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Assessing ecosystem services for the Integrated Management of Sakabansi dam in northern Benin

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1. Introduction

Agro pastoral dams are water holding infrastructure constructed either by damming a river or re excavating a natural pond for the purpose of fresh water provision (Ibouraima, 2005). In Benin, such agro pastoral dams provide various ecosystem services which are instrumental for riparian communities' livelihood and biodiversity (Baba, 2013; Kpéra et al., 2012). The dam of Sakabansi in northern Benin represents the main source of fresh water supply during dry seasons, the agro pastoral dam of Sakabansi village is also central for the preservation of endangered species including the IUCN red listed Africa crocodile (Kpéra et al., 2012). Yet, over the last decades, the management of this dam has been challenged by a drastic conversion of natural ecosystems (in the catchment area) into farmlands (Capo-Chichi et al., 2009) and various stakeholder conflicts over the use of ecosystem services (Kpéra et al., 2014). Recently, a harrowing conflict opposing the local dam management committee and the municipal council of Nikki over fisheries considered by both parties as an important source of financial income (Baba, 2013; Kpéra et al., 2012) resulted to a drastic shrinkage of the dam buffer zone from its initial 12.46 km² to about 63 hectares in 2013 (Baba, 2013), as well as the neglect and abandonment of seasonal maintenance activities previously carried out by the local dam management committee together with detrimental impacts on the fresh water and ecosystem regulating services provided by riparian ecosystems.

A close analysis of this conflict as well as riparian stakeholders' attitude suggests not only a poor understanding of the interrelations between the dam system components (dam and riparian ecosystems mostly), but also a poor perception of ecosystem services and goods provided by the system dam-buffer zone and probably an overvaluation of fishing activities as compared to the whole range of services provided by the dam system (reservoir and buffer zone). This recalls the urgent needs to assess, quantify and value ecosystem services provided by such system and to explore tradeoffs and ways to reconcile riparian stakeholders' needs of provisioning services with the sustainable management of the dam.

Against this background, the concept of ecosystem services has been widely documented as effective in reconciling development priorities and ecosystem preservation (de Groot et al., 2010; Potschin and Haines-Young, 2011) thanks to its ability to foster tradeoffs analysis and to link ecosystem properties and functions to human well-being (Costanza et al., 2014; Groot et al., 2010; Spangenberg et al., 2014; Tallis et al., 2012). In spite of its successful implementation in various natural resources management

contexts and sectors (Bateman et al., 2013; Fisher et al., 2011; Harrison et al., 2014; Mace et al., 2012; Sinare and Gordon, 2015; Turner and Daily, 2008), its implementation in Sub Saharan countries, especially in West Africa remain inadequately tested (Leh et al., 2013; Nelson et al., 2009). Framed by the concept of ecosystem services, this research aims therefore to address the following research questions: (1) what ecosystem services are provided by Sakabansi dam and its buffer zone and at what spatial scale are they used and valued? (2) What is the economic value of services provided by such system (dam-buffer zone) to riparian communities?

2. Material and Methods

2.1. Overview of the area of study

The village of Sakabansi is located in the commune of Nikki, department of Borgou. Two socio cultural groups namely the Baatombu (45.4%) who are farmers in majority and the Fulbe (40.4%) whose main activity is cattle herding prevail in the village even though several other groups exist. In 2010, the population of Nikki was estimated to be 137,721 inhabitants (Baco et al., 2012, unpublished) representing an increase of more than 30% as compared to 2002. Likewise, the population of Sakabansi increase from 9,411 inhabitants in 2004 to almost 145,518 in 2014 (Nikki Health Zone projections, 2014, unpublished). Such increase in population triggered an exponential demand for land and food thus resulting in a rapid conversion of natural ecosystems into farmlands as observed in figure 1.

