Taboos and social contracts: Tools for ecosystem management – lessons from the Manambolomaty Lakes RAMSAR site, western Madagascar

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ABSTRACT

Traditional taboos and social contracts played an important role in managing the Manambolomaty RAMSAR site. Taboos are defined as a prohibition imposed by social custom as a protective measure' and social contracts are – in conservation sense – a common agreement for achieving conservation, sustainable development and development of resources objectives. The Manambolomaty Lakes RAMSAR site, District of Antsalova in western Madagascar, is composed of four lakes (Soamalipo, Befotaka, Ankerika and Antsamaka) surrounded by the Tsimembo deciduous forest. The first three lakes with forest surrounding encompass 14,701 ha and are being managed by two local Associations: FIZAMI (*FIkambanana Zanatany Andranobe MIray*) and FIFAMA (*FIkambanana FAmpandrosoana Mamokatra Ankerika*). The associations have used traditional taboos and social conventions to manage their local natural resources by incorporating a GELOSE (*GEstion Locale SEcurisée*) management system to conserve biological diversity, maintain resource sustainability and socio-economic viability. This site has the highest concentration of the endemic and critically endangered Madagascar fish eagle (*Haliaeetus vociferoides)*, representing 10 % of the global population, and many other species of different faunal groups are also in good conservation status such as Decken's sifaka (*Propithecus deckeni*) and Western lesser bamboo lemurs (*Hapalemur occidentalis*) and Madagascar flying fox (*Pteropus rufus*). Culturally, the site is known as a unique source of the endemic tree *Hazomalania voyroni* (Hernandiaceae), which is used by the *Sakalava* people for constructing coffins, and being buried in a coffin made of this wood is a great honour for the *Sakalava* people. From Manambolomaty's Lakes fish yields, estimated at 60-100 tons per fishing season, FIZAMI and FIFAMA are one of the few Malagasy Associations with active bank accounts supported by management of their natural resources and associated activities. Their fisheries management system has increased the annual local revenue estimated at more than $ 1,562 US / fisherman per season. The tax of fish sales to wholesale fish buyers forms 56 % of the two local Commune's budgets. This has made the Community-Based Wetlands Conservation at the Manambolomaty Lakes site well known in the conservation circles within Madagascar and has been modelled by other organizations and associations. Consequently, the Manambolomaty Lakes site is in the process of being added into the System of Protected Areas of Madagascar (SAPM) (Figure 1).

RÉSUMÉ

Les tabous traditionnels et conventions sociales jouent un rôle important dans la gestion du site RAMSAR Manambolomaty. Le tabou peut-être défini comme une prohibition imposée par la coutume sociale à titre de mesure de protection tandis qu'en terme de conservation, le contrat social est un accord commun pour atteindre les objectifs de conservation, de développement pérenne ainsi que du développement des ressources. Le site RAMSAR Manambolomaty, situé dans la partie occidentale de Madagascar, district d'Antsalova, est composé de quatre lacs (Soamalipo, Befotaka, Ankerika et Antsamaka) dont les trois premiers ainsi qu'une partie de la forêt caducifoliée de Tsimembo – totalisant environ 14,701 ha – sont gérés par deux Associations locales : FIZAMI (*FIkambanana Zanatany Andranobe MIray*) et FIFAMA (*FIkambanana FAmpandrosoana Mamokatra Ankerika*). La gestion des ressources naturelles par ces deux Associations se base sur le respect des tabous traditionnels et conventions sociales. FIZAMI et FIFAMA ont adopté le système de gestion du type GELOSE (*GEstion LOcale SEcurisée*) pour conserver la diversité biologique et assurer les activités socio-économiquement durables. Ce site abrite la plus forte concentration d'une espèce d'oiseau gravement menacée, le Pygargue de Madagascar (*Haliaeetus vociferoides)* représentant 10 % de la population globale ; plusieurs autres espèces fauniques telles que le Propithèque de Decken (*Propithecus deckeni*), l'Hapalémur occidental (*Hapalemur occidentalis*) et la Roussette (*Pteropus rufus)* y bénéficient aussi d'un bon statut de conservation. Sur le plan culturel, ce site abrite une ressource unique de l'arbre endémique *Hazomalania voyronii* (Hernandiaceae), une espèce utilisée par la tribu *Sakalava* dans la confection de cercueils car il n'est de plus grand honneur pour les *Sakalava* que de pouvoir se faire enterrer dans un cercueil confectionné dans cet arbre. Le produit de la pêche à Manambolomaty est estimé à 60-100 tonnes par saison et à l'issue de la gestion des ressources naturelles et des activités y afférentes, FIZAMI et FIFAMA sont

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parmi les rares Associations malgaches qui ont réussi à avoir un compte bancaire. Leur gestion de la pêcherie augmente considérablement le revenu annuel local qui est estimé à plus de 1 562 US$/pêcheur par saison. La taxe collectée à partir de la ristourne de pêche constitue près de 56 % du budget communal des deux communes. Cette gestion communautaire de la zone humide de Manambolomaty est si bien connue dans le domaine de la conservation à Madagascar, qu'elle sert de modèle pour d'autres organisations et associations. En conséquence, le Complexe Lacustre Manambolomaty est proposé pour être inclus dans le Système des Aires Protégées de Madagascar connu sous le sigle SAPM.

