptive capacity and social-ecological resilience (Folke et al. 2002).

TRUST-BUILDING AND COLLABORATION. Trust is an essential precursor to collaboration in any natural resource management initiative (Pretty and Ward 2001). Experience shows that successful co-management involves the building of trust, which often takes time (Olsson et al. 2004). Levels of trust in Sainte Luce prior to the project were found to be poor – both intra-community trust as well as community trust in external partners including QMM and Azafady (Azafady unpub. data). The participatory assessment helped to build community trust in Azafady as demonstrated through an increase in willingness to attend focus groups and a gradually more positive engagement with field agents. This trust served to increase community interest in discussions about resource management facilitated by Azafady, which in turn fuelled motivation to act.

One of the aims of establishing the stakeholder platforms was to promote direct communication between stakeholders

and hence to increase trust and collaboration. Collaboration necessitates dialogue and effective dialogue requires that both parties are speaking the same language, both literally and figuratively. In contrast to a local history of community meetings held by external stakeholders, at which plans or events are typically presented to local people in technical or difficult language, Miaro platform meetings have proactively supported non-elite community members to play a key role in proceedings, expressing their ideas and concerns in their own words and ensuring that all members are communicating at the same level. As a Miaro Committee member commented after presenting the action plan at the December 2012 stakeholder meeting, “It makes us feel stronger to stand up in front of them [QMM] and express our concerns and our ideas.”

The collaborative approach adopted within Project Miaro is serving to strengthen local institutions through information exchange and advice. One of the activities identified in the Miaro action plan was to trial the cultivation of a *mahampy* reed-bed in order to create a sustainable source of the economically important resource which is already threatened due to over-harvesting and wild fires, and it is likely that stocks will be further reduced by mining activity. With the construction of the mine in Mandena necessitating the clearing of land containing vital *mahampy* stocks (Kraemer 2012), QMM’s biodiversity team had worked with communities in that region to develop a *mahampy* plot to help increase availability of the resource. They offered to share their experiences with the Miaro Committee and, through a site visit and technical demonstration, the Miaro Committee was able to gather information which was used to create their own *mahampy* reed-bed in Sainte Luce.

In addition to vertical collaboration with more powerful or influential institutions, horizontal collaboration can also help to foster social learning and can increase understanding of social-ecological systems and how to manage them (Armitage et al. 2009). Through the stakeholder platforms, community level institutions (including the Miaro Committee and the COBAs from five *fokontany* bordering the NAP) have exchanged ideas and resolved common resource issues such as the persistent illicit harvesting of an endemic plant, *Ravenala madagascariensis*, by commercial operators. In support of horizontal information exchange and learning, community representatives from Sainte Luce have also been involved in a site visit to the successful locally-managed marine areas in Andavadoaka on the west coast of Madagascar, where they learnt about the benefits of marine reserves and how to enforce the rules. These lessons are now being put into practice in Sainte Luce in the development of a locally-managed marine protected area to support the ecological and economic sustainability of the lobster fisheries.

The focus on cross-scale collaboration in ACM stems from a recognition that environmental management may benefit from a combination of different knowledge systems – both traditional and scientific – and that responding effectively to social-ecological feedbacks requires the linking of social actors – horizontally and vertically – in governance arrangements (Olsson et al. 2004, Armitage et al. 2009). Whilst it seems that Miaro activities have helped to increase trust between the community and Azafady, there is a significant correlation between trust and the level of financial and organisational support dedicated to addressing community concerns, something which presents a challenge to Azafady due to the insecure nature of NGO funding streams. The

extent to which the project has helped to increase trust between the community and QMM is uncertain given the dynamic nature of trust and the difficulty of measuring it. QMM’s central role in resource management in Ambatoatsignana makes it all the more vital for them to establish and build community trust, since without this, collaborative conservation efforts are unlikely to succeed.

