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Shining a light on Madagascar's mangroves

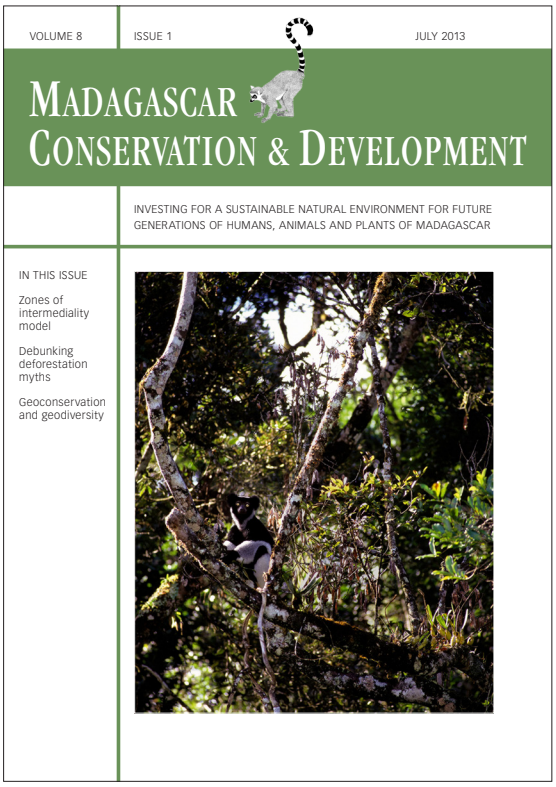
Madagascar's terrestrial forests contain as much as 5% of the world's floral and faunal diversity and exhibit >80% endemism (Giri and Muhlhausen 2008). From the verdant rainforests of the northeast to the dry spiny forests of the southwest, generations of researchers and visitors have been captivated by the country's extraordinarily diverse and unique biodiversity. It is these forested ecosystems which continue to receive the lion's share of attention in many of the documentaries, books, scientific articles and natural history media profiling the island. Far less prominent in western media are the millions of Malagasy people living within and dependent on nearly all of Madagascar's ecosystems. Research and conservation tend to focus on areas of high biodiversity to the detriment of comparatively less biodiverse ecosystems and the crucial services provided to their residents. Mangroves exemplify this – as compared with other Malagasy ecosystems, they're not as biodiverse yet support thousands of people and have received less conservation attention than many of their terrestrial peers. These salt-tolerant halophytic trees and shrubs are found exclusively in tidal and inter-tidal areas within more than 120 countries between 30° N and S latitude (Tomlinson 1986, Kuezner et al. 2011). As of 2005, Madagascar's mangroves represented 2% of the global distribution (Africa's third largest extent behind Nigeria and Mozambique), covering nearly 2,800 km^2 primarily along the west coast (FAO 2007, Giri and Muhlhausen 2008, Giri et al. 2011).

The tremendous importance of mangrove ecosystems is in their 'provisioning' (food (e.g., fisheries and aquaculture), fuel (e.g., wood) and alternative energies (e.g., wind and wave), natural products (e.g., construction materials, sand and pearls), genetic and pharmaceutical products, ports and shipping), 'regulating' (carbon sequestration, shore-line stabilization, storm and flood protection, waste filtration), 'supporting' (soil and sediment formation, nutrient cycling) and 'cultural' (tourism, recreation, education) services (cf. Lau 2012). Of these services, the carbon captured by these 'blue' (i.e., marine) forests has received considerable attention (cf. Pendleton et al. 2012). Mangroves are amongst the most carbon-dense forests in the tropics, with equal to or greater above- and greater below-ground stocks than terrestrial forests (Donato et al. 2011, Kauffman and Donato 2012, Adame et al. 2013).

Despite their importance and in agreement with global trends (cf. Polidoro 2010, Spalding et al. 2010), Madagascar's mangroves are being rapidly degraded and in some areas clear-cut for wood products (e.g., timber and charcoal) and converted for small- and industrial-scale agriculture and aquaculture. Erosion, sedimentation and siltation from intensive upstream farming, burning and terrestrial deforestation also contribute to loss. Our analysis of mangrove dynamics, assessed using USGS-produced national-level maps (as described in Giri and Muhlhausen 2008) indicates a country-wide net loss of approximately 21% (57,000 ha) from 1990–2010. While natural processes (e.g., forest succession linked with sedimentological processes and impacts from cyclones) are important factors affecting changes in mangrove cover, there is little doubt that Madagascar's mangroves are subject to significant and increasing anthropogenic impact. While rates of terrestrial deforestation continue to receive lots of attention, our comparison of mangrove dynamics with terrestrial forest-loss data (cf. Harper et al. 2007) indicates that several of Madagascar's largest mangrove ecosystems exhibited higher rates of loss than surrounding terrestrial forests. The long-term ramifications and potential for natural or assisted regeneration remain unclear, but with such widespread modification and conversion, many of the important services associated with relatively intact mangrove ecosystems may be at best compromised and at worst disappear. Of particular global significance, once disturbed, mangrove ecosystems can become significant sources of carbon dioxide emissions (Grimsditch et al. 2012). There is also an equally uncertain and potentially far-reaching ripple effect poised to influence surrounding and closely linked marine and terrestrial ecosystems.

