



Coping with local peoples' livelihood dependence on the transboundary Dinder–Alatish National Parks in Sudan and Ethiopia from the Sudanese Perspective

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Abstract

The local peoples' dependence on Dinder National Park, Sudan, for their livelihoods and economic and conservation implications of the livelihood activities were analyzed. Our study attempted to answer major questions about the main livelihood strategies, their economic and conservation implications as well as the perceptions of local people and park administration on the use and management of the park and cooperation for TBPA management. A mixed research method was employed in this study in data collection. Households' livelihood strategies are ranked according to their share in households' total income. Accordingly, 92% of respondents ranked agriculture as a primary source of livelihood in the rank 1 category, and 33% of respondents ranked livestock rearing as the primary source in the rank 2 category important source of livelihood. The ranking of second and third options varied across both households and villages. Households collect forest products to supplement their livelihoods and the collection of other environmental goods is irregular and difficult to quantify. Further human activities in the area are compiled from different publications and annual reports. Agricultural expansion into the park and livestock trespassing are the major threats to Dinder and neighboring Alatish National Park. A cooperative transboundary response will be helpful to cope with these challenges.

Keywords Livelihoods · Transboundary protected area · Dinder National Park · Alatish National Park · Cooperation

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1 Introduction

A livelihood encompasses the possessions of assets and activities needed to make a living. It is considered sustainable when it can “cope with and recover” from challenges and continues to maintain its good and service provisions to the next generation (Chambers & Conway, 1992).

Rural communities in both Sudan and Ethiopia employ diversified economic activities such as agriculture, agro-pastoralism, and nomadic pastoralism, and in some cases, the latter is considered as “lifestyle” than the economy for livelihoods (El Sammani & Salih, 2006; Elhadary, 2010; Randall, 2015). These strategies are usually augmented with forest products collection, fishing, hunting, and others in many developing countries (Adam et al., 2013; Angelsen et al., 2014; Walelign, 2015; Yemiru et al., 2010). The role of natural resources in rural livelihoods and poverty alleviation has been investigated by several studies (Angelsen et al., 2014; Kamanga et al., 2009; Pouliot & Treue, 2013; Vedeld et al., 2012). The income from these natural resources is accounted as environmental income, and it shares up to 28% of total household income (Angelsen et al., 2014). Specifically, Angelsen et al. (2014) defined environmental income as “extraction from non-cultivated sources: natural forests, other non-forest wildlands such as grass-, bush- and wetlands, fallows, but also wild plants and animals harvested from croplands.” Total household income is the aggregate of incomes from different sources such as income from crop production, livestock rearing, wage, remittance, environmental income, and support from both government and non-government organizations and other economic activities they engage in to pursue their livelihoods (Walelign, 2015). The relative share of environmental income to total household income indicates households’ dependence on natural resources (Angelsen et al., 2014 and Yemiru et al., 2010).

Since environmental income plays a significant role in households’ livelihoods and determines their dependence on natural resources, it is important to manage natural resources and promote sustainable livelihoods and conservation objectives.

The Sudanese Dinder National Park (DNP) is important for conservation and local peoples’ livelihoods, as they depend on it for multiple uses (Alers et al., 2007; HCENR & WCGA, 2004; Oehm, 2008). Local communities inside and the surrounding area depend on the park for livestock grazing and water, farming land, construction material, firewood, charcoal production, and collection of other products such as wild fruit, honey, fish, medicinal plants, and bushmeat, among others (Abdalla, 2015; Hassaballah et al., 2016; Mahgoub, 2014; Van Hoven & Nimir, 2004). These activities in the area pose threats to biodiversity and park management. The park administration considers them trespassing (Berihun et al., 2009; Hailu, 2011; Lindsay et al., 2009).

The trespassing is determined based on the violation of access. Access to natural resources determines their use and management (Nakakaawa et al., 2015; Naughton-Treves et al., 2011; Tesfaye et al., 2011). Creating protected areas (PAs) is common strategies for natural resources management and biodiversity conservation (Gurney et al., 2014; Pudyatmoko et al., 2018). In many developing countries, the management of PAs has been characterized by the exclusion of local people that depend on the resources for their livelihoods (Brockington & Igoe, 2006; Naughton-Treves et al., 2011), and DNP is no exception (Badri, 2012). This approach could endanger the peoples’ livelihoods (Angelsen et al., 2014) and lead to conflicts between local people and managers of PAs (Bavinck & Vivekanandan, 2011; Norgrove & Hulme, 2006).

However, following international environmental agendas such as the 1982 World Parks Congress in Bali and the 1992 United Nations (UN) Conference on Environment and Development in Rio, PA, management shifted to more people-centered management models. This led to various policy development such as integrated conservation and development projects (ICDPs) and community-based conservation (CBC) (Beck, 2000; Naughton-Treves et al., 2005). In addition to national PAs, various countries have taken a lead in managing adjoining PAs collaboratively, which are referred to as transboundary protected area (TBPAs). Transboundary protected area (TBPA) is a protected area that stretches across the border of two or more sovereign countries and dedicated for biodiversity conservation and natural resources management through a collaboration of the countries that share the border(s) where the protected area is located (Busch, 2008).

This paper presents the local peoples' dependence on the park and its social and ecological implications, as well as the mechanism of coping with the pressure through transboundary cooperative park management from a Sudanese perspective. Coping strategies/mechanisms refer to the management plan to promote conservation and help local households pursue alternative livelihoods and sustainable natural resource extraction.

This study explores four major questions. First, what are the main livelihood strategies of the households inside and around the park? Second, what are the development and conservation implications of these livelihood strategies? Third, what are local people's perceptions about park management strategies? Fourth, what is the perception of DNP administration about the park use, management, and transboundary cooperative park management? Answering these questions has important implications for how local people depend on the park and the interventions needed to balance the use and management of the park.

2 Study area background

DNP is located at the border of Sudan and Ethiopia, where it shares a 75-km-long border with the Ethiopian Alatish National Park (ANP) (see Fig. 1). The DNP was founded in 1935 after the 1933 Convention Relative to the Preservation of Fauna and Flora in their Natural State with an area of approximately 10,000 km². In contrast, ANP is a very recent park established in 2006, covering the area of 2665 km². They also share ecosystems with similar characteristics and common threats. Wildlife migration between them exposes the animals to increased illegal hunting (Alers et al., 2007; HCENR & WCGA, 2004; Hailu, 2011; Marye et al., 2008; UNEP, 2007). DNP falls in three Sudanese regional states, namely Sennar, Gedarif, and Blue Nile (HCENR & WCGA, 2004). The population survey for this study was restricted to Blue Nile State, where the DNP shares a border with ANP. DNP and other PAs in Sudan are administrated under the umbrella of Wildlife Conservation General Administration (WCGA), which is under the Ministry of Interior.

