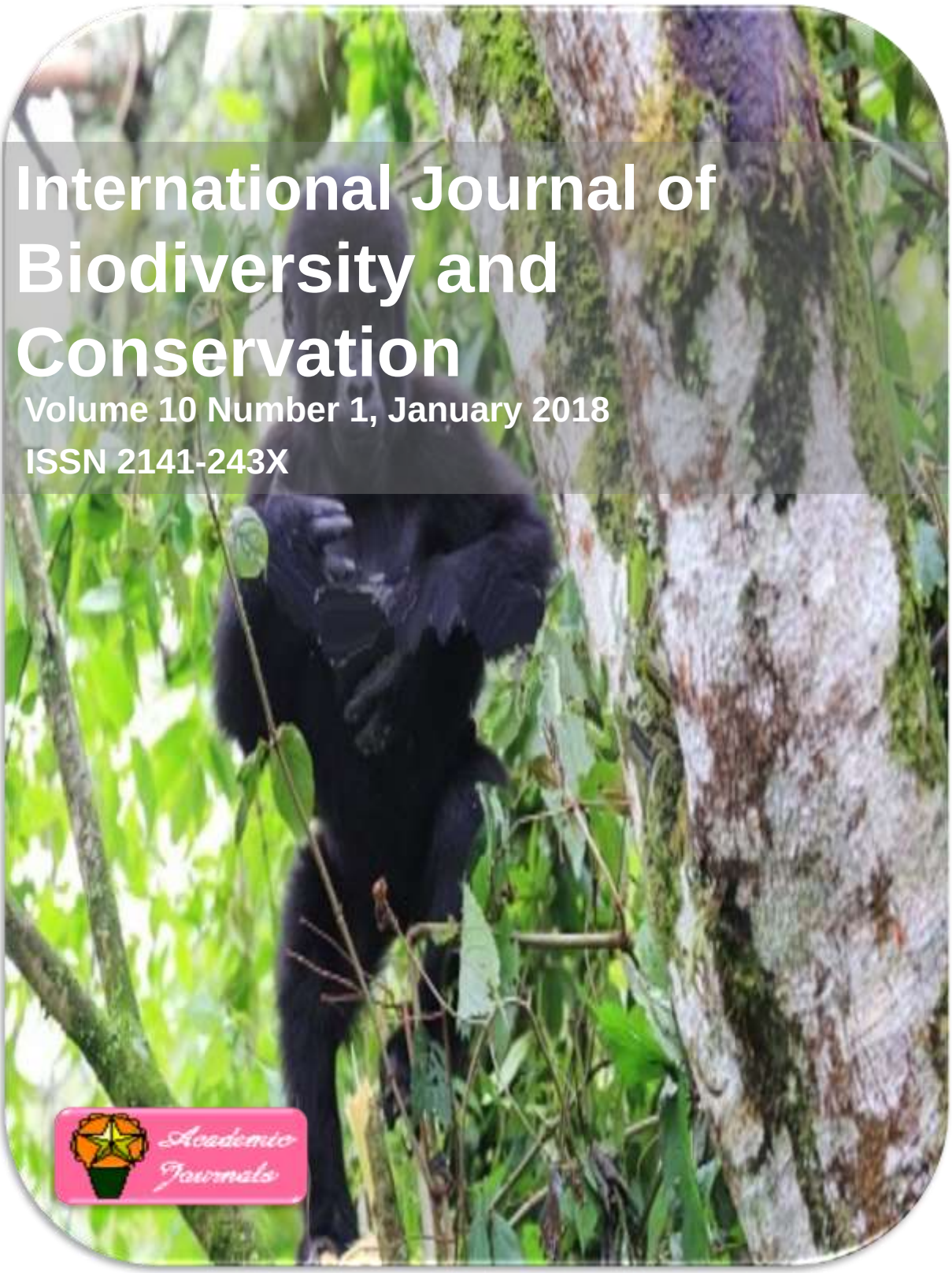


International Journal of Biodiversity and Conservation

Volume 10 Number 1, January 2018
ISSN 2141-243X

Academic Journals

ABOUT IJBC

The **International Journal of Biodiversity and Conservation (IJBC)** (ISSN2141-243X) is published Monthly (one volume per year) by Academic Journals.

International Journal of Biodiversity and Conservation (IJBC)provides rapid publication (monthly) of articles in all areas of the subject such as Information Technology and its Applications in Environmental Management and Planning, Environmental Management and Technologies, Green Technology and Environmental Conservation, Health: Environment and Sustainable Development etc.
The Journal welcomes the submission of manuscripts that meet the general criteria of significance and scientific excellence. Papers will be published shortly after acceptance. All articles published in IJBC are peer reviewed.

Contact Us

Editorial Office: ijbc@academicjournals.org

Help Desk: helpdesk@academicjournals.org

Website: http://www.academicjournals.org/journal/IJBC

Submit manuscript online http://ms.academicjournals.me/

EditorialBoard

International Journal of Biodiversity and Conservation

Table of Contents: Volume 10 Number 1 January 2018

ARTICLES

academicJournals

Vol. 10(1), pp. 1-11, January 2018
DOI: 10.5897/IJBC2017.1123
Article Number: 275541666925
ISSN 2141-243X

http://www.academicjournals.org/IJBC

International Journal of Biodiversity and Conservation

Full Length Research Paper

Evaluation of land use land cover changes using remote sensing Landsat images and pastoralists' perceptions on range cover changes in Borana rangelands, Southern Ethiopia

Habtamu Teka[1*], Casper I. Madakadze[2], Joel O. Botai[3], Abubeker Hassen[4], Ayana Angassa[5] and Yared Mesfin[6]

[1]Department of Animal and Range Sciences, Madda Walabu University, Ethiopia.
[2]Department of Plant Production and Soil Science, University of Pretoria, P. Bag X20 Hatfield, Pretoria, 0028, South Africa.
[3]Department of Geography, Geo informatics and Meteorology, University of Pretoria, Pretoria, South Africa.
[4]Deparment of Animal Science and Wilde life, University of Pretoria, Pretoria, South Africa.
[5]School of Animal and Range Sciences, Hawassa University, Awasa, Ethiopia.
[6]Department of Natural Resource Management, Arsi University, Rustavi, Georgia, Ethiopia.

Received 23 June, 2017; Accepted 24 October, 2017

Studies on land-use/land cover (LULC) changes through remote sensing techniques represent vital tools for generating rational information for sound decision making on natural resources management. Related to the launching of the first Landsat satellite in 1973 there is a region of attention on the use of remote sensing techniques as tool for planning the appropriate management in rangelands. This study therefore aimed at mapping LULC changes and identifying the associated changes that have occurred in the Borana rangelands up to 2003 as well as assess pastoralist perceptions on the driving forces. Landsat image scenes of Multispectral Sensor, Thematic Mapper and Enhanced Thematic Mapper Plus acquired in 1973, 1986 and 2003 were used to investigate LULC changes over time. The analysis of images revealed that woodland cover of the Borana rangelands increased from 11.3% in the 1973 to 49.26% in 2003. However, grassland cover declined from 58 to 32% during the same period. Cultivated areas gradually increased from 2 to 5% but it is lower compared to the woodland cover expansion rate. The decrease of normalized difference vegetation index (NDVI) values for 2003 compared to the 1973 is also an evident for the reduction of vegetation. Severe droughts, population increase, poor government policy are among the major drivers of LULC changes in the study area. The implementation of appropriate pastoral land-use policies based on the ecological potential of the region and pastoralists local knowledge have all been suggested for ensuring sustainable management of Borana rangeland and improve the livelihood of pastoralists.

Key words: Land use land cover, land absorption coefficient, land consumption rate, normalized difference vegetation index.

INTRODUCTION

In the tropics, it is well acknowledged that human activities such as land cultivation, grazing, mining and settlements represent the main drivers of land use land cover (LULC) changes and land dynamic (Meyer, 1995). Such human activities including direct or indirect anthropogenic pressures are sources of continuous threat on territorial land on one hand and impact negatively the livelihood security of people who depend on such land ecosystem on the other hand. In the case of land ecosystem such as rangelands, pastoralists are among the people who are mostly affected by such human activities.