Collaboration is only useful if stakeholders are committed to open and honest discussion and negotiation. In the face of widely divergent interests, approaches and operational timeframes, meaningful collaboration in Sainte Luce has been challenging. Collaboration is also both resource intensive and logistically difficult. For these reasons, collaboration between non-community actors with an interest in Sainte Luce’s resources could and should be improved. As described above however, there has been some progress in this area and even more in terms of cross-scale connections linking community members to other useful actors increasing learning and strengthening management. With the future mining project likely to present ever more difficult decisions about natural resource management, it is vital that all stakeholders in the area continue to collaborate and to adopt an adaptive approach to management to build on the small but significant progress made to date.

CHALLENGES, LESSONS LEARNT AND THE ROAD AHEAD

The approach adopted by Azafady in Sainte Luce has aimed to facilitate a shift towards a more resilience-oriented model of governance. Drawing on ACM concepts and focusing on attaining broad-based community participation can be an effective way of increasing collaboration and creating a governance structure which corresponds to local social and ecological realities. Building resilience, however, takes time and requires the ongoing support of stakeholders. Although the Sainte Luce example displays promising indications of what an ACM-informed approach can achieve, there are numerous inherent limitations to such an approach and numerous challenges which must be overcome before it can be claimed that it can result in significant and lasting gains in social-ecological resilience. Some of the key challenges and lessons learnt are discussed below.

Scale: The *fokontany* of Sainte Luce was selected as the focus of Azafady’s project as a result of the organisation’s history in the village and its proximity to the NAP conservation zones and other forest fragments. However, it is not only the community of Sainte Luce which uses the natural resources located near to this village. Inhabitants of at least five other villages rely on forest and marine resources in question (Azafady unpub. data). Therefore, whilst other *fokontany* are included on the Miaro platform, it would have been preferable to conduct similar activities such as the participatory assessment and establishment of a resource management coordination committee in the surrounding villages in addition to Sainte Luce. Indeed, the process described here was useful as a pilot but it is rare that an ACM governance structure would focus on a single community. However, the core tenets of ACM – multi-stakeholder collaboration, adaptive management and a focus on learning – have nonetheless helped to inform a governance structure which has the capacity to better respond to and recover from future stresses, whether endogenous or exogenous. To what extent this capacity is realised depends strongly

on the continued collaboration of stakeholders and a commitment to ensuring genuinely inclusive decision-making informed by sound monitoring data. These elements have already proved challenging in Sainte Luce where diverse stakeholder interests persist and approaches to environmental governance are still not fully aligned. Azafady is continuing to support the community of Sainte Luce to address these issues and is likely to play a role in supporting community interests in natural resource management in the wider Ambatoatsignana area in future. The governance model for this area and the specific stakeholder roles within it are still being defined, but given its position as manager of the NAP, its role in creating biodiversity offset sites and its mining interests in the area, QMM holds considerable power to determine what this will look like. The need for the mining company, as well as other stakeholders, to draw on the lessons learnt from the Miaro experience is therefore key in ensuring that future strategies are effective in maximising the resilience of communities and ecosystems.

Monitoring: This is the backbone of adaptive management. The successful continuation of the project in Sainte Luce and beyond will require collaborating partners to work with communities to ensure that the participatory monitoring of resources continues and that it feeds into management decisions. In Sainte Luce, participatory monitoring should also be expanded to include other priority resources such as *mahampy* so that appropriate management strategies can be designed. There is a real need to increase scientific monitoring of ecosystems in order to ensure that resource management decisions enhance rather than erode ecological resilience. Azafady's conservation volunteer programme is well placed to support this but collaboration and information sharing with other partners will be essential.

In order to assess the impact of improved governance on social vulnerability, socio-economic monitoring of households should be introduced using the sustainable livelihoods framework or another holistic analysis tool. In order to avoid survey fatigue experienced in similar projects (e.g., Cripps and Harris 2009), a suitable participatory monitoring method should be designed. The combination of ecological and social monitoring, using both scientific methods and participatory tools which foster continued community learning, will enhance communities' adaptive capacity and support ongoing resilience-building.