To address the park and people relationship, it is important to understand the human settlement as well as demographic dynamics. Although DNP was nearly uninhabited prior to the 1960s (UNEP, 2007), archeological evidence indicates the human settlement in the Dinder area dates back before the nineteenth century (Harrison, 1898 cited in Abdel Hameed & Eljack, 2003). Another documented human settlement in the area includes the indigenous Gumuz tribe in Magano village in 1912. The large-scale population migration to the area occurred in the period 1960–1981. The main factors behind this large migrants' influx to the area were famine and severe drought in western Sudan and West African countries in the 1960s, and civil war in 1981 in Sudan (Alers et al., 2007).



Fig. 1 Study area map (own elaboration 2016 by Sada Haruna) the three surveyed villages are marked with a red circle

A dramatic expansion of mechanized rain-fed agriculture was also a pulling factor for seasonal laborers that resulted in both permanent and season settlements. The combination of the above factors increased the population in the area in the last half century. The human settlement before establishing the park was ignored and not controlled after the park establishment (Interview 2016, Nadri). “Every time we visit the park we see not only new families but a new village in different places both inside and outside the park” (Interview 2016, Nimir).

3 Methods

3.1 Data sources and methods of data collection

Both primary and secondary data were collected. The main primary qualitative and quantitative data were generated in structured and semi-structured household surveys, key informants' interviews with experts, park managers, and government officials working in the area of conservation and development. Secondary data, qualitative and quantitative, were compiled from management plans of the parks and scientific studies conducted in the area. The other sources of secondary data were reports and documentation on national parks such as development project reports and annual reports from Wildlife Conservation General Administration (WCGA) headquarter in Khartoum and DNP office in Dinder town.

The list of ten villages and respective households inside and in the vicinity of DNP in Blue Nile State was obtained from the park administration office. Then, three villages were randomly selected. A total of 64 households from three villages, namely Jabel El Nour, Manchalag Barani, and Manchalag Gowani, were randomly selected for the household survey. The survey was administered by two Sudanese postgraduate students from the University of Khartoum after the pretest was conducted by the first author with the help of a translator (one of the two students), and the objectives of the study, data needed, and research methods were explained to them in details. Each survey took place at the household residence and lasted between 45 and 70 min. Additional information from key informant interviews was collected (see Table 1).

This study used the Poverty and Environment Network (PEN) questionnaire format. PEN questionnaire is a prototype survey instrument developed by the Poverty and Environment Network (PEN) research project coordinated by the Center for International Forestry Research (CIFOR). The questionnaire is designed to collect wide-ranging data about the role of environmental income and rural livelihoods (Angelsen et al., 2014). The respondents were asked to rank the sources of income in their total income and products they collect and known to be collected from the park.

After the respondents provided the list of their economic activities, they were asked if they also take part in other economic activities they did not mention based on information

Table 1 Number of key informant interviews

No	Name of institutions	No. interviewees
1	Wildlife Conservation General Administration and Dinder National Park	5
2	Wildlife Research Center	1
3	Sudanese Environmental Conservation Society	2
4	Forests National Corporation and CWM project office	4
5	REDD+/Sudan project office	1
6	Ministry of Livestock, Fisheries and Rangelands	1
7	United Nation Development Program	2
8	Nile Basin Initiative and Independent Researcher	1
9	UNESCO/Man and Biosphere Program	1
Total	18	

collected from park administration, literature, and other households' responses. In the follow-up question, the respondents were asked to rank the list of livelihood activities according to their importance and level contributions. Similar to the economic activities, the respondents were asked to rank the most important forest products they collect and know to be collected from the park. Finally, we asked the respondents if they ever participated in any activity or received any support from the park administration or projects and what they think about the park management.

3.2 Data analysis

Descriptive statistics were used for data analysis and to summarize the findings. Information on human activities in the area was compiled from published and unpublished studies since the 1960s and complemented with data from annual reports from the WCGA/DNP office. Qualitative data were recorded with proper care to capture the responses given by respondents. It was analyzed and set in contrast to information of the management plan, literature on the study subject in general, and in the study area in particular.

Although the literature on the environmental income of rural households is growing, the diverse methodologies applied and the limited local focus in the study areas make drawing general conclusion daunting.

Vedeld et al. (2004) analyzed multiple studies of forest income and reported a significant heterogeneity in the definition of the key variables and methods and their drawbacks. For instance, despite the same study population and income from the same subcategory in Uganda, different data collection methods employed led to up to a 12% difference (Jagger et al., 2012). Challenges with such environmental income studies include survey implementation difficulties, a heterogeneous definition of some terms used such as forests, non-timber forest products (NTFP)s, and different responses by the members of the same household (Fisher et al., 2010).

The respondents in this study provided significantly different responses to the monetary values of the same products. As a result, it is difficult to conclude the absolute environmental income in the area. However, since the primary objective of this study is to assess the importance of natural resources for rural livelihoods and the implications for nature conservation and development, this study analyses the relative share of different income sources to rural households' livelihoods. The findings are explained with additional information from key informant interviews.

4 Results and discussion

4.1 Rural livelihoods and their economic and conservation implications

- (i) What are the shares of different economic activities in total households' income of the communities inside and around the park?

In this study, economic activities that households engage in for subsistence and income generation were identified. While subsistence refers to items consumed in the households, income generation refers to petty trade at the local market and items sold to the other businessmen from Khartoum. The income generation activities in the area include charcoal production, gum collection, honey collection, and handicrafts among others. Figure 2

