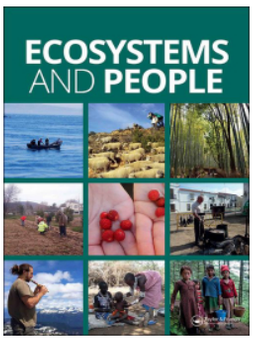

Ecosystems and People

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/tbsm22

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To cite this article: Irene A. Koko, Salome B. Misana, Aad Kessler & Luuk Fleskens (2020) Valuing ecosystem services: stakeholders' perceptions and monetary values of ecosystem services in the Kilombero wetland of Tanzania, Ecosystems and People, 16:1, 411-426, DOI: 10.1080/26395916.2020.1847198

To link to this article: https://doi.org/10.1080/26395916.2020.1847198

Published online: 27 Jan 2021.

ECOSYSTEMS AND PEOPLE
2021, VOL. 16, NO. 1, 411–426
https://doi.org/10.1080/26395916.2020.1847198

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RESEARCH

Valuing ecosystem services: stakeholders' perceptions and monetary values of ecosystem services in the Kilombero wetland of Tanzania

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ABSTRACT

Despite formal recognition of the need to incorporate multiple values in the assessment of ecosystem services, the operationalisation of a consistent integration of different types of values is still limited. This article assesses stakeholders' perception and monetary (economic) values of ecosystem services delivered by the Kilombero wetland in Tanzania. A mixed-methods approach was employed, which included deliberative elements (diverse stakeholder focus groups) to recognise stakeholders' perceptions on important ecosystem services alongside a survey to collect data on household characteristics, land use, status of ecosystem services and economic values of six provisioning ecosystem services (paddy production, maize production, water for domestic use, fishing, firewood and thatch grass). Findings revealed that stakeholder groups perceived the importance of ecosystem services differently. Analysis of the six provisioning ecosystem services in economic terms showed that paddy production generated the highest share of monetary value of about 56%. Furthermore, the study found out that there were differences in perceived and monetary values generated; for instance, paddy had much higher economic values than people acknowledged. The combined use of deliberative and monetary values is imperative in the assessment of ecosystem services as it will provide specific and complementary roles in supporting a management plan for the wetland ecosystem.

ARTICLE HISTORY
Received 3 September 2019
Accepted 26 October 2020

EDITED BY
Marta Berbés-Blázques

KEYWORDS
Ecosystem services; stakeholders' perceptions; monetary values; wetland; sustainable wetland management

1. Introduction

Interest in the valuation of ecosystem services has increased manifold in the past decade due to increased awareness of the loss of ecosystem benefits as a consequence of unsustainable environmental management. Assessment of ecosystem services aims to inform environmental management and planning using multiple values such as ecological, socio-cultural and economic (Millennium Ecosystem Assessment 2005; IPBES 2012; UNCEEA 2014). Ecological values are described in terms of how the service contributes to the health of the ecosystem, using indicators such as resilience and diversity (De Groot et al. 2010). Socio-cultural values entail human attitudes and perceptions regarding the importance of ecosystem services, while economic value reflects the relative importance of ecosystem services in monetary terms (De Groot et al. 2010; Nieto-Romero et al. 2014). Valuing ecosystem services and incorporating these values into decision-making processes would help decision-makers to consider sustainable use of ecosystem services (Geijzendorffer et al. 2015). However, trade-offs between values have been noted (Rodríguez-Ortega et al. 2014). Methods for measuring the values of ecosystem services tend to define the values being measured, and as a result of dominance of the biophysical and economic approaches, the values obtained only partially reflect the concerns of the ecosystem service beneficiaries (Martín-López et al. 2014). Therefore, in order to make well-informed decisions about management of ecosystem services, a combination of disciplines and valuation methods is recommended (Martin López et al. 2008; Gómez-Baggethun and Ruiz-Pérez 2011). Although there has been formal recognition of the need to integrate multiple values in ecosystem assessment, its operationalisation has remained largely elusive. Consideration of multiple ways to express values by different analytical tools and to capture the diversity of stakeholders' perceptions is still limited in ecosystem services literature (Chan et al. 2012; Jax et al. 2013; Martín-López et al. 2014). Stakeholders in this context are defined as 'any group or individuals who can affect or is affected by the ecosystem services' (Vermeulen and Koziell 2002).

Incorporating stakeholders' perceptions and how they value ecosystem services in the decision-making process will likely result in better management plans (Menzel and Teng 2010; Young et al. 2013). Stakeholders' involvement in valuation studies is an appropriate move for identifying the main relevant services, assessing their values, and discussing trade-offs involved in ecosystem services use (De Groot et al. 2006). Conflicts and dissatisfaction can arise when potential trade-offs resulting from differing values within and among stakeholder groups are not

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properly considered (McShane et al. 2011; Vira et al. 2012). Therefore, careful consideration of different views is necessary regarding sustainable management of ecosystem services.

It is vital to note that stakeholders' perceptions on the relative importance of ecosystem services have influence on monetary values, because preferences determining the 'utility' that a person obtains from a particular ecosystem service are usually influenced by non-economic factors related to ethical and moral motivations (Kahneman and Knetsch 1992; Spash 2006; Martín-López et al. 2007; Kumar and Kumar 2008). Similarly, the economic values are not objective facts, instead they reflect the socio-culturally constructed realities of particular societies (Cligget and Wilk 2007). Thus, a combination of socio-cultural and economic values would help to raise awareness about wetland benefits in decision-making and resource management options for wetland ecosystems. Previous studies that have analysed the role of stakeholder perception in valuing ecosystem services primarily focused on developed countries. For example, Paletto et al. (2014) looked at variable stakeholder preferences related to forest ecosystem services in Italy, and concluded that different backgrounds and cultures influenced the priorities given to forest ecosystem services. Lamarque et al. (2011) observed two contrasting stakeholders' perceptions of the effects of agricultural management on ecosystem services delivery, one negative and the other positive (considering low to medium management intensity). Also, Martín-López et al. (2012) found that environmental behaviour, formal studies and gender variables influenced peoples' recognition of the ecosystem's capacity to provide services. Such studies emphasise the role of social-cultural values in the assessment of ecosystem services. Furthermore, economic valuation of ecosystem services has received a lot of attention in scientific literature and several studies have provided a framework for valuing ecosystem services, such as the function analysis framework of De Groot et al. (2002); the Millenium Ecosystem Assessment framework (MA 2003); the spatial scales and stakeholders framework of Hein et al. (2006); the 'cascade model' (Haines-Young and Potschin 2010); and the UNCEEA (2014) System of Environmental-Economic accounting whereby they distinguished between biophysical and monetary ecosystem accounting. Despite the existence of different frameworks, a combination of stakeholders' perceptions and economic values in ecosystem assessment is still limited.