Elsewhere, rapid human population growth, increased frequency of droughts and expansion of settlement in arid and semi-arid environment are among the well-known drivers of land use changes (Vitousek et al., 1997). On the contrary, in arid and semi-arid areas for example, vegetation changes are triggered by both anthropogenic and natural factors such as soil moisture (White et al., 2008), erratic and uneven distribution of rainfall (Fensham et al., 2005) and grazing (Rahlao et al., 2008). However, up to date remote sensing tools used were mostly directed to assess land vegetation cover changes because plants are key indicators of the healthiness of ecosystem and its ecological dynamics (Jensen, 1996).

Knowing that plants are part of arid and semi-arid ecosystem and that such ecosystems are highly susceptible and vulnerable to natural and anthropogenic perturbations that often affect the livelihoods of security of pastoralists, therefore it is essential to identify the driving forces (for example biotic and abiotic) of land use changes, especially for appropriate management of ecosystem and ensuring the livelihoods security of pastoralists. This implies gathering data on the type of ecosystem and its land use dynamics. As a result, remote sensing and geographic information systems are one of the key tools available to land use planner. In Judean Mountain and the Judean Desert in the Mediterranean and Arid ecosystems, Shoshany et al. (1994) has successfully monitored vegetation cover change through remote sensing technique.

Multi temporal satellite image plays an important role in monitoring of vegetation cover changes in rangeland through prepared LULC map (Palmer and Fortescue, 2003) and Normalized Difference Vegetation Index (NDVI) (Eklundh and Olsson, 2003). Using multiple satellite images acquired at different dates over the same study area provides an opportunity to planners to monitor changes in land cover by using proxy parameters such as vegetation index differencing (Purevdoria et al., 1998). For land use planners, Landsat series [that is the multi-spectral scanner (MSS), Thematic Mapper (TM) and Enhanced Thematic Mapper Plus (ETM+)] provide with multiple satellite image data that plays a major role in detecting changes land use land cover change (De Fries and Belward, 2000). Schmidt and Gitelson (2000) used Advanced Very High Resolution Radiometer (AVHRR) satellite image for monitoring temporal and spatial vegetation cover changes in Israeli transition zone.

However, in arid and semi-arid environment, such multi-temporal satellite imagery have been poorly applied for monitoring and planning for land use changes, such as Borana rangelands, Southern Ethiopia. As a result, carrying out research on the dynamics of LULC changes through multi-temporal satellite approach could therefore play an important role in providing valuable information to planners on the way to successfully plan changes and map changes over time (Moshen, 1999).

The importance of traditional knowledge is widely acknowledged as valuable tools for natural resources management and monitoring changes over time. In East Africa, the Borana rangelands was known as one of the best remaining pastoral lands however, increasing rangeland use has driven vegetation decline and threaten traditional knowledge of pastoralists with regards to access, use and management of natural resources of that area. Pastoralists' approach over management of the Borana rangelands consist of mobility of herds during wet and dry season, strong community norms and regulations on range and water resource use (Coppock, 1994).

Rangelands use by shift from grazing land to crop land and other livelihoods activities has driven changes in Borana areas and in pastoralists while contributing to erode traditional knowledge of pastoralists on livestock grazing practices (Desta and Cppock, 2004). For appropriate land use planning, monitoring and safeguarding, it is crucial to document pastoralists' traditional knowledge on rangeland uses and their perceptions on land use/land cover changes.

This study aimed at improving rangelands (grasslands, woodlands and cultivated lands) management by detecting land use/land cover changes over time (1973-2003) in the Borana rangelands of Ethiopia. The specific objectives were two folds: 1) map LULC document, the major driving forces of such changes and patterns of change over time period of 1973 to 2003 using satellite (Landsat) image data analysis, and 2) assess pastoralists' perceptions on rangeland cover changes in

*Corresponding author. E-mail: dreyaman@gmail.com. Tel: +251-913870962.

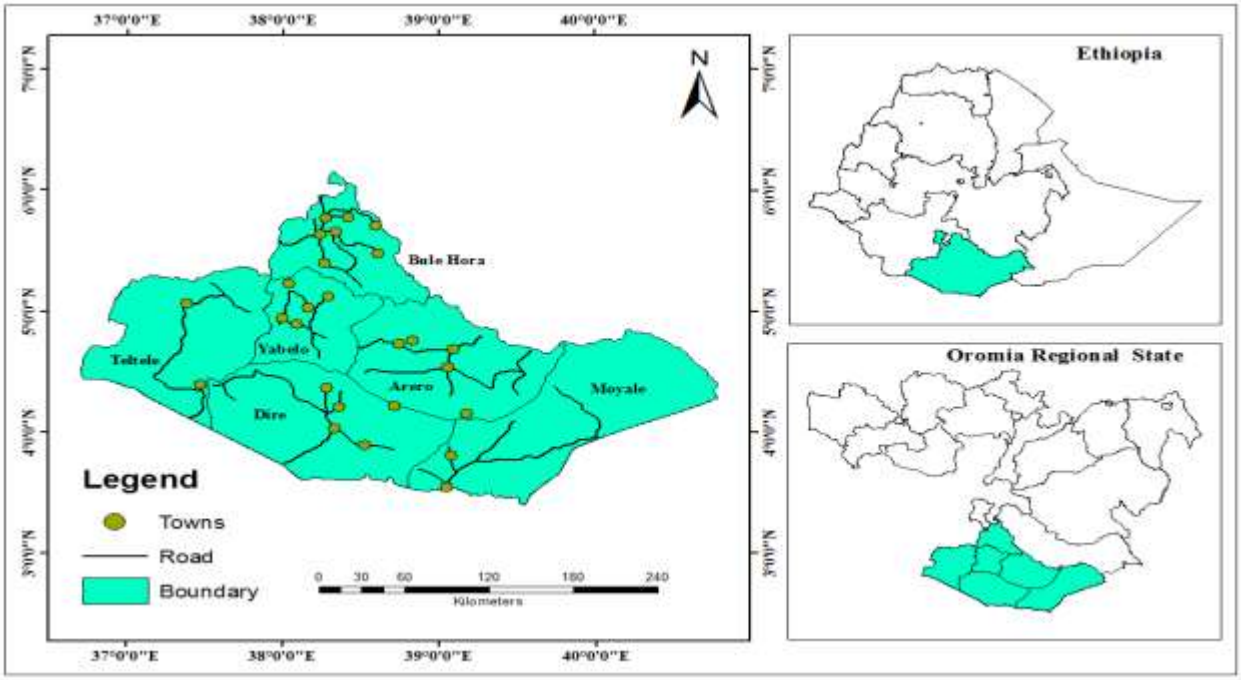


Figure 1. Location of the study area in Borana rangeland in Southern Ethiopia.

the study area.

MATERIALS AND METHODS

Study area

The study area Borana rangelands, covers approximately 63,939 km^2 (Figure 1), and hold the largest pastoral population in Oromia Regional State of Ethiopia. The Borana rangeland is located between 4° to 6°N of latitude and 36° to 42° E of longitude and its altitude ranges from 1000 to 1600 (Coppock, 1994). The area is characterized by arid and semi-arid climate with annual rainfall ranging on average between 500 and 700 mm (Helland, 1982). Rainfall is bimodal with 60% of the annual high precipitation encountered during March-May (main rainy season) and the remaining is encountered during September-November (short rainy season). The long dry season is from late November to early March. The mean annual temperature varies from 15 to 24°C and shows little variation across seasons. The vegetation cover of Borana rangelands is mainly evergreen and semi evergreen bush land, with shrubby *Acacia* and *Commiphora*. The rangeland is dominated by alien genera, and dwarf shrub grassland (Gemedo, 2004). The geology of the area is dominated by 40% quaternary deposits, 38% basement complex formation and 20% volcanic (Coppock, 1994).

The satellite images

For this study, Landsat image of Multi Spectral Scanner (MSS), Thematic Mapper (TM) and Enhanced Thematic Mapper Plus (ETM+) for the year 1973, 1986 and 2003 obtained from Global Land Cover Facility (https://www.landcover.org) were used, respectively (Table 1). In order to cover the study area, eight satellite images were mosaic and thereafter extracted by using the study area boundary. LULC classification was done based on classification criteria drawn for East African rangelands by Pratt and Gwynne (1977) (Table 2).

