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REPORT

A Socio-Ecological Assessment Aiming at Improved Forest Resource Management and Sustainable Ecotourism Development in the Mangroves of Tanbi Wetland National Park, The Gambia, West Africa

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Abstract Although mangroves dominated by *Avicennia germinans* and *Rhizophora mangle* are extending over 6000 ha in the Tanbi Wetland National Park (TWNP) (The Gambia), their importance for local populations (both peri-urban and urban) is not well documented. For the first time, this study evaluates the different mangrove resources in and around Banjul (i.e., timber, non-timber, edible, and ethnomedicinal products) and their utilization patterns, including the possibility of ecotourism development. The questionnaire-based results have indicated that more than 80% of peri-urban population rely on mangroves for timber and non-timber products and consider them as very important for their livelihoods. However, at the same time, urban households demonstrate limited knowledge on mangrove species and their ecological/economic benefits. Among others, fishing (including the oyster—*Crassostrea* cf. *gasar* collection) and tourism are the major income-generating activities found in the TWNP. The age-old practices of agriculture in some parts of the TWNP are due to scarcity of land available for agriculture, increased family size, and alternative sources of income. The recent focus on ecotourism (i.e., boardwalk construction inside the mangroves near Banjul city) received a positive response from the local stakeholders (i.e., users, government, and non-government organizations), with their appropriate roles in sharing the revenue, rights, and responsibilities of this project. Though the guidelines for conservation and management of the TWNP seem to be compatible, the harmony between local people and sustainable resource utilization should be ascertained.

Keywords Mangroves · Socio-ecology · Tanbi Wetland National Park · Resource utilization · Participatory methods · The Gambia

INTRODUCTION

Mangroves along tropical and sub-tropical coastlines have well-established ecological and economic potential. Their vulnerability with respect to natural and anthropogenic impacts is frequently emphasized (Duke et al. 2007; Alongi 2008; Bosire et al. 2008). Although these forests have been studied systematically in many parts of the world for flora and fauna composition/distribution, vegetation dynamics, forest loss and evolution, predictable future trends, etc. (Berger et al. 2008; Massó i Alemán et al. 2010; Satyanarayana et al. 2011), the topics evaluating their significance in the local livelihoods are limited (e.g., Walters et al. 2008), and none are available for West Africa (although much information exists in French "grey literature"—reports, thesis research, etc.).

In reality, anthropogenic activities are often a prime cause for mangrove depletion (Duke et al. 2007) and the loss of biological diversity and economic values (Kairo et al. 2002). In this context, several researchers have suggested not to ignore the function of these ecosystems with regards to local livelihoods (Walters et al. 2008). Moreover, perhaps the new and strict forest conservation measures in harmony with the needs of the local populations and sustainable dependency could mitigate the above impacts to a greater extent. When mangrove degradation occurs, exploitation activities are shifted to other part(s) of the ecosystem and result in overexploitation of the remaining resources (Hernández-Cornejo et al. 2005). Therefore, the information on different trade-offs and their

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priority should be recognized first to manage the remaining mangroves better (FAO 1994).

In The Gambia, the mangroves occupy 581 km^2 equaling 2.1% of the total (mangrove) cover in Africa (Spalding et al. 2010). Since the 1970s, they are under considerable pressure due to natural and anthropogenic processes: coastal erosion, fuelwood collection, overfishing, conversion to agricultural fields, urban development and land used for tourism and recreation (Simier et al. 2006). As the countries in the Sahel region often experience drought and famine, The Gambia is the destination for several immigrant groups (Harpham 1996), which is also partly responsible for its increased population between 1983 and 2003 (CSD 2004). On the other hand, a greater part of Banjul city (The Gambia's capital) is less than 1 m above the mean sea level and thus very vulnerable to the effects of sea level rise and ocean surges (Jallow et al. 1996; UNEP 2002). In this context, Jallow et al. (1996) identified some response strategies and adaptation options for this area including wetland preservation and mitigation. At this point, we recall that mangroves are suggested to play a role in the protection of tropical coasts (Dahdouh-Guebas and Koedam 2006; Mukherjee et al. 2010).

Apart from research on fishery-related aspects (e.g., Albaret et al. 2004; Laë et al. 2004; Ecoutin et al. 2005; Simier et al. 2006), studies on The Gambian mangroves remain scarce in the scientific literature. In addition, no efforts were made in evaluating the mangrove resources and their utilization patterns in the vicinity. In 2003, the City Council of the coastal city of Oostende (Belgium) and the Banjul City Council (The Gambia) started a joint collaboration under "Oostende–Banjul city link" for strengthening education and research activities between these two maritime cities. One of their main objectives was to emphasize mangrove ecosystem and management at Tanbi Wetland National Park (TWNP), formerly referred to as Tanbi Wetland Complex (TWC). Within this framework, studies on remote sensing, ethnoecology, ecotourism, and engineering were carried out (Hirani 2005; Maniatis 2005; Debry 2009; Foré 2009; Vandaele and Vande Wynckel 2011). Since tourism is an important sector of the Gambian economy (Jallow et al. 1996; Sharpley et al. 1996), the Banjul City Council wanted to develop ecotourism in the TWNP to familiarize the local people as well as tourists with this ecosystem. In fact, ecotourism—defined here as ecologically sustainable tourism—is one of the best strategies for understanding the value of natural resources (Datta et al. 2010).