Collaboration: Communicating the aims of Project Miaro both to the community and to other stakeholders was initially a major challenge which persisted due to the novelty of a participatory and collaborative approach in an area characterised by mistrust, non-collaboration and a history of top-down projects. Even after project aims were understood and mutually agreed, collaboration has remained challenging in view of the inevitably divergent agendas and work plans of the various private and public organisations operating in Sainte Luce. Although partners have affirmed their commitment to collaboration, the organisation of stakeholder meetings – both the entire platform and smaller coordination meetings – at a mutually convenient time has proven difficult and meetings are often postponed, leaving long gaps in communication. Continued meaningful collaboration requires all partners to recognise that considerable effort must be made on all sides to ensure that mutual benefit is reaped. It is this awareness which will help to ensure that the

new institutional structure persists and that it continues to improve local environmental governance.

CONCLUSION

In Sainte Luce, as in numerous other contexts in Madagascar and beyond, the combination of multiple complex factors operating within one small social-ecological landscape increases the certainty that the future is uncertain. Change is definite, therefore adaptation is critical. Systems must be established which help to build social-ecological resilience to enable both communities and ecosystems to cope with change. Such systems are, however, slow to develop. In Sainte Luce, concerted effort from all stakeholders will be required to nurture the nascent spirit of stakeholder collaboration and learning in the pursuit of more sustainable and equitable resource governance.

In describing the case of Sainte Luce, we have sought to demonstrate that simply involving local people in natural resource management is not sufficient to meet the challenges presented by complex and dynamic social-ecological contexts. We have highlighted the need for a more nuanced and considered approach which takes account of the interconnectivity of people's lives and the environment, the need for social learning for sustainability and the advantage of combining different types of knowledge and institutions in creating adaptive and sustainable management structures.

It should be emphasised that there was no intention to create an ACM system; such a system cannot be created but rather emerges from existing structures (Olsson et al 2004). Indeed, with limited financial and human resources, Azafady's aim was not to implement a full adaptive co-management system. Rather it was to draw on ACM concepts to guide the provision of support for improved resource management which would enable both the community and ecosystems to better withstand future changes in their environment. ACM was therefore utilised as an underlying approach rather than being a goal in and of itself. In outlining the approach taken by Azafady in Sainte Luce, therefore, as well as the strengths and limitations of such an approach, we have brought to light experience which can be drawn on by others working to support effective and sustainable environmental management in complex and dynamic contexts.

ACKNOWLEDGEMENTS

The authors would like to thank the staff of ONG Azafady and Azafady UK, in particular those directly involved in Project Miaro: Emahalala Rayonné Ellis, Randrianantenaina Mbola Sylvestre, Andriamifidisoa Rinah, Zafison Théophile and Remboho Judicaël Thècle, Mark Jacobs and Lisa Bass. We are also grateful to the anonymous reviewers and the editors for their helpful comments and suggestions. Finally, we would like to acknowledge the donors whose generous funding enabled the implementation of Project Miaro: AusAID and SmartFish/FAO/EU.

REFERENCES

- Adger, W.N. 2000. Social and ecological resilience: Are they related? *Progress in Human Geography* 24, 3: 347–364. (doi:10.1191/030913200701540465)
- Adger, W. N. 2006. Vulnerability. *Global Environmental Change* 16, 3: 268–281. (doi:10.1016 /j.gloenvcha.2006.02.006)
- Agrawal, A. and Ribot, J. 1999. Accountability in decentralisation: A framework with South Asian and West African cases. *Journal of Developing Areas* 33, 4: 473–502.