Prior to image classification and NDVI analysis the acquired satellite images were geometrically corrected and radiometrically normalized then registered image to image. These applications were carried out using ENVI; satellite image analysis software.

Image classification and data analysis

For vegetation cover changes analysis, a post classification comparison of change detection method was used. The most widely used method of change detection is a comparative analysis of spectral classifications for series of time produced independently (Singn, 1989). Landsat images of three years were independently classified using supervised classification method. Since class change precision depends on spectral separation, the interest class group was created and used by maximum likelihood classifier and smoothed with filter to reduce the misclassified pixels (Erdas, 1999).

Overall, our analysis was based on hybrid classification approach (Odindi et al., 2012). In this approach, the ISODATA unsupervised classification algorithm was used to categorize the natural classes. Separability parameters were used for the reliability test of the methodology. Classes that show low degree of separability were regrouped until seven dominant classes were obtained. By combining the visual images inspection of false color composite and unsupervised classified image, two sets of samples each with 25 points were created namely: the training set and post-classification set. The training set was used as Regions of Interest (ROIs) in the maximum likelihood of supervised classification while

Table 1. Satellite images acquired for three different times in the Borana rangelands.

Month	1973		1986		2003	
	Path	Row	Path	Row	Path	Row
January	181	56	169	56	169	56
January	181	57	169	57	169	57
January	180	56	168	56	168	56
January	180	57	168	57	168	57
January	179	56	167	56	167	56
January	179	57	167	57	167	57

Table 2. LULC classes used and their brief definitions in Borana rangelands.

Number	Class	Definition
1	Woodland	Area naturally covered by dense indigenous tree
2	Grassland	Area dominated by indigenous grass and forbs
3	Bareland	Area neither covered by vegetation nor used for crop production
4	Cultivated/built up area	Areas used for cropping and settlement

the post-classification ROIs was used for accuracy assessment using the confusion matrix (Congalton, 1991). Supervised classification was repeated three times and the derived outputs for the 2nd and 3rd land cover classifications yielded similar results which showed level of accuracy and consistence in the classification. Consequently, the LULC classes were sized down from seven classes to four classes comprising of grassland, woodland, bareland, and cultivated/built up area.

Once the classification was made for 1973, 1986 and 2003, the percentage of LULC changes was calculated as follows:

% trend change = (observed change/sum of change) x 100

The annual rate of change was obtained by dividing percentage change by the number of the study years: 1973-1986 (13 years) and 1973-2003 (30 years). The greenness of the study years were evaluated by calculating NDVI values as follows:

NDVI = (NIR-RED)/ (NIR+RED)

The prediction of LULC class changes to another class in the future based on past changes was done using Markov chain model (Aavikson, 1995). This is done by computing transition matrix of pixels in each class for two time periods. The matrix contains unchanged pixels diagonally, while other cells contain pixels that have changed the probabilities of change between classes computed by dividing each cell value by its row total.

On the other hand, the spatial distribution of occurrences within each land use category was interpreted using land consumption rate (LCR) and land absorption coefficient (LAC) formula as follows:

LCR = A/P
LAC = $(A_2-A_1)/ (P_2-P_1)$

Where, A = areal extent of the rangeland in hectares, P = population. A_1 and A_2 are the area extends (in hectares) for the early and later years, and P_1 and P_2 are population numbers for the early and later years, respectively. LCR is a measure of compactness and indicates a progressive spatial expansion of settlers and LAC is a measure of change in consumption of new state of land by each unit increase in human population. The 1973, 1986 and 2003 population statistics were obtained from the censuses of Ethiopian Central Statistics Authority (CSA) (CSA, 2008) following a recommended 2% growth rate of pastoral area. The estimated population figure was calculated using the following formula:

$$n = r/100 * Po \quad (1)$$

$$Pn = Po + (n * t) \quad (2)$$

Where, Pn and Po are the estimated population and base year population, respectively, r = growth rate (2%), n = annual population growth, and t = number of years projecting for the given period.

Pastoralist perceptions on the driving forces of changes of vegetation and land cover

The major driving forces of change of vegetation and land cover in the study area were investigated using 200 key knowledgeable pastoral respondents. A group discussion was carried out with local key informants, community development practitioners, and with local and regional relevant professionals. Semi-structured interviews with the key informants were also used to generate information to identify the major causes driving changes of vegetation or land cover, and to understand the perception of Borana pastoralists on these changes. Scores were given for the identified drivers of change and these were put in order of priority. Secondary data was used for comparison of the present and the past status of vegetation and land cover changes and to identify the scale and degree of these changes. The correlations and strength of the relationships between independent (pastoralist perceptions in vegetation and land cover change) and dependent variables (Landsat image data) were computed using Stata version 10.

Table 3. Classification of land-use /cover changes in the Borana rangelands of southern Ethiopia.

Land type	1973		1986		2003	
	(ha)	(%)	(ha)	(%)	(ha)	(%)
Woodland	462294	11.3	1762173	39.31	2213242	49.26
Grassland	2363172	57.75	1505662	33.59	1425993	31.74
Bareland	1186877	29.01	1036548	23.12	630843	14.04
Cultivated	79533.6	1.94	178476	3.98	222895	4.96
Total	4091877	100	4482859	100	4492972	100

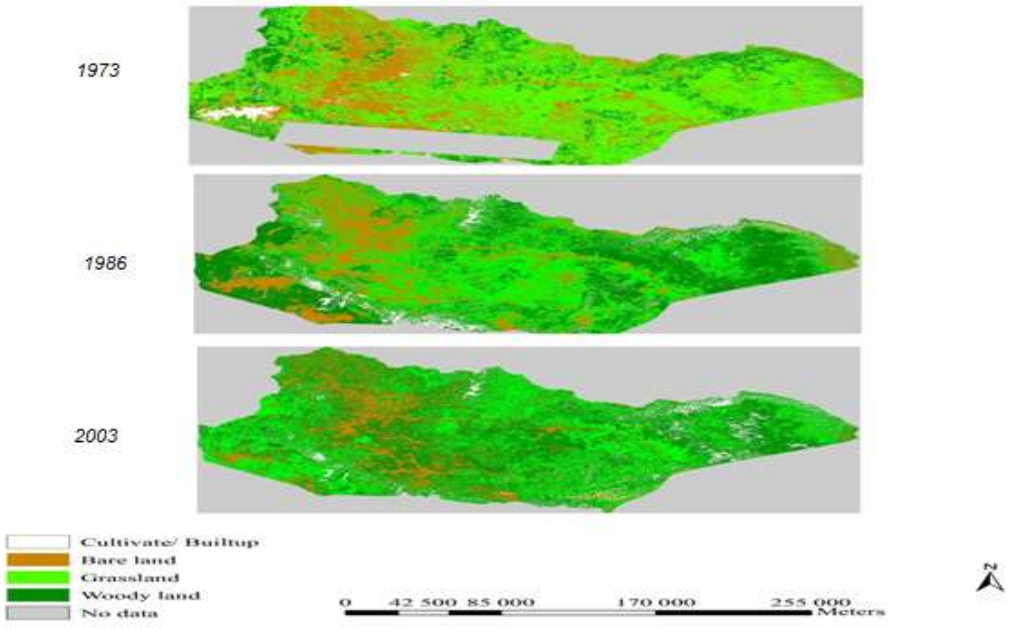


Figure 2. Land-use/land-cover change classification maps.

RESULTS

Classification accuracy assessment

Highest producer's accuracy (71%) and low omission error (28%) was recorded for grassland of the year 1986 Landsat image. In contrast, the producer's accuracy (66%) was low for the cultivated/built-up area for the same year. For bare land, the producer's accuracy (73%) was higher in 2003 than (71%) 1973. The overall classification accuracy of 1973 was 67.3 and 69.1% and 69.5% for the year 1986 and 2003, respectively.