In developing countries, particularly in Sub-Saharan Africa, quite a few studies have engaged stakeholder perceptions in valuing ecosystem services. Zhang et al. (2016) found that rural communities in Nigeria had low awareness of regulating and supporting services. Again, McNally et al. (2016) noted that most people who depended on the Wami River in Tanzania placed a low value on non-recreational hunting, provision of traditional medication and prevention of salt-water intrusion. Sinare et al. (2016) presented a new method for classifying landscape units corresponding to local landscape perceptions in Burkina Faso. Hartter et al. (2014) established that perceived ecosystem benefits played an important role in the way the forest park was viewed and valued locally. Also, Abunge et al. (2013) provide the linkage between ecosystem and human wellbeing from the perspective of different stakeholder groups in a Kenyan coastal fishery context. All these studies underscore the importance of incorporating stakeholders' perspectives in ecosystem assessment and management. In Tanzania, several studies have been conducted on valuation of ecosystem services, such as Mombo (2013), Swetnam et al. (2011), Fisher et al. (2011), Siima et al. (2012), Fagerholm et al. (2012) and Mombo et al. (2016). All these studies, however, addressed a single value. The aim of this study was to assess ecosystem service values according to stakeholders' perceptions and monetary value derived from the Kilombero wetland ecosystem in Tanzania. Specifically, the relative importance of ecosystem services was analysed by considering stakeholders' perceptions and financial value generated.

This article is organised into five sections. Section 2 describes the overall methods and materials used for the study. Section 3 presents an analysis of socio-economic characteristics of the surveyed respondents, stakeholders' perception regarding the most and least important ecosystem services, as well as economic values of the provisioning ecosystem services for different villages. Section 4 entails a discussion of stakeholders' perceptions and income values of ecosystem services. This is followed by conclusions and recommendations for further research in Section 5.

2. Material and methods

2.1. Study area

The study was conducted in six villages located in the Kilombero wetland, situated within Kilombero District in the Morogoro Region, Tanzania (Figure 1). According to the Tanzania National Bureau of Statistics (2013), the total population in the Kilombero District in 2012 was 407,880 and with a growth rate of 3.9%. The Kilombero wetland ecosystem was an interesting area for this study as it is one of the largest seasonal freshwater lowland floodplains in East Africa, providing essential services and livelihood support functions to the people in and around the wetland (Kangalawe and Liwenga 2005; Mombo 2013). The capacity of the wetland to store water during the wet season and release it during the dry season provides communities with the opportunity to grow crops in both wet and dry seasons. Besides the possibility of crop production, the wetland

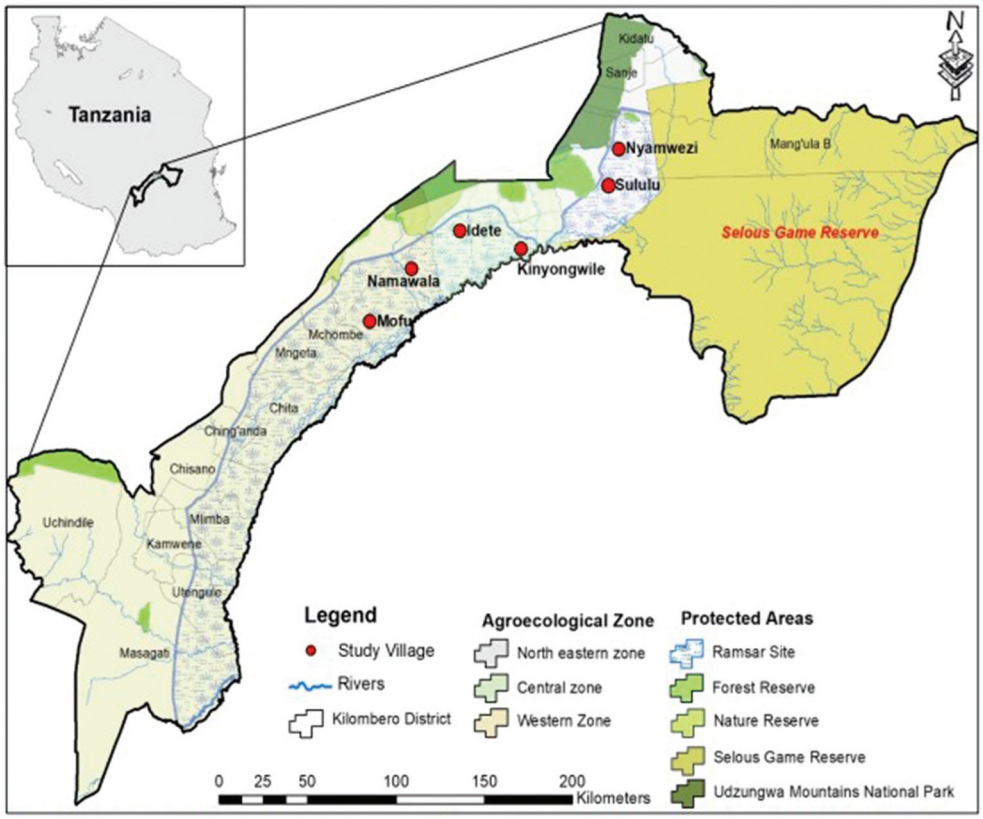

Figure 1. Location of the study villages and Kilombero wetland in Kilombero District.

also provide other services that support human welfare such as livestock grazing, water and fish supply, game and natural products (Mombo 2017). Despite its uniqueness in the provision of ecosystem services, the wetland are increasingly under pressure due to land use conversion. Land use patterns across the Kilombero wetland have changed significantly over time. Large areas that were formerly classified as grassland or woodland have been converted to other types of land use, particularly cropland and grazing land (Msofe et al. 2019). Changes in land use associated with different factors may alter wetland functions which may affect provision of ecosystem services and their values.

Six villages representative for the other villages in the study area were selected considering the fact that Kilombero District is divided into three major agro-ecological zones: north-eastern zone, central zone and western zone. The north-eastern zone lies along the Udzungwa Mountain Range and is characterised by loamy, clayey and sandy soils. This area is good for sugarcane and paddy production. The central zone experiences frequent flooding, therefore it is good for paddy production. The western zone is characterised by clayey, sandy and clay-loamy soils and is good for maize, paddy, banana and livestock production (Kilombero District Council 2009). Two villages were randomly selected from each of the three agro-ecological zones. In the north-eastern zone, Sululu and Nyamwezi villages were selected; in the central zone, Idete and Kiyongwile villages were chosen; and in the western zone Mofu and Namawala villages were chosen (Figure 1). It was essential to consider these different land units with homogeneous sets of characteristics as they play an important role for ecosystems and their services.

2.2. Data collection methods

In this study, a mixed-methods approach was employed, comprising a total of eight Focus Group Discussions (FGDs) with different groups of stakeholders, followed by a household survey to gather extensive qualitative and quantitative data on the stakeholders' perceptions and monetary values of ecosystem services. FGDs were held at the beginning of the study to better understand the local context, the ecosystem services provided by the wetland and their status, and to compare and contrast the perceptions of different stakeholder groups regarding the most and least important ecosystem services in the wetland. The average group size was 10 people; this helped to keep FGDs manageable. The groups were made up of men and women. Three main stakeholder groups were considered for the FGDs: local communities at village level, district officials, and representatives of non-governmental organisations at district level. At the village level, six FGDs were organised – one in each of the selected study villages. The local

community groups comprised farmers, livestock keepers, pottery makers, fishers and brick makers. Local communities are stakeholders who depend mostly on the wetland ecosystem for their livelihood. At the district level two FGDs were conducted. The first included a group of Kilombero district officials from different departments such as agriculture, wildlife and forest, land use planning, and water. This group was considered important as the officials play a major role in the ecosystem management through promoting conservation programmes and building local support to manage the ecosystem. The second group comprised representatives from non-governmental organizations (NGOs) that deal with the environment. This group has a lot of interest in wetland conservation, but it has very low influence when it comes to making decisions about the wetland ecosystem itself. Therefore, it was crucial to include such stakeholders in order to get their perception concerning values of ecosystem services.