The study presented here was carried out in two phases and was first aimed at assessing the importance of the TWNP in the urban and peri-urban livelihoods (i.e., for timber, non-timber, edible, and ethnomedicinal products); and second, to investigate the proposal of ecotourism (i.e., site selection for boardwalk construction) and its path of success through involving the local stakeholders.

MATERIALS AND METHODS

Study Area

The Gambia with its 80 km stretch of coastline is bordered by Senegal on three sides (north, south, and east) except on the west bordering the Atlantic Ocean on the west coast of Africa (Fig. 1), and characterized by the sudano-sahelian climate of long dry (from mid-October to early June) and short rainy (from mid-June to early October) seasons (Albaret et al. 2004). With no significant mineral or natural resource deposits, many people (about 75%) depend on the limited agricultural base (crops and livestock) for their subsistence. The country is facing problems of increased urbanization, solid wastes, escalating tourism, intensified agricultural practices, coastal erosion, etc. (GEF 2002).

The river Gambia is the only major waterway flowing westwards across The Gambia before reaching the Atlantic Ocean. The mangroves dominated by *Avicennia germinans* L. and *Rhizophora mangle* L. are extending over 200 km along this river (Spalding et al. 2010). A Ramsar status (no. 1657) was conferred to the Tanbi Wetland ($\sim$6000 ha) in 2007 and in 2008, it was gazetted as a National Park (DPWM 2008). The other mangrove species such as *Laguncularia racemosa* (L.) Gaertn. F. and *R. harrisonii* Leechman are also found in the vicinity. However, the impact of drought caused several hydrological changes and ultimately mangrove species' distribution in some pockets (Diop et al. 2002). Two management plans exist for the TWNP, particularly aimed at establishing the accessibility zones, conservation areas, improved communication between local people and institutions, and to incorporate the community component in mangrove management (cf. Sukardjo 1995; DPWM 2000).

Local People's Demography, Dependence on Mangroves, and Views on Ecotourism in the TWNP

We used a combination of "participatory rural appraisal" and "rapid rural appraisal"—"participatory reflection and action" (*sensu* Chambers 2002)—to assure the inclusion of local knowledge into the collection of scientific data and into the stakeholder analysis.

A first questionnaire (Online Appendix 1A: data set 1) survey carried out in February–March 2005, provided information on (i) local people's socio-demographic, cultural and economic characteristics (e.g., name, age, gender, nationality or place of origin, religion, language,