- ALT (Andrew Lees Trust) and Panos. 2009. *Voices of Change: Oral Testimony of the Antanosy People*. Andrew Lees Trust and Panos London. Available at <<http://andrew-leestrust.org/hepa.htm>>
- Andrianirina, R. R., Ramarojohn, L., Burnod, P. and Teyssier, A. 2011. After Daewoo? Current Status and Perspective of Large Land Scale Acquisitions in Madagascar. *Observatoire du Foncier à Madagascar*, CIRAD, International Land Coalition, Rome. Available at <<http://www.observatoire-foncier.mg/downloads/After-Daewoo-engl-2011.pdf>>
- Antona, M., Motte Biénabe, E., Salles, J. M., Péchard, G., Aubert, S. and Ratsimbarison, R. 2004. Rights transfers in Madagascar biodiversity policies: Achievements and significance. *Environment and Development Economics* 9, 6: 825–847. (doi:10.1017/S1355770X04001640)
- Armitage, D., Plummer, R., Berkes, F., Arthur, R. I., Charles, A. T., et al. 2009. Adaptive co-management for social-ecological complexity. *Frontiers in Ecology and the Environment* 7, 2: 95–102. (doi:10.1890/070089)
- Bezanson, K., Gérin, J., Jolly, A. and Rajaobelina, L. 2012. Report of the International Advisory Panel, 2012 Mission, 12–24 September 2012. Available at <<http://www.riotintomadagascar.com/english/summary.asp>>
- Carpenter, S. R., Walker, B. H., Anderies, J. M. and Abel, N. 2001. From metaphor to measurement: resilience of what to what? *Ecosystems* 4, 8: 765–781. (doi:10.1007/s10021-001-0045-9)
- CIFOR (Center for International Forestry Research). 2008. Info brief No. 13. Available at <http://www.cifor.org/publications/pdf_files/infobrief/013-infobrief.pdf>
- Cinner, J. E., Daw, T. M., McClanahan, T. R., Muthiga, N., Abunge, C., et al. 2012. Transitions toward co-management: The process of marine resource management devolution in three east African countries. *Global Environmental Change* 22, 3: 651–658. (doi:10.1016/j.gloenvcha.2012.03.002)
- Colchester, M. 1994. Sustaining the forests: The community-based approach in South and South-East Asia. *Development and Change* 25, 1: 69–100. (doi:10.1111/j.1467-7660.1994.tb00510.x)
- Colfer, C. J. P. 2005. The complex forest: Communities, uncertainty, and adaptive collaborative management. Resources for the Future and Center for International Forestry Research, Washington, D.C.
- Conley, A. and Moote, M. A. 2003. Evaluating collaborative natural resource management. *Society and Natural Resources* 16, 5: 371–386. (doi:10.1080/08941920390190032)
- Consiglio, T., Schatz, G. E., McPherson, G., Lowry II, P.P., Rabenantoandro, J., Rogers, R. R. and Rabehevitra, D. 2006. Deforestation and plant diversity of Madagascar's littoral forests. *Conservation Biology* 20, 6: 1799–1803 (doi:10.1111/j.1523-1739.2006.00562.x)
- Corson, C. 2011. Territorialization, enclosure and neoliberalism: Non-state influence in struggles over Madagascar's forests. *Journal of Peasant Studies* 38, 4: 703–726. (doi:10.1080/03066150.2011.607696)
- Cripps, G. and Harris, A. 2009. Community Creation and Management of the Velondriake Marine Protected Area. Blue Ventures Conservation, London. Available at: <<http://www.blueventures.org/conservation-reports/community-creation-and-management-of-the-velondriake-marine-protected-area.html>>
- Diaw, M. C., Aseh, T. and Prabhu, R. (eds.) 2009. *In Search of Common Ground: Adaptive Collaborative Management in Cameroon*. Center for International Forestry Research. Bogor, Indonesia.
- Evers, S. 2005. Trumping the ancestors: The challenges of implementing a land registration system in Madagascar. In: *Competing Jurisdictions – Settling Land Claims in Africa*. S. Evers, M. Spierenburg and H. Wels (eds.) pp 223–242. Koninklijke Brill NV, Leiden, The Netherlands.
- Evers, S. J. T. M., Campbell, G. and Lambek, M. 2013. Land competition and human-environment relations in Madagascar. In: *Contest for Land Madagascar – Environment, Ancestors and Development*. S. J. T. M. Evers, G. Campbell and M. Lambek (eds.) pp 1–20. Koninklijke Brill NV, Leiden, The Netherlands.
- Folke, C. 2006. Resilience: The emergence of a perspective for social-ecological systems analyses. *Global Environmental Change* 16, 3: 253–267. (doi:10.1016/j.gloenvcha.2006.04.002)
- Folke, C., Carpenter, S., Elmqvist, T., Gunderson, L., Holling, C. S. and Walker, B. 2002. Resilience and sustainable development: Building adaptive capacity in a world of transformations. *AMBIO* 31, 5: 437–440. (doi:10.1579/0044-7447-31.5.437)