KEYWORDS: Manambolomaty Lakes, RAMSAR, Community-Based Wetland Conservation, Taboo, GELOSE, SAPM, western Madagascar, Antsalova.

INTRODUCTION

Biological conservation and ecosystem management require strong involvement of local human communities and self-enforced codes of conduct such as social conventions, traditional taboos and religions. The broad definition of a taboo is 'a prohibition or ban imposed by social custom or as protective measure' (Webster 1993). In conservation, social contracts can be defined as an adequate system of management that is established by communities with goals of conservation, sustainable development, and development of resources (Watson et al. 2007). Taboos and social contracts play a key role in the achievement of management objectives (McDonnell and Pickett 1993, Lubchenco 1998, Colding and Folke 2001), and North (1990, 1994) defined these behavioral norms as "Informal Institutions". Most of the world's conservation hotspots are associated with regions where traditional societies occur (Myers et al. 2000, Orme et al. 2005). Informal institutions have been neglected in conservation planning in biodiversity rich developing countries (Alcorn 1995, Robbins 1998). Habitat protection through the creation of reserves has been the major approach for protecting biodiversity (McNeely 1993, Gadgil 1998). Reserve creation has often overlooked the behavioral norms (Lingard et al. 2003). Recently, it is believed that transformation of these informal institutions for the purpose of conservation and sustainable management of resources, and species and natural heritage conservation may reduce considerably the current high cost of formal institution enforcement (Colding and Folke 2001, Lingard et al. 2003). Consequently, this has lead to the concept of Community-Based Natural Resources Management which is based on strengthening social conventional rules and norms (Child 1996).

We have seven years (2001-2008) of experience in assisting and directing two local Associations, FIZAMI (*Fikambanana Zanatany Andranobe Miray*) and FIFAMA (*Fikambanana Fampandrosoana Mamokatra Ankerika*), in their government-authorized management and sustainable use of natural resources and in Community-Based Wetlands Conservation in western Madagascar. The conservation role of these two associations is based on the Traditional Ecological Knowledge (TEK) concept that represents multiple bodies of knowledge accumulated through many generations of close interactions between people and the natural world (Drew 2005), traditional taboos and social conventions (Berkes et al. 2000, Colding and Folke 2001). In this paper, we discuss how taboos and social conventions related to Manambolomaty wetland management have successfully contributed to the local fisheries activities, wetlands and forest resource management and conservation of the critically endangered Madagascar fish eagle (*Haliaeetus vociferoides*). As

FIGURE 1. The Manambolomaty Lakes site is in the process of being added into the System of Protected Areas of Madagascar.

these informal institutions are site-specific (Colding and Folke 2001, Drew 2005), the 'Lake Keeper (*Tompondrano*)' – through several generations – constitutes in the Manambolomaty Lakes site an important source of information for taboos and TEK that were used to establish the Associations' charters (*Cahier des charges*) and the RAMSAR management plan in establishing the community conventions and traditional taboos regarding wetland and forest resource use.

METHODS

The Associations' charters and RAMSAR management plan were reviewed to get data on taboos and social conventions regarding wetland and forest resource use. 'Ancestral spirits' spoke also on behalf of the *Tompondrano* and his family to remind publicly – especially during the opening fishing season ceremony – the main traditional taboos. Following the current generic method for community-based fishery management (Molares and Freire 2003), annual regulation of fishermen, fish yields and fishing period were recorded to assess the impact of fishing activities on fish populations. Fishermen numbers were obtained and displayed on their dugout canoes by permits for each fisherman prior to the opening fishing season. Daily fish catches by each fisherman – that are composed mostly of introduced *Tilapia* spp. (Watson et al 2007) – were recorded and weighted by a designated fishing camp leader during the fishing season. For the respect of tradition, the opening fishing season was set in June, a period believed by *Sakalava* people as a good month and called locally as *Volambita*. During the fishing season, net length and mesh size of each fisherman were monitored by FIZAMI and FIFAMA in collaboration with Antsalova Forestry Representatives and The Peregrine Fund for technical assistance. Also, fishing camps and forest resource use were periodically checked for fish salting, slash-and-burn agriculture or forest burning and clandestine camps. At each camp, fuel wood utilized by fishermen for drying fish were checked to see if fishermen were cutting live trees. To asses the impact of wetland and forest resource use on Madagascar fish eagles – as it is a flagship and umbrella species, its conservation helps to protect many other threatened taxa and wetland ecosystem as whole – each occupied nest was visited three times during the breeding season, during eggs laying, hatchling and dispersal periods, and to follow the population status (for more details see Rabarisoa et al. 1997, Watson et al. 2007).

MANAMBOLOMATY LAKES COMPLEX – HISTORICAL OVERVIEW The Community-based Conservation and Madagascar fish eagle (*Haliaeetus vociferoides*) project activities were carried out within the Manambolomaty Lakes (S19°01'11"; E44°26'08"; Figure 2), one of the first RAMSAR sites designated in Madagascar along with Tsimanampetsotsa Lake on 25 September 1998. This site is in central western Madagascar and includes four major lakes (Soamalipo, Befotaka, Ankerika and Antsamaka) and they are surrounded by the Tsimembo deciduous forest. The *Sakalava* tribe is the major ethnic group in this area (TPF and DWCT 2003). This study was conducted at Soamalipo and Befotaka Lakes in the Masoarivo Commune and managed by the FIZAMI Association while Ankerika Lake resides in the Trangahy Commune and it is managed by the FIFAMA Association. Together the two Associations manage an area of lakes and forest of approximately 14,701 ha and the two Communes represented the nearest local authorities that are in charge of supervision and management directive for both Associations.