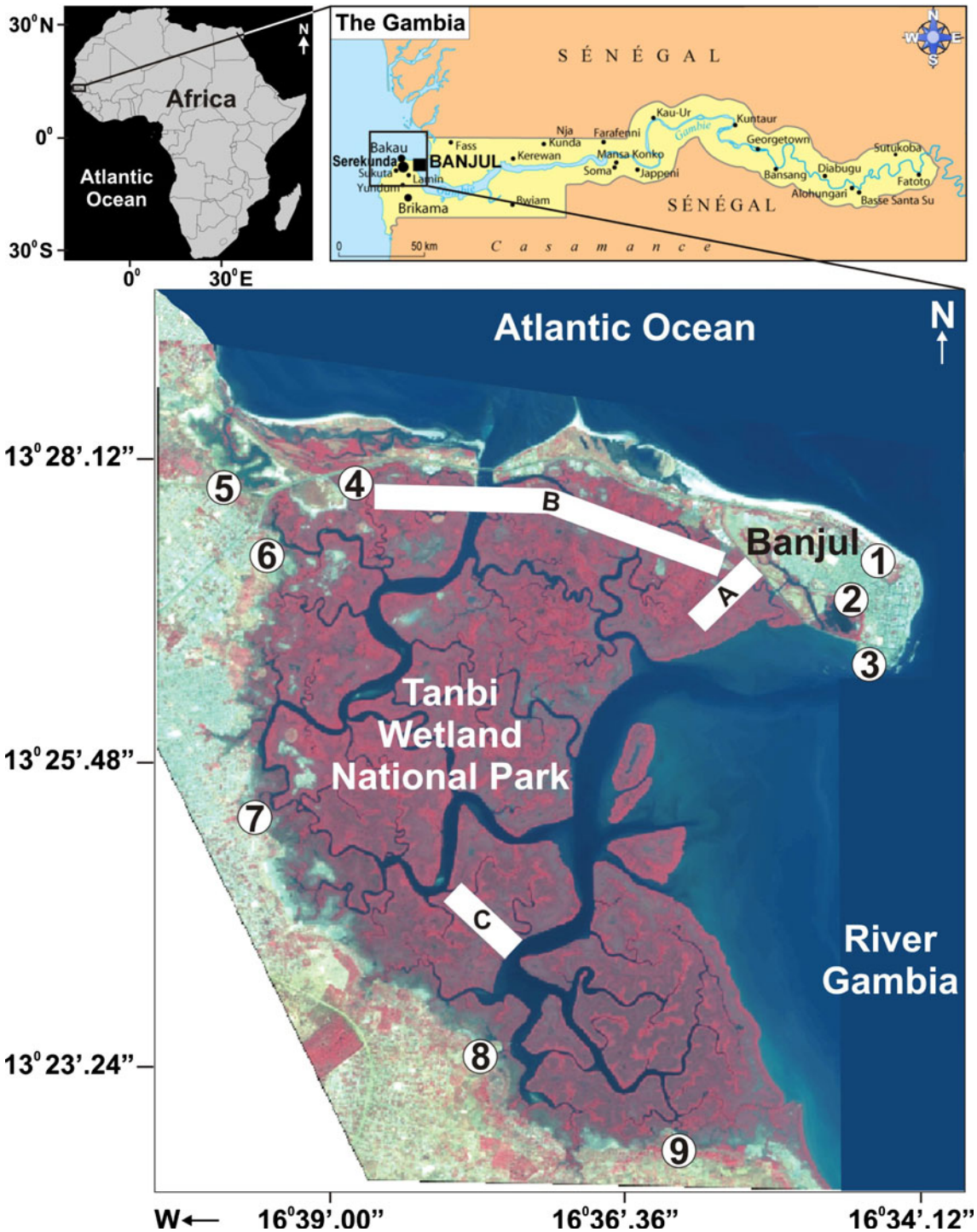

Fig. 1 The mangroves in TWNP of The Gambia, West Africa (2005 QuickBird satellite image). *Numbers* in each *white circle* represents the mangrove-adjacent peri-urban and urban areas or people in the vicinity being consulted for questionnaire (i.e., Online Appendix 1A) survey (*1*, *2* Banjul, *3* Wafi Njago, *4* women engaged in oyster collection, *5* agricultural area, *6* Old Jeshwang, *7* Faji Kunda, *8* Lamin, and *9* Mandinari). The *white bands* (with *A*, *B* and *C letters*) are the areas proposed for boardwalk construction inside the mangroves by local stakeholders

occupation, marital status, education, and income); (ii) knowledge on mangroves (e.g., species names and their ecological and economic benefits) as well as (iii) dependence on various resources (i.e., timber, non-timber, edible, and ethnomedicinal forest products). In addition, local people's perceptions on the ecosystem, changes in connection with agricultural practices, waste dumping, etc., were gathered simultaneously. Altogether, 70 households

representing 0.4% of the population (total population of The Gambia in 2005 was 1 593 256 with (average) 8.5 members in each house) were interviewed from urban and peri-urban areas (15 in Banjul constituting an urban population and 55 outside of Banjul, i.e., peri-urban population) (Fig. 1). In Banjul, two locations—one bordering the mangroves (every alternate household) and another in the main street (every eighth building), were chosen; whereas in the neighboring wards/villages (i.e., Wafi Njago, Old Jeshwang, Faji Kunda, Lamin, and Mandinari), every alternate household along a street close to mangroves was visited (stratified random sampling as suggested by Watts (1996). However, the low sample size is understandable with practical difficulties (e.g., language, local transport, etc.) and time limit (i.e., two-month expedition administering questionnaires and ground-truth). Apart from the interviews, attention was also paid to local fishing and related activities (e.g., preparation of lime from oyster shells), and a list of fishes available at the TWNP was obtained from the local Fisheries Department. The mangrove taxonomic identification was carried out using Tomlinson (1986).

A second questionnaire (Online Appendix 1B: data set 2) survey exclusively meant for the purpose of investigating ecotourism was carried out during the next phase of our investigation, i.e., July–September, 2008. Data were generated from 33 questionnaires interviewing tourists coming from China, United Kingdom, the Netherlands, Portugal, and Spain.

In addition, local stakeholders, i.e., users, government and non-government organizations, were consulted to know their interest in ecotourism development (i.e., boardwalk construction inside the mangroves), and then group discussions were organized with them to manage this ecotourism development efficiently. For the stakeholder analysis, we used the "Four Rs Method", which aims at understanding the roles of stakeholders in terms of revenue, rights, responsibilities, and relationships, played by the different stakeholders that participated in this investigation (Mayers 2005). The process unveils underlying power structures and (dis)incentives for sustainable natural resource use or management.

To execute the Four Rs Method, the local stakeholders were divided into four groups with respect to their appropriate roles in the TWNP namely: (i) "Users" represented by fishermen, farmers, researchers, representatives of the community development and tourists; (ii) "Government Organizations" represented by the Departments of Parks and Wildlife Management, Land Survey and Mapping, Forestry, and Education, the National Environmental Agency (NEA), the Navy and the local City and Municipal Councils; (iii) "Non-Governmental Organizations" represented by the West African Bird Study Association, the Sahel Wetland Concern, the African Mangrove Network, Green Actors of West Africa, the Sea Life Center and others meant for protecting crocodiles, dugongs and dolphins; and finally (iv) the TWNP itself.

We organized meetings with stakeholders that were professionally closely linked to the TWNP. The participants that were present were asked to indicate which of the above four stakeholder groups they thought were most important within the first three R-categories (Rights, Responsibilities, and Revenues). To make this visually easier for the participants, we used the pebble scoring technique. For each R-category, the participants were asked to distribute 16 pebbles over the four stakeholder groups. The more pebbles a stakeholder group received, the more important it was perceived within each of the R-categories. Each participant was asked to motivate the distribution of pebbles. Finally, the different opinions were discussed by the entire participants group and an average was reached.