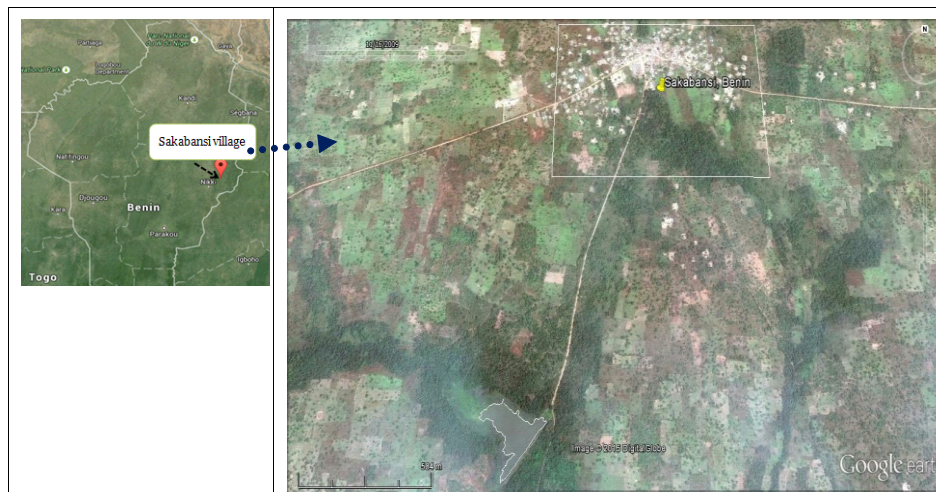


Figure 1: Overview of Sakabansi village geographic position and landscape. In gray (bottom left), the agro pastoral dam of Sakabansi village

The area belongs to Benin agro ecological zone 3 characterized by a Sudano- Guinean climate with one rainy and one dry season. The mean annual rainfall varies between 900 - 1300 mm (Baco et al., 2012, unpublished). The natural vegetation is mainly woody savannas dominated by *Anogeissus leiocarpa*, *Margaritaria discoidea*, and *Holarrhena floribunda* among tree species and *Combretum ghosalense* and *Acacia ataxacantha* among shrubs. The dominant type of soil is tropical ferruginous explaining its strong propensity to erosion once the protective grass and tree layers are degraded. Constructed in 1984, the dam of Sakabansi has a total storage capacity of 250,000 m³ out of which half is considered as active storage capacity (125,000 m³). The watershed covers an estimated area of 20 km² (Kpéra et al., 2012).

2.1. Research methodology

To assess, quantify and value ecosystem services provided by Sakabansi dam system (dam, buffer zone), 2 village meetings, 15 group discussions and 124 interviews were held in 10 localities (Central agglomeration of Sakabansi village, Guirgirè, Gourè Matchou, Barougoussi, Gnel Bodeeji, Gourè Dèmè, Kotaagui, Gourè Gbata, Gnel Djaouga and Don Plawi) using semi-structured questionnaires. Interviewees were selected through a stratified sampling method and randomly within each strata (based on communities' main occupation). For specific actors (*Shea* butter and mustard processors for instance), snowball sampling method has been used.

The quantification and valuation of ecosystem services were based on a set of preselected indicators which were validated during the first two village meetings. The quantification of ecosystem services was based on both potential (timber, construction poles,

pasture, Shea nuts, Seeds of *Parkia biglobosa*, soil prevented from being eroded, fertile soils for crop production, etc.) and actual benefits (vegetable farming, fish harvest) derived from the ecosystem services. The valuation was mainly based on market pricing of marketable goods such as Shea nuts (*Vitellaria paradoxa*), seeds of *Parkia biglobosa*, construction planks, timber (local market conditions in 2013). For regulating services (erosion prevention, soil fertility) and other non-merchandized goods in the locality such as forage and pasture, the valuation was based on avoided damage cost and other relevant proxies.

3. Results and Discussion

About twenty four different services/goods associated with either the dam (fresh water services) or riparian ecosystems have been recorded from both focus group discussions and interviews. Due to time constraints and the lack of relevant proxies, only nine of them have been categorized, quantified and valued. Based on these latter, the Total Economic Value (TEV) of benefits derived from the dam system has been estimated to 131,446 € (data of 2014). Figure 2 shows the relative weight of each ES sub-category to the TEV, it highlights the crucial importance of provisioning services (raw materials, fresh water, food) for riparian communities and the little consideration/knowledge of ecosystem regulating services including soil erosion (Figure 2a).

