Full Length Research Paper

Important economic and ecological activities of Wetland resources of Nyando Wetlands

Ngũgĩ David Gathegi[1]*, Edi Ruto Tergat[2] and Bernard Loroupe Rudisha[3]

[1]Livestock and Fisheries, Ministry of Agriculture, P. O. Box, 391-30100, Eldoret, Kenya.

[2]Department of Fisheries and Aquatic Sciences, School of Natural Resource Management, University of Eldoret, P. O. Box 1125-30100, Eldoret, Kenya.

[3]Department of Economics and Agricultural Resource Management, School of Business and Economics, Moi University, P. O. Box, 3900-30100, Eldoret, Kenya.

Wetland resources of Nyando Wetlands support important economic and ecological activities. However, it is faced with multiple pressures from different anthropogenic Activities within the wetlands and upstream. The Nyando wetlands are facing increasing threats of reclamation for agriculture. This is bound to intensify as population pressure increases. The question therefore is; should Nyando Wetlands be conserved or converted? Using market and contingent valuation methods, within the benefit-cost analysis framework, an economic valuation was carried out to determine the benefits of conserving or converting the Nyando wetlands. The results revealed that Nyando Wetlands yield a flow of economic benefits of the consumptive goods and services estimated at about US$ 1.5 Billion (US$ 62,500 / Ha / year) with an infinite present value of US$ 75.5 Billion at 2% discount rate. Thus the reclamation of the wetlands would imply high economic costs to the government and local communities. To reduce the pressure of reclamation, it is suggested that educational campaigns on the importance of wetlands be carried out.

Key words: Wetland value, market price, contingent valuation, goods and services.

INTRODUCTION

Kenya's wetlands[1] occupy about 3 to 4% of the total landmass, which is approximately 14,000 km^2 of the land surface and increases up to 6% in the rainy seasons (Government of Kenya, 2008). Wetlands goods and services satisfy various objectives of different users: Food security and cash income (fishing, hunting and agricultural production), health (drinking water and hygiene), recreation and culture (spiritual enrichment,

cognitive development and aesthetic experience) (McCartney and Van Koppen, 2004). Wetlands generate a huge variety of plant, animal and mineral products used and valued by people all over the world, whether in local, rural communities or in far-off cities in foreign countries (Ramsar, 2011). Because of their socio-economic importance, wetlands have attracted significant portions of human populations who survive by exploiting their resources, through different resource utilization activities, often driven by economic and financial motives (Kirsten, 2005). Such reliance on natural resource exploitation for livelihood, always poses a great danger to the resources, more so if their value is not known or appreciated by the

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[1] The Environment Management and Coordination Act 1999 (EMCA) defines wetland as "an area permanently or seasonally flooded by water plants and animals.

stakeholders.

Nyando wetland is one of the largest and economically important deltaic wetland ecosystems fringing the Lake Victoria and covering about 10,000 Ha (Wandinga and Makopa, 2001) and performs important ecological, hydrological and socio-economic functions. However in recent years, the Nyando Wetlands have been facing increasing threats from agricultural activities like livestock grazing, reclamation for rice growing and other seasonal crops among others. This stems from the increasing human population within the wetlands; 316 persons per km^2 (Government of Kenya, 2010). In addition, wetlands are perceived to have little or no economic value (Kirsten, 2005) and that no formal markets exist for their services to humanity (Jodi et al., 2005) hence making wetlands conservation not to be seen as a serious alternative compared to other uses that seem to yield more tangible and immediate economic benefits. As a result inadequate resources are fed into their management which breeds environmental degradation through inappropriate commercial exploitation of wetlands (Oglethorpe and Miliadou, 2000). Despite these threats, the Nyando wetlands still provide a substantial flow of ecosystem goods and services which forms the backbone of the wetland community livelihood. The value of this flow has, however, not been established and as a result, management decisions have not adequately considered the economic importance these goods and services provide to the local communities and the national economy. Thus valuation of the wetlands goods and services would help policymakers know whether to allow conversion or not. This paper therefore aimed at determining the economic value of Nyando wetlands in order to offer policy insights.