Finally, other techniques like personal observation (to verify tourism activities in the field), and participatory mapping (i.e., use of TWNP area map by local stakeholders for choosing an appropriate place for boardwalk construction) were also used.

Data Analysis

The first data set obtained from the peri-urban and urban populations was analyzed for their differences in mangrove resource utilization via the χ^2 test of independence (SPSS v.11.5), while the second data set regarding ecotourism (through group discussions) was processed through the "Four Rs method" clarifying the roles—in terms of Revenue, Rights, Responsibilities. Based on the results from the pebble scoring technique, on the participants' justifications for the pebble distributions, on observations and on best professional judgement, the "relationships" were established a posteriori.

RESULTS

Demographic Information

The age of interviewed people varied between 17 and 81 years and men prevailed in the interviewed population (Table 1A). The nationality of these respondents was largely Gambian, but immigrants (not born in The Gambia but living there for more than 4 years) were also represented. Languages used by the locals of The Gambian origin include Wolof, Mandinka, Fula, and Jola, whereas others could communicate in Serer (from Senegal), Creole (from Guinea Bissau), Bambara (from Mali), Aku, and

Table 1 Demographic information of the local households (A) (n = 70), and tourists (B) (n = 33) in The Gambia

	(A) No. of respondents	%	(B) No. of respondents	%
1. Nationality				
Gambians	54	77	–	–
Immigrants	16	23	–	–
Tourists	–	–	33	100
2. Gender				
Male	38	54	21	64
Female	32	46	12	36
3. Age group				
17–20 years	2	3	–	–
21–30 years	13	19	7	21
31–40 years	17	24	11	34
41–50 years	14	20	5	15
51–60 years	11	16	5	15
61–70 years	–	–	3	9
71–80 years	3	4	1	3
>81 years	1	1	–	–
Not sure	9	13	1	3
4. Ethnicity by religion				
Muslim	56	80	–	–
Christian	10	14	–	–
Others	4	6	–	–
5. Marital status				
Single	18	26	8	24
Married	45	64	13	40
Live-in relationship	–	–	11	33
Widowers	7	10	1	3
6. Literacy				
Primary/secondary school	26	37	1	3
College level	4	6	21	64
University level	2	3	10	30
Arabic school	8	11	–	–
No schooling	30	43	1	3

Temne (from Sierra Leone), in addition to Arabic, French, Swedish, German, and English. Overall, the literacy rate in the urban population was higher (67%) than in the peri-urban population (56%). The average income of the individual respondents ranged from 35 to 1000 Gambian Dalasis per day (currency conversion rate in February 2005: 39 GMD are equal to 1 EUR, approximately).

Local People's Knowledge on Mangroves

Despite the fact that many respondents see mangroves as vegetation for timber and non-timber products, the peri-urban people (98%) also mentioned their role as fish breeding and nursery grounds, habitat for migratory birds, and their usefulness in soil erosion control and sediment accumulation processes. More than 80% of the peri-urban households consider mangroves as very important for their subsistence ($\chi^2 = 7.852$, $P < 0.05$), in contrast to the urban people (87%) who recognize mangroves largely for commercial purposes through obtaining timber, non-timber and fishery products. Among the four (true) mangrove species listed in study area description, only *A. germinans* and *R. mangle* are distributed widely in the forest and the local populations have different vernacular names for each species in their spoken idioms (Table 2). In this context, the urban households had a limited knowledge on the mangrove species present and their ecological and economic benefits. However, 40% of the urban population was familiar with the names of "TWNP" or "TWC", as if they were aware of the existing wetland and mangrove forest.

We should clarify at this point that it does not mean that everybody regularly visits the wetland. In fact, anecdotic observations taught us that many inhabitants of Banjul city perceive the mangrove as wasteland and disease-infested forests (see also below).

Mangrove Resource Utilization

The results indicated that peri-urban households rely on mangroves to a greater extent ($P < 0.05$) than the urban ones (Fig. 2). Among the 70 households interviewed, 65% of the peri-urban population (only 7% in the urban population) collected fin and shellfish (e.g., species belonging to *Batrachoides*, *Elops*, *Ethmalosa*, *Crassostrea*, *Lutjanus*, *Megalops*, *Mugil*, *Penaeus*, *Pseudotolithus*, *Sphyraena*, *Synodontis*, *Thalassoma*, *Tilapia*, etc.) from the TWNP. Although they said no adverse effects of fishing on the mangrove vegetation occurs (89% in peri-urban and 73% in urban populations), some claim that oyster (*Crassostrea* cf. *gasar*) (species' name according to Lapègue et al. 2002) harvesting practices through mangrove root cutting could damage the mangrove trees considerably. The collection of oyster shells (Fig. 3a, b) is indeed a major (large-scale) activity to prepare lime that in turn is used as whitewash or cement locally.