In terms of biodiversity, more than 50 species of water birds have been documented (Razafimanjato et al. 2007), of which more than 20 species are endemic including at least five threatened species: Madagascar fish eagle (*Haliaeetus vociferoides*, CR), Madagascar teal (*Anas bernieri*, EN), Humblot's heron (*Ardea humbloti*, EN), Malagasy squacco heron (*Ardeola idae*, EN) and Madagascar plover (*Charadrius thoracicus*, VU). Additionally, 80 bird species have been recorded in the Tsimembo Forest of which 31 are endemic. Seven species of lemurs have been documented, of which two are threatened (Mittermeier et al. 2006): Western lesser bamboo lemur (*Hapalemur occidentalis*, VU) and Decken's sifaka (*Propithecus deckeni*, VU). This site is also the population stronghold for the endangered freshwater big-headed turtle (*Erymnochelys madagascariensis,* EN). Culturally, the Tsimembo Forest is the only known source of the endemic tree *Hazomalania voyroni* (Hernandiaceae) which is used by the *Sakalava* people for constructing coffins, and being buried in a coffin made of this wood is a great honor for the *Sakalava* people (Schatz 2000).

The two local Associations FIZAMI and FIFAMA were respectively created in November 1997 and January 2000 to protect wetlands, the biological diversity and local culture while regulating natural resource-related activities by means of enhancing traditional taboo and social conventions. This corresponds to the decentralization of natural resource management by encouraging local communities to manage their own natural resources under a 'management charter' following a governmental protocol, also known as GEstion LOcale SEcurisée (GELOSE) in accordance with Malagasy Law #96-025. A 3-year probationary management contract for both Associations was officially inaugurated on September 29th, 2001. The Associations' management charters' contain all social conventions and traditional taboos associated with the Manambolomaty Wetlands site. Traditionally, these wetlands are owned and controlled by the inherited *Tompondranos* (keepers of the lakes) who have ancestral powers of wetland management. In Soamalipo and Befotaka Lakes, the *Tompondrano* is the descendant of the *Sakalava* clan *Satria* and in Ankerika Lake this person comes from the *Tsialofo* clan. Originally, these clans used the Manambolomaty Lakes area for raising zebu cattle; their activities have had little impact on the integrity of the wetlands. During the 1990s there was a massive arrival of migrants who were unaware of wetland traditional taboos and rules which led to overexploitation of wetland and forests resources (TPF and DWCT 2003). Therefore, re-enhancement of traditional taboos via the establishment of social conventions (as written in Associations Charter) and the RAMSAR management plan were believed to be the best solution for maintaining the wetland and forest ecosystems.

RESULTS

SOCIAL CONVENTIONS, TRADITIONAL TABOOS AND WETLANDS FISHERIES MANAGEMENT From the Associations' Management Charters (*Cahier des Charges*) and RAMSAR Management Plan review, all of the outstanding traditional taboos and social conventions that correspond to wetland management objectives are listed in Table 1.

Apart from these written traditional taboos and social conventions, *Satria* and *Tsialofo* ancestors reminded on behalf