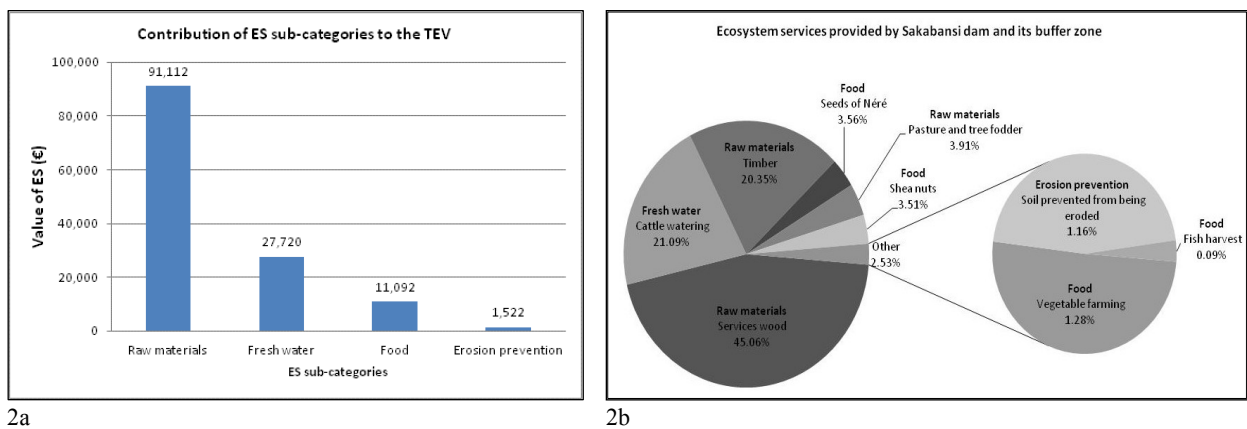


Figure 2: Contribution of ecosystem services provided by Sakabansi dam and the buffer zone to the Total Economic Value (TEV)

Figure 2b shows the specific contribution of ecosystem services to the total economic value. Though raw materials including service woods (construction poles) and timber production is the most important sub-category of services provided by the system dam-buffer zone, fresh water services especially cattle watering represents the second most important contributor to the total economic value of services provided by the system. Interestingly, this valuation shows that fisheries which Sakabansi dam major stakeholders opposed represent less than 0.1% of the total economic value of ecosystem services provided by the system. Even within fresh water services, the benefits derived from fisheries were only about 0.30% compared to watering cattle (74.15%) and vegetable farming (4.5%). Such information is likely to stimulate consensus among stakeholders of the dam in order to provide insight in the often unseen value (or considered as naturally given for free) of fresh water and forest ecosystems services.

4. Conclusion

Agro-pastoral dams which was constructed in the 1980s to face water scarcity and to promote rural development nowadays perform multiple functions beyond their primary goals. Yet, more than 50% of these dams currently undergo various degradation resulting mainly from the rapid expansion of agricultural lands over natural ecosystems and stakeholders' conflicts over resources (use of ecosystem services). Given the wide success of the concept of ecosystem services and the economic valuation of ecosystem services in reconciling development objectives and ecosystems' preservation, this research attempted to catch what services are provided by such complex system to riparian communities and how the values assigned to each service by riparian communities could be used in tradeoffs analysis to reconcile stakeholders' competing interests and ensure the sustainable management of the system (dam-buffer zone).

Due to difficulties to quantity and value non-use and option values within such a short time frame, the current term "Total Economic Value" should be taken cautiously as it is mainly based on the use value of ecosystem services. Besides, the computed total economic value does not account for tradeoffs between ecosystem services nor the numerous other provisioning, regulating

and information services stated and acknowledged by local communities. This is strongly highlighted by the following statement of one interviewee (Shea butter and mustard seller, May, 2013). *"We are not always processing butter or mustard for income. Sometimes, it's just the feeling to be busy at home, the opportunity to go in the local market to sell something and to meet friends and parents and to be informed about what is going on in our commune or country that matters most"*. All valuation methods are subject to criticisms, including the methodology of this research. Future researches are expected to improve the weaknesses of this research and to build on the strengths and opportunities provided by such explorative work.

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