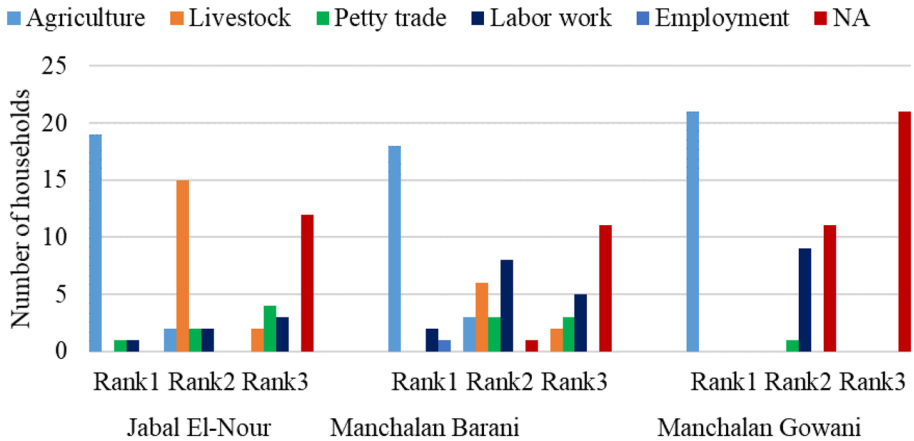


Fig. 2 Livelihood ranking in the three surveyed villages. NA = information not available

presents the ranking of livelihood activities according to their contribution to households' total income. The result shows that the livelihood strategies vary across households and villages. The differences are mainly because of the level of restrictions on land use based on the proximity to the park core and buffer zone. The main economic activities inside and around the park include agriculture, livestock rearing, collection of fuelwoods, charcoal, honey, and NTFPs, fishing, hunting for bushmeat and employed labor in mechanized agriculture in the area and male family members work in the local market (loading and unloading trucks).

Accordingly, in Jabal El Nour, rank 1 category options are 85.7% agriculture, 9.5% labor work, and 4.8% full-time employment. Rank 2 is more diverse, comprising 38.1% labor work, 28.6% livestock, 14.3% petty trade, 14.2% agriculture, and 4.8% rely only on agriculture which they ranked as the first means of livelihood. More than half (52.4%) households do not have the third livelihood option, whereas labor work, petty trade, and livestock account for 23.8%, 14.3%, and 9.5%, respectively.

Similarly, agriculture is the primary livelihood strategy in Manchalan Barani. It is ranked as the first option by 90.4% of respondents, while petty trade and labor work take an equal share of 4.8% each. Petty trade is the most common option in the rank 2 category (71.5%), whereas agriculture and labor are equally important for 9.5%, and the rest (9.5%) do not have the second option. Like in Jabal El Nour, more than half (57.1%) of households do not have the third option. The other respondents ranked petty trade (19.1%), labor work (14.3%), and livestock (9.5%) as the third option.

Manchalan Gowani is significantly different as their livelihood options are not as diverse as in the other two villages. All respondents ranked agriculture as the first option, and none of them have the third option. More than half (52.3%) households do not have the second option in the other two villages. The labor work is common, accounting for 42.8%, whereas petty trade is least (4.8%) common in this village. Our result indicates that livelihood strategies vary across both villages and households. It is also interesting to note Manchalan Gowani, which is inside the park, has less diverse options, whereas Jabal El Nour, located outside the park, has more diverse options. This is probably because Jabal El Nour has relatively better access to roads and market. The relative flexibility of WCGA in buffer and

development zone gives more advantages to the other two villages compared to Manchalan Gowani.

In overall rankings of livelihood strategies in the three villages, agriculture is the most dominant in the rank 1 for 92% of households followed by 5% ranking labor work as their primary source of livelihood. In contrast, two households ranked labor work and full-time employment in the first category. Livestock and labor work account for 33% and 30%, respectively, in rank 2 category. Those who did not rank agriculture (8%) in the rank 1 category ranked it as the second important in the rank 2 category. While 20% of households do not have the second livelihood means, 9% ranked petty trade as their second as their source of livelihood. The vast majority (70%) of households do not have the third option, and labor work and petty trade are ranked third by 13% and 11%, respectively. The rest (6%) ranked livestock as their third source of livelihood. Ranking of the same source of income in a different order by different households indicates a variation of livelihood strategies across villages and households.

Despite the common regularities about rural economy such as dependence on natural resources, large-scale poverty, and diverse livelihood (Angelsen et al., 2014; Davis et al., 2010; Mcelwee, 2008; Van der Ploeg, 2012), the socioeconomic characteristics are not uniform across the households. Rural households face multifaceted challenges. This requires diverse policy strategies (Ansoms & McKay, 2010). Similarly, DNP management requires diverse policies that include wildlife conservation, range management, forest management, and local community livelihood.

Angelsen et al. (2014) noted that households' dependence on environmental resources is better described by the relative importance of environmental incomes' contribution to households' livelihoods regardless of the households' absolute income level. However, absolute income is very important to explain high environmental dependence, mainly when the debate is over the claim that the poor are placing more pressure on the environment (Barbier, 2010). This is mainly because the better-off households extract the larger volume of environmental products, and it is usually misleading to suggest that the poorest households cause more degradation. Accordingly, our interview shows that most of the charcoal production and gum Arabic collection is practiced by the better-off businessmen from other areas.

4.2 Collection of non-timber forest product

Non-timber forest products (NTFPs) refer to a wide range of products in forests and woodlands such as wild fruits, medicinal plants, resins, firewood, grasses, gums, and other non-timber products (CIFOR, 2011). These products are essential to rural livelihoods as they are used for both consumption and income generation (Adam et al., 2013; Heubach et al., 2011). The residents inside and around DNP collect different NTFPs for both subsistence and income generation. Fuelwood is the most dominant source of energy for cooking and light. For this, deadwood is collected from the ground or dry branches of standing trees and/or the leftovers of forage and/or construction materials. Other NTFPs are wild fruits, leaves (for handicrafts), gums, medicinal plants, and others.

Regarding the most important forest products they collect and know to be collected from the park, 66% of the respondents ranked fuelwood as the most important product they collect from the park. In cases where respondents refused to give a response about the resources they collect from the park, they were asked what they collect from their environment, which is basically inside and around the park. This is based on the response to the

question where respondents were asked about the nearest park boundary to their household. Our analysis shows 66% of the respondents do not know the boundary of the park. This matches with the arguments of key informants about the park boundary extension by 20 km in 1984. Experts from different government institutions and NGOs believe that the park expansion project was not communicated to the local people. The rest of the respondents gave the estimation of 15 min to a half day to reach the boundary.

The collection of forest and non-forest products depends on the household's seasonal labor allocation, assets households' hold, and seasonal availability of resources. During agricultural seasons households mostly engage in agriculture activities which include land preparation, weeding, harvesting, and others (Walelign, 2015; Walelign & Nielsen, 2013). Community lifestyle and labor availability are other reasons for households to collect NTFPs and diversify their livelihoods strategies (Berhanu et al., 2007).