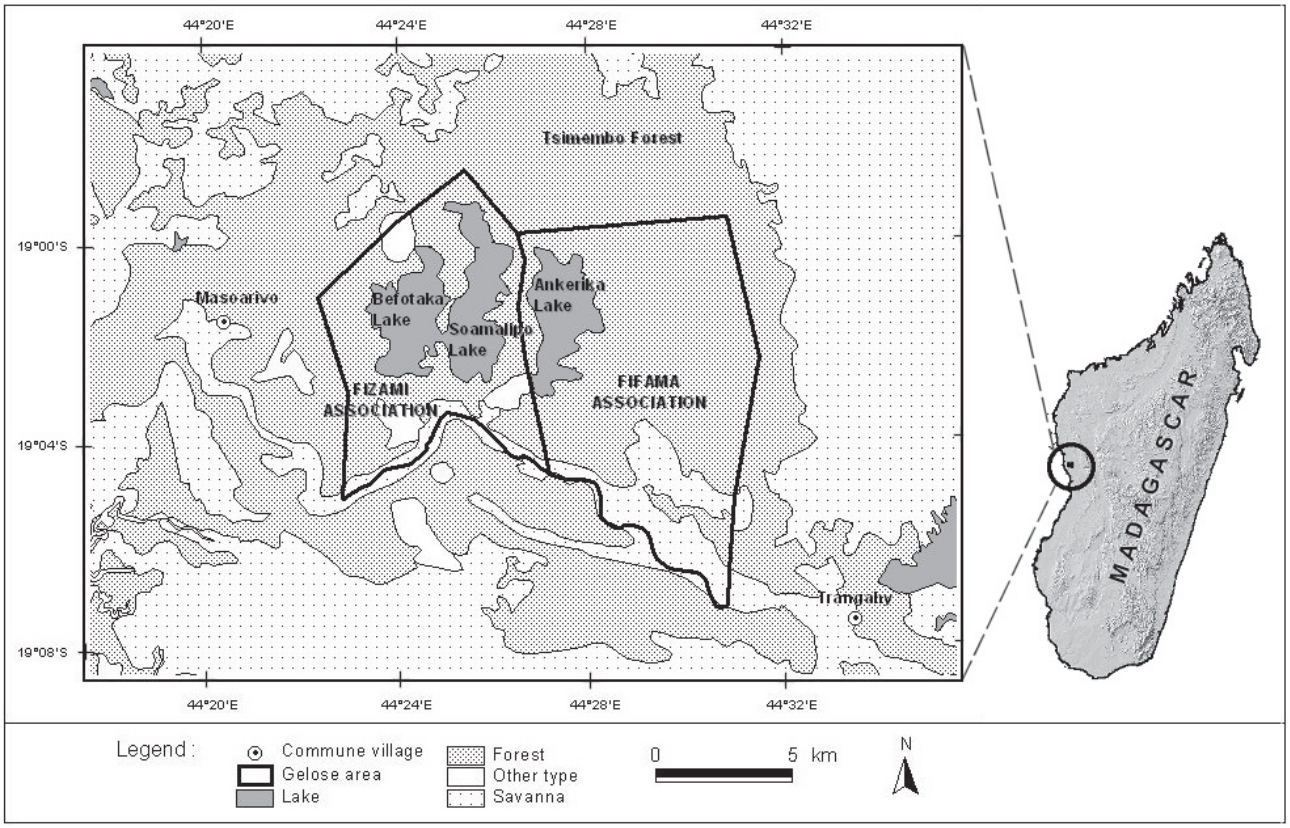

FIGURE 2. Map of Manambolomaty Lakes showing GELOSE resource management delimitation for FIZAMI and FIFAMA Associations in western Madagascar.

of the *Tompondranos* the main taboos regarding the use of lakes during the day of the opening fishing season.

The night prior to the official opening fishing season, local communities were overnighting under the one tamarind tree (*Tamarindus indica* Fabaceae) at the sacred site along the lakeshore. This tree has high spiritual value for *Sakalava* tribe. All night, they were singing traditional songs instrumented with traditional drums to excite the ancestors to attend and honor the opening fishing season ceremony the following day. This procedure continued until the ceremony was over about 13 hours later. The actual opening season begins in morning from 1000h-1100h. It is believed by the *Sakalava* people that this mid-morning time is the best period for the ancestral blessing. One sub-adult female of back-colored *Tompondrano's* zebu – with a white spot (about hand-size) in its front side and white tipped tail – was sacrified for expressing obedience towards the ancestors. The zebu's blood was drunken by ancestral spirit staying in *Tompondrano* family to express the continuity of life between today's generation and their ancestors. The meat taken from zebu's hump, heart, offal, and a black banana (rare variety of banana in the area) – that are considered as valuable food – were cooked without salt as a gift to the ancestors. *Sakalava* people believed that salt brought the bad luck into their life. These foods and drinks composed of honey (symbolizes a high respect toward the ancestors) and water were then dropped from a dugout canoe into specific corners of the lakes (three for Soamalipo / Befotaka and one for Ankerika) for the ancestors. Normally, ancestral servers included men and women wearing *lambahoany* (Malagasy cotton sheets) and women had their hair pleated in the *Sakalava* style. Once these groups of servers returned to festivity place, several groups of fishermen began fishing to mark the start time of the fishing season. Ancestral satisfaction was reflected by the number of persons within the *Tompondrano* family where the spirits of ancestors entered into them during the ceremony. Notably, these persons with ancestral spirit behaved differently than during their daily routine behaviors. The captured fish from these first groups of fishermen and the remaining zebu meat were shared among the community to receive benediction from the ancestors – and this marked the end of ceremony. All *Tompondrano* expenses for the opening fishing season ceremony were reimbursed from the sell of fishing permits at the end of fishing season.

CONSERVATION IMPLICATIONS Fishermen and fishing yields. The annual regulations of fishermen, fish yields, and the fishing season in the Manambolomaty Lakes have been recorded from 2002 to 2007 (Table 2). The number of fishermen working in the Manambolomaty Lakes has never exceeded the annual conventional quota of 400 persons. The annual fishing season opens in June for FIZAMI and most recently – in August 2005 and August 2006 – for FIFAMA when the *Tompondrano* (keeper of the lake) passed away during January 2005. From 2002 to 2004, fish yields were stable at 89-116 tons, and then they dropped to 34 tons in 2005. The long time spent for the process of *Tompondrano* replacement affected the FIFAMA Association functioning during this later year. In 2006 they increased to 67 tons and by 2007 were up to 200 tons.