Four different categories of ecosystem services were distinguished: provisioning services, regulating services, habitat services and cultural services. Such categories were based on the TEEB (2010) classification. Though several literature sources (e.g. IPBES 2012; Haines-Young and Potschin 2013; UN Committee of Experts on Environmental-Economic Accounting (UNCEEA) 2014) classify ecosystem services into three categories, this study used the TEEB classification due to its explicit inclusion of habitat services as a separate aspect. This was crucial for this study, as the Kilombero wetland is a very important ecosystem in the provision of habitat services. The specific ecosystem services listed in each category were compiled from stakeholders during FGDs and from literature: Millennium Ecosystem Assessment (2005); TEEB (2010); Haines-Young and Potschin (2013). Table 1 lists the specific ecosystem services included within each category.

Local stakeholders' perceptions regarding the importance of ecosystem services were assessed using a Pebble Distribution Method (PDM), also referred to as a ranking exercise (Colfer and Prabhu 1999; Sheil et al. 2003). Ranking of ecosystem services according to their relative importance was done for the complete set of ecosystem services generated in the study area. Each local resident was given 10 matchsticks, and was asked to allocate the matchsticks to the listed four categories of ecosystem services. Participants were told to put more sticks on the ecosystem service category that they perceived to be most important and fewer sticks on the less important ones. They were cautioned that for an ecosystem service to be important, it had to be enjoyed and valued. Diverse values could be considered, including economic, socio-cultural and environmental factors. Afterwards, the same number of sticks was distributed again to each participant and this time they were asked to rank specific ecosystem services (sticks that each participant distributed were recorded). Ecosystem services that were assigned a lot of sticks were considered most important and the ones that received fewer sticks were less important. In this type of ranking exercise, the local stakeholders are forced to distribute a finite number of sticks among many services, providing insightful information on trade-offs (Vira et al. 2012; Needles et al. 2015). None of the local stakeholders in the FGDs was familiar with the concept of ecosystem services; only a few of them showed intuitive understanding. Thus, it was necessary to describe the concept of ecosystem services to the participants as 'the benefits/products that nature provides to society' (Millennium Ecosystem Assessment 2005). District officials and environmental NGO participants were also asked to rate categories and specific ecosystem services based on overall importance on the scale of 1–3, with 1 as least important, 2 as somewhat important and 3 as most important.

In the survey, a household questionnaire was administered through face-to-face interviews, to gather information on household characteristics, land use, ecosystem services use and status, and economic values of ecosystem services (quantities of products produced and the cost involved, time used to collect materials/products in the wetland and the price of different products). In order to minimise bias and ensure representativeness across the sample villages, Yamane's statistical formula was used to calculate the sample size for the study. The Yamane

Table 1. Ecosystem services that stakeholders were asked to rank.

Ecosystem services category	Ecosystem services
Provisioning	Paddy production**
	Maize production**
	Water for domestic uses (drinking, cooking and bathing)**
	Fuelwood**
	Fishing **
	Thatch grass**
	Medicinal plants**
	Fodder (for livestock keeping)**
	Bushmeat (wildlife hunting) **
	Fiber and other materials**
Regulating	Climate regulation**
	Air quality regulation*
	Pollination*
	Soil formation and regulation*
	Diseases and pest control**
	Flood prevention**
	Carbon sequestration*
	Erosion control**
Cultural	Aesthetic: appreciation of natural scenery*
	Recreational (opportunities for tourism and recreational activities)**
	Inspiration for culture art and design*
	Spiritual and religious inspiration**
	Science and education**
Habitat	Nursery breeding grounds**
	Genepool protection (wildlife protection)*

Source: Millennium Ecosystem Assessment (2005); TEEB (2010); Haines-Young and Potschin (2013) and Field Data (2016/2017).
*Identified through literature review.
** Identified through literature review and field data.

formula is a simplified formula for a finite population and assumes a normal distribution (Yamane 1967). In total, 369 households were interviewed between August 2016 and September 2017. The sample was proportionally divided among the six sampled villages to obtain the sample size for each village (Table 2). Most of the selected study villages were inhabited by about 500 to 600 households, except for Nyamwezi and Namawala which hosted about 900 and 1500 households, respectively. Despite the differences in the number of households sampled per village, the selected sample size was considered representative and sufficient to capture the variability between the villages concerning values of ecosystem services. To obtain the sample households for the study, a simple random sampling technique was employed. The Village Executive Officers (VEOs) provided a complete list of households in each village. Using these lists, heads of household to be interviewed were randomly sampled using a lottery method.

2.3. Data analysis

2.3.1. Assessing ecosystem services priorities

FGD count data on the importance of ecosystem service categories and specific ecosystem services were used as input for statistical analysis. Quantitative data on relative values of important and less important ecosystem services were analysed using Kruskal–Wallis and Friedman tests. The Kruskal–Wallis test, also known as the 'one-way ANOVA on ranks', is a rank-based non-parametric test used to determine statistically significant differences between groups as an independent variable on a continuous or ordinal dependent variable (Field 2013). In this study the Kruskal–Wallis test was used to determine statistically significant differences between the six villages and occupation categories within local stakeholder groups, while the Friedman test was used to determine differences among perceived values of ecosystem services within each of the stakeholder groups. Qualitative data on the status of ecosystem services and drivers of ecosystem service changes obtained from focus group discussions were analysed using content analysis. FGDs were recorded using a voice recorder and were then transcribed. Thereafter, statements that had been mentioned frequently by participants were systematically categorised into different themes and these were ecosystem service status, drivers of ecosystem service change and concerns regarding ecosystem service changes. Differences and similarities in statements that illustrated each theme were identified. Then key phrases and expression of the respondents were retained and used to support quantitative data analysis.

Table 2. Sample size by village.

Agro-ecological zones	Village	Total number of households	Sampled household	Proportion of the Sample (%)
Northern zone	Nyamwezi	900	70	19
	Sululu	619	47	13
Central zone	Idete	549	42	11
	Kiyongwile	580	46	13
Western zone	Mofu	621	48	13
	Namawala	1500	116	31
Grand total		**4,769**	**369**	**100**

Source: Lists of Village Executive Officers (for total number of households).

2.3.2. Economic valuation method

Six provisioning ecosystem services (paddy cultivation, maize, water for domestic use, firewood, fishing and thatch grass) were valued in monetary terms; two other provisioning services (fodder and medicinal plants) could not be valued as they were considered 'free service' and therefore difficult to monetise using exchange value. Valuing the provisioning ecosystem services was adopted because of availability of data from the survey and secondary sources. Also it was the ecosystem service category that was perceived by local residents/villagers through focus groups to be of higher importance compared to other ecosystem service categories.

For each valued ecosystem service, the percentage of participating households, data on what they produce, cost of production and net benefit were calculated at household level. Then, the net-benefit calculated for each of the six valued provisioning ecosystem services at household level was extrapolated using the percentage of the participating households in such activity and the total number of households in each of the sampled villages.

The valuation was done in such a way that it is aligned with national accounting. In the System of National Accounts (SNA), goods and services are valued at exchange rates, based on representative market prices where these are available (United Nations et al. 2009). The SNA provides standards on how products and assets can be valued in the context of national accounts. The resource rent approach was applied to get economic values of the selected ecosystem services. According to the resource rent method, the ecosystem service values can be estimated as a residual of the total revenue after all costs for capital and labour have been deducted (UN Committee of Experts on Environmental-Economic Accounting (UNCEEA) 2014).