The pattern of a collection of forest products in the area is irregular and difficult to quantify. The women and children collect fuelwood and other products mostly on a daily basis or at anytime needed. They also collect "as much as" they can. This makes it difficult for respondents to estimate the quantity of products they collect. Moreover, although forest products collection for subsistence is allowed, collecting for a commercial is prohibited, and the products will be confiscated by the paramilitary officers when encountered (see supporting materials 1). On the other hand, some local people work as laborers for gum collection for businessmen outside the area, mainly from Khartoum. A few others collect and sell the products themselves. The reason why local people prefer to work as laborers instead of selling the products by themselves is attributed to limited transportation and market access. The respondents were also asked what they think of the availability of the environmental goods they collect. Regarding the perception of the respondents about the change in the availability of these resources over the last five years, 56% of respondents said the availability of these resources has reduced over time, and 25% of respondents asserted that there was no change in availability, whereas 19% noted an increased availability of products.

4.3 Tree felling and wood collection

The construction of houses in the area is another important phenomenon. Besides, cutting trees for construction is also the settlers' strategy to occupy the land and claim the right to use it. *Acacia seyal* and *Balanites aegyptiaca* are the most preferred tree species. As a result, the woodland ecosystems have been converted to shrubs dominant ecosystem in some area (Abdalla, 2015; Van Hoven & Nimir, 2004). The houses are mostly traditional huts with different types (*Gottia*, *Rakoba*, *Sareef*, *Kornok*, and *Zareeb*) based on their styles and sizes. The same author studied the housing density and structure in DNP and reported that a single household owns more than one type of house because of their various uses. Accordingly, 80% of households own *Gottia* and 76% own *Rakuba* in addition to *Gottia*. Many households own two of each type of huts depending on their family size (7.7 on average) and area of land they claim to own (3.95 hectares on average), and as maximum three of *Rakoba*. *Sareef* is a fence constructed with bigger poles and it is used to store household items and to sleep outside during extremely hot weather, whereas *Zareeb* is for keeping livestock. Explaining the types of the constructions is important because different structures have different durability and demand of wood for construction. Depending on the size and type of hut the quantity of wood needed varies as well. For instance, one *Gottia* consumes 75 to 100 poles

and a large amount of grass for roofing and others take 30 to 50 poles. As a result of fungal decay and insect infestation, majority these houses require reconstruction within 1–4 years' intervals while only 15.2% lasts more than 4 years (Abdalla, 2015). WCGA also destroys newly constructed huts to reduce and avoid new settlement in the area, but this has not helped much as people relocated to other points and continued to cut down other trees. This demands proper land use policy and human settlement control in a sustainable manner.

Although DNP launched reforestation projects in the area in collaboration with Forest National Corporations (FNC) and Community Watershed Management Component (CWMC), its coverage is limited in Blue Nile State because of local people's resistance to participate in projects. The contentious relation between park authorities and local people was the main cause of the challenges in this specific area of the park.

Figure 3 shows the main human activities in DNP over the period 1998 to 2015.

The cases were quantitatively reported such as a number of livestock inside the park. To determine the level of pressure on the park, it is important to quantify the reported activities. Although the number of reported mechanized crop fields seems small, its significance is large as a single mechanized field occupies large hectares of land. Although mechanized agriculture scheme allocates a maximum of 4.2 km² (420 ha) per person that invest in agriculture, up to 32% of these investors own ten to thirty folds of the maximum allocation set in the scheme. Just only in Gedarrif 33,600 km² (3,360,000 ha) of land is under cultivation of which 66% is unplanned (Elhadary & Samat, 2011).

- (ii) What are the economic and conservation implications of the livelihood strategies in the area?

Agriculture is one of the most important economic activities in the area that poses a great threat to the park. Destruction of wildlife habitat by clearing the vegetation, disruption of seasonal migratory animals' routes which exposes them to increased poaching and reduction of grazing land are some of the negative impacts of agriculture (Mahgoub, Interview 2016). As discussed in human settlement in and around DNP section, the human settlement followed different patterns. The most important is the settlement during the 1980s. This was a period when a large population influx occurred following drought and famine in western Sudan and later population continued to grow due to mechanized agriculture. Mechanized agriculture was the pulling factor for the labor workers, and these workers settled in the area either permanently or temporarily (Suliman, 1986). The same study found the land use competition in DNP as a potential threat to wildlife and a cause of conflicts between the park administration and local people. As wildlife cause damage to both crops and livestock, a conflict between community and wildlife was also common. A large majority of households highlighted the decline in wildlife population due to human activities and explained their content about the improvement of grazing land (Abdalla, 2015) whereas Van Hoven & Nimir, (2004) reported a decline in the wildlife population.

According to the experts, the agricultural scheme expanded at the expense of the rangeland and forest. This has at least two major impacts. First, it leads to the destruction of wildlife habitats and secondly, it forces the pastoralists to further encroach the park for grazing. Besides, the scheme also caused other environmental problems such as soil erosion and the introduction of invasive species such as Mesquite.

Moreover, the Ministry of Agriculture has been supporting large-scale agricultural production by wealthy individuals from Khartoum since 1970s after the establishment