Attempts have been made in the past to put a monetary measure on the values of wetlands (Barbier, 1993; Turner, 1991). Various methods have been used to value wetlands resources such as Contingent Valuation Method (CVM), Travel Cost Method (TCM) and Replacement Costs among others (Perman et al., 1997; United Republic of Tanzania, 2003). Globally, economic value of wetlands and their associated ecosystem services has been estimated at US$14 trillion annually (Millennium Ecosystem Assessment, 2005). Some wetlands have been valued across the globe. However, the valuation has been based on specific goods and services. For example, agriculture, fishing and firewood provision of Hadejia-Nguru Wetland in Nigeriawas valued at approximately US$34-54/ha (Barbier et al., 1997), agriculture in Nakivubo Wetland in Uganda was estimated at US$500/ha (Emerton et al., 1999), grazing in Zambezi Basin wetlands ranged in value from US $ 16/ha in the Barotse Wetland to US$97/ha in the

Caprivi Wetland (Turpie et al., 1999), harvestable resources in the Olifants River catchment in South Africa was estimated at US$1-14/ha/year (Palmer et al., 2002), and grazingin wetlands of southern Africa was US$257-343/ha among others. In Kenya, three ecosystem valuation studies have been done. These studies are wildlife viewing in Lake Nakuru National Park estimated at US$ 7.5 -15 M (Navrud and Mungatana, 1993) using CVM and TCM, Tana Delta (Emerton, 1994) and Yala Wetlands estimated at US$ 120.4 M (Ikiara et al., 2010) by use of both CVM and market price. These studies aimed at carrying out an economic valuation with a view of quantifying the economic benefits accruing from various wetlands in the world so as to facilitate optimal and informed decisions about wetland management for a sustainable future. They also highlighted potential economic losses that could arise from continued degradation and thus giving an impetus for wise use of the wetland resources by the communities.

METHODOLOGY

Study area, sampling procedure and data

The Nyando wetlands covers an area of 3,600 km^2, situated within the Winam Gulf between longitudes 34°47"E and 35°44"E, and latitudes 0°07"N and 0°20"S and about 750,000 people reside within it (Raburu et. al., 2012). It can be grouped as Lacustrine Wetlands (lake like), Riverine Wetlands (those associated with the rivers and streams), Palustrine Wetlands (swamps), a combination of Riverine / Palustrine Wetlands and Manmade Wetlands (created by man). It was formed during the Miocene period (about 20 million years ago) as a result of vertical upwarping of the African surface and the resultant sagging of the great ridge center (Bugenyi, 2001) and has within it some of the most severe problems of agricultural stagnation, environmental degradation and deepening poverty found anywhere in Kenya (Abila and Othina, 2005; Schuyt, 2005). It was reclaimed for agricultural production during the 1940's. The land remained under intensive agricultural activities for 15 to 20 years before the prolonged rains of 1963 (*Uhuru* rains) that caused floods due to overflow of Nyando River. The Nyando River drains into the Winam Gulf of Lake Victoria and is a major contributor of sediment, nitrogen and phosphorus to Lake Victoria. There are three Agro ecological Zones (Lower midland zone 3, 4, and 5). The mean annual temperature ranges between 20 to 30°C while the mean annual rainfall range between 1,000 and 1,800 mm (Government of Kenya, 2005). The rainfall is bi-modal with long rains (March to June) and short rains (October to November) (Government of Kenya, 2005). The flood-prone lakeshore area is mostly used for subsistence production of maize, beans and sorghum, combined with commercial production of sugar cane and irrigated rice.

Across-section survey was used between May 2011 to August 2011 in which information relating to the economic valuation of wetland goods and services was collected from a cross section of the population involved in the different resource utilization activities. This research design was considered because it permits the

collection of various wetland value attributes at a given point in time. 11 enumeration sites were purposively selected which had 20,479 households (Government of Kenya, 2010) adjacent to each other around the Gulf. This sampling technique was employed because Nyando wetland communities were not homogenous in terms of wetland utilization, conservation challenges, socio-economic values attached and development concerns and threats. Respondents were proportionately selected according to the household size per location to give each household an equal opportunity of response. The mean Household size was 6 (SD 2.75) persons with mean farm size at 2.9 (SD 2.2) acres. About 72% undertook farming as the main occupation with about 78% not going past primary level, that is, 8 years of basic education. About 95.6% enjoy the wetland benefits and about 96.4% agreeing that the wetland was being degraded.

In each location, line transect sampling was then employed to determine the movement path during data collection. Line transect is a sampling technique by which scientists record data regarding communities in an ecosystem. This method of sampling involves only a small section of large natural area, yet produces an accurate representative sampling of the biotic and abiotic parts of that community. The path started from the wetland to riparian areas with each targeted household separated by five homesteads along the transect path. Line transect sampling is reliable, versatile, and easy to implement method to analyze an area containing various objects of interest. A sample size of 270 was obtained (Mugenda, 2008), 277 questionnaires were administered and 274 used in analysis.