The following equation was used to calculate the resource rent:

$$RR = TR - (IC + LC + FC) \quad (1)$$

where RR is resource rent, TR is total revenue, IC are intermediate costs, LC are labour costs and FC are user costs of fixed capital.

Total revenue consists of sales of specific economic activity expressed in basic prices, i.e. price before subsidies on products are subtracted, and taxes on the product are added (United Nations, EC, International

Monetary Fund, Organisation for Economic Co-operation, UN Development Programme, The World Bank 2009). Intermediate costs consist of operating costs, i.e. only current expenses excluding capital expenses or investment. The user costs of fixed assets consist of consumption of fixed capital (depreciation) and return on fixed capital (cost of capital). The cost of capital can be estimated as the interbank lending rate plus a risk premium (United Nations, EC, International Monetary Fund, Organisation for Economic Co-operation, UN Development Programme, The World Bank 2009). Thus, for the households/communities in this study the cost of capital would be depending on where they borrow money.

Several sources of data were used to calculate the resource rent. For paddy, maize, water for domestic use and firewood, data from the household survey which included data on production, price, cost and revenue were analysed. For the other two provisioning services (fishing and thatch grass) data collected from the household survey were complemented with information from the Southern Agricultural Growth Corridor of Tanzania (SAGCOT) report (Environmental Resources Management Limited 2012) to get economic values. The base year for the SAGCOT report was 2010 and they projected production prices and costs up to 2030. The values were calculated in Tanzania Shillings (Tsh), and then converted into Euro (€) with an exchange rate of Tshs. 2300 for €1 (average for 2016/2017).

3. Results

3.1. Socio-economic characteristics of the surveyed respondents

A total number of 369 heads of households were interviewed, ranging in age from 19 to 84 year, with a mean of 45 and standard deviation of 15 year. About 51% of all surveyed respondents were males and 49% were female. Households consisted of a minimum of 1 and a maximum of 26 family members, with a mean of 6; this is much higher than the average household size for Kilombero District and the nation as per the 2012 Tanzania census where the mean was 4 and 5, respectively. The main economic activity of the majority of respondents (83%) in the Kilombero wetland was exclusively focused on crop cultivation. Only 5% were solely depending on livestock keeping. About 7% of the respondents were agro-pastoralists, they engaged in both crop farming and livestock keeping. Another 4% engaged in farming together with other activities such as fishing, brick making and pottery making and only 1% engaged in farming together with petty trading.

3.2. Relative importance of each category of ecosystem services as perceived by stakeholders

The average relative importance assigned to each ecosystem service category by the local residents groups ranged from 1 to 70% (Figure 2). Looking across the villages, the value assigned to the provisioning ecosystem services by the local stakeholders was higher than the value assigned to other categories of ecosystem services (Figure 2). Although stakeholders perceived the mentioned provisioning ecosystem services to be important, they also noted some ecosystem service trade-offs. This was revealed during FGDs with local stakeholders from the study villages, where participants described the status of different ecosystem services. They admitted to have experienced an overall decreasing trend in most of the ecosystem services. One concerned participant from Mofu Village complained thus:

> Here in the village we have cleared most of the forest and natural vegetation for crop cultivation. Apart from that a lot of migrants come to the village with a lot of livestock and they graze in the forest. We do not have any forest any more. This has great impact on cultivation because we believe that forests influence rainfall, and currently we have been experiencing long dry periods. It is also difficult to get forest products.

District officials placed higher values on provisioning, regulating and habitat ecosystem services categories, while NGO stakeholders dealing with the environment perceived the habitat and cultural ecosystem services categories as significantly more valuable than the provisioning ecosystem services (Figure 3). Both local residents and district officials placed a significantly lower value on the cultural ecosystem services (Figures 2 and 3).

3.3. Relative importance of ecosystem services as perceived by all stakeholders

The relative importance of specific ecosystem services as perceived by villagers, district government officials and environmental NGO workers were analysed using Friedman's test, as presented in Table 3. From this table the highest mean rank score is 16.15 (for paddy rice as perceived by local residents) and the lowest mean rank score is 6.00 (for thatch grass, as perceived by environmental NGO workers). Table 4 presents analysis regarding the relative importance of ecosystem services as perceived by the villagers from the six villages, using the Kruskal-Wallis test, with the highest mean rank being 61.14 for maize and the lowest rank being 19.18 for paddy rice in Sululu Village. Furthermore, Table 5 presents analysis regarding the relative importance of ecosystem services as perceived by occupational

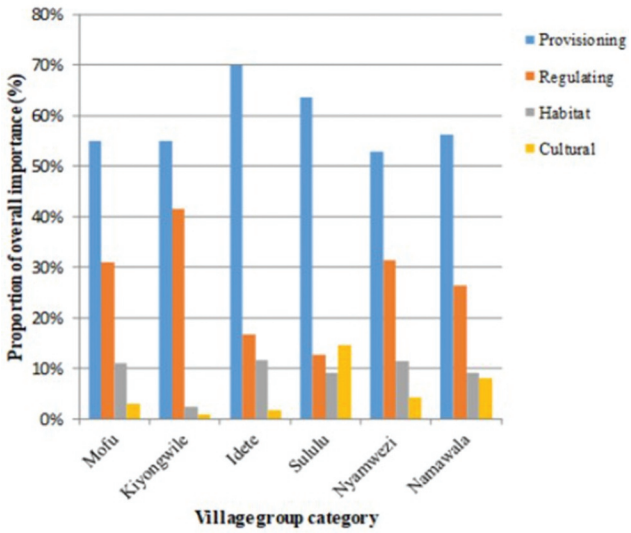

Figure 2. Relative values assigned to each ecosystem services category by local residents.

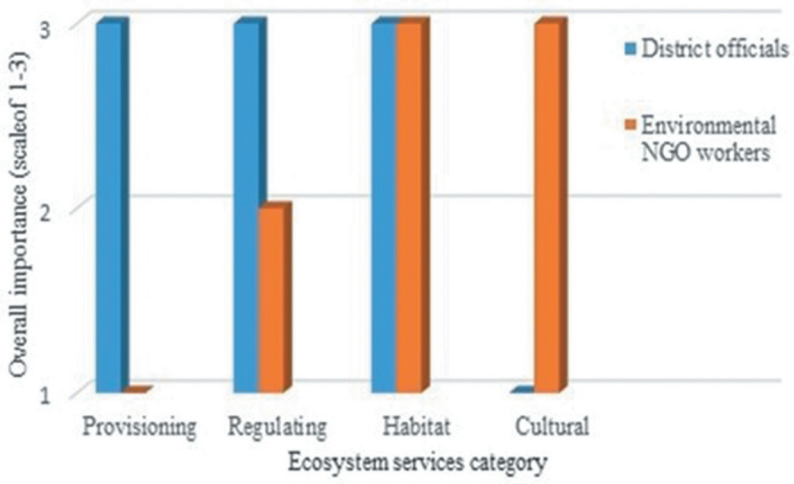

Figure 3. Relative values assigned to each ecosystem services category by district officials and environmental NGO workers in district FGDs.

categories within local stakeholders. The highest mean rank is 62.33 (i.e. livestock keepers' priority given to fodder) and the lowest mean rank is 24.86 (i.e. fisher folks' priority to paddy cultivation).