- Fritz-Vietta, N., Rottger, C. and Stoll-Kleemann, S. 2009. Community-based management in two biospheres in Madagascar – distinctions and similarities: What can be learned from different approaches? *Madagascar Conservation & Development* 4, 2: 86–97. (doi:10.4314/mcd.v4i2.48648)
- Ganzhorn, J. U., Lowry II, P. P., Schatz, G. E. and Sommer, S. 2001. The biodiversity of Madagascar: One of the world's hottest hotspots on its way out. *Oryx* 35, 4: 346–348. (doi:10.1046/j.1365-3008.2001.00201.x)
- Grumbine, E. 1994. What is ecosystem management? *Conservation Biology* 8, 1: 27–38. (doi:10.1046/j.1523-1739.1994.08010027.x)
- Hannah, L., Dave, R., Lowry II, P. P., Andelman, S., Andrianarisata, M., et al. 2008. Climate change adaptation for conservation in Madagascar. *Biology Letters* 4, 5: 590–594 (doi:10.1098/rsbl.2008.0270)
- Hanson, P. 2007. Governmentality, language ideology and the production of needs in Malagasy conservation and development. *Cultural Anthropology* 22, 2: 244–284. (doi:10.1525/can.2007.22.2.244)
- Hanson, P. W. 2012. Toward a more transformative participation in the conservation of Madagascar's natural resources. *Geoforum* 43, 6: 1182–1193. (doi:10.1016/j.geoforum.2012.03.005)
- Harris, A. R. 2011. Out of sight but no longer out of mind: A climate of change for marine conservation in Madagascar. *Madagascar Conservation & Development* 6, 1: 7–14. (doi:10.4314/mcd.v6i1.68058)
- Hockley, N. J. and Andriamarivololona, M. M. 2007. The economics of community forest management in Madagascar: Is there a free lunch? USAID, Antananarivo, Madagascar. Available at <http://pdf.usaid.gov/pdf_docs/pnadi290.pdf>
- Hogg, F., Funnel, S., Shrum, M., Ellis, E. R. and Tsimijaly, L.H. 2013. The useful palms of Sainte Luce: Implications for local resource availability and conservation. *Palms* 57, 3: 133–144.
- Holling, C. S. 1986. The resilience of terrestrial ecosystems: Local surprise and global change. In: *Sustainable development of the biosphere*. W. C. Clark and R. E. Munn (eds.) pp 292–317. Cambridge University Press, Cambridge.
- Holling, C.S. 2001. Understanding the complexity of economic, ecological and social systems. *Ecosystems* 4, 5: 390–405. (doi:10.1007/s10021-001-0101-5)
- Horning, N. R. 2008. Strong support for weak performance: Donor competition in Madagascar. *African Affairs* 107, 428: 405–431. (doi:10.1093/afraf/adn036)
- Horning, N. R. 2012. Debunking three myths about Madagascar's deforestation. *Madagascar Conservation & Development* 7, 3:116–119. (doi:10.4314/mcd.v7i3.3)
- Huitema, D., Mostert, E. Egas, W., Moellenkamp, S., Pahl-Wostl, C. and Yalcin, R. 2009. Adaptive water governance: Assessing the institutional prescriptions of adaptive (co-) management from a governance perspective and defining a research agenda. *Ecology and Society* 14, 1: 26. Available at <<http://www.ecologyand society.org/vol14/iss1/art26/>>
- Ingram, J. C., Whittaker, R. J., Dawson, T. P. 2005. Tree structure and diversity in human-impacted littoral forests, Madagascar. *Environmental Management* 35, 6: 779–798. (doi:10.1007/s00267-004-0079-9)
- IUCN. 2013. The IUCN Red List. Available at <<http://iucnredlist.org/>>
- Kasperson, J. X., Kasperson, R. E. and Turner, B. L. 1995. *Regions at Risk: Comparisons of Threatened Environments*. United Nations University Press, New York.
- Kraemer, A. 2012. Whose forests, whose voices? Mining and community-based nature conservation in southeast Madagascar. *Madagascar Conservation & Development* 7, 2S: 87–96. (doi:10.4314/mcd.v7i2S.5)
- Kull, C. A. 2002. Madagascar aflame: Landscape burning as peasant protest, resistance, or a resource management tool? *Political Geography* 21, 7: 927–953. (doi:10.1016/S0962-6298(02)00054-9)
- Lowry II, P. P., Randriatafika, F. and Rabenantoandro, J. 2008. Conservation status of vascular plant species from the QMM/Rio Tinto mining area at Mandena, Tolagnaro (Fort Dauphin) region, southeast Madagascar. *Madagascar Conservation & Development* 3, 1: 55–63. (doi:10.4314/mcd.v3i1.44137)
- Marcus, R. R. and Kull, C. 1999. Setting the stage: The politics of Madagascar's environmental efforts. *African Studies Quarterly* 3, 2: 1–8.
- Middleton, K. (ed.) 1999. *Ancestors, Power and History in Madagascar*. Koninklijke Brill NV, Leiden, The Netherlands.