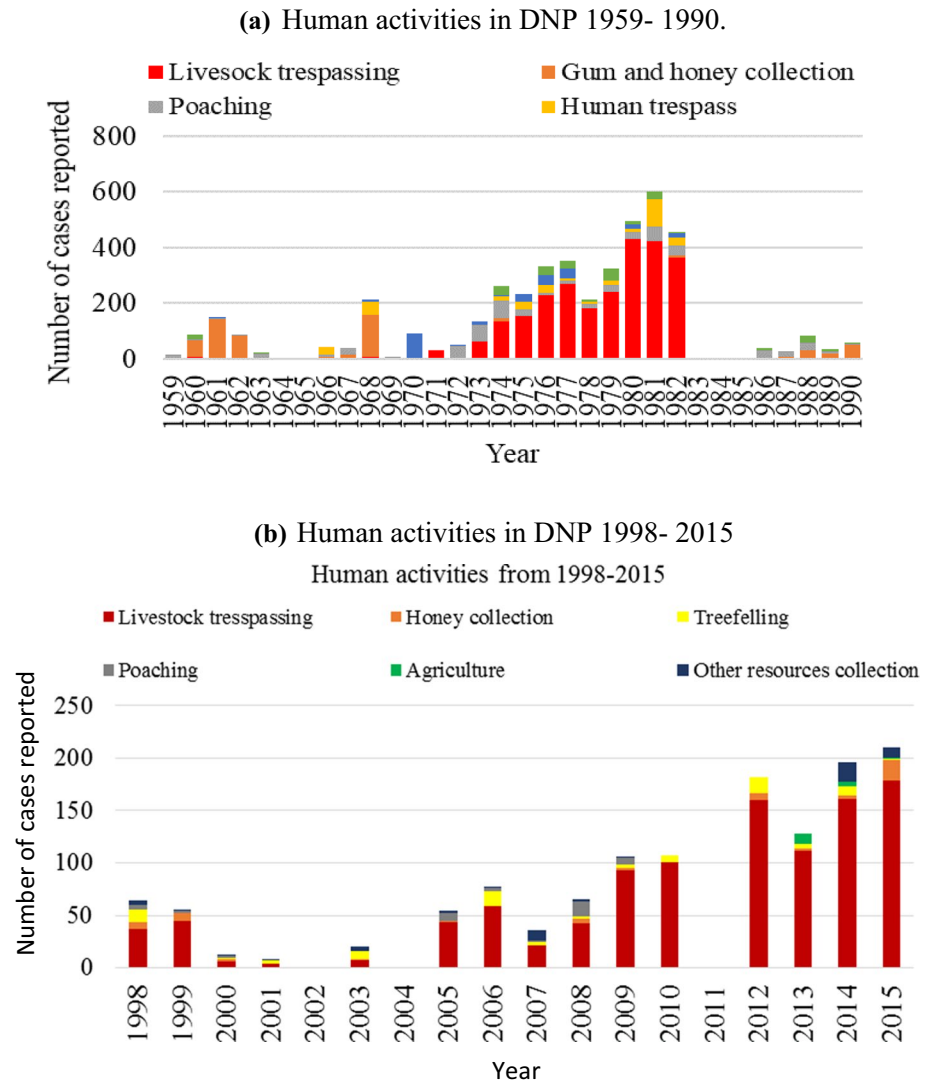


Fig. 3 Human activities inside and around DNP. *Source:* Compiled from Mahgoub (2014), Mohammed and Hashim (2015), Yousif and Mohamed (2012) and annual reports

of the Mechanized Farming Corporation (MFC) in 1968 (Elhadary, 2007). These wealthy peoples include businessmen, retired government officials, and army members. The main differences between agricultural land use inside and outside the park are the methods used and the scale. Inside the park, only tradition farming with traditional tools is allowed. Local people inside the park are not allowed to use agrochemical inputs such as herbicides and fertilizers and tractors to intensify their agricultural practices besides their limited means to finance these practices. In contrast, farming outside the park is mechanized and large scale. The expansion of mechanized agriculture has been the reason for the decline of pasture land, destruction of wildlife habitat as the local

communities are forced to encroach the park further (Abdalla, 2015; Mahgoub, 2014, and interview 2016).

According to Mahgoub a researcher at Wildlife Research Center (WRC), “this affects wildlife migration by interrupting their routes.” The clearing of the land for agriculture scheme exacerbated hunting of wildlife using automatic rifles and led to extinctions of some species such as Soemmerring’s gazelle and significant decline for other wildlife populations (Mahgoub, 2014, and interview 2016).

Livestock rearing is practiced in the study area by both sedentary agro-pastoralist and nomadic pastoralist. They are different in scale as nomad pastoralists own large number of livestock. The park is used by pastoralists for livestock grazing and watering. These activities affect the park’s grassland, woodland, riverine and meadow (Mayas) ecosystems. For instance, overgrazing and deforestation reduce the land cover which leads to increased soil erosion. Soil erosion was the cause for siltation of some Mayas in DNP (Hassaballah et al., 2016). A large number of herders migrate to the park during the dry season for grazing. Periodically, the livestock also grazes on the agricultural residues, but this is not enough to keep the livestock from trespassing to the park (Mahgoub, 2014, interviewed 2016). The trespassing of the livestock causes a lot of problems beyond its direct impact on the park. It has been reported that violent conflicts happen between herders and park rangers. WCGA/DNP have a strong policy on livestock trespassing, i.e., confiscating 50% of livestock. This creates a violent conflict between armed herders and armed police force of WCGA.

Fire also poses a substantial threat to DNP ecology. Repeated fire was a cause for the change in the composition of species diversity and destruction of habitats. According to Mahgoub (2014), DNP is dominated by *Acacia seyal* due to its fire resistance (see supporting material 2). The main sources of fire are poachers, nomads (open fire cooking), honey collectors, charcoal producers, farmers, and park rangers for road opening and reduce view obstruction by grass (Abdalla, 2015; Oehm, 2008). Different researchers (Dasmann, 1972; Kanno, 2004; Mahgoub, 2014; Oehm, 2008) used GIS and remote sensing to analyze temporal fire distribution in DNP from NASA satellite images and reported maximum 59% of the area burned in 2005 and minimum 21% in 2002. We assume that this had a significant impact on grassland ecosystem which is less resistant to fire.

WCGA has specific administration office for each park. DNP administration headquarter is located in Dinder town, 150 km away from the park. WCGA assigns paramilitary officers for the protection of the park from illegal human activities. Although the DNP authorities applied rigorous protection efforts against poaching, it is still practiced. Roan antelope, giraffe, red-fronted gazelle, and tiang are most targeted animal species (Abdalla, 2015; Dasmann, 1972; Mahgoub, 2014). Patrolling is more difficult during the wet season because of limited infrastructures such as road access, and limited funds. Therefore, WCGA closes the park during the rainy season from May to September. Despite this, poaching takes place during both the dry and wet season (Mahgoub, 2014). Poisoning of water points was also used by poachers and this affects the livestock as well. The protectionist law enforcement approach by the park administration has been a reason for the conflict between local people and park authorities. The animosity between local people and park authorities resulted in the death of individuals from both sides (exchanged shooting) but data on these casualties were inaccessible.

- (ii) What is the perception of the local people about the park management strategies?

According to many conservationists, the success of park and protected area management depends on local people's perception and support, and the ability of the park management authority to integrate the local people's need in their conservation plan (Andrade & Rhodes, 2012; Bennett & Dearden, 2014). Therefore, ignoring the dependence of local people on park resources for their livelihoods and strict law enforcement escalates the conflicts between the local community and park management authorities (Bavinck & Vivekanandan, 2011; Himmelfarb, 2012).