3.3.1. Provisioning ecosystem services

District officials and environmental NGO workers rated water for domestic use as the highest provisioning ecosystem service and local stakeholders rated paddy highest (on average). All stakeholder groups placed the lowest value on thatch grass (Table 3). Local stakeholders (villagers) and district officials placed higher value on firewood and fodder than environmental NGOs. From the six villages, only Sululu and Nyamwezi villagers ranked paddy cultivation lower than other provisioning ecosystem services. Local residents also perceived maize cultivation to be an important provisioning service, whereby Sululu Village ranked maize higher compared to other villages. Significant differences exist between the villages regarding crop production, particularly maize and paddy (Table 4). Moreover, compared to other local stakeholders' occupational groups, farmers ranked paddy cultivation higher and fodder for livestock keeping lower (Table 5). Livestock keepers and fisher folks assigned their highest priority to fodder and fishing and lowest priority to fishing and paddy cultivation, respectively. Hence, there are significant differences in the mean rank of fodder and fishing among the local stakeholders occupational groups (Table 5).

3.3.2. Regulating ecosystem services

On average, local residents and environmental NGO groups perceived climate regulation (interpreted as influence of vegetation on temperature and rainfall) as the most valuable regulating ecosystem service. Compared to other stakeholders, district government officials placed higher value on air quality regulation than on any other regulating ecosystem service. All

Table 3. Relative importance of specific ecosystem services as perceived by villagers, district government officials and environmental NGO workers using Friedman's statistical test.

	Mean rank		
Ecosystem services	Local residents (villagers)	District government officials	Environmental Non-governmental organization workers
Provisioning ecosystem services			
Paddy	16.15	11.40	8.90
Maize	10.75	9.60	7.40
Water for domestic use	15.74	15.80	13.40
Fishing	7.78	8.10	8.60
Fodder	8.52	8.30	7.60
Firewood	9.27	9.80	7.30
Medicinal plants	7.58	9.20	7.40
Thatch grass	7.24	8.00	6.00
Regulating ecosystem services			
Air quality regulation	8.19	12.10	8.70
Climate regulation	9.44	9.70	10.00
Pollination	9.14	8.10	8.70
Carbon sequestration	9.26	10.70	8.90
Diseases and pest control	8.54	8.00	7.50
Cultural ecosystem services			
Spiritual inspiration	8.74	6.40	10.70
Tourism	8.07	8.10	11.10
Science and education	9.11	8.30	12.60
Habitat ecosystem services			
Nursery (Breeding ground)	8.61	11.40	14.00
Genepool protection	8.86	8.00	12.00

Source: Author's analysis of FGD data.

Table 4. Statistical test of relative importance of ecosystem services as perceived by villagers from six villages using Kruskal-Wallis test.

	Mean Rank						
Ecosystem services	Idete	Kiyongwile	Mofu	Namawala	Nyamwezi	Sululu	Sig.
Provisioning ecosystem services							
Paddy	42.08	35.33	48.85	42.59	27.71	19.18	**0.004**
Maize	30.75	37.25	24.70	32.82	27.75	61.14	**0.000**
Water	42.50	32.04	39.30	26.77	42.46	28.05	0.141
Fishing	35.25	41.50	32.95	32.64	36.89	32.64	0.552
Fodder	32.79	32.08	36.55	32.59	39.07	39.59	0.717
Firewood	44.75	34.50	36.70	37.68	30.57	29.50	0.268
Medicinal plants	39.42	33.33	33.90	36.68	38.14	30.50	0.510
Thatch grass	32.00	34.83	35.40	35.09	39.79	35.09	0.595
Regulating ecosystem services							
Air quality regulation	37.75	34.33	28.50	37.23	39.14	34.32	0.553
Climate regulation	26.04	43.71	44.45	39.36	30.04	31.82	**0.039**
Pollination	32.25	39.75	41.60	37.00	35.79	27.00	0.361
Carbon sequestration	32.00	38.42	44.50	37.73	31.57	30.73	0.349
Diseases and pest	34.88	29.63	30.15	29.86	43.54	42.86	0.052
Cultural ecosystem services							
Spiritual inspiration	38.67	29.04	29.55	32.05	39.46	42.91	0.160
Tourism	40.17	28.50	31.85	28.50	41.04	41.32	**0.041**
Science and educational	40.17	27.08	42.50	33.95	43.79	40.59	**0.024**
Habitat ecosystem services							
Nursery (Breeding grounds)	29.17	42.04	40.45	45.41	28.29	29.41	**0.016**
Genepool protection	28.21	44.17	45.00	42.18	27.82	28.45	**0.005**

Sig. is significance level of difference between villages at 5%. The numbers in the significance column are p-values. Significant differences ($p < 0.05$) are in bold.
Source: Author's analysis of FGD data.

stakeholder groups rated carbon sequestration as the second important regulating ecosystem service (Table 3). Within the local community stakeholder group, Mofu and Kiyongwile villagers placed highest value on climate regulation while Idete villagers attributed lower value to this service. Climate regulation is the only regulating ecosystem service for which a statistically significant difference existed between the studied villages (Table 4). Furthermore, among the five local stakeholder occupational groups, brick makers ranked climate regulation higher (Table 5). Farmers ranked disease and pest control higher while fishers ranked it lower compared to other occupational groups. There is no significant difference in the mean rank of regulating ecosystem services across the occupational groups (Table 5).

3.3.3. Cultural ecosystem services

The results indicate that district officials placed significant lower relative values on cultural ecosystem

Table 5. Statistical test of relative importance of ecosystem services as perceived by occupational groups using Kruskal-Wallis test.

Ecosystem services	Farmers	Livestock keepers	Fishers*	Pottery makers *	Brick makers*	Sig.
Provisioning ecosystem services						
Paddy	41.82	37.44	24.86	34.05	25.44	0.066
Maize	33.60	33.78	37.55	43.00	31.69	0.613
Water	31.06	48.67	32.64	38.68	37.44	0.157
Fishing	29.50	33.33	61.41	29.50	33.81	**0.000**
Fodder	28.74	62.33	37.68	31.59	33.88	**0.000**
Firewood	35.27	38.17	38.50	29.50	37.50	0.724
Medicinal plants	37.24	34.28	34.05	36.68	30.50	0.687
Thatch grass	34.31	35.78	35.41	38.18	36.25	0.887
Regulating ecosystem services						
Air quality regulation	36.40	33.06	34.86	34.86	36.50	0.976
Climate regulation	36.24	30.28	36.59	33.23	40.13	0.786
Pollination	36.24	36.39	36.18	34.27	32.38	0.979
Carbon sequestration	35.77	34.67	30.73	37.73	38.88	0.839
Diseases and pest	40.00	38.44	29.86	39.23	33.65	0.354
Cultural ecosystem services						
Spiritual inspiration	39.29	29.89	29.27	34.82	36.63	0.307
Tourism	36.32	32.22	34.59	38.82	32.69	0.817
Science and education	37.27	27.94	33.95	39.59	33.63	0.546
Habitat ecosystem services						
Nursery (Breeding grounds)	37.97	30.06	33.05	32.32	39.81	0.520
Genepool protection	31.32	32.72	49.09	34.36	37.69	**0.034**

Sig. is significance level of difference between villages at 5%. The numbers in the significance.
column are p-values. Significant differences ($p < 0.05$) are in bold.
* These occupational groups also engaged in farming.
Source: Author's analysis of FGD data.

services than on other categories of ecosystem services. This was revealed through FGDs where the district game officer claimed, 'Previously we had tourist hunting blocks and other areas with unique species like the Kibasila swamp, but currently most of the places have been encroached for settlements and agricultural activities. This has impacted tourism negatively'. Environmental NGO stakeholders placed higher value on the importance of the wetland ecosystem for science and education, tourism, as well as for spiritual inspiration than district officials and local residents (Table 3). Compared to district officials, villagers placed high value on science and education. Looking across the local residents group, Kiyongwile and Namawala villagers placed lower value on tourism than other villages. Significant differences existed between the studied villages with regard to tourism and educational science services (Table 4). Within local stakeholder occupational categories, pottery makers ranked tourism and educational science services higher while livestock keepers ranked the same services lower (Table 5).