The households in the peri-urban (92%) and urban (8%) areas are using mangrove fuelwood obtained from *A. germinans* and *R. mangle* (Fig. 3c) (Table 2). Within the peri-urban households that depend on mangroves for construction or service wood (96%) (Fig. 2), the majority of them use it for housing purposes (e.g., roof, fence, etc.) (Fig. 3d, e),

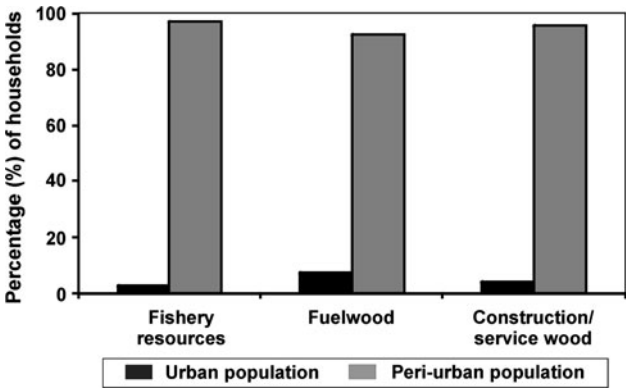

Fig. 2 Local households in peri-urban and urban settings, and their percentage dependence on various mangrove resources in the TWNP (based on questionnaire survey)

whereas others depend on mangroves for making furniture and wood carvings. At this point, we highlight that we define "service wood" as wooden items that are of service in daily activities (e.g., furniture, cultural, and ornamental items, cutlery, toys, etc.), but different from fuelwood (firewood, charcoal), timber (construction wood for houses) and non-timber forest products or NTFP (forest fruits, ethnomedicinal, or ethnochemical products, etc.). In mangrove-adjacent villages, the twigs and branches of *Rhizophora* spp. are also used to make dyes for soaking fishnets to increase their durability (Table 2). The use of mangrove sticks for making fish traps, and comb/needles for weaving fishnets is common.

The investigation on mangrove plants for edible and ethnomedicinal purposes revealed that the tender leaves of

Table 2 Common mangrove species in the TWNP of The Gambia with their vernacular names and uses

Scientific name	Language	Vernacular name(s)	Use
Avicennia germinans	Wolof	*Kecho*, *Whe*, *Njull*	Fuelwood, construction/service material, edible (tea), and medicine for anemia
	Serere	*Mbal*	
	Karuninka	*Kapacha*	
	Mandinka	*Jibikung*, *Jibukumo*, *Gubukung*, *Gibukung*, *Jibukungo*, *Jubukung*, *Chubung*, *Jibukung*, *Jibikungo*, *Darambo*, *Kweta*, *Finta*	
	Jola	*Kamkak*, *Wafite*, *Walayeme*, *Katumpek*	
	French	*(Palétuvier) Noir*	
	English	*Black mangrove*	
Rhizophora mangle	Wolof	*Honka*, *Mangi*, *Wule*, *Mangigaye*	Fuelwood, construction/service material, dye for fishnet
	Serere	*Yeh*, *Njaspal*	
	Karuninka	*Kamank*	
	Mandinka	*Manko*, *Manko foro*, *Manki wulleng*, *Manki ke*, *Manki muso*, *Manko wulerio*, *Manki foro*	
	Jola	*Kumanka*, *Kasolak*, *Weyeme*, *Keymek*, *Yeme*	
	French	*(Palétuvier) Rouge*	
	English	*Red mangrove*	

Fig. 3 **a**, **b** The mounds of oyster (*Crassostrea* cf. *gasar*) shells collected by local fishermen to burn and prepare lime that in turn is used as cement or whitewash locally; **c** the bundles of mangrove fuelwood in *R. mangle* forest; **d** the mangrove wood used as racks for drying fish (i.e., *Tilapia* spp. in *close-up*, and **e** house fence. The photographs were taken by Preetika Bhanderi and Danae Maniatis

A. germinans are used to prepare tea, and the decoction after boiling its roots and leaves is fed to people suffering from anemia (particularly to women after childbirth) (Table 2). However, according to the respondents, the overall trend of mangrove resource utilization is decreasing over the years where it was more pronounced in the peri-urban settings with 89% of the interviewed households.

People's Perceptions on Mangrove Ecosystem Changes

Altogether, 73% of the peri-urban households (47% in the urban population) reported one or another form of change in the vicinity. With the release of waste into mangrove sites on the southern side of Banjul city (due to a break-down of the wastewater pumping system that was active since colonial days), about 20% of the urban people consider mangrove forests as responsible for mosquito prevalence and diseases. Addressing specifically the relationship between mangroves and malaria, the entire urban households (only 58% from peri-urban) believe it to be true. In response to the settlements in Banjul—the place which is more susceptible to natural disasters like floods, coastal erosion, cyclones, and tsunamis, compared to other peri-urban/rural areas in the south,—the greater part of the households (76%) recalled their previous witnessing of riverine and flash floods since 1948. Nearly 97% of the respondents consider that the TWNP should be protected and well managed under scientific direction. More locals in the peri-urban area (87%) have expressed their willingness to join in forest conservation and management schemes with the option of "limited access and licensed extraction" of resources (78%), followed by "open access and extraction of non-living resources" (15%), and "zero access" (7%)—as per the answers provided in the questionnaire (Online Appendix 1A).