Despite the shift of DNP to a Biosphere Reserve concept, the participation of local people in the park management is still limited (Interviews 2016, Abdelhameed, Ali, Nadri and Nimir). In this study, special consideration was given to the progress since the implementation of GEF-UNDP DNP project between 2000 and 2004. One of the important impacts of the GEF-UNDP DNP project is the partially improved relationship among the stakeholders by creating the Village Development Committees (VDC), Farmers' Union, Pastoralists' Union, and other organizations. Sudanese Environmental Conservation Society (SECS) was responsible for the community mobilization and campaigns for public environmental awareness. The project was financed by GEF and received additional funds from UNDP for the advocacy of community participation. The community members participated in capacity building training such as beekeeping, agroforestry techniques and reforestation activities (Interviews 2016, Ali and Nimir). Local communities that organized under Village Development Committees (VDC) were provided with a revolving fund to pursue alternative livelihoods to reduce their dependence on the park (Van Hoven & Nimir, 2004). However, community participation in decision-making was very limited (Badri, 2012). ENWM/CWMC allowed community members to participate in a decision-making process. However, this was also limited to development activities such as in animal husbandry, water harvesting and management of rotating fund instead of integrated park management and resource utilization.

With the regard to local people participation in park management, project activities and support they receive from park administration, 87.5% of respondents have not participated in any form and only 12.5% participated in project activities. "The participation of local people was usually based on their compliance with the order given from WCGA/DNP" (Elnour, Interview 2016). Our study area (Blue Nile State) is known for a contentious relationship with park administration socially and politically. In 2010, a village called Manta-goa was dropped from ENWM/CWMC project due to public resistance, and in 2011, project staffs were evacuated from Bau area following unrest leaving behind project resources such as computers, generator, documents, and furniture (ENWM/CWMC, 2016). This confirms the argument that participation is usually based on loyalty and compliance of local people with the top down order from WCGA. Another most important factor about local people's participation in projects is the nature of the study area. Blue Nile State is characterized by relatively less endowment by natural resources, less population, resistant communities, and distance from service points such as markets and the DNP office. According to experts from different institutions and WCGA/DNP, Gedarrif State is a prioritized area for its dense population and high socioeconomic activities around Rahad river bank. This is probably the reason why community participation is less in Blue Nile State.

According to Alers et al. (2007), DNP is viewed as a "national treasure" by the local people and this was manifested through the strong public support the park has received over the years. However, there are discrepancies in responses. The fact that 66% of interviewed people did not know the nearest park boundary to their household can be interpreted in two ways: First, they might be unwilling to accept the park administration strategy because of the limited support they receive and claims and counterclaims of

the land by both the local community and the park administration. Second, they might not be well informed about the park boundary extension by 20 km in 1984 (Maghoub, 2014). Majority of the local community members in our study did not have much positive perception about the park administration. However, they highlighted the role of village leaders in land use for agriculture and grazing.

- (iv) *What is the perception of DNP administration about the park use, management, and transboundary cooperative park management?*

In the beginning, the primary objective of DNP management was to control and reduce poaching. However, a paramilitary law enforcement without cooperating and consulting local people created an intense animosity between park administration and the local communities. Later, WCGA/DNP in collaboration with experts from various institutions developed the first management plan in 2004. This management plan changed the system to integrated management for economic development and conservation. Later, DNP laid out the Management and Utilization Plan 2011–2015 based on the review of 2004 management plan (Lindsay et al., 2009).

The proliferation of protected areas during the 1980s and 1990s led to a paradigm shift in economic development arguments to integrate conservation in economic development policies through community capacity building, public participation in decision-making processes and power decentralization. With the introduction of Integrated Conservation and Development Projects (ICPDs) during the 1980s, 23 projects were launched with the aim of combining rural development and conservation activities across several developing countries (Wells & Bradon, 1992). Following the encouraging results of the projects, ICDPs multiplied around the parks in developing countries with significant support for conservation (McShane & Wells, 2012).

Although there are still shortages, integrated projects have received significant attention and funding for poverty reduction and biodiversity conservation (Abramovitz, 1991; Bowles et al., 1998). Similarly, DNP received USD 750,000 between 2002 and 2006 from the Global Environmental Facility (GEF) for the development project. The project helped WCGA/DNP to enhance the institutional capacity and develop a comprehensive management plan underscoring the objective of increasing public participation in the park management (UNEP, 2007).

The latest development in and around DNP was implemented by Eastern Nile Watershed Management Project (ENWMP) under the Sudan Component of Community Watershed Management (CWM) from 2009 to 2015. It includes rural livelihoods improvement and sustainable biodiversity conservation. The project was funded by the Government of Sudan, Global Environment Facility (GEF) and the Government of Finland (see Table 2 for the project budget).

The outcomes of this project include enhanced agricultural productivity, forest management, and sustainable livestock ranching to support local livelihoods. The development interventions include improved extension work on agriculture, livestock, and forestry technologies. For instance, the provision of improved seeds (see Table 3), training in animal husbandry and promotion of scientifically supported farming system. In addition to these services, the local people were also provided with revolving funds and sub-grants for small-scale investment in agriculture including horticulture. According to the project report, the production of sorghum was increased by 116% and sesame by 73% after the adoption of recommended packages in Dinder during the project lifetime (see Table 4). The success of GEF-UNDP project in relatively reducing conflicts between

Table 2 ENWMP project budget

Project financing	Currency	At the start of project			After the restructure		
		Cash	In-kind	Total	Cash	In-kind	Total
Government of Sudan	USD millions	3.88	9.32	13.20	3.88	9.32	13.20
Global Environment Facility	USD millions	4.00		4.00	4.00		4.00
Government of Finland	EUR millions	6.95		6.95	6.58		6.58
Government of Finland for Technical Assistance	EUR millions	2.30		2.30	2.67		2.67
Total USD:	USD millions	7.88	9.32	17.20	7.88	9.32	17.20
Total EUR (from GoF):	EUR millions	9.52			9.52		9.52

Source: ENWM Project Report 2016, unpublished

Table 3 Improved crop seeds distribution in Dinder by ENWMP. Source: ENWMP Project records 2016, unpublished

Year	Tons of seed provided	No. beneficiaries	kg of seed/farmer
2011	12	1667	7.2
2012	21	3729	5.6
2013	28	3205	8.7
2014	15	1255	12
2015	3.9	300	13
Total	79.9	10,156	46.5

Table 4 Yield of dominant crops in DNP

Yield	Crop	
	Sorghum	Sesame
Baseline yield (kg/ha)	519	202
Yield in 2012 (kg/ha)	1231	336
Yield in 2013 (kg/ha)	945	353
Yield in 2014 (kg/ha)	1186	362
Average no. of farmers in assessment	39	54
Average yield for during the 3 years period	1121	350
Average % increase in yield over baseline	116%	73%
Targeted % increase in yield by the end of project	70%	70%

Source: ENWMP Project records 2016, unpublished

local communities and park administration and ENWM/CWMC project improving local livelihood and in turn reducing the pressure on the park and rehabilitation have helped park administration to change its perception about local people and collaboration with other institutions to a better outlook.