FISH AND TREE HARVESTING METHODS None of the fishermen who are using the conventional net size (100 m x 1 m) and mesh width of three fingers are using salt to preserve fish. Annual average of 1-5 poachers were caught using long

TABLE 1. List of social conventions and taboos adopted by FIZAMI and FIFAMA Associations for the Manambolomaty Lakes wetland management

Wetlands Management objectives	Institutions	Description
Regulate resource use and extraction	Convention	Annually, a total of 400 fishermen from both Associations are allowed to fish (250 fishermen from FIZAMI and 150 from FIFAMA). Migrants have no right to fish, but they are allowed to buy and collect dried fish provided they have collecting licenses issued from Madagascar's National Fishery Department.
Regulate access to resources in time	Taboo	Annual fishing period is limited from June (coincides with *Volambita* in Malagasy moon calendar) to the end of November. The date of opening the fishing season depends exclusively on the *Tompondrano*'s decision.
Regulate resource withdrawal methods	Convention	Fishing nets of 100 m in length and with 3-finger sized mesh (6 cm) are to be used during the fishing season. During the closed season, local communities can fish, but they must use only fishing lines to catch fish for family consumtion.
	Taboo and Convention	The practice of salting fish is traditionally a taboo. With this practice, fishermen usually use extremely long nets with small mesh.
	Convention	Live plants can not be used as firewood.
Protect wetlands species in time and space	Convention	No wild animals can be harvested / hunted in the lakes apart from fish and Bush pigs (*Potamochoerus larvatus*) and Common tenrec (*Tenrec ecaudatus*) in the forest. Specific emphasis is given to threatened birds species such as the endangered Madagascar fish eagles, Meller's duck *Anas melleri* and Madagascar crested ibis *Lophotibis cristata*; as well as the endangered Madagascar big-headed turtle *Erymnochelys madagascariensis* (TPF and DWCT 2003). All lemur species are banned from hunting. Concerning tree species, emphasis is given to those species that have commercial value (e.g. *Dalbergia* sp.) or cultural (e.g. *Hazomalania voyroni*).
Regulate withdrawal of vulnerable life history stages of species	Convention	Common tenrecs that are pregnant or with young are prohibited to be hunted. In contrast, the introduced and destructive Bush pig can be hunted during all life stages throughout the year.
Preserve wetland integrity and beauty for future generations	Convention	It is prohibited to exploit or practicing slash-and-burn agriculture within the forest managed by the Associations.
	Convention	Fishermen camps are limited to eight specific sites authorized by the Associations to minimize their impact and disturbance on the wetland ecosystems.
	Convention	Burning forest habitat for any reasons is banned.
	Taboo	Transporting live charcoal embers on the water, relieving ones 'needs' in the water and as well as bringing women to the islands such as Nosy Sarotsy, Rehampy and Nosindambo are taboos.

nets (> 100 m) with small mesh that were confiscated by both Associations. The poachers' main objectives for this unconventional method of taking fish was to use them for the practice of fish salting to be sold to middle men in Morondava (about 200 km to the south) or in Antananarivo (about 900 km east). In collaboration with Commune of Trangahy, Soatana village elders, The Peregrine Fund technicians, Forestry Representatives from Antsalova and the FIFAMA Association has controlled Ankerika Lake. On 11 August 2005 at a clandestine camp at Betangiriky one person was caught preparing salted fish. This person's illegal net was burned by the Association's resource controllers on 13 August 2005 so he couldn't reuse it. One month later, this person paid his traditional fine of one zebu cow and 20 liters of rum to the FIFAMA Association. However, in the same year,

TABLE 2. The number of fishermen, fishing season opening and closing dates and fish yields at the Manambolomaty Lakes site from 2002 to 2007 (* Only from Soamalipo/Befotaka in the FIZAMI. Drought affecting the Antsalova region in 2004 may have impacted the fish harvest; †: Regional drought was also coincided with the death of Ankerika Tompondrano in earlier January 2005; - Data deficiency)

Year	Fishermen (numbers)	Opening fishing season (FIZAMI/FIFAMA)	Season closes for both Associations	Fish yield (tons)
2002	196	-	30 November 2002	93
2003	266	-	30 November 2003	89
2004	262	(8 June 2004 / -)	30 November 2004	116
2005	213*	(28 June 2005 / 12 August 2005)	30 November 2005	34†
2006	265	(23 June 2006/11 August 2006)	30 November 2006	67
2007	298	(2 June 2007 / 08 June 2007)	30 November 2007	200

controllers composed of the Commune Rurale of Masoarivo, The Peregrine Fund technicians, and a Forestry Representative from Antsalova helped the FIZAMI Associations to control Soamalipo and Befotaka Lakes and two consecutive visits were made to the Betangiriky illegal camp on 13 July and 14 August 2005. Twelve illegal nets greater than 100 m in length and with small mesh belonging to unknown owners, 15 baskets (60 cm x 60 cm) of salted fish and 15 bags of salt (60 cm x 40 cm) were found and confiscated during the initial visit to this camp. All nets were destroyed by burning on 15 August 2005, and all salted fish and salt were given to the Masoarivo Commune to be sold with the money collected from this sale going to the community treasury. Although it is well stated in the Association charters that Masoarivo Commune is the supporter of the FIZAMI Association regarding wetland management objectives and activities, the Mayor from this commune has remained aloof because of possible corruption charges tied to him, as he was supposedly bought by the persons who were salting fish. In fact, four persons were caught by the FIZAMI Association during their second visit. They found fish that had been salted and unfortunately, this went unpunished. To date, the traditional fine of one cow and 20 liters of rum remained unpaid. Fortunately, the ban on using live trees as firewood has been fully respected as fishermen have always used firewood from dead trees for drying their fish. Until now, the only unacceptable practice by fishermen is the length of their nets and this remains the greatest issue at the Manambolomaty Lakes site.