Ecotourism

The tourists found in this study were represented largely by nationals from the Netherlands (52%) and United Kingdom (27%), of which most received an education up to college

Table 3 Scores given to the local stakeholders (TWNP = Tanbi Wetland National Park; Users = fishermen, farmers, researchers, representatives of the community development and tourists; GO = governmental organizations; NGO = non-governmental organizations) sharing revenue, rights, and responsibilities for the ecotourism in the TWNP of The Gambia

	Category			
	TWNP	Users	GO	NGO
Revenue				
Researchers	3	10	1	2
Sea Life Center	8	2	2	4
Department of Parks and Wildlife Management	5	5	3	3
West African Bird Study Association	5	6	4	1
Representatives of the community development	5	4	3	4
Average	5.2	5.4	2.6	2.8
Percentage	32.5	34.0	16.0	17.5
Rights				
Researchers	4	3	6	3
Sea Life Center	4	6	2	4
Department of Parks and Wildlife Management	5	4	5	2
West African Bird Study Association	2	4	6	4
Representatives of the community development	3	3	4	6
Average	3.6	4	4.6	3.8
Percentage	22.0	25.0	29.0	24.0
Responsibility				
Researchers	4	7	3	2
Sea Life Center	4	4	4	4
Department of Parks and Wildlife Management	3	5	5	3
West African Bird Study Association	2	4	6	4
Representatives of the community development	4	4	4	4
Average	3.4	4.8	4.4	3.4
Percentage	21.0	30.0	28.0	21.0

The scores, with a max. of 16 points per category (per line) are given in relation to each stakeholder's profile/interest discussed during group discussions with the representatives of these categories that were present. Please refer to the methodology for a detailed description on these quantifications and on the details of the categories

and/or university levels (>90%) (Table 1B). The general response of the local stakeholders (>75%) on ecotourism is positive in terms of economic development through foreign exchange and employment opportunities. Yet, 59% have observed a decline in tourists in recent years. The stakeholders chose three areas for boardwalk construction inside the mangroves (Fig. 1), along with their justifiable roles in sharing the revenue, rights, and responsibilities of this project (Table 3). The areas proposed take into account other activities or scenic aspects of the mangrove such as bird watching, to visit a local reptile park, a local lodge (for refreshments), and mangrove afforestation sites via traveling inside the mangrove creeks. Finally, the area close to Banjul (location-A in Fig. 1) was preferred by the majority's opinion of benefiting the capital city (for better economic growth and infrastructure development) with ecotourism development.

DISCUSSION

Local People's Knowledge and Perceptions of the TWNP Mangroves

Both *A. germinans* and *R. mangle* are widely distributed in the TWNP (Maniatis 2005), and the local populations, mostly from the peri-urban areas, are able to distinguish them clearly. However, the functional use of having more than one vernacular name in Wolof, Serere, Mandinka, and Jola languages for each species (Table 2) remains unclear. As already mentioned by Kinteh and Sillah (2005), the general perceptions of the local populations of mangroves with respect to their services (ranging from sustained livelihoods to protection against cyclones, reduction of shoreline erosion, etc.) are positive. The local fishermen treat them as wind-breaks whereby fishing in the TWNP is

easy and safer than going to sea (cf. Walters et al. 2008). While men are involved in fishing and tourism sectors, women are engaged in the oyster collection. The oyster harvesting in the TWNP has already been described as an exclusive women's activity (Kinteh and Sillah 2005), but differential wood cutting practices between men and women have been observed elsewhere in West Africa (Feka et al. 2011). In addition, some women smoke the fish and sell them, together with other agricultural products, in local markets. Overall, the fishing and tourism activities appear to have a stronghold in The Gambia (Jallow et al. 1996; Sharpley et al. 1996; Laë et al. 2004).

The negative attitude of some people in the urban area that regard mangroves as a source for mosquitoes and diseases might be due to a lack of awareness. Mosquitoes are indeed a major problem in The Gambia with stagnant water in the pools within the mangrove environment and local drainage system (Thomas and Lindsay 2000). Several projects with the aid of UNDP, World Bank, WHO, etc., are continually facilitating treatment and preventive measures for diseases like malaria, filariasis, etc. (Aikins et al. 1993).

A high literacy rate in the urban households is a key factor for their familiarity with the TWNP. Despite some qualitative assumptions on the ecosystem changes, mangroves in the TWNP are spatially static over the last 38 years (unpublished data Maniatis 2005). The age-old practices of agriculture in some parts of the TWNP are particularly aimed at achieving food self-sufficiency (Sillah 2002). Sillah (2002) has mentioned that some areas in the TWNP are likely to be encroached if mangrove die-back occur in upstream areas and demand for various forest products in the downstream areas. On the other hand, the decreasing mangrove resource utilization nowadays is due to available alternatives such as non-mangrove wood, kerosene, gas and medicinal facilities in the vicinity, if income permits. The local people's option with "limited access and licensed extraction" of mangrove resources is meant to benefit the next generation(s) with their sustainable utilization. The involvement of financial compensation in forest conservation and management schemes, i.e., for mangrove seed collection, nursery and plantation works (Bosire et al. 2008), has also led to achieve maximum cooperation from the peri-urban population.