Change detection and LULC

In the Borana rangelands, grassland shows significance decrease over the year that is by 24.16% from 1973 to 1986 and by 26.01% from 1973 to 2003. In the contrary, woodland exhibits an increase of 28.01% from 1973 to 1986 and 37.92% from 1973 to 2003. The other land use did not have such a big change (Table 3 and Figure 2). Over the 30 years period, the changes associated with woody, grass, bareland and cultivated land cover per year were estimated at 1.27, 0.87, 0.50 and 0.1%, respectively.

LULC map (Figure 2) shows an increment of woody plant in 2003 and decrease of bareland compared to the years 1973 and 1986. The decrease could be attributed to canopy cover damage when remote sensing images were taken at that period of time. Since no remote sensing images were available for few parts of Southern Borana, therefore these areas were excluded in the present analysis, especially those for the year 1973.

The NDVI value also revealed the reduction of vegetation cover or biomass from the 1973 to 2003. In

Table 4. Land-use/covers changes following Transition probability matrix from the year 1973 to 2003 in Borana, Southern Ethiopia.

Parameter	Land cover 2003				
	LULC class	Woodland	Grassland	Bareland	Cultivated land
Land cover 1973	Woodland	0.66	0.36	0.06	0.09
	Grassland	0.34	0.28	0.21	0.18
	Bareland	0.40	0.29	0.18	0.13
	Cultivated land	0.04	0.29	0.19	0.13

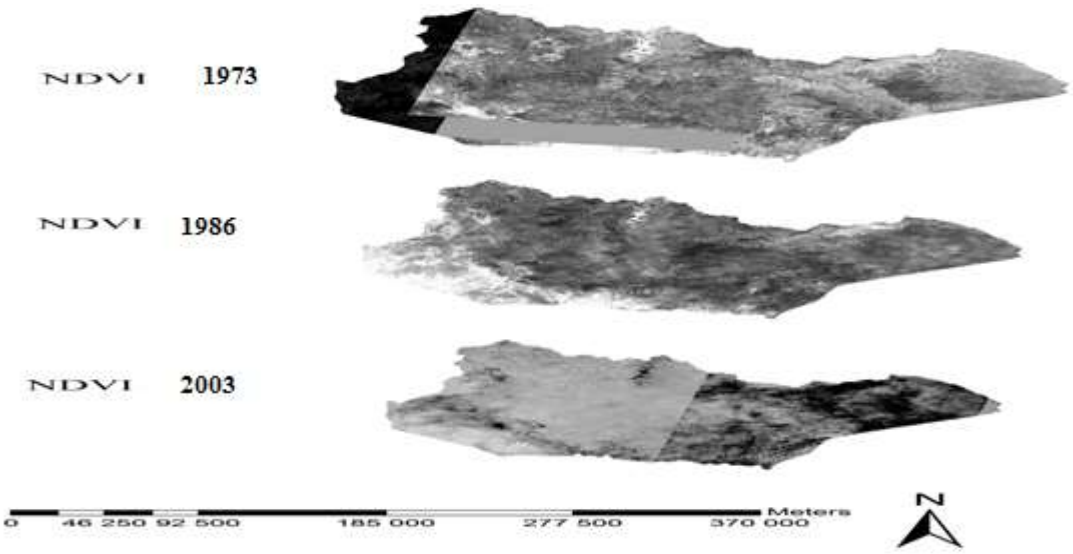


Figure 3. Trend of NDVI changes in the Borana between the 1973 and 2003.

1973, 46.14% of the total area was bareland, whereas, 53.86% was covered by vegetation (Table 4 and Figure 3). The minimum negative NDVI value was -0.93, while the bareland portion and the maximum NDVI value was 0.93, especially for the dense vegetation parts of the study area. For the year 2003, the non-vegetation covered area was 57.20%, (with a minimum NDVI value of -0.65) whereas the vegetation covered area was 42.80% (maximum value of NDVI 0.83).

LULC change prediction

After using the Markov model to detect land cover change, a 4 by 4 matrix table of land cover categories for the year 1973 and 2003 was constructed to predict the probability of LULC class changes over the years. As shown in Table 4, woodland had 0.66 probability of remaining woodland and a 0.36 of changing to grassland in 2003. On the other hand, a 0.34 probability of change from grassland to woodland showed that there might be a high level of instability in grassland during this period. The 1973 grassland cover had a 0.28 probability of remaining grassland in 2003. Bareland also had a 0.18 probability of the remaining bareland in 2003. Cultivated land had a 0.13 probability of the remaining as cultivated land. Moreover, cultivated land had a 0.29 probability of changing to grassland and a 0.19 probability of changing to bareland.

Detection of change of land consumption rate and land absorption coefficient

The land consumption rate (LCR) for cultivation was 0.12 in the 1973, 0.23 in the 1986 and 0.16 in the 2003 (Table 7). LCR showed a slight increment within this time period. In general, Land Absorption Coefficient (LAC) was 0.21 (1973-2003). During the different period, LAC was 069 (1973-1986) and 0.084 (1986-2003). Both LCR and LAC

Table 5. Population, land consumption rate and absorption coefficient changes in Borana Southern Ethiopia.

Parameter	Period of the year		
	1973	1986	2003
Population	641,982	786,364	1,317,409
LCR	0.12	0.23	0.17
LAC (1973-2003 years)		0.69	

LCR = Land consumption rate; LAC= land absorption coefficient.

Table 6. Pastoralists' perception towards rangeland cover changes in the study area.

Major driving forces	% Respondents
Drought/rainfall variability	22.60
Policy issue	21.56
Increment of livestock population	18.81
Bush encroachment	12.73
Settlement	10.19
Change of livelihood	8.88
Increment of human population	5.10
Number of water points	0.13
Total	100

showed that as population increased the land absorption ability declined drastically.

The corresponding human population values for the recorded time period are also presented in Table 5. From 1973 to 1986, the LAC increased with population but declined sharply as population increased.

Driving forces of land-use/cover change and their correlation

According to Borana pastoralists', eight forces driving changes in LULC changes were identified. Among them recurrent drought, policy issue and increment of livestock population are mentioned as the prime factors (Table 6).

From group discussion, it is understood that continuous heavy grazing pressures have contributed to changes of land-cover from grassland to woodland. Human population growth is partly due to the infiltration by the highland farmers in the area. In addition, the recent expansion of public services like water points, school and health posts might have contributed to the expansion of settlements in the study area. From a policy perspective, sedentarization of pastoralists is a government rural development strategy. This has widely affected pastoral land-use patterns over the years. Moreover, the opportunistic farming activities also instigate the expansion of settlements in order to manage the farm plot as mentioned by our respondents. The steady increase of human population attracts the boom of livestock population, which pressurizes the changes of land-use. Overall, people stated that the changes in land-use/cover are mainly caused by frequent droughts and increasing numbers of dry years among other drivers, which highly affected their livelihoods. Further, the correlation and strength of their relationship among different driving forces and dependent variables (rainfall and year time series) are presented in Tables 7 and 8.

DISCUSSION

The observed decline of bareland cover in 2003 compared to 1973 might be explained by the poor capture of satellite sensing image of woody plant canopy. The larger canopy cover observed in Southern Ethiopia might have been interpreted as vegetation cover instead of bareland (Haile et al., 2010). However, data collected through on ground observation, local community responses and NDVI values tend to reveal that the bareland cover increased in recent years compared to the 1973. The expansion of bareland in the fragile and environment is often explained by cultivation practices leading to pronounced period of soil erosion even during small rain events and wind effects. In the Afar low-land of north eastern Ethiopia (Tsegaye et al., 2010) and in southern Ethiopia (Mintesnot, 2009) similar changes have also been reported in arid environments (Elmore et al., 2000). In addition, Solomon et al. (2007) have all reported that the increasing expansion of woodland cover around patch of resource areas was attributed to the increase of grazing pressures around these areas. In areas where there was low grazing pressure, high density of woody plants was reported (Brown and Archer, 1999).

NDVI is known as a measure of a photo that is from synthetically active vegetation in a given area (Asrar et al., 1985; Myneni et al., 1995; Weiss et al., 2004). The NDVI had strong correlations with biomass, vegetation phenotype, density of leaf and canopy cover (Petter and Eve, 1995; Tucker et al., 1985; Weiss et al., 2004). The NDVI analysis across the Borana rangeland showed, the

Table 7. Correlations between the different driving forces with dependent variables such rainfall.