The first step in the valuation process involved the identification of wetland goods and services yielded by Nyando Wetlands. A workshop to provide basic information about the consumptive wetland goods and services was held. All the goods and services identified were listed in the questionnaire for valuation during the survey. The following valuation techniques were selected; (a) The market price method was used to value wetland goods traded in the open market with direct use value. These goods included crops, livestock fodder and feeds, fish, domestic water and forest and non-forest products whose subsistence consumption values and gross values were obtained to assign monetary values to benefits derived from the consumptive wetland resources of Nyando. (b) The CVM was considered to value wetland services for which people had some knowledge about and therefore could estimate their value, willingness to pay, in a hypothetical market, Conservation Trust Fund. The CVM is a survey-based technique where a sample of the population is asked a series of questions about their willingness-to-pay for various hypothetical programs (payment vehicle) that change environmental services (Lantz et al., 2010). This study used iterative bidding game as an elicitation mechanism to elicit WTP with a Conservation Trust Fund as the payment vehicle. The limitation of the bidding game is normally the starting point bias as this study started at Ksh 1,000. The contingent valuation scenario was that despite of the goods and services communities derive from the wetland, degradation was still eminent. To curb the problem, conservation, wise use and rehabilitation measures were to be implemented by Non Governmental Organization (NGO) through a monthly contributory Conservation Trust Fund. The limitation of such a scenario might be that little attention to the economic theory of household decision making could have been considered.

Structured questionnaires were administered to respondents to elicit quantitative data on the consumptive resources. The survey established details on each of the resources harvested, the amount harvested annually, the quantity sold as raw produce and the selling price per unit, the number of products produced from natural products and the amount sold and the selling price of these. Data was also obtained on the areas of land cultivated, the type of crops grown and amounts harvested, as well as livestock numbers and production among others. These were triangulated with in-depth Interviews and Focus Group Discussions (FGDs) with various key informants and members of the various resource user groups to gain insights on how the wetland was utilized. In addition, the study considered on secondary data sources to augment the primary data.

Descriptive statistics were used to explain key consumptive goods and services. On the other hand, the estimation of value of the key components of direct consumptive use values for a typical household was used to calculate the annual value of the Nyando wetlands. The Direct Use (consumptive) Value of Nyando wetlands products were calculated using the formula:

$$CV = \sum_{i=1}^{N} \gamma \, (P * T * H)$$

Where, CV = consumptive value in Kenya shillings (Ksh); γ - Percentage of households collecting a particular wetland product; P = mean value of wetland product collected per trip; T = mean number of trips made per HH for wetland product collection per year, and H = total number of households

For an estimation of the wetland's present value of finite annual streams of environmental net benefits, the following formula was used:

$$PV = \beta \, (1+r)^n - 1/r(1+r)^n$$

Where; β = stream of annual consumptive use values; r = the discount rate, and n = number of year under consideration

For the infinite annual streams of environmental goods and services case, the assumption was that the stream of benefits would flow constantly in the future due to sustainable utilization. In this case the PV of these future benefits was obtained through a simple expression that emerges when n approaches infinity (Pearce et. al., 1995 and United Republic of Tanzania, 2003). That is;

$$PV = \beta \, / \, r \quad n \to \infty$$

RESULTS

Key consumptive wetland resources

Virtually all the households living within the Nyando wetland derived a number of direct uses for their livelihoods. Maize was the most dominant crop at the locations with about 77% of the households growing it and identified by the Focus Group Discussion as the staple crop together with sorghum (36.8%). Beans were grown by 35.65% households while kales by 27.95%, indigenous vegetables by 27.05%, rice by 25.9% and tomatoes by 18.05% among others.

Fishing was being carried out by 33.6% of the households while livestock kept were cattle (77%), goat (56%), sheep (54%), donkey (2%) and local chicken (86%). Fodder is consumed by cattle, goat, sheep and donkey while feeds by chicken. Livestock water use depended on the number of livestock kept. Most animals consumed water from the source hence *ad libitum*. On the other hand, households in Nyando wetland get water from surface water sources like Rivers, wells/pans, lake and vendors.