- Myers, N., Mittermeier, R. A., Mittermeier, C. G., Da Fonseca, G. A. B. and Kent, J. 2000. Biodiversity hotspots for conservation priorities. *Nature* 403: 853–858. (doi:10.1038/35002501)
- Nadasdy, P. 2007. Adaptive co-management and the gospel of resilience. In: *Adaptive Co-management: Collaboration, Learning and Multi-level Governance*. D. Armitage, F. Berkes and N. Doubleday (eds.) pp 208–227. UBC Press, British Columbia.
- Norris, S. 2006. Madagascar defiant. *BioScience* 56, 12:960–965. (doi:10.1641/0006-3568(2006)56[960:MDJ]2.0.CO;2)
- Olegario, R., Harvey, W. and Mueller, M. 2012. QMM/Rio Tinto in Madagascar, Case A: Protecting the island's biodiversity, Oxford University Centre for Corporate Reputation, Oxford University, Oxford.
- Olsson, P., Folke, C. and Berkes, F. 2004. Adaptive co-management for building resilience in social-ecological systems. *Environmental Management* 34, 1: 75–90. (doi:10.1007/s00267-003-0101-7)
- Plummer, R. 2009. The adaptive co-management process: An initial synthesis of representative models and influential variables. *Ecology and Society* 14, 2: 24. Available at <<http://www.ecologyandsociety.org/vol14/iss2/art24/>>
- Plummer, R. and Armitage, D. R. 2009. Charting the new territory of adaptive co-management: A Delphi study. *Ecology and Society* 12, 2: 10. Available at <<http://www.ecologyandsociety.org/vol12/iss2/art10/>>
- Plummer, R. and Fitzgibbon, J. 2004. Co-management of natural resources: A proposed framework. *Environmental Management* 33, 6: 876–885. (doi:10.1007/s00267-003-3038-y)
- Pollini, J. and Lassoie, J. P. 2011. Trapping farmer communities within global environmental regimes: The case of the GELOSE legislation in Madagascar. *Society and Natural Resources* 24, 8: 814–830. (doi:10.1080/08941921003782218)
- Pretty, J. and Ward, H. 2001. Social capital and the environment. *World Development* 29, 2: 209–227. (doi:10.1016/S0305-750X(00)00098-X)
- Raik, D. 2007. Forest management in Madagascar: An historical overview. *Madagascar Conservation & Development* 2, 1: 5–10. (doi:10.4314/mcd.v2i1.44123)
- Raik, D. and Decker, D. 2007. A multi-sector framework for assessing community-based forest management: Lessons from Madagascar. *Ecology and Society* 12, 1: 14. Available at <<http://www.ecologyandsociety.org/vol12/iss1/art14/>>
- Ramasinoro, A. A. 2010. Etude d'impact environnemental relative à la création de la nouvelle aire protégée d'Ambatoatsinanana. Ministère de l'Environnement et des Forêts. Government of Madagascar.
- Ribot, J. C. 2002. African Decentralization: Local Actors, Powers and Accountability. United Nations Research Institute for Social Development, Geneva, Switzerland.
- Rio Tinto. 2008. Rio Tinto and Biodiversity, Achieving Results on the Ground. Rio Tinto, London. Available at <<http://www.riotinto.com/documents/ReportsPublications/RTBiodiversitystrategyfinal.pdf>>