Driving forces and measurable parameter	P	RF	WL	GL	BL	CL	LS	Reg equation with RF	R^2
Rainfall	-0.78								
Woodland	0.89	-0.98						WL= 8896731+ (-18514x)	0.95
Grassland	-0.89	0.99	-0.98					GL= -2570223+10820.7x	0.99
Bareland	0.90	-0.97	0.99	-0.98				BL= 3290943+ (-5839.5x)	0.94
Cultivated land	0.92	-0.96	0.99	-0.99	0.99			CL= 750724.9+(-1473.72x)	0.92
Livestock population	0.96	-0.57	0.73	-0.60	0.74	0.77		LS= 487946.9+ (-359.62x)	0.32
Human population	0.99	-0.69	0.83	-0.72	0.83	0.86	0.98	HP= 2970867+ (-5130.91x)	0.47

P=Period from 1973-2003; RF=rainfall; WL= woodland; GL= grassland; BL= bareland; CL= cultivated land; LS= livestock population; Reg = regression; R^2= confidence of determination.

Table 8. Correlation between the different driving forces with dependent variables such year time serious.

Driving forces and measurable parameter	P	RF	WL	GL	BL	CL	LP	Reg equation for period of year 1973-2003	R^2
Rainfall	-0.78								
Woodland	0.89	-0.98						WL= -1.04+53249x	0.80
Grassland	-0.89	0.99	-0.98					GL= 5.6+-27345.6x	0.64
Bareland	0.90	-0.97	0.99	-0.98				BL=-3.27+16960.5x	0.81
Cultivated land	0.92	-0.96	0.99	-0.99	0.99			CL= -8592780+4413.32x	0.84
Livestock population	0.96	-0.57	0.73	-0.60	0.74	0.77		LS =-3411217+1893.3x	0.92
Human population	0.99	-0.69	0.83	-0.72	0.83	0.86	0.98	HP = -4.49+23091x	0.98

P=Period from 1973-2003; RF=rainfall; WL= woodland; GL= grassland; BL= bareland; CL= cultivated land; LS= livestock population; Reg = regression; R^2= confidence of determination.

highest positive and negative NDVI values were largely observed from the 1973 MSS imagery. For the inherent biases in reflectance measurements of the MSS sensors and the atmospheric cloud cover, high positive value of NDVI could be associated with the high percentage of grassland cover (Peters and Eve, 1995). On the other hand, the low value of NDVI value in year 2003 might be due to the high proportion of woody plant cover (Nemani et al., 1996). The other probable reasons for the low value of NDVI obtained in year 2003 were driven by canopy coverage and the extent of bareland use. They all have certainly contributed to reduce the NDVI value. Overall, NDVI values are useful measurement in understanding the vegetation cover of the Borana rangelands and can be used in rangeland monitoring and management approaches.

Over the years, between 1973 and 2003, Borana rangelands has demonstrated persistent LULC changes and this might be associated to different factors sure as rainfall variability and heavy grazing pressure (Oba and Kotile, 2001) shift in the traditional management practices and poor government regulations mainly ban of rangeland fire and developing communal rangelands (Oba et al., 2000). According to

Angassa and Oba (2008) and McCarthy et al. (2002), banning of range fire facilitates the propagation of weeding species and inhibits woody plant growth. Consequentially, the survival of desirable herbaceous is undermines by dominated weeding species (Singn, 1989). Gemedo et al. (2006) noted that woody vegetation clearing out for home construction purposes, enclosure management along with the pastoralist's involvement in agricultural cropping activities through land clearance also contributes to woody plant decline.

The observed increase of cultivated/built in Borana rangelands might be explained by the farming activities pastoralists used as an alternative for lowering drought risk and rainfall uncertainty (Campbell et al., 2005). Frequently, occurring drought (1972/1973, 1984/85 and 1999/2000) results to food insecurity and livestock loss in Borana rangelands. In addition, infiltration by large groups of farmers from the neighboring areas also contributed to the expansion of cropping in the study area. Similar to East African pastoral land, the expansion of cropland in the Borana rangeland has significantly contributed to the change of grassland management practice to cultivate land practice (Reid et al., 2004).

Despite pastoralists resistance (Chatty, 2007), voluntary crop farming and settlements have been established in the Borana areas for generating income and livelihood diversification (Reid et al., 2004). Pastoralists resist the expansion of cultivation and sedentarization and mainly this reduces the size of their rangelands and mobility to utilize the unevenly distributed resources in this unpredictable environment (Chatty, 2007).

In semi-arid areas of East Africa, the changes of land-use/cover have been accelerated by government policies since the 1973 (Omiti et al., 1999; Reid et al., 2004). This is also true in the case of Ethiopia. Recurrent drought is among the prominent natural catastrophes that have caused changes of land cover (Ndikumana et al., 2001). As an alternative, pastoralist had shifted their land uses from grassland to woodland and other land use forms (Coppock, 1994; Gemedo, 2004). Among other drivers of shift in the rangeland cover included population increase of human and livestock, conversions of rangelands to crop land in valley bottoms (dry season grazing areas) and increasing pressure on grazing due to multiple (ranch and private enclosures) end uses and competition for land from other tribes (*Gari and Somali*) in Borana grazing area (Oba and Kotile, 2001). Although dry land cropping represents an opportunity for pastoralists to increase income without damaging the land (Campbell et al., 2005), however, other scholars indicated that it represents a way of increasing risks and threats to the livelihood of pastoralists (Little et al., 2008). This has to do with the fact that increasing land cropping in semi-arid area contribute to aggravate desertification and expansion of bareness lands Traditionally, the Borana pastoralists used to regulate their rangelands by traditional by-laws. However, these by-laws have been violated since the 1973 by inappropriate intervention policies of the government. As a result, such inappropriate intervention policies might have contributed to explain the current impacts on rangeland use and cover in the Borana area.

Earlier studies (Angassa and Oba, 2008; Coppock; 1994; Oba et al., 2000) have shown that an increase in the abundance of woody vegetation cover could have been driven by the ban of fire and continuously high grazing pressures. On the other hand, there is expansion of woody plant cover in the areas where there is little grazing due to aggressiveness of some species (Brown and Archer, 1999). In the present study, encroachment of woody cover across the Borana rangeland is highly pronounced so that the shifts from grassland to woodland would be approximately five-times greater in just three decades. These changes might have significant implications on pure pastoralism practices that rely on livestock production for the most part. The recent demand for land use forms for farming purpose has certainly led to a push for more use of land for large scale mechanized farming along with the expansion of large private farming activities in semi-arid areas. In those areas, climate variability plays a major role in regulating ecosystem function. Since drought represents one of the major climatic factors affecting negatively LULC changes therefore it is more likely that traditional land-use practices might be influenced by drought in Borana. This means that the observed LULC changes in the Borana rangelands might adversely affect ecosystem dynamics. The latter may have a negative impact on livelihoods of pastoralists in turn. As a result, to sustain pastoralists' livelihoods support systems and masteries normal ecosystem functioning in the Borana rangelands the following important issues should be addressed: a) careful implementation of initiatives related to pastoralist driven land use policies that are ecologically sound, and b) regulating population growth in the rangelands.

Conclusions

Providing key information on LULC changes is vital for understanding land use dynamics and monitoring resources over time. Gathering such information could contribute to policy makers with insights to make informed decision over land use planning and enhancing pastoralists' livelihoods through proper support. This study has demonstrated the usefulness of satellite remote sensing image used in producing land- use/cover maps and changes in the Borana rangelands for the past 30 years. It is evidenced that: i) the proportion of woodland cover increased in the year 2000 compared to

the 1973 whereas, the grassland proportion declined for the same period; ii) the increase in cultivated land/built up area represents a recent phenomenon related pastoralist grassing systems; iii) bareland increased affecting therefore the productivity of the rangeland and eventually the livelihoods of the pastoral communities in southern Ethiopia; and iv) drought, population pressure, inappropriate government policy and mismanagement of rangelands are the major driving forces of changes in land-use/cover in Borana rangeland areas.