One strategy for combating mangrove loss is through carbon financing mechanisms (e.g., REDD+ – reducing emissions from deforestation and forest degradation) and other payments for ecosystem services (PES). Carbon financing mechanisms such as REDD+ do not lack critics (e.g., Beymer-Farris and Bassett 2012, Corbera 2012), and the concept of "selling nature to save it" (McAfee 1999) generally faces many challenges, including securing land-tenure rights for traditional forest users, equitable cost and benefit sharing, leakage, additionality, the risk of non-permanence and liability. While there are a growing number of international studies demonstrating the potential for mangrove carbon projects (e.g., Donato et al. 2011, Kauffman and Donato 2012, Adame et al. 2013), there are added challenges in actually realizing incomes from 'blue carbon'. In simply measuring emission removals, all current, approved methodologies were designed for terrestrial forests. In addition, vast stretches of mangrove ecosystems fall short of current minimum height and canopy-cover requirements for forest – so they are considered non-forest – and the exact nature of succession dynamics, carbon fluxes and the impacts of climate change (e.g., sea-level rise, cyclone frequency and magnitude) are uncertain and remain areas of active research (Alongi 2011, Beymer-Farris and Basset 2012, Grimsditch et al. 2012, Ullman et al. 2012). In short, while very promising and requiring continued investigation, the long-term appropriateness, success and viability of mangrove carbon projects remain to be seen.

Recently, the multi-faceted value of mangroves has received more attention (Alongi 2011, Grimsditch et al. 2012, Lau 2012, Pendleton et al. 2012). If successfully applied to mangroves, carbon finance generated through REDD+ projects could be part of a consensual, community centred approach that explores "bundling" (single payments for packaged services) or "stacking" (separate payments for each service) (as described in Lau 2012) as many ecosystem services as possible. But as with carbon financing mechanisms, the challenges and costs associated with developing and implementing non-carbon PES are diverse, and the potential outcomes not without legitimate concern (e.g., perverse incentives/preference towards certain services at the expense of others; erosion of traditionally and



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ethically motivated conservation; involuntary participation of coastal communities; stakeholder coordination) (Corbera 2012, Lau 2012). While the business-as-usual scenario in mangroves would likely be problematic for coastal communities, monetizing ecosystem services is an extremely complex and delicate proposition. PES must look beyond carbon to acknowledge and incorporate the inherent interconnectedness and open nature of ecosystems and their services while also recognizing the holistic values provided for people.

Organizations such as NGOs can play a meaningful role in helping to raise funds for and invest and participate in the research and development of PES schemes and in creating needed inter-sectoral links. Since 2008, Blue Ventures' Blue Forests programme has been working to evaluate and establish community-based conservation in Madagascar's mangroves through scientific research and partnerships on the ground. The Blue Forests programme aims to make tangible contributions to poverty alleviation, climate-change preparedness and biodiversity protection in vulnerable coastal communities by assessing the feasibility of mangrove REDD+ and other PES opportunities for Madagascar's mangroves. By growing partnerships with other conservation organisations and private stakeholders, collaborations with Malagasy institutions and authorities, and participatory planning sessions with local communities, the project has gathered and analysed important information on long-term dynamics and relationships between local people and mangroves in several of Madagascar's mangrove ecosystems. These data have helped guide engagement with communities and other NGOs in numerous locales, including Ambondrolava, where the local management association in partnership with Honko (NGO focussed on mangrove conservation and education) has undertaken mangrove reforestation since 2008; the Baie des Assassins, where communities have had permanent mangrove reserves since 2006 and conducted community-based monitoring since 2008; and Belo sur Mer, where villages have forged partnerships with neighbouring villages and implemented temporary mangrove fishing closures since 2011. In areas which have exhibited substantial mangrove deforestation according to our national analysis (i.e., mangrove loss "hot-spots"), such as Ambanja and Ambaro bays, detailed measurements of carbon stocks have been conducted alongside community consultations to elucidate the drivers of loss and establish the feasibility of mangrove REDD+. Through a joint-effort with Aqualma (aquaculture operations, part of the UNIMA group), we have assessed mangrove carbon stocks and deforestation in Mahajamba Bay. Similarly, our programme has partnered with WWF Western Indian Ocean to study REDD+ feasibility in another mangrove loss "hot-spot", the Tsiribihina Delta. Throughout these study sites, work by multiple conservation organisations and local authorities has led to an increased awareness of the diverse values of mangrove forests to local livelihoods.

When communities acknowledge the full extent of values they are afforded from the services provided by healthy, intact mangrove ecosystems, they can come up with their own workable, practicable conservation strategies. In several locations, our team has witnessed communities initiating conservation without financial compensation. In the Tsiribihina Delta, local women replant areas of deforested mangrove using propagules harvested nearby. In several of Madagascar's largest mangrove ecosystems, such as the Tsiribihina and Mangoky Deltas and the bays of Ambanja and Ambaro, communities have formed forest policing groups and organise voluntary, rotating patrols to prevent illegal logging and charcoal production. In Ambanja, charcoal makers replant mangroves in exchange for using nearby woodlots in the surrounding hills. In Belo sur Mer, increasing numbers of villages implement short term bans on use of mangrove forests to augment the productivity of local fisheries. These inspiring community initiatives could be described as a land ethic, incited by locals and applied to the blue forests of the west coast. The introduction of finance through PES could strengthen and further disseminate this ethic through education and awareness and help ensure long-term support for the continued development and expansion of community-based management. This could spread existing initiatives across Madagascar's mangroves, potentially providing a catalyst for widespread attention towards improving and safeguarding ecosystem functioning.

Given the current status of Madagascar's mangroves, it seems essential that they take a more prominent role in the island's conservation narrative. By shining light on Madagascar's mangroves and sharing the experiences of efforts such as Blue Ventures' Blue Forests programme, we aim to bring the status of the mangroves to the attention of MCD's readers and help empower coastal communities through conservation, restoration, reduced-impact use and the exploration of alternative livelihoods.

For more information on the Blue Ventures Blue Forests project, please contact enquiries@blueventures.org

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