- Rio Tinto. 2013. About QMM. <<http://www.riotintomadagascar.com/english/about/QMM.asp>> accessed 27 August 2013.
- Sabatini, G., Salley, S., Ramanamanjato, J.-B. 2007. A review of the spiny lobster fishery in the Tolagnaro (Fort-Dauphin) Region. In: *Biodiversity, Ecology and Conservation of Littoral Ecosystems in Southeastern Madagascar, Tolagnaro (Fort Dauphin)*. J. U. Ganzhorn, S. M. Goodman and M. Vincelette (eds.) pp 299–308. Smithsonian Institution, Washington, D.C.
- Sandy, C. 2006. Real and imagined landscapes: Land use and conservation in the Menabe. *Conservation and Society*. 4, 2: 304–324.
- Seagle, C. 2012. Inverting the impacts: Mining, conservation and sustainability claims near the Rio Tinto/QMM ilmenite mine in southeast Madagascar. *Journal of Peasant Studies* 39, 2: 447–477. (doi:10.1080/03066150.2012.671769)
- Smith, S. M., Shepherd, D. D. and Dorward, P. T. 2012. Perspectives on community representation within the Extractive Industries Transparency Initiative: Experiences from south-east Madagascar. *Resources Policy* 37, 2: 241–250. (doi:10.1016/j.resourpol.2011.01.001)
- Temple, H. J., Anstee, S., Ekstrom, J., Pilgrim, J.D., Rabenantoandro, J., Ramanamanjato, J.-B., Randriatafika, F. and Vincelette, M. 2012. Forecasting the path towards a Net Positive Impact on biodiversity for Rio Tinto QMM. IUCN, Gland, Switzerland. Available at <<https://portals.iucn.org/library/efiles/edocs/2012-049.pdf>>
- UNDP. 2013. Human Development Report 2013. The Rise of the South: Human Progress in a Diverse World. United Nations Development Program, Geneva. Available at <<http://www.pk.undp.org/content/dam/pakistan/docs/HDR/UNDP-PK-HDR-GLOBAL-2013.pdf>>
- Vincelette, M., Dean, L. and Ganzhorn, J. U. 2007. The QMM/Rio Tinto project history in Tolagnaro and its social and environmental concepts. In: *Biodiversity, Ecology, and Conservation of Littoral Ecosystems in Southeastern Madagascar, Tolagnaro (Fort Dauphin)*. J.U. Ganzhorn, S.M. Goodman and M. Vincelette (eds.) pp 1–8. Smithsonian Institution, Washington, D.C.
- von Heland, J. and Folke, C. 2014. A social contract with the ancestors – culture and ecosystem services in southern Madagascar. *Global Environmental Change* 24: 251–264. (doi.org/10.1016/j.gloenvcha.2013.11.003)
- Walker, B. H., Holling, C. S., Carpenter, S. R. and Kinzig, A. P. 2004. Resilience, adaptability and transformability in social-ecological systems. *Ecology and Society* 9, 2: 5. Available at <<http://www.ecologyandsociety.org/vol9/iss2/art5/>>
- Wollenberg, E., Edmunds, D. and Buck, L. 2000. Using scenarios to make decisions about the future. *Landscape and Urban Planning* 47, 1–2: 65–77. (doi:10.1016/S0169-2046(99)00071-7)
- World Bank. 2013. Measuring the Impact of the Political Crisis. <<http://www.worldbank.org/en/news/feature/2013/06/05/madagascar-measuring-the-impact-of-the-political-crisis>> accessed 20 August 13.