In the case of Ethiopian rangelands, drought, human and livestock's population increase, conversions of rangelands to crop land in valley bottoms represent the main drivers' forces of land cover changes. Such changes have impacted pastoralists' livelihoods. In order to survive, pastoralists have shifted their land uses from grassland to woodland and other land use forms (Coppock, 1994; Gemedo, 2004). In the long run, pursuing such land uses shift might not be sustainable approach because additional rangelands will continue to be degraded. Appropriate response to the issue of further degradation of rangelands calls for providing a careful implementation of pastoralists' land use policies that are not destructive of the ecosystem and its functioning.

Further studies should focus on promoting lower stocking rates and reducing human and livestock population's growth through educational campaigns and raising public awareness on the necessity of conserving the ecological functioning of the ecosystem and sustainable livelihood of pastoralists in the Borana rangelands of southern Ethiopia at the same time

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

REFERENCES

Angassa A, Oba G (2008). Herder perceptions on impacts of range enclosures, crop farming, fire ban and bush encroachment on the rangelands of Borana, Southern Ethiopia. Hum. Ecol. 36:201-205.

Asrar G, Kanemasu ET, Yoshida M (1985). Estimates of leaf area index from spectral reflectance of wheat under different cultural practices and solar angle. Remote Sens. Environ. 17:1-11.

Brown JR, Archer S (1999). Shrubs invasion of grassland: recruitment is continuous and not regulated by herbaceous bio-mass or density. Ecology 80:2385-2396.

Campbell DJ, Lusch DP, Smucker TA, Wangui EE (2005). Multiple methods in the study of driving forces of land use and land cover change: A case study of SE Kajiado District, Kenya. Hum. Ecol. 33:763-794.

Central Statistical Agency (CSA) (2008). Central Statistical Authority Report of the 2007 Population and Housing Census. Addis Ababa, Ethiopia, CSA.

Chatty D (2007). Mobile peoples: Pastoralists and herders at the beginning of the 21st Century. Rev. Anthropolog. 36(1):5-26.

Congalton RG (1991). A review of assessing the accuracy of classifications of remote sensed data. Remote Sens. Environ. 37:35-46.

Coppock DL (1994). The Borana Plateau of Southern Ethiopia. Synthesis of Pastoral Research, Development, and Change, 1980-91. Systems Study No. 5. Addis Ababa, Ethiopia: International Livestock center for Africa (ILCA).

De Fries RS, Belward AS (2000). Global and regional land cover characterization from satellite data: an introduction special issue. Int. J. Remote Sens. 21:1083-1092.

Elmore AJ, Mustard JF, ManningSJ, Lobell DB (2000). Quantifing vegetation change in Semi- arid environments. Precision and accuracy of special mixture analysis and normalized difference vegetation index. Remote Sens. Environ. 73:87-102.

ERDAS (1999). Field Guide Earth Resources Data Analysis System. ERDAS Inc. Atlanta, Georgia. P 628.

Fensham RJ, Fairfax RJ, Archer SR (2005). Rainfall, land use and woodland cover change in semi-arid Australia savanna. J. Ecol. 93:596-606.

Gemedo D, Brigitte LM, Isselstein J (2006). Encroachment of woody plants and its impact on pastoral livestock production in the Borana lowlands, Southern Oromia, Ethiopia. Afr. J. Ecol. 44:237-246.

Gemedo D (2004). Vegetation Ecology, Rangeland Condition and Forage Resources Evaluation in the Borana Lowlands, Southern Oromia, Ethiopia. PhD Thesis,Georg-August Universität Göttingen, Germany. Cuvillier Verlag Göttingen.

Haile G, Assen M, Ebro A (2010). Land use /cover dynamics and its implication since 1960's in the Borana rangelands of southern Ethiopia. Livest. Res. Rural Dev. 22(7).

Jensen JR (1996). Introductory digital image processing, A remote sensing perspective, (2nd edn). Upper Saddle River, New Jersey: Prentice Hall.

Little PD, McPeak J, Barrett CB, Kristjanson P (2008). Challenging orthodoxies: understanding poverty in pastoral areas of East Africa. Dev. Chang. 39:587-611.

Meyer WB (1995). Past and Present Land-use and Land-cover in the U.S.A. Consequences 1:24-33.

McCarthy N, Kamara A, Kirk M (2002). The effect of environmental variability on livestock and land use management: The Borana plateau, Southern Ethiopia. Socioeconomics and policy research working paper 35. ILRI (International Livestock Research Institute), Nairobi, Kenya and IFPRI (International food policy research institute), Washington, DC, USA. 35p.

Mintesnot Z (2009). Bush encroachment mapping using classification and spectral mixture analysis in Borana rangelands: A case study of Yabello Woreda. MSc Thesis, Addis Ababa University, Ethiopia.

Moshen A (1999). Environmental Land Use Change Detection and Assessment Using with Multi - temporal Satellite Imagery. Zanjan University press.

Myneni RB, Hall FG, Sellers PJ, Marshak AL (1995). The interpretation of spectral vegetation indexes. IEEE Trans. Geo Sci. Remote Sens. 33:481-486.

Ndikumana J, Stuth J, Kamidi R, Ossiya S, Marambii R, Hamlett P (2001). Coping mechanisms and their efficiency in disaster-prone pastoral systems of the greater horn of Africa: effects of 19995-97 droughts and the 1997-98 El-nino and the responses of pastoralists and livestock. ILRI Project Report Nairobi, International Livestock Research institute.

Nemani RR, Running SW, Pielke RA, Chase TN (1996). Global vegetation cover changes from coarse resolution satellite data. J. Geophys. Res. 101:7157-7162.

Oba G, Kotile DG (2001). Assessment of landscape level degradation in southern Ethiopia: Pastoralists versus ecologists. Land Degrad. Dev. 12:461-475.

Oba G, Post E, Syvertsen PO, Stenseth NC (2000). Bush cover and range condition assessments in relation to landscape and grazing in southern Ethiopia. Landsc. Ecol. 15:535-546.

Odindi J, Mhangara P, Kakembo V (2012). Remote sensing land-cover change in Port Elizaberth during South Africa's democratic transition. SAFR J. Sci. 108:5-6.

Omiti JM, Parton KA, Sinden JA, Ehui SK (1999). Monitoring changes in land-use practices following agrarian de-collectivisation in Ethiopia. Agric. Ecosyst. Environ. 72(2):111-118.

Palmer AR, Fortescue A (2003). Remote Sensing and Change Detection in Rangelands. Durban, International Rangelands Congress.
Peters AJ, Eve MD (1995). Satellite monitoring of desert plant community response to moisture availability. Environ. Monit. Assess. 37:273-283.
Rahlao SJ, Hoffman MT, Todd SW, McGrath K (2008). Long-term vegetation change in the succulent karoo: South African following 67 years of rest from grazing. J. Arid Environ. 72:808-819.
Reid RS, Thornton PK, Kruska RL (2004). Loss and fragmentation of habitat for pastoral people and wildlife in East Africa. Concepts and issues. Afr. J. Range For. Sci. 21:171-184.
Schmidt H, Gitelson A (2000). Temporal and spatial vegetation cover changes in Israeli transition zone: AVHRR- based assessment of rainfall impact. Int. J. Remote Sens. 21:997-1010.
Shoshany M, Kutiel P, Lavee H (1994). Monitoring Temporal Vegetation Cover Changes in Mediterranean and Arid Ecosystems Using a Remote Sensing Technique: case study of the Judean Mountain and the Judean Desert. J. Arid Environ. 33:9-21.
Singn A (1989). Digital change detection techniques using remotely sensed data. Int. J. Remote Sens. 10:989-1003.
Solomon T, Snyman HA, Smit GN (2007). Rangeland dynamics of southern Ethiopia: (1) botanical composition of grasses and soil characteristics in relation to land use and distance from water in semi-arid Borana Rangelands. J. Environ. Manag. 85:443-452.
Tsegaye D, Moe SR, Vedeld P, Aynekulu E (2010). Land use/cover dynamics in northern Afar rangelands, Ethiopia. Agric. Ecosyst. Environ. 139:174-180.
Tucker C, Vanpraet CL, Sharman M, van Ittersum G (1985). Remote sensing of land use and vegetation from mesoscale hydrological studies. Int. J. Remote Sens. 21:213-233.
Vitousek PM, Mooney HA, Lubchenco J, Melillo JM (1997). Human domination of earth's ecosystem. Science 277:494-499.
Weiss JL, Gutzler DS, Coonrod JE, Dahm CN (2004). Long-term vegetation monitoring with NDVI in a diverse semi-arid setting, centeral New Mexico, USA. J. Arid Environ. 58:248-271.
White JD, Gutzwiller KJ, Barrow WC, Randall LJ, Swint P (2008). Modeling mechanisms of vegetation change due to fire in a semi-arid ecosystem. Ecol. Model 214:181-200.

academicJournals

Vol. 10(1), pp. 12-38, January 2018
DOI: 10.5897/IJBC2017.1132
Article Number: CF3BC2166929
ISSN 2141-243X

http://www.academicjournals.org/IJBC

International Journal of Biodiversity and Conservation

Full Length Research Paper

Can communities close to Bui National Park mediate the impacts of Bui Dam construction? An exploration of the views of some selected households

Jones Lewis Arthur

International Relations and Institutional Linkage Directorate, Sunyani Technical University, P. O. Box 206, Sunyani-Ghana.