THREATENED SPECIES PROTECTION As part of wetland ecosystem, several threatened taxa have also benefited from Manambolomaty Lakes RAMSAR site management. Taboo enhancement is useful tools for threatened species conservation, as noted Colding and Folke (2001). In an analysis of 70 specific species-taboos, about 30 %, predominantly mammals and reptiles were found to involve species recognized as Threatened by The International Union for the Conservation of Nature (IUCN) (Colding and Folke 1997). Hunting of threatened animals has therefore declined at the Manambolomaty Lakes site since the commencement of GELOSE in 2001. As umbrella species, conservation of Madagascar fish eagles has helped protect many other threatened species and wetland ecosystem as whole. As source of local meat and for compromising the social convention restriction, introduced Bush pigs (*Potamochoerus larvatus*) have been hunted throughout the year and it can be hunted during different life stages to minimize its impact on community's crops, as stated by one of FIZAMI member (M. Mahasaky pers. com.). To prevent the detrimental harvesting of Common tenrecs (*Tenrec ecaudatus*), they are hunted for local consumption only during the non-breeding season. This protein source mitigation has allowed some threatened species to have good conservation status. Although some lemur traps were sometimes found in the forest, and a carapace of a Big-headed turtle near some settlements (J. Rabearivony pers. obs.), this wetland site is important in maintaining biodiversity (Dodman et al. 1999, Rabarisoa 2001, Razafimanjato et al. 2007). The polyandrous Madagascar fish eagles have been stabile at 9-12 breeding pairs (Table 3). Pairs were defined as the number of females that occupied a nest site. In Manambolomaty Lakes about 70-80 % of nests contain two males and one female. Manambolomaty Lakes has one of the highest concentrations of breeding fish eagles in Madagascar (Figure 3), representing about 10 % of the remaining population in the world (Watson and Rabarisoa 2000). Many other threatened waterbirds are also protected at this site (Razafimanjato et al. 2007). The organization of fishermen within five specific camps in Soamalipo / Befotaka – two permanents and three temporary – and three in Ankerika with only one permanent have minimized human disturbances and helped to protect the threatened species. Looking at an important plant species of the Tsimembo Forest, the endemic Hazomalany tree (*Hazomalania voyroni* Hernandiaceae) is important to the culture of *Sakalava* people for making traditional coffins (TPF and DWCT 2003).

TABLE 3. Number of Madagascar fish eagles at the Manambolomaty Lakes site from 2002-2007

Madagascar Fish Eagles	Year					
	2002	2003	2004	2005	2006	2007
Male (n)	18	18	19	18	20	20
Female (n)	9	9	11	11	12	11
Total	27	27	30	29	32	31

WETLAND INTEGRITY AND UNIQUENESS No traces of slash-and-burn agriculture have been documented within the main Tsimembo Forest managed by the FIZAMI and FIFAMA Associations. Such agricultural practice was devoted to *Ziziphus mauritania* (Rhamnaceae – introduced tree species) forest (TPF and DWCT 2003). Control of illegal camps was one of the tasks of the Associations and forestry representatives from Antsalova, the nearest district town. An illegal camp in Bekofoky (Ankerika), for instance, was removed in August 2005. The 8th legal camp at Akoririky was also removed in 2004 because fishermen were deforesting a 65 m x 20 m area for extending the camp without the Association's permission. This deforestation altered wetland

FIGURE 3. The endemic and critically endangered Madagascar fish eagle (*Haliaeetus vociferoides*). The Manambolomaty Lakes site has one of the highest concentrations of breeding fish eagles in Madagascar.

ecosystem integrity and beauty. No forest fires have been recorded since the start of the GELOSE process in 2001. Taboos regarding carrying live charcoal embers on the water as well as bringing women to the islands of Sarotsy, Rehampy and Nosindambo of the Manambolomaty Lakes have been well respected by the fishermen. These acts are considered 'religious taboos' and linked to the sacredness of the areas (Colding and Folke 2001). These taboos have helped in contributing to the maintenance and protection of the biological diversity and habitat for threatened species (Gadgil 1987). These islands are isolated, not occupied by humans and are part of several Madagascar fish eagle home ranges. Apart from one permanent nest of Madagascar fish eagles at the island of Nosindambo, it also contains the largest population, more than 1,000 individuals of the Madagascar flying fox, a vulnerable Madagascar endemic bat species (Jenkins et al. 2007). Therefore, the maintainance of wetland integrity and beauty is supported by species-specific and habitat taboos that are considered as 'non-use taboos' of resources for strengthening the 'preservationist ethic' (Muir 1916, Harris 1979, Colding and Folke 2001).

BEYOND BIOLOGICAL CONSERVATION MILESTONES For the sustainability of common property management, biodiversity conservation should be coupled with rural economic development (Child 1996). We selected here the main economical and biological conservation milestones of FIZAMI and FIFAMA associations regarding Manambolomaty wetlands management.

In 2002, both Associations opened bank accounts in Morondava (the nearest financial town) by depositing money they had collected from issuing fishing permits in their resource management zones. These bank accounts for both Associations continue to grow from the resource use permits. In 2004, the Associations bought with their funds rice stock to sell to local community members at a reduced rate during the annual rice shortage period (November to April), thus providing a tangible benefit to the communities for managing their fisheries and forest resources.

In 2003, 1,214 tree seedlings of *Commiphora* spp. Burseraceae – plant species that can be used for plank making – were raised in a local nursery built by the associations with 1,184 transplanted to several openings and degraded areas around the three lakes. A management area boundary was demarcated and marked with cement blocks at trail and road crossings and a management perimeter line was cut 1.5-2 m wide by 54 km long.