3.3.4. Habitat ecosystem service

District government officials and NGO workers perceived the function of the Kilombero wetland in maintaining a plant nursery as the most important habitat service. Furthermore, the environmental NGO workers placed higher value on genepool protection than the local residents and district government officials (Table 3). Within the local stakeholder group, Mofu, Kiyongwile and Namawala villagers placed significantly higher value on maintenance of a nursery habitat and genepool protection than other villagers (Table 4). In the same vein, fisher folks assigned higher values to genepool protection than other local stakeholders' occupational groups. Thus, there is a significant difference in the mean rank of genepool protection across occupational categories (Table 5).

3.4. Monetary value of the provisioning ecosystem services

Paddy farming is practised by 90% of the sampled households and it is mostly done in the flooded alluvial fans and swamps. Survey results showed that there were differences in average paddy production resource rent per household in the study villages. Compared to other valued ecosystem services, paddy had a higher standard deviation and it generated an annual average resource rent across the 6 villages of €251 per household (Table 6).

Maize is cultivated in the Kilombero wetland mostly in the upland areas and in the wetland during the dry season after the harvest of paddy. Almost 10% of the agricultural land in the wetland is used for maize cultivation. Average maize production resource rent also varied across the study villages. This had an impact on the resource rent for every study village. The average cost for maize production was €253/ha which is lower than that of paddy production. The annual average maize net-benefit (resource rent) from all studied villages was €48/household (Table 6).

Firewood was the main source of energy used by almost 90% of the households in the wetland. The study revealed that a household used about 1 medium-size bundle of firewood per two days, which is

Table 6. Monetary values of six ecosystem services.

	Average monetary values (Euro/household/year)						Total monetary values (kEuro/year)					
Study village	Paddy	Maize	Firewood	Thatch grass	Fishing	Water	Paddy	Maize	Firewood	Thatch grass	Fishing	Water
Idete	247	21	76	7	1	57	135.4	11.4	41.6	4.0	0.6	31.3
Kiyongwile	8	5	37	2	3	23	4.6	3.1	21.4	1.2	1.6	13.3
Mofu	37	63	106	42	122	23	21.1	19.6	62.5	7.8	7.6	14.3
Namawala	34	32	101	13	12	23	818.8	82.8	145.8	28.4	3.5	85.5
Nyamwezi	268	99	91	41	53	57	168.8	44.6	67.2	7.4	3.8	51.3
Sululu	546	55	97	19	2	57	47.2	66.3	67.9	16.2	1.1	14.2
Total	251	48	85	14	4	44	1,196.0	227.8	406.5	65.0	18.2	210.0

Source: Author's analysis of survey data.

equivalent to 9 kg. Therefore, a household was using 182 bundles (1,620 kg) of firewood per year. The average resource rent between the villages varies. Compared to the other sampled villages under this study, Kiyongwile Village generated the lowest average firewood resource rent. The average annual firewood net benefit (resource rent) across the study villages was €85/household (Table 6).

Thatch grass is used mainly for roofing and fencing around the compounds in the study villages. Result from the study revealed that 65% of the household respondents were living in thatched grass houses. The main types of grass used are *Pennisetum* and *Panicum Maximum*, which are mostly found in grasslands. On average, households used 220 bundles of thatch grass per year. Thatch grass generated an average annual net-benefit of €14/household across study villages (Table 6).

Fishing is another economic activity in the Kilombero wetland. The size of the village population involved in fishing depends on the location of the village in terms of its distance from the river. As a consequence, in some of the villages such as Mofu, the percentage of productive fisher folks is higher than in other villages. The average annual resource rent obtained from fishing activities is €64/household for households who engage in fishing, and €4/household considering all households (Table 6). Fishing generated low income compared to other ecosystem services that were valued in this study.

Findings also indicated that households got domestic water from wells and from the rivers. Villagers were organised in water user associations (WUAs) for community wells and they paid for the maintenance of these wells. Every household in Namawala, Idete and Nyamwezi villages paid €0.43 (€5.16/year) each month while in the remaining villages such as Mofu, Kiyongwile and Sululu every household paid €0.21 cents (€2.52/year) for maintenance of wells. Variation in the payment for maintenance of the wells was because villagers autonomously planned and budgeted for maintenance of the wells. When a household needed water, water was delivered at a price of €0.02 per 20-litre bucket. Therefore, €0.02 is estimated as labour cost for either hired persons or family members. The estimated use of water was about 10 buckets per day per household, equivalent to 200 litres. An average household used 72,000 litres per year equivalent to 72 m^3 at a market price of €2/m^3 in Namawala, Idete and Nyamwezi, and €1.5/m^3 in Mofu, Kiyongwile and Sululu. Hence, the difference in labour cost and the estimated price of water resulted to variation in water for domestic use net benefit for the selected villages.

The aggregated values of the six valued ecosystem services in the selected study villages within the Kilombero wetland ecosystem was €2,123,291, or €445 per household, per year. The largest contribution came from paddy production, followed by firewood, maize production, water for domestic use, thatch grass extraction and fishing (Figure 4). Furthermore, the result revealed difference regarding the monetary and perceived values of ecosystem services (Figure 5).

4. Discussion

This study shows that the Kilombero wetland ecosystem is highly beneficial in supporting the livelihoods of communities inhabiting the area. The wetland provide a number of livelihood options such as crop cultivation, livestock keeping and fishing, and a variety of other products such as firewood, thatch grass, water for domestic use, fodder and medicinal plants. The findings further show that crop cultivation is the main source of income to all surveyed households. This is expected, as it was noted earlier that all survey respondents are engaged in farming yet some of them perform other activities. These findings are consistent with Kangalawe and Liwenga (2005) and Mombo (2017) who indicated that the wetland ecosystem has high potential for a diversity of livelihood activities. In practice, there were considerable differences in the benefits accruing from the wetland, among the households in this study. This can be ascribed to the occupation of the household head; for instance, the households who see themselves as fisher folks and livestock keepers get more benefit from livestock keeping and fishing respectively, than others. This is also reflected in the way local stakeholders' occupation groups perceived importance of ecosystem services. Mostly, they perceived higher values to the ecosystem services that relate to their activity. The fact that the use of Kilombero wetland has increased and intensified is mainly the result of pressure due to