Forest and non-forest consumptive values were also common (Figure 1). Wood was being used as firewood, charcoal and construction. Wood for firewood was the common forest product derived from the wetland by
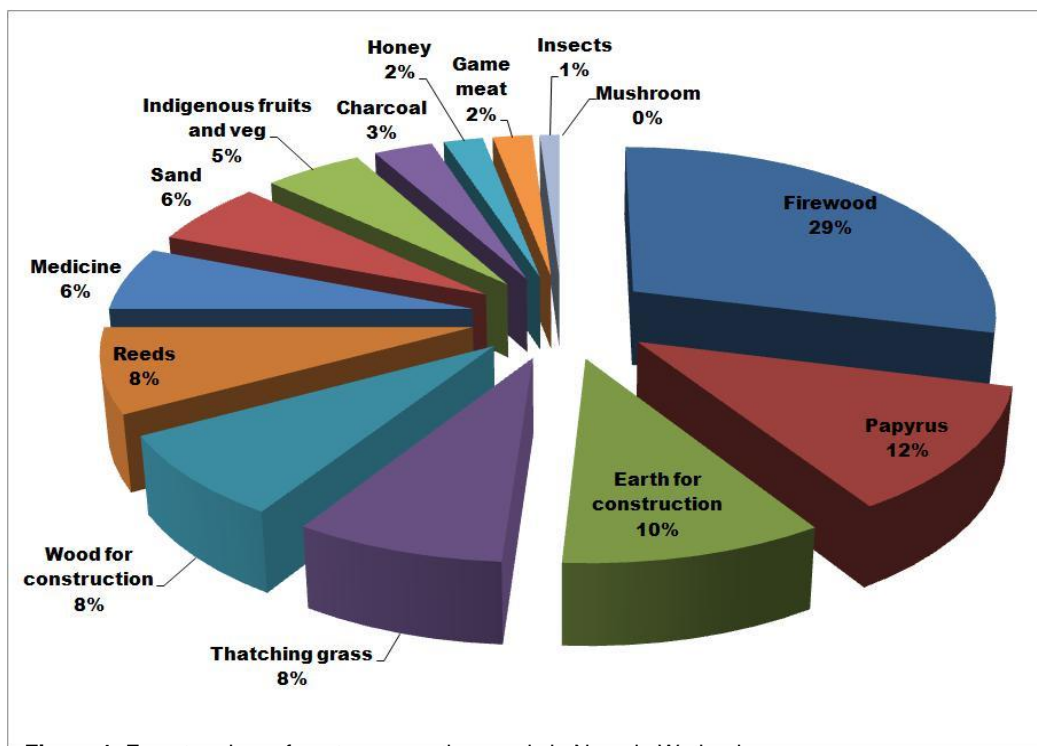
Figure 1. Forest and non-forest consumptive goods in Nyando Wetlands.

Table 1. Sum of consumption goods and service

Consumptive goods and services	Category	Value (Ksh)
Crops		2,402
Livestock	Fodder	2,494
	Feeds	320
Water	Domestic	1,365
	Livestock	1,065
Fish		132,242
Forest and non-forest products		3,449
Non-marketed		38
Total (Ksh)		**143,376**
Total (US$)		**1,509**

1 US$ = Ksh 95.

about 85% of the households using it as a source of energy with a share of 29% of the total forest and non-forest products in the wetlands. Others were medicinal plants, indigenous foods, game meat, earth for construction, grass for thatching and fodder, honey and insects and among others. Mushroom had the least share.

Economic value of consumptive wetland resources

The aggregated economic value of consumptive wetland goods and resources per annum was obtained by summing up the value of crops, livestock, water, fish, natural goods and unpriced benefits (Table 1). The aggregated economic value of consumptive wetlands resources was estimated at Ksh 143.4 Billion (US$ 1.5 billion) or Ksh 6 Million/Ha/year (US$ 62,500/Ha/year). At 2% discount rate, the infinite wetland consumptive resources economic value was about Ksh 7.2 Trillion ((US$ 75.5 Billion) while at 15% discount rate yielded about US$10.1 Billion.

Economic value of fish accounted for about 92% of the total consumptive economic value while Food provision value of Nyando wetlands was estimated at US$ 1221.8/Ha/year.

DISCUSSION

Many wetlands have been shown to provide substantial value in spreading risk by providing resources that enable households to broaden their activity portfolios (Turpie et al., 1999; Schuyt, 2005). Nyando wetlands is most valuable as it provides many benefits; crops, water, fodder and fish among others, to the livelihoods of the surrounding and far off communities in terms of its use values and an opportunity to spread risk as well as functioning as a safety net. Complete dependency on natural resources for livelihoods is a sign of extreme poverty and deprivation (Béné, 2003; Kangalawe and Liwenga, 2005) hence loss of Nyando Wetlands could affect the welfare of the communities living around them. However, the U-shaped relationship between household incomes and the amount of resources harvested (Narain et al., 2005) implies that tackling poverty may reduce environmental degradation up to a point after which there will be increased environmental degradation (Mwakubo and Obare, 2009). There is a need, therefore, to strengthen Nyando community livelihood enhancement measures in order to reduce reliance on wetland resources. This may be done through the promotion of efficient harvesting technologies that would not only increase the value of raw wetland resources, but also provide the much needed employment and alternative incomes to the population engaged in wetland exploitation (Mathoko et al., 2009; Macharia et al., 2010).