In 2004, offices were built for each Association in the village of Ankirangato for FIZAMI and village of Bejea for FIFAMA, with funding from RAMSAR and logistical assistance from The Peregrine Fund. Also in 2004, the two Associations received 'Gift to the Earth' awards from the World Wildlife Fund for Nature for their pioneering role in applying and succeeding in Madagascar's localized resource management (GELOSE) control, sustainable resource use and biodiversity conservation.

From 2005-2015, the two Associations became the first recipients in Madagascar of a 10-year management period from the Malagasy government. They are being supported by the National Forestry and Fisheries Departments, local authorities, police and judicial personnel, and along with continued support and assistance from The Peregrine Fund.

From 2006-2010, the Associations have issued fishing permits covering a 4-year period (September 2006 to September 2010) which has been developed and supported by the regional representative of the Madagascar Fisheries Department. In 2006, the two Associations, FIZAMI and FIFAMA, and the two Communes, Masoarivo and Trangahy, received from the RAMSAR organization communication materials such as solar panels and several accessories for the single-sideband modulation (SSB) radio to improve their existing erratic functioning communication equipment.

In 2007, United State Agency Aid and Development (USAID) in Madagascar expressed their satisfaction towards the Associations' wetlands management by constructing four wells, two in Trangahy and Masoarivo Communes respectively, for providing clean potable water in the area. On behalf of a consortium of three Associations, FIZAMI, FIFAMA and SAMAKA (*Sakaizan'ireo Aina Misy ao Antsamaka Kajiana ho Anto-pivelomana*), the Madagascar National RAMSAR organization awarded to the 'Local RAMSAR Committee', known locally as *Komity Mpitantana Sity RAMSAR* (KMSR) and the three Associations, FIZAMI, FIFAMA and SAMAKA, an office constructed in the Masoarivo Commune during 2007 as their contribution for supporting their conservation efforts in the Manambolomaty Lakes region.

DISCUSSION

The success of Manambolomaty Lakes wetland management undertaken by FIZAMI and FIFAMA could be considered as the results of strong involvement of all stakeholders and collaboration between the Associations, local authorities and technical supports from regional forestry and fishery representatives and The Peregrine Fund. This collaboration has made the Manambolomaty Lakes fishery management ecologically durable and economically viable.

SUSTAINABLE MANAGEMENT OF LOCAL FISHERY The world's fisheries have shown drastic declining catches per effort in association with over-fishing by humans (da Silva 2002, von Sarnowski 2004). In many of Madagascar's lakes, over-fishing is associated with unsustainable harvesting methods and little respect for traditional rules and taboos (Razafiarisoa 1995). In Alaotra Lake (central eastern Madagascar), for instance, nets with small meshes (in Malagasy *ramangaoka*) have previously been used (Razafiarisoa 1995). The lack of respect for local taboos by 'new migrants' from other regions (e.g. Itasy, Alaotra and Mantasoa) relative to traditional fishery management in Kinkony Lake, northwestern Madagascar, is one example of a local fisheries declining trend (Razafiarisoa 1995).

In 1990s, detrimental harvesting methods and the disobeying of taboos were also frequently encountered in Manambolomaty, especially prior to GELOSE era (TPF and DWCT 2003). Fortunately, Manambolomaty Lakes Community-Based Wetland Conservation began in 2001 and fish resources were rapidly re-established through the regulation of resource withdrawal and withdrawal methods as well as access to resources in time (Tables 1-3) (*Tompondrano* pers. com.). As the annual weight or number of fish caught is one of the standard indicators of biological yields status (Hilborn and Walters 1992), stability of Manambolomaty Lakes fish yields (at 60-100 tons per year) in 2002, 2003 and 2006 showed the ability of two existing Associations, FIZAMI and FIFAMA, to mange their natural resources. In very rainy years, respectively in 2004 and 2007, yields reached up

116 tons to 200 tons. Many fishes from higher altitude rivers and lakes (e.g. Ankakobo) might have been carried downstream into the Manambolomaty Lakes. The lowest fish yields were in 2005, which sadly coincided with the death of the Ankerika *Tompondrano* 'keeper of the lake' and obviously impacted and disrupted wetland management until a replacement was found in 2006.

Madagascar's first settlers – through hunting system – were probably responsible for recent extinctions of several lemur species, at least 17 taxa according to Godfrey and Jungers (2003). Recently, poaching of protected and endemic fauna living within protected areas had become more prevalent (Goodman 2000, Garcia and Goodman 2003, Patel et al. 2005). Forest degradation in the form of slash-and-burn agriculture and conversion of natural habitat into cattle pastures are the two major threats to Malagasy biodiversity (Goodman 2006), while local extirpations of threatened fauna – including turtles, birds, primates, fruit bats and carnivores – are associated with hunting (Garcia and Goodman 2003, MacKinnon et al. 2003).