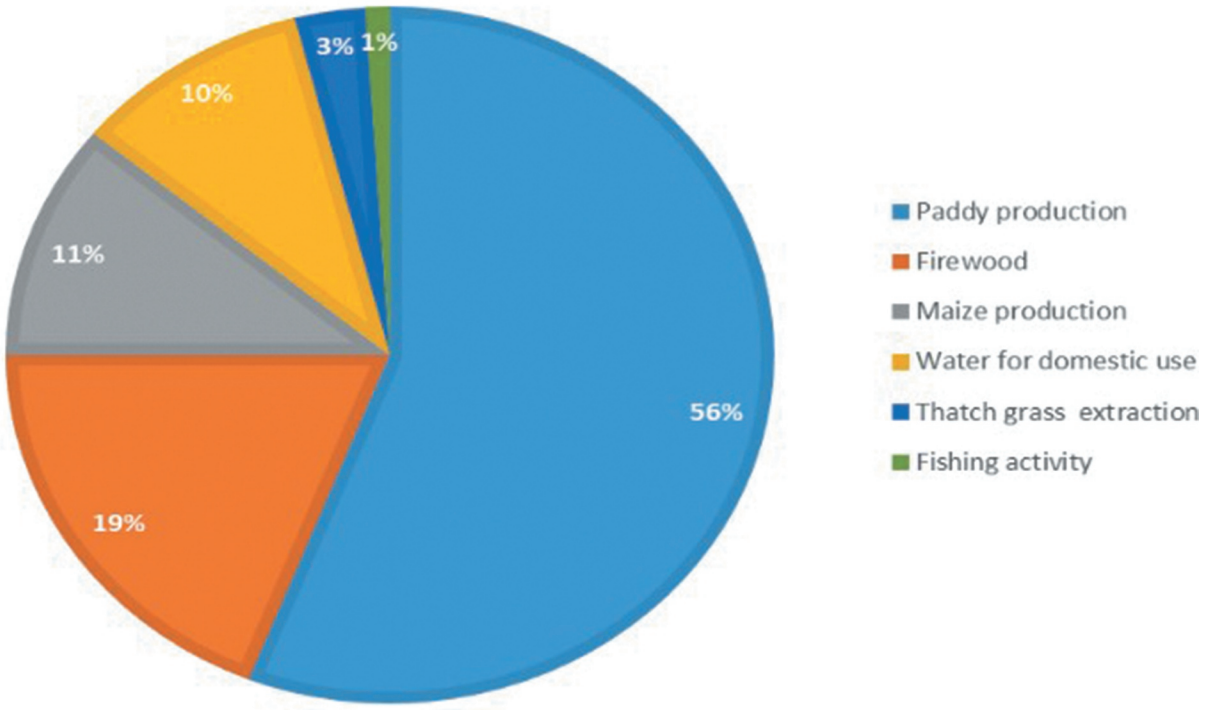

Figure 4. Contribution of the six valued provisioning ecosystem services to monetary value.

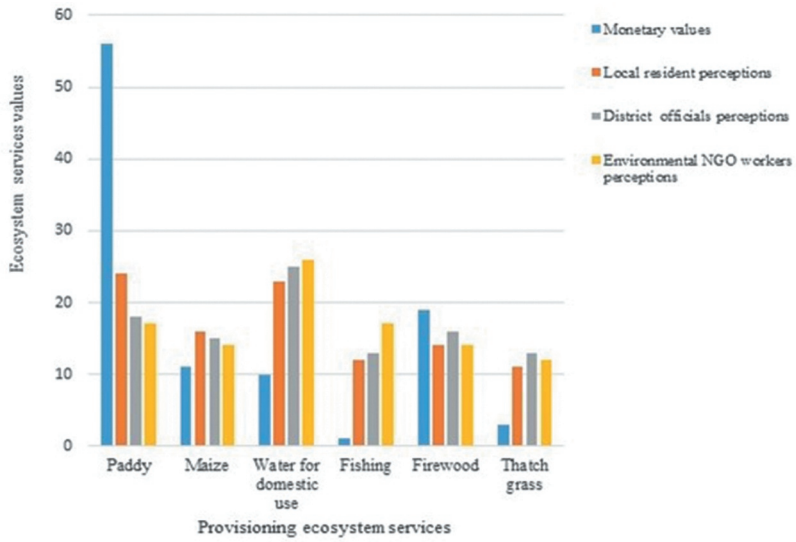

Figure 5. Perceived and monetary values of the provisioning ecosystem services.
Source: Author's analysis of survey and FGD data.

population growth and increased socio-economic activities. There is therefore a need to develop alternative income generating activities in order to safeguard livelihood contributions of the wetland.

As gathered from the focus group discussions, stakeholders tend to assign the highest priority to the services that they mostly depend on to sustain their livelihood. The local stakeholders give provisioning services the highest importance at an average of 57%. Regulating services were also widely recognised, habitat functions were also still attributed 10%, while a low level of relative importance was given to cultural ecosystem services. The discussants perceived provisioning ecosystem services to be most important because they are very reliant upon the natural resources for their sustenance and it is the main source of their income. Likewise, the study by Shoyama and Yamagata (2016) indicated that local communities have a greater preference for use values as compared to other stakeholders. McNally et al. (2016) also found that stakeholders assigned the highest priority to ecosystem services that were mostly linked to their livelihood or, for institutional stakeholders, their domain of responsibility. District officers and environmental NGO workers accorded higher value to services with both direct uses

(provisioning and some cultural services) and indirect uses (regulating and habitat services), whereas local stakeholders mostly placed higher value on services with direct uses (provisioning services). Similar differences were described by Abdul-Wahab and Abdo (2010) and Pan et al. (2016), who found that stakeholders who were knowledgeable about the environment showed higher interest to both direct and indirect use of ecosystem services.

Stakeholders' perceived values of ecosystem services differently depending on various factors, including their cultural background, their place of attachment, the impact of the service on their income and individual experience and situations (Lewan and Söderqvist 2002; Lamarque et al. 2011; Suwarno et al. 2016; Maestre-Andrés et al. 2016). These different views and interests of stakeholders often result in different visions on the management of the area (Tacconi 2000; Reed 2008). This is demonstrated by stakeholders' perceptions in the Kilombero wetland. Local stakeholders considered provisioning ecosystem services to be the most important ecosystem services as these directly benefitted them, while district government officials and environmental non-governmental organization workers considered also the regulating and habitat services. This can result to different views on the management of the area. For instance, local stakeholders or villagers would prefer to expand rice production, hence convert more wetland areas to farm plots, whereas district officials and environmental non-governmental organization workers support nature conservation, and therefore prefer the area to be used sustainably in order to also maintain the regulating and habitat services. Thus, it is essential to balance different interests in the management decisions of the wetland. If a management strategy relies on the interest of one particular group of stakeholders only, this may be unacceptable for other stakeholders' groups.

Difference in ecosystem services prioritization existed also between local stakeholders' occupational groups. Farmers were more likely to prioritize paddy cultivation, livestock keepers prioritized fodder and fishers prioritized fishing. This shows that human preference and needs determine ecosystem services values. The result is consistent with the findings from Hicks et al. (2013) who found that stakeholder groups differed in the extent to which they prioritized ecosystem services. Fishers tended to assigned greater estimates to fishery and managers to culture. Similar differences were described by Bernues et al. (2014) who indicated that farmers gave more importance to ecosystem services directly related to their own farming activity whereas citizens showed more general concerns. The other occupation groups in this study, such as pottery makers and brick makers assigned their higher priorities to science and education and to climate regulation services respectively. Surprisingly, these two services were highly prioritized but had no direct connection with the activities that they perform. Although there were differences in prioritization of ecosystem services within local stakeholder occupational groups, a majority of survey respondents confirmed that their main occupation was farming, yet they were also engaged in other activities such as fishing, and brick and pottery making to earn their living.