Mangrove Fishery Resources

The estuarine fish production contributes significantly to the coastal subsistence economy of many developing countries (Laë et al. 2004; Simier et al. 2006; Walters et al. 2008). In fact, The Gambia estuary matches all the criteria of a "normal" (or "type E") estuary widely open to marine and freshwater domains (Simier et al. 2006). Several researchers have marked this estuary as one of the last West African estuaries with no major natural or artificial disturbances (e.g., Ecoutin et al. 2005; Simier et al. 2006). However, based on the perception of informants, the overall fish catch per person in the TWNP has decreased in recent years due to increased population size of the fishing community as well as diminishing fish stocks. Though most of this activity was said to be for local subsistence, some commercial attempts by the Senegalese (with bigger pirogues) have been observed. On the other hand, there is still a gap of knowledge on fishery-related activities in The Gambia due to irregular monitoring (Laë et al. 2004).

Although the current natural stock of molluscs is still sufficient to meet the local demand (FAO 2004), the situation is changing dramatically due to overexploitation and the loss of productive molluscan beds through habitat destruction, pollution, etc. (Varghese et al. 2008). In general, mangrove roots and the lower parts of trunks provide a suitable and safe environment for infauna and epifauna (Ellison 2008). Yet, some unsustainable practices such as oyster collection through mangrove root cutting are damaging the plant (Sukardjo 1995). In the TWNP, the collection of *Crassostrea* cf. *gasar* is a major activity since ancient times (Simier et al. 2006) (Fig. 3a, b). Perhaps educating the local people on further consequences of the mangrove root destruction could reduce this problem to some extent.

Timber, Non-timber, and Edible Forest Products in the TWNP

Anthropogenic uses of mangroves are noticeably high for construction and fuelwood in many developing countries (e.g., Walters et al. 2008). In the TWNP, the mangrove fuelwood is important and often linked to fishing and oyster collection activities, whereby smoking fish and steaming oysters is carried out simultaneously. The local populations use short wood for housing fences, furniture, and wood carvings (Fig. 3), whereas tall wood is used for house and boat constructions. Similarly, the usage of mangrove bark for preparing dye to color and increase the durability of fishing nets was reported elsewhere (Hernández-Cornejo et al. 2005; Dahdouh-Guebas et al. 2006; Walters et al. 2008). The medicinal value of mangroves in the TWNP (Table 2) is comparable with the observations of Bandaranayake (1998, 2002), and Pattanaik et al. (2008). The tea made from *A. germinans* leaves is also used locally in the Mexican mangrove areas to alleviate gastric diseases (Hernández-Cornejo et al. 2005).

Ecotourism

The monitoring/management of natural resources combined with ecotourism also lead local people to become

guardians of their own environment and thereby protect it from natural or anthropogenic threats. Tourism has been one of the most buoyant sectors of the economy contributing 12% to the GDP while being a major foreign exchange earner and a healthy employment generator all of which owe its significance to the coastal environment. It will be diversified and the innovations will seek to introduce and promote ecotourism, cultural, inland and community-based tourism as well as conference tourism (The Republic of The Gambia 1996). In the case of the TWNP, the engineering works pertinent to boardwalk construction are still in progress. Moreover, the Croco's Ark Trust, in association with The Gambia Reptile Park, is planning to reintroduce and maintain the two West African endemic crocodile species—*Osteolaemus tetraspis* (Cope 1861) and *Mecistops cataphractus* (Cuvier 1825), as a part of this ecotourism development (Shirley 2008).

The personal involvement of decision makers in field-related activities and/or projects that have been intended for environmental monitoring would improve the results of sustainability (Redman 1999). For the development of ecotourism as well as management of biodiversity in the TWNP, both rights and responsibilities are well shared among the stakeholders with a given importance to both local users and government organizations (Table 3). While users are directly involved in the field-related activities, the government holds the responsibility of management. However, the proportion of revenue is high for the TWNP and user categories coinciding with the concept of ecotourism, i.e., environmental respect as well as maximum benefit for users (Pearce and Moran 1994). Overall, the development/management of ecotourism in the TWNP is primarily dependant on users, followed by government and non-government organizations (Table 3). The relationships between stakeholders (Fig. 4) indicate that the government usually manages both natural assets, i.e., the TWNP ecosystem and users, whereas the non-government organizations also try to manage the natural assets with some rules imposed on users. Direct users are the ones who influence their surrounding natural environment the most with their sustained intervention and possible dependence, and vice versa: they are most influenced by it. They also influence the government and non-government organizations. Therefore, importance should be given to the local dependent users while dealing with nature management projects and to achieve sustainable human–environment systems (Lambin 2005). To make ecotourism successful, we emphasize that important tasks are to raise awareness about the TWNP's ecosystem services, and to educate both foreign and domestic tourists and visitors. Mangrove forests, or the TWNP as a whole for that matter, also need to be promoted adequately to potential visitors, an issue known to be interpreted in different ways in the Caribbean with possible focus on the mangrove's wild and mysterious nature (adventourism), or with the mangrove as a background (Avau et al. 2011).