Accordingly, the local Associations FIZAMI and FIFAMA have established unique indicators in order to measure their management efficiency. These indicators include (i) forest surrounding the wetland sites remains intact and no trace of human-caused forest fire occurs; (ii) site contains seven lemur species and at least 40 waterbirds species; (iii) the number of Madagascar fish eagles remains stable at 10 pairs; (iv) annual fish yields is more than 45 tons; and (v) the population of the Big-headed turtle (*Erymnochelys madagascariensis)* represents all age class (adult, juvenile and hatchling). The first four indicators have been achieved successfully by these Associations (e.g. Watson and Rabarisoa 2000, Razafimanjato et al. 2007). Regarding Big-headed turtle restoration, it has been suggested to achieve the zoning of some parts of the lake and lake shore as breeding site for this species (R. Lewis pers. com.). This turtle breeding area would be prohibited from fishing activities, thereby allowing the population to increase. Locally, eggs and adults of this species are taken as sources of protein. Hence, whilst this zoning requires full consensus from local communities and is technically dependent on local and / or regional Fishery Representatives; all other protected fauna are in good conservation status and wetland ecosystem as a whole are generally healthy. As such, the Manambolomaty Lakes is one of the best proposed sites in Madagascar to be added into the existing protected area network (Randrianandianina et al. 2003). This zoning will be one of the main activities undertaken in 2008 after permanent protected status of the Manambolomaty Lakes. This requires full participation of The Durrell Wildlife Conservation Trust (DWCT), the organization with specialists in turtle conservation working in the Antsalova area. As far Manambolomaty Lakes, it would be an important Malagasy site for International Heritage candidate because of its wetland ecosystem integrity, its endemic and threatened taxa and recreational aspects, concluded M. Nicoll (pers. com.).

ECONOMIC VIABILITY It is premature to say if Manambolomaty Lakes fisheries has had a positive impact on the local economy, but Watson and Rabarisoa (2000) estimated annual fish harvest was worth about $479,495 US which represents about $1,562 US / fishermen per season. Given the local current price of dried fish (about $2 US / kg), the annual revenue of the local communities is increasing. Currently, it is estimated that about 56 % of the two local Commune's budgets, Trangahy and Masoarivo, are being collected from the tax of fish sales to wholesale fish buyers.

Direct benefits to local economies and other forms of development stated in Madagascar's Action Plan (MAP), a 5-year plan (2007-2012) for developing Madagascar, have also been initiated at the Manambolomaty Lakes site. Like other western regions in Madagascar, diseases from unsafe water (e.g. bilharzias, diarrhea) occur in many areas surrounding the Manambolomaty Lakes. Since social life improvement is one target area under the System of Protected Areas of Madagascar (SAPM) and MAP, wells have contributed largely to decreasing diseases from unhealthy drinking water. Strengthening the educational system at primary schools is a way to reduce poverty and is one of Madagascar's commitments. We continue supporting all primary schools in the Manambolomaty Lakes area (e.g. Amberegny, Masoarivo, Ambalamanga, Soatana and Trangahy) by providing school materials (e.g. notebooks, pencils, pens, chalk and chalkboards) to local students. We also provide support in the Melaky regional sporting events, like the *Jeux de Melaky*, to complement school education in the area. Currently, of 1,184 trees transplanted, 80 % continue to grow (TPF and DWCT 2003). This contributed largely to the Madagascar's 'green revolution' by putting value back into non-forested land. Transplanting trees will slow down the impact on trees by communities in the Tsimembo Forest. Infrastructure setting is part of national government in Madagascar. Three associations' offices were built around Manambolomaty RAMSAR site for this purpose for FIZAMI, FIFAMA and the Local RAMSAR Committee (KMSR). These facilities have helped the local Associations to administer their wetland management. Communication materials such as solar panels and several accessories for the single-sideband modulation radio were given to the Trangahy and Masoarivo Communes. Beyond fishery management sustainability, these direct and indirect benefits are demonstrating the economic viability of wetland management undertaken by FIZAMI and FIFAMA in the Manambolomaty Lakes area.

CONCLUSION

The positive performance of the FIZAMI and FIFAMA Associations in Community-Based Wetlands Conservation at the Manambolomaty Lakes site has become well known in the conservation circles within Madagascar; and the model established by The Peregrine Fund has been copied and applied to many by other organizations in similar situations throughout the country. In 2005, for instance, a team from Missouri Botanical Garden (MBG) working in Mahabo, southeast Madagascar, visited the Manambolomaty Lakes site to learn and to do an experience of exchange on how FIZAMI and FIFAMA Associations used their taboos and social conventions to manage the Manambolomaty Lakes wetlands and forest. This exchange of information and experience was requested by their founder, Liz Claiborne and Art Ortenberg Foundation, for the sustainable use of plants species utilized by a Women's Association developing a basket making art for the international market. The only issue faced by FIZAMI and FIFAMA Associations in this management system was the interference caused by a few local politicians who were supporting a minority local group, and especially the migrants of the area that were not abiding to the local traditional rules, taboos and conservation policies. As the current Madagascar's national program is to increase in number and surface of

Protected Area (PA), we would suggest at each new specific site the strong consideration of taboos and social conventions for achieving the management purposes. Although this approach may sometime fail to protect certain endangered Malagasy species – example, *Hapalemur alaotrensis* (Durbin et al. 2003, 2008) – our findings corroborated the previous researches in Madagascar (e.g. Lingard et al. 2003, Watson et al. 2007), and worldwide (Colding and Folke 2001) that are supporting the taboos and social conventions enhancement are the efficient tools for conserving endangered species and ecosystem as a whole, as it is economically viable and ecologically durable.

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