The estimated economic value (US $ 62,500/Ha/Year) was relatively higher compared to similar African case studies, whose value varies between US$ 45 to 90/Ha/year (de Groot, 2006) hence plausible (Stuip et al., 2002) given its close proximity to Kisumu City with diverse resource utilization activities that command higher returns. Food provision value of Nyando wetlands (US$ 1221.8 /Ha/year) fell well within the range of suggested values in De Groot et al. (2002) of $6 to 2761/Ha/year. The economic value of fish accounted for 92% of the total estimated value concurring with empirical findings in Turpie (2000) and Ikiara et al. (2010); in which fishing was the most significant wetland service contributor to household income. Loss of the estimated economic value of consumptive goods and services in Nyando Wetlands could be an economic problem because important values would be lost, some perhaps irreversibly. The value would help policy development to curb conversion and over-exploitation of Nyando wetlands as any development decision would have to consider economic costs of conversion or degradation. The policy option here could be to undertake cost-benefit analysis for any proposed wetland investment in Nyando Wetlands. This suggests that preservation may not be advocated as a policy because development option would be sacrificed hence reduced welfare.

Conservation and sustainable utilization of these natural stocks of capital is critical to the survival of the present and future generations. Although higher discount rate, like 15% for this study, may be favoured given that it discourages investment (and by implication environmental damage) in the present, it is unfair for the future generation given that it yielded an infinite value of about US$10.1 Billion. Nyando wetlands have an intrinsic value, that it has long-term life support system hence reason enough to protect it. A low discount rate of 2% was therefore preferred, although it reduces the welfare of the current generation, yielding infinite value of US$ 75.5 Billion. Therefore, wetlands management decisions on the overall economic efficiency of the various competing uses of the Nyando Wetlands resources to improve the community's welfare would be necessary. This would require enhanced promotion of education and public awareness on wetland resources and values to encourage understanding and participation of the public, private sector, local authorities, NGOs and other interested parties through all appropriate means. In addition, economic value could also be sustained by levying tax or charge to polluters such as the industries within the Nyando wetlands. Such economic incentives could be used for conservation and protection measures. On the other hand, provision of awards for wetland conservation could also be enhanced. Such awards could be such as a provision of compensation for suspension of unsustainable activities.

According to Balmford et al. (2002), the total economic value of intact wetlands far exceeds that of converted wetlands. Consequently, the estimated consumptive value of goods and services in this study would certainly be higher if the Nyando wetland was still intact. However, since it is being converted, its value is significantly lowered, a situation that has over time created long term 'national capital debts, which are being paid at a high cost through expenditures on programs that aim towards wetland restoration, management and sensitization. In the face of this, immediate conservation and sustainable utilization of these natural stocks of capital is critical to the survival of the present and future generations. This is because a great deal of wetland economic benefits (over US $ 1.5 Billion) accrues at the Nyando wetland community, particularly the subsistence level. Although this may not be feasible to the Planning Units, it ought to be taken as a substantial amount (Emerton et al., 1998; Karanja et al., 2001), whose loss through unsustainable wetland utilization would make Nyando wetland communities poorer. In other words, the government will have to meet the costs of providing the socio-economic needs of the population that were initially provided by the wetland freely or at a lower cost. These are reflected in terms of all foregone subsistence livelihood products, incomes and employment losses, in favor of unsustainable wetland utilization activities or development projects which only offer short term solutions to important social economic problems (Gumm, 2011).

In conclusion, this study gives a valuable insight into the livelihood supporting goods and services provided by the Nyando wetlands. It highlights the considerable economic value that Nyando wetlands contributes towards the local economy and, it is hoped, this direct consumptive use value will inform decisions and justify investments of financial resources to promote the more sustainable use of the Nyando wetlands. Any further significant loss or continued degradation of the wetland and their inherent values would be economically disastrous for Kenyan economy. The infinite present value is meant to meet the intergenerational efficiency objective. This calls for conservation rather than conversion being experienced.

Conflict of Interest

The authors have not declared any conflict of interest.

ACKNOWLEDGEMENT

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