Received 24 July, 2017; Accepted 22 September, 2017

This paper explores the perceptions of families and households near Bui National Park, on the impact of Bui dam on their capital assets and how they navigate their livelihoods through the impacts of Bui Dam construction. The mixed methods approach was applied to sample views of respondents from thirteen communities of which eight have resettled as a result of the Bui Dam construction. In-depth interviews were conducted with 22 key informants including four families to assess the impacts of Bui Dam on community capital assets and how these communities near Bui Dam navigate their livelihoods through the effects of the dam construction, and whether the perceived effects of the Bui Dam differed for families in the different communities who were impacted by the dam construction. The results of the study showed that the government failed to actively integrate policies and programmes that could build on the capacity of communities to navigate their livelihoods through the effects of Bui Dam construction and associated resettlement process. Also, dam construction can have both positive and negative impacts on the livelihood opportunities of nearby communities. Conservation efforts, including the establishment of Bui National Park, will not always result in positive effects on people's livelihoods, because conservation efforts limit community access to livelihood resources such as fishing grounds, arable land for farming and game. It is recommended that countries that intend to construct dams conduct relevant and case sensitive needs assessment to ensure that the livelihoods of nearby communities are not necessarily adversely impacted.

Key words: Community, capital assets, dams, resettlement, livelihoods, conservation, protected area.

INTRODUCTION

Biodiversity conservation is relevant to Ghana as a result of its diverse benefits; it provides people with opportunities for water, food, clean air, livelihoods, cultural values and tourism opportunities (Baird and Dearden, 2003; Convention on Biological Diversity (CBD), 2010, 2014; Dudley, 2008; Pereira et al., 2012;

E-mail: jonesarthur2002@yahoo.co.uk.

Porter-Bolland, 2012). In spite of the benefits of biodiversity, issues of conservation remain a global challenge (Lindenmyer, 2015; Outlook, 2015; Teyssedre and Robert, 2015). Such challenges include changes in species abundance and community structure, shifts in the distribution of species and communities, and the genetic diversity in domesticates and wild species (Pereira et al., 2012; Teyssedre and Robert, 2015). Challenges associated with biodiversity conservation have resulted in many interventions including the Convention on Biological Diversity (CBD) Strategic Plan for Biodiversity 2011-2020, the Aichi Biological Targets, and efforts to establish and expand global network of parks and protected area including 17% of the Earth's land surface and 10% of marine protected areas (Spalding et al., 2013; Maxwell, 2015; Leadley et al., 2016; Tobon et al., 2017).

Of equal concern is the fact that much of the worry associated with biodiversity loss is narrowed down to developing countries, but conservation needs in these countries often conflict with the needs for economic development, sometimes related to the construction of dams. Dams are important for varied reasons: enable energy access and security and improve revenue (Kyei-Dompreh, 2012; Prado et al., 2016); provide employment (Nusser, 2014; Fernside, 2016); support activities to aid the control of flood and irrigation opportunities (WCD, 2000; Billington and Jackson, 2017); and support the growth and development of intensive agriculture (WCD, 2000; Lawrence et al., 2014).

Dam construction is significantly considered an important national development agenda of Ghana due to its positive impact on the social and economic development of the nation. Ghana relies heavily on hydroelectricity for household and industrial use (Dzorgbo, 2001; Alhassan, 2009; Turner et al., 2012; Obour et al., 2016). For example, it was expected that after the commissioning of the Bui Dam, a total of about 1205 MW of electricity was to be produced from key large hydro sources of Akosombo, Kpong and Bui (Kabo-Bah et al., 2016). Hydro dams are also significant in providing both temporal and permanent employment opportunities. For example, the construction of the Bui Dam resulted in a maximum of 1,836 employments at the dam site (Kirchherr et al., 2016). Some arguments in favour of hydro dam construction have linked the Akosombo dam construction to ready and cheap hydroelectric power that provides power to 60% of the mining, manufacturing and commercial activities that incidentally employs a significant number of Ghanaians (Energy Commission, 2005). It shows that construction of dams in Ghana significantly impacts on the livelihoods of people including reducing the scourge of poverty: creation of auxiliary economic activities such as 90% of fish harvest (73,000 to 82,000 metric tonnes) in the Volta Lake (Sarpong, Quaatey and Harvey, 2005); estimated US$ 2.4 million of fish caught (FAO, 1991; 2005; Braimah, 2001); and trading in auxiliary jobs such as carpentry, fishing nets and outboard motors (Sarpong et al., 2005).

Meanwhile, the construction of hydro dams have been extensively contested; dams are sometimes non-profitable due to the fact that the high cost of dams are substituted for capital investments in sections of the economy such as health, education and infrastructure (Ansar et al., 2014; Fernside, 2016) and flooding of large land surface areas (e.g. flooding of 3.6% of Ghana through the Akosombo dam construction) and displacement of communities and livelihoods (Bartolomé et al., 2000; Kalitsi, 2004; Dzodzi, 2006; Cave et al., 2010). For example, the construction of Bui Dam, Ghana resulted in the flooding of nearly a quarter of the Bui National Park, displacement of seven communities, and the destruction of community assets including important plant and animal species (Ofori-Amanfo, 2005; ERM, 2007; IUCN, 2010; Ghana News Agency, 2012; Miine, 2014).

Dams can adversely impact water resources (Zhang et al., 2008; Miller et al., 2011) including the construction of dams on the Mekong River that lead to the blocking of migratory routes of fish, extinction of some fish species, reduction in storage capacity due to reservoir sedimentation, and starvation of downstream channels (Piman et al., 2016). Experiences in Ghana also show that the development of the Akosombo Dam resulted in changes in the natural environment, destruction of plants, animals and other living organisms, and alteration of the chemical chemistry of some water bodies with attendant increase in the incidence of water borne diseases such as bilhazia, malaria and hookworm (Kalitsi, 2004).

Dams can impact the livelihoods of downstream river-dependent communities; the construction of the Kpong Dam, Ghana particularly, adversely affected the livelihoods of people involved in farming and fishing whose activities revolved around the seasonal flow regimes of the Volta River (Peter, 2013; Owusu et al., 2017). Dams have social cost and implications including the worldwide dam-related displacement of 40 to 80 million people (WCD, 2000; Krueger, 2009; Chen et al., 2016). In other cases of dam impacts, communities become displaced and resettled, whilst some people are also deprived of access to resources and assets such as farmlands, roads, and health and educational resources (Ferraro et al., 2011; International Rivers, 2013; Fernside, 2016).

Dam-related displacement and consequent resettlement of communities form the core of this study. Although, dam construction has some benefits, the adverse impacts are also very clear such as, the loss of infrastructure, economic upheavals, shift in social roles and loss of assets that support community livelihoods (Biswas, 2012; Peter, 2013; Fratkin, 2014). Dam construction can also impact community governance structures including land title and indigenous rights

(Bennett and McDowell, 2012). In other instances of dam construction, protected area resources can be impacted, including the flooding of ecological resources that uphold the ecological integrity of many conserved areas (Hall and Jordaan, 2011; Klein et al., 2011; Dornelas et al., 2014; Sa-Oliveira et al., 2015; Lees et al., 2016). Although, some studies have examined dam/biodiversity conflict, a few studies have looked at the effects of dams on communities nearby Protected Areas (PAs)-"a clearly defined geographical space, recognized, dedicated and managed through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values" (Dudley, 2008: 8).