Ecosystem Changes and the Recommendations for Better Management of the TWNP

The loss of mangroves due to sustained human intervention, more than natural causes, is a known fact (Duke et al. 2007; Dahdouh-Guebas and Koedam 2008; Ellison 2008). However, the consequence of mangrove destruction or degradation is often only realized when natural calamities bring about losses to human lives and properties (Mukherjee et al. 2010). According to Maniatis (2005), some mangrove areas in the TWNP have been disturbed earlier for Banjul city expansion and other developmental activities. The local populations have linked the agricultural practices in some parts of the TWNP (e.g., cultivation of paddy, fruits, and vegetables in addition to rhun palm trees (genus *Borassus*) for palm wine extraction) to land scarcity, increased family size, and alternative sources of income due to decreased fish production. At the same time, many respondents recognized the connection between mangrove loss and damages due to natural hazards.

Currently, the concept of socio-ecology is used widely in forestry research for recommending appropriate conservation and management strategies (e.g., Dahdouh-Guebas et al. 2006; Walters et al. 2008; Nfotabong Atheull et al. 2009). The major obstacles that have prevented the rational use of mangroves in Africa are the sectorial approach of mangrove resource management, poverty of many indigenous coastal communities, and the lack of awareness among the decision makers (Kairo et al. 2001). Although the management guidelines developed for the TWNP seem to be appropriate, the process of creating accessibility zones and conservation areas should consider the role of mangroves in local livelihoods. Furthermore, the management guidelines should involve local populations more actively for their maximum cooperation (Kairo et al. 2001; Sillah 2002). The TWNP signboards with a clear text and pictures that convey information on the illegal activities such as waste dumping, tree felling, animal hunting, etc., inside the national park can create more awareness in both local populations as well as visitors. Radio broadcasting (in view of its popularity) to reach out to a wider public is also a plausible option. Educating children in primary/secondary schools on mangroves is always advisable. Nevertheless, the establishment of a joint stakeholder council/group would also help the local government to take more informed (resource) management decisions. It is needless to say that the implementation of existing rules and regulations is the major challenge in the TWNP, and

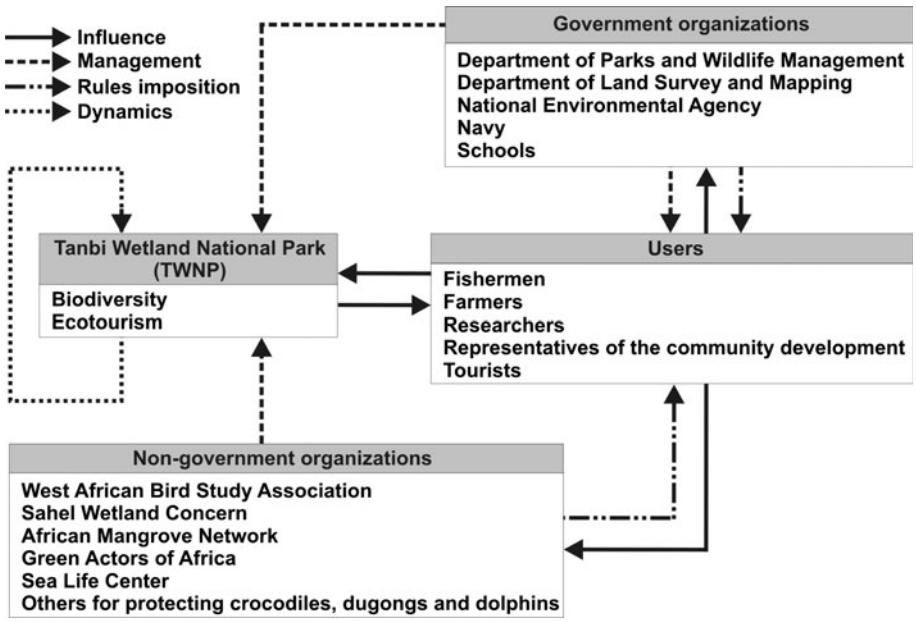

Fig. 4 The stakeholders and their relationship (based on "Four Rs method") for managing ecotourism as well as biodiversity in the TWNP

hence warrant a careful reconsideration and enforcement for its sustainability.

CONCLUSIONS AND PERSPECTIVES

This study, credibly the first of its kind for the mangroves in The Gambia, highlights the significance of the TWNP for local livelihoods. The uses of mangrove resources, knowledge of mangroves and perceptions on ecosystem changes are different between the peri-urban and urban populations. Among others, fishing and tourism are the major income-generating activities in the vicinity. However, population growth in recent years indicates a likely encroachment into mangrove areas in the near future (for agriculture, settlements, etc.) and thus one needs to think carefully for sustainable alternatives to protect this ecosystem. Our study also stresses the importance of forest conservation and management strategies through involvement of the local stakeholders. The ecotourism project can be successful if the stakeholders carry out their assigned roles under the established relationships. Since the process of stakeholder's governance (in the lines of revenue/benefits, less/more rights, and responsibility) is still open for possible negotiation, the most useful information on this aspect would be generated once the boardwalk construction is finished and operational. We hence recommend future studies to focus on the ecotouristic potential of boardwalk construction. Nevertheless, the wastewater pumping system in Banjul needs to be fixed and the release of waste into mangrove channels (and thus pollution) should be regulated to achieve both ecological and economic benefits with minimal long-term effects. Though some studies have examined the capacity of mangroves in wastewater treatment (e.g., Mohamed et al. 2009), it is still difficult to hypothesize that waste dumping would not cause major changes in flora and fauna (Cannicci et al. 2009).

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