Improved fodder production was also introduced into the area, but this works only for sedentary pastoralists as they have less livestock. Another important development is the rehabilitation of dried Mayas (meadows) alongside the introduction of improved water harvesting techniques. Honey collection practices and modern honey hives significantly contributed in reducing the impact of fire (Interviews 2016, Belila, Elmahi and Sherif).

The ENWMP was participatory, involving stakeholders from national, regional states, local communities. Similar to the first GEF-UNDP DNP project the capacity building was for both government staffs and local people through Village Development Committees and improved relationship between park and communities (Interviews, Belila, Adam, Sherif, 2016). This ensures the continuity of the impact of the activities undertaken by the project. The following points show the contribution of the project for integrated and sustainable park management.

- A reforestation component by FNC helped to increase fire resistant species such as *Acacia seyal* and *Balanites aegyptiaca* and the creation of 221 km of firebreaks also significantly contributed to fire management (ENWM/CWMC, 2016, interviews).
- The park zoning into core zone, buffer zone and development zone was introduced to achieve a win-win outcome for rural development and biodiversity conservation (Naughton-Treves et al., 2005). DNP has been classified into buffer zone, development zone and core zone (see Fig. 4) with specific targets and actions to achieve the management objectives in each zone. Additionally, there is a transboundary zone specified. It is clearly stated in the management plan that all zones are subject to change when needed (Lindsay et al., 2009).
- The core zone is the area exclusively dedicated for biodiversity conservation. This area covers 53% of the total area of the park.
- The buffer zone comprises woodland ecosystems where nondestructive human activities are allowed for livelihoods of the communities in the area. This zone covers 26% of total area of the park.

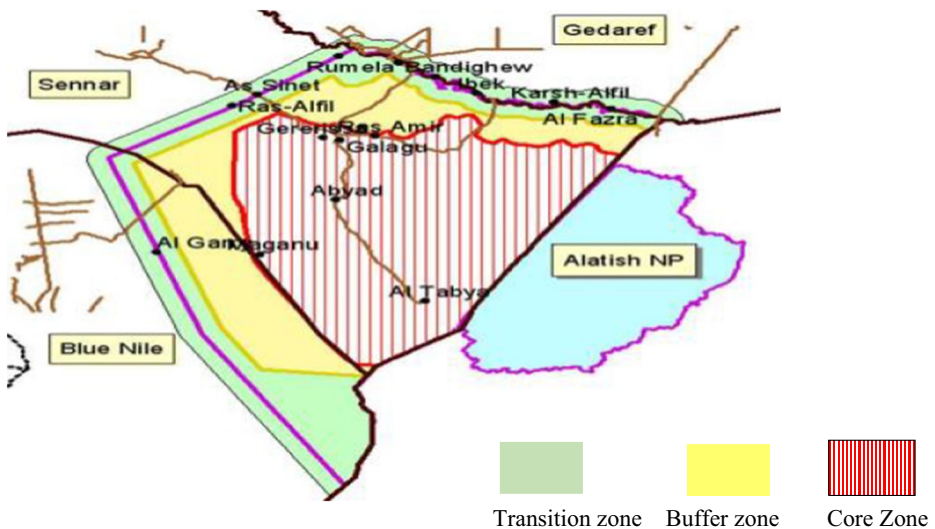


Fig. 4 DNP management zones. Source: Lindsay et al. (2009)

- The transition zone sets a 5 km corridor along the three states' boundary (El Gedarif, Sennar, and Blue Nile). It is designed to be used sustainably by the local communities and pastoralists and covers 21% of the park area. It is also set to limit human activities in the area that would otherwise expand to the buffer zone. This implies that the use of the buffer zone depends on the successful management of the transition zone.

Successful park management requires to integrate the local users' role in decision-making as well as strong institutional collaboration. This involves Wildlife Research Center, Forest National Corporation (FNC), Sudanese Environmental Conservation Society (SECS), Higher Council for Environment and Natural Resources (HCENR) and the relevant ministries that have central roles to play in DNP management to implement policy packages in each zone.

Although DNP shifted to Biosphere Reserve in 1979 and registered as a Ramsar site in 2005, it was only after GEF-UNDP project that WCGA's approach relatively changed to people-oriented contrary to its initial exclusive wildlife conservation. The WCGA staff were mainly military personnel in the past. However, now the institution has created different departments that run by trained professionals. The administration's collaboration with other institutions has significantly improved. Furthermore, WCGA has taken initiative to establish transboundary conservation management in collaboration with Ethiopia drawing lessons from ENWM/CWMC project. These developments are promising for biodiversity conservation and livelihood improvement.

4.4 Transboundary protected area management

Establishment of TBPAs is growing across the world (Barquet et al., 2014). The 15 Southern African Development Community (SADC) member countries have demonstrated the benefit of cooperative resource management among themselves for conservation, peace, and economic integration by establishing Trans-Frontier Conservation Areas (TFCAs) (Hanks & Myburgh, 2015). Muboko (2017), highlighted the socioeconomic and conservation progresses made by Malawi-Zambia TFCAs as an example. The African Highlands Initiative (AHI) has been working on integrated natural resource management in Ethiopia, Kenya, Tanzania, and Uganda. The initiative has achieved success in technology adoptions which in turn improved watershed management, crop production and community participation (German et al., 2013).

DNP and ANP face common challenges (HCENR & WCGA, 2004; Hailu, 2011; Marye et al., 2008; UNEP, 2007). These common challenges of the parks include encroachment, livestock trespassing, and poaching. They are transboundary in their nature and require a profound cooperative management plan. Transboundary protected area (TBPA) has been proposed in the southeastern part of DNP where it shares a border with ANP of Ethiopia to tackle these problems. Hailu (2011) studied potentials and challenges for transboundary management for the two parks and reported strong public and officials support for a TBPA establishment. However; it is important to note Lange (2009), argument that TBPAs are usually perceived as trendy in some cases. This has high relevance in our study as many key informants from WCGA stressed on the possibility to obtain funding when asked open-ended questions about the importance of TBPAs establishment of the two parks.

In this study, the Trillo-Santamaría and Paül (2016) TBPA framework is used to explain the potential DNP and ANP cooperative management (Fig. 5).