Resettlement is defined as "the sudden and uncompromising removal from what is familiar" to a different settlement, which sometimes destroys social relationships, and compound risks and hazards for displaced people (Bennett and McDonald, 2012: 1-2). Bartolomé et al. (2000: 4) also suggest that resettlement is "the involuntary and forced relocation of people." The construction of dams may lead to resettlement of communities, and the deprivation of people's access to resources and assets such as farmlands, sacred groves, roads, health centres and schools (Gordon and Amatekpor, 1999; Andam et al., 2010; Ferraro et al., 2011; United Nations Development Programme (UNDP), 2011a; International Rivers, 2013). Other cases of resettlement of communities may lead to economic upheaval, loss of cultural identity, shifts in social roles, and most especially, the loss of voice of the impacted communities (The World Bank, 2004; Le Roux and White, 2004; Bennett and McDowell, 2012; Peter, 2013).

In resettlement-related forced land acquisition, communities can be affected through the loss of access to lands for farming and generation of incomes (Syagga and Olima, 1996; Han and Vu, 2009). Abbink (2012) argues that the construction of hydro dams can have substantial effects on the environment, socio-economic systems, livelihoods, and the social organization and culture of the people living near the dam or downstream. The Akosombo Dam project in Ghana, for example, led to the loss of community shrines, traditional religious grounds such as sacred groves, and also led to an adverse health implication for some nearby communities (Kalitsi, 2004; Dzodzi, 2006). Further, the Akosombo Dam reservoir led to an increase in some water-borne diseases including bilharzia and malaria, but also resulted in the reduction and elimination of other diseases such as river blindness (onchocerciasis), in some areas near the dam (Kalitsi, 2004).

Some literature has also argued that the failure to foresee such adverse consequences of the Akosombo Dam construction makes it difficult for a comprehensive plan to be developed and implemented to address dam impacts, such as the anticipated social and health effects (Ding, 2007; Lerer and Scudder, 2005; Ty et al., 2013). Some authors have argued that the social cost associated with the construction of large dams does not make economic sense for their construction (Ansar et al., 2014). The actual costs of hydropower megaproject development dam construction can adversely have impact on conservation efforts such as established protected areas (ERM, 2007). For example, Bui Dam resulted in the exhumation and reburial of some ancestors buried in the communities, but many ancestral heritage sites, and community landmarks for the communities of Bator Akaiyakrom, Bui and Dokokyina could not be salvaged (ERM, 2007; Ghana News Agency, 2012). Although, these ancestors have been reburied, there is still no plan to construct a proper structure, such as a tombstone, to preserve the royalty of the ancestors (even though these burial marks did not exist in the original burial sites). Of critical importance is the destruction of nearly a quarter of BNP, together with the ecological resources and integrity that sustained tourism in the Bui area (ERM, 2007). The Bui Dam construction has also led to the loss of visitor opportunities to the park, which in 2008 stood at 280 (Jachmann et al., 2011). The implication for the loss of visitor opportunities is reduced revenue for the park.

This research examines communities adjacent to Bui Dam, on which construction begun in 2009. Nearby the Bui Dam is the Bui National Park (BNP), established in 1971 to primarily protect biodiversity. The construction of the Bui Dam led to the flooding of nearly a quarter of BNP, and consequently led to the displacement of eight communities of about 1,280 people (Ampratwum-Mensah, 2013; Marfo, 2014; Naab et al, 2016). These communities have to make adjustments to their livelihoods due to the park, and also because of the introduction of an intervention such as Bui Dam. The embankment of the Black Volta at Bui has resulted in the eviction and resettlement of affected communities into two new resettlement camps- Bui and Gyama (Jama) camps. The dam has destroyed to many features including part of the bank of the Black Volta and land resources including riverine gallery of forest, created 36 islands and a 500 km reservoir shoreline, and destroyed 50% of grassland, 20% of savannah woodland, and 25% of the water and riverine gallery forest (ERM, 2007; Ghana News Agency, 2012a), and also altered habitat for the park's red-listed hippopotamus (CBD, 2010).

The construction of Bui Dam also has impact on infrastructure such as roads, clinic, community centre, cemeteries and sacred sites, ancestral villages, and houses of the affected communities. Currently, eight communities have been relocated due to the Bui Dam construction. The park is also threatened by encroachment through resettlement, mining and logging. These activities have therefore challenged the sustenance of the protected area including its exotic

species. This situation is even worsened by the already limited and deplorable conditions of such facilities. Although, some reliefs such as new accommodation facilities, access roads, and bore holes have been provided for the resettled people, many continue to live from hand to mouth. The situation is compounded by the number of people who have lost their farmlands to flooding as well as people whose fishing livelihoods have shifted from river to lake fishing. In many cases, some compensation were provided to the affected people to cushion the impact of the Bui Dam on their livelihoods (ERM, 2007). In many of such cases, the affected people have complained about the resettlement package as inadequate as compared to their livelihood situation before the dam construction.

This study seeks to understand the changes experienced by these communities as they navigated their livelihoods through the impact of the Bui Dam construction, but through a conceptual framework that echoes the concept of livelihoods (Carney, 1995; Rakodi, 2014). Livelihood issues have received significant attention as a result of their critical effect on poverty reduction efforts and efforts to improve livelihood conditions (Carney 1995; Scoones, 1998; De Haan and Zoomers, 2003; Ellis, 2005; Rakodi, 2014). Livelihoods can be well understood through the application of the sustainable livelihoods approach, which emphasise that livelihoods are central to "...the capabilities, assets or resources, entitlements and activities required for a means of living" (Chambers and Conway, 1992: 6). The focus of the approach is that livelihood capabilities focus on people's ability to cope with perturbations and the ability to identify and usefully apply livelihood opportunities and assets (Carney; 1997; Hussein, 2002; Scoones, 2015). The sustainable livelihood (SL) approach focuses on six underlying principles: (1) understanding people's priorities and livelihood strategies (people centred); (2) responding to the expressed priorities of the poor people (response and participatory); (3) ensuring that micro-level realities (such as capital assets and capabilities) inform macro-level institutions and processes (multi-level); (4) sustainable from economic, institutional, social, and environmental dimensions (sustainable); (5) working with public, private, and civil society actors (conducted in partnership); and (6) process-oriented, responding to changing livelihoods (dynamic) (Chambers and Conway, 1992). The 1990s approach to livelihood was about the actor (including the poor people), the place (such as communities), and specific context to apply livelihood studies (such as poverty reduction).

The livelihood concept is argued to be significant in improving the living conditions of people when the livelihood can be sustainable, that is "when it can cope with, and recover from stresses and shocks, maintain or enhance capabilities, assets and entitlement, while not undermining the natural resource base" (Chambers and Conroy, 1992: 6). The sustainable livelihood framework provides an understanding of the effects of relocation from the perspective of capital assets, the stock of assets and capabilities available to households (Carpenter et al., 2006; Green and Haines, 2012; Masud et al., 2016). The literature identifies seven types of capital assets-social, natural, political, human, physical, cultural and financial. Capital assets in practice, can be stored, accumulated, depleted, or exchanged, and also be applied to generate a flow of income or other benefits (Norris and Stevens, 2006; Folke et al., 2010; Bennett et al., 2012; Masud et al., 2016). Capital assets are important in developing strategies to support people to cope with stresses in livelihoods (Moser, 2008; Nelson, 2010), build disaster resilience to address household food security (Ranola and Cuesta, 2016), and increase farm production and reduce rural poverty (Folke et al., 2010; Bennett et al., 2012).

Closely linked to livelihoods research is the concept of capital assets. Capital assets are the stock of assets and capabilities available to households (Carpenter et al., 2006; Green and Haines, 2012). The literature suggests seven types of capital assets: social, natural, human, physical, financial, cultural and political (Table 1) (Carney