In addition, there were differences in local stakeholders' perceived values between the studied villages. Climate regulation was the only regulating ecosystem service with a statistically significant difference between the villages. In particular, Mofu and Kiyongwile villages ranked climate regulation higher compared to other villages. These two villages have received some environmental awareness education which in one way or the other may have helped them to understand the importance of regulating services, particularly climate regulation services. Other differences in relative importance attributed to ecosystem services among villages may have a biophysical basis. Villages with larger extension into the floodplain have higher stakes in paddy production, whereas Sululu village has more dryland area and shows clearly higher financial value as well as perceived value of maize production. The agro-ecological zones play a role in the patterns of cultural and habitat services: cultural values were highest in the northern zone, neighboring national parks, which can explain the higher ranks for tourism and science and education; whereas habitat services were ranked higher in the villages located deeper in the floodplain (Mofu, Namawala, Kiyongwile). Thus, it is essential to use integrated bottom-up approaches to sustainable wetland management which will take into account needs and interests of the potential users of the Kilombero wetland and can help to make sure the right priorities are set for the well-being of local communities and the wetland.

Stakeholders' perceptions allow identifying ecosystem services trade-offs and priorities at different levels. The involvement of beneficiaries having different interests is often the most efficient and reliable way of explaining ecosystem services' trade-offs (Turkelboom et al. 2016). As it was noted earlier, villagers were interested in maximizing provisioning ecosystem services, particularly crop farming, fishing and water which may reduce many regulating services such as soil quality, climate regulation, water regulation and habitat function. Recognizing ecosystem services trade-offs allows decision makers to understand the effects of preferring one ecosystem services over another, and the consequences of focusing only on the present provision of ecosystem service rather than its future. Policy and decision makers should develop strategies that minimize effects of ecosystem services trade-offs and should acknowledge the fact that short-term demands on ecosystem services may affect the longer-term provision of these or other

ecosystem services. Hence, this could be beneficial for planning and management of the wetlands and it may lead to more effective and credible management decisions for the sustainability of the wetland ecosystem.

Furthermore, by the study's focus on examining both perceived and monetary values of ecosystem services, they can be compared. Agro-products, particularly paddy, generated a higher monetary value than FGD participants acknowledged in deliberations. Vice versa, water, fishing and thatch grasses were perceived to be much more important than one would argue on the basis of economic values. For example, fishing generated the lowest monetary value, yet FGD participants perceived it as an important ecosystem service. This means that, despite the fact that fishing generated low economic values, it has other values such as cultural and nutritional values which leads stakeholders to perceive it as an important ecosystem service. Hence, some ecosystem services that were perceived to be highly important in deliberation are crucial for the livelihood of local communities, even though they have a low monetary value. Since these services are also vulnerable in nature, it is imperative to prioritize and incorporate these services in wetland policy decisions to safeguard their sustainability in the long term. Hence, the perceived and monetary values generated from this study may have specific and complementary roles in supporting management plans for the Kilombero wetland ecosystem.

The combined use of social and economic valuation techniques in this study offers an appropriate framework for ecosystem services valuation. The valuation was observed from different perspectives of analysis. This is supported by Wilson and Howarth (2002) and Nijnik and Mather (2008) who suggest that suitable approaches should combine different theoretical concepts, and integrate analytical and participatory techniques. We also agree with Ringold et al. (2013) and Tallis et al. (2012) who proposed that combining both scopes provides most information, here covered respectively by asking stakeholders to rank ecosystem services valuable to them and generating economic values for ecosystem services. This is important in land management, where trade-offs between alternative land uses exist and a prioritization of ecosystem services to be decreased or enhanced may be required (Hicks et al. 2013). While economic values often are a dominant driver of land management decisions, a monetary (economic) valuation approach remains somehow deficient to capture the actual values of ecosystem services for decision making (Laurans and Mermet 2014). This calls for the inclusion of non-monetary valuation techniques, which examine the importance of ecosystem services by involving preference, needs and demands expressed by stakeholders. It offers solutions and alternatives to some of the limitations of monetary valuation (Baveye et al. 2013). On the other hand, perceived values give only a relative idea of the importance attributed to different ecosystem services, with unclear contribution to livelihoods. Thus, it is unlikely that a single valuation approach can accurately capture ecosystem service values and be useful for decision making. This suggests that a pluralistic approach is essential in valuing ecosystem services.

5. Conclusion

This study presented an assessment of ecosystem services values in the Kilombero wetland from both a socio-cultural and economic perspective. In contrast with many ecosystem services valuation studies that focus on either biophysical models or monetary values of ecosystem services, we carried out an assessment using a combination of deliberative discussions (focus groups) and a survey to value ecosystem services. We found that these different methods used to assess ecosystem services values revealed different results. Particularly, paddy cultivation generated higher economic values than people acknowledged in the discussions, while other provisioning ecosystem services including water, fishing and thatch grasses were perceived to be much more important than was revealed on the basis of economic values. This indicates that different valuation methods uncover different trade-offs among ecosystem services. It is therefore essential for decision makers to be supported by a plurality of ecosystem services valuation methods to guide their plans for wetland management.

Our result also show that different stakeholders perceived the importance of ecosystem services differently. Local communities perceived provisioning ecosystem services to be of higher importance than other services. Contrary to the villagers, district officials and NGO stakeholder perceived and considered also some of the regulating, habitat and cultural ecosystem services to be of high importance. Perceived values also varied remarkably across local stakeholders' occupational groups. For instance, farmers, livestock keepers and fishers placed higher priorities on the services that directly relate to their own activity. Thus we suggest the use of integrated bottom-up approaches to sustainable wetland management, as such taking into account needs and interests of the potential users of the Kilombero wetland. This should be done by involving local communities in sustainable resources management, which will not only ensure that plans are appropriate, but also promote ownership from communities. As such, bottom-up planning can contribute to both the well-being of local communities and conservation of the wetland.

An important aspect to consider in the valuation of ecosystem services from the perspectives of stakeholder and monetary values, is the risk that people do not perceive the ecosystem functions underlying the benefits to society. Therefore, there is a need to further incorporate biophysical aspect responsible for maintaining the integrity of an ecosystem. We emphasize the strength of a pluralistic framework, by which both local context and values can be adequately assessed and properly translated into decision-making. The integration of stakeholders' perceptions and income values into the decision making context, together with knowledge on ecological functions, can help to better design strategies to safeguard ecosystems and their services.

Acknowledgments

This study was part of the first author's PhD research at the University of Dar-es-Salaam, Tanzania under GlobE - Wetlands in East Africa project funded by the German Federal Ministry of Education and Research(BMBF) under grant no.FKZ 031A250A-H. We express our appreciation to the communities in the Kilombero wetland for their enthusiastic participation in this study particularly in the group discussions and household survey. Many thanks to our colleagues of GlobE, particularly Hafidhi Kabanda for his suggestion and comments on the economic part of this study.

Disclosure statement

There is no conflict of interest.

Funding

This work was supported by German Federal Ministry of Education and Research(BMBF) under grant no. [FKZ 031A250A-H].

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