TBPA management requires profound and clear joint management guidelines based on the cooperation of the two parties including their counterpart stakeholders (Erg et al., 2012). The role and mandate of these stakeholders are important in determining the direction the cooperation would take and the success of the transboundary initiative (Leibenath et al., 2010). Sandwith et al. (2001) pointed out the importance of identifying shared values and vision (see Fig. 5) in the framework between the two collaborating PAs stakeholders. It is also important to identify shared environmental characteristics such as ecosystems, and threats. In the case of DNP and ANP, these issues are already well documented in their respective management plans. This simplifies the initiation phase of TBPA cooperation. The next step should be proper implementation of these shared values and visions cooperatively. The characteristics of cooperation and requirements need to be specified and frequently monitored and evaluated (Erg et al., 2012; Sandwith et al., 2001: 34). Different scholars have developed guidelines for TBPAs management (Erg et al., 2012; Sandwith et al., 2001) stressing the importance of having a clear written agreement from the beginning of the process.

So far, DNP- ALNP transboundary initiative is at an early stage of conducting the study on the possibility of establishing a transboundary management plan. WCGA has had several meetings and partnership visits with their Ethiopian counterparts. The meetings minutes were not accessible as they have not reached a clear consensus. Once the two parties reach an agreement and written memorandum, they could proceed to develop a strategy of TBPA management. The strategy should include details of land use planning (zoning), conservation, socioeconomic development, ecotourism, the needs for infrastructure, security, and staff development (Sandwith et al., 2001). Another crucial factor for the successful functioning of TBPA is the availability of sufficient funds (Erg et al., 2012). Developing a clear and profound common structure increases the possibility of securing funds. Finally, the implementation of the management plan should be through cooperation and regular information exchange. This will enable them to make necessary adjustments to their respective and the joint management plans when needed (Erg et al., 2012).

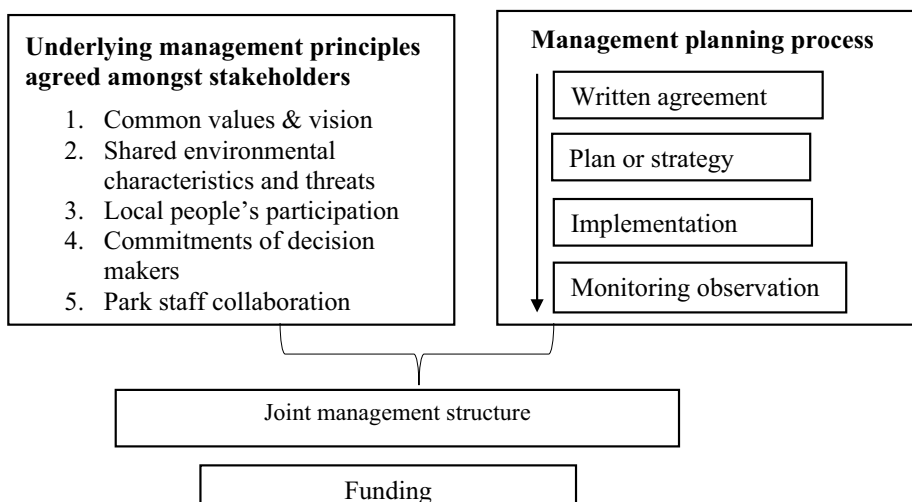


Fig. 5 TBPA framework. Adapted from Trillo-Santamaría and Paül (2016)

Different studies have demonstrated the success of transboundary conservation schemes in different forms (German et al., 2013; Hanks & Myburgh, 2015 and Muboko, 2017). However, transboundary protected area management could be more complicated when added to a long-standing border dispute between Ethiopia and Sudan (Wubneh, 2015). The author highlighted different diplomatic negotiations for border demarcation. However, the border demarcation has not been conducted up to date and the conflict continues to take place. On July 3, 2018, Ethiopian Satellite Television (ESAT) reported the violent conflict between the troops of the two countries after the army of Sudan killed several Ethiopian farmers (Wolde, 2018). On August 5, 2018 the Sudan Tribune reported that the Deputy Prime Minister of Ethiopia and Vice-President of Sudan met to discuss border dispute resolution through joint technical committee.

Therefore, it is important to resolve border disputes and national conflicts first. For instance, the former governor of Sennar State was removed from office during the GEF-UNDP project because of his strong advocacy to convert park area in Sennar State to agricultural land. This kind of conflicts of interest can sabotage the transboundary initiative if expanded to the border area.

5 Conclusion

In the process of pursuing their livelihoods, local people in and around DNP put pressure on the park. The local communities depend on the park for the extraction of natural resources for both subsistence and income generation. These activities are known to be the cause for the degradation of the park. The lack of clarity with the regard to land tenure and the park boundary combined with agricultural expansion into the park and livestock trespassing have been the major threats to park. Although environmental income which indicates the dependence on the environment does not include agriculture and livestock in its definition, we consider both as livelihood strategies which are increasingly depending on the park as a result of new settlements and decline in grazing land.

The pattern of collection of forest products in the area is irregular and difficult to quantify. Besides, the respondents provided significantly different responses to the monetary values of the same products. As a result, we were not able to determine environmental income in monetary term. Instead, ranked according to their importance. The wealthy individuals from other areas collect forest products, mainly Gum Arabic and produce charcoal for income generation.

Our findings confirm the suggestion of Wunder et al. (2014) to carefully carry out case-by-case analysis to in the study of livelihoods and to determine the contribution of forests in a particular study area. As noted in the same study, where forest products extractions are illegal the respondents are hesitant to specify the quantity of products they collect. This is the underlying condition in the case of DNP. The same study explained the challenge of recalls when products are collected on a daily basis. Our study context fits with this view.

For a long time, the focus of the park administration has been on wildlife protection. However, following GEF-UNDP and ENWM/CWMC projects, the park administration is moving toward the implementation of the Biosphere Reserve concept. These projects demonstrated the mechanisms of reducing local people dependence on the park by providing households with alternative livelihoods such as improved seeds and trainings in scientifically supported farming system.

The local people participation in the projects and collaboration with other institutions have helped WCGA to see a bigger picture and aim to establish TBPA in collaboration with Ethiopia. This will help to reduce poaching and livestock trespassing as the border area will be designated as core zone dedicated for biodiversity conservation. The collaboration of WCGA with other institutions will also help to bridge a gap in national policy among relevant ministries.

Finally, the park administration needs to work with the communities in Blue Nile State and help them with similar livelihood alternatives implemented mainly in Gedarrif and Rahad area.

We agree with Van Hoven and Nimir (2004) that placement of WCGA under the Ministry of Interior which is not ideal for wildlife conservation and natural resource management in general. We recommend the WCGA to be under more appropriate ministry such as Ministry of Wildlife Conversation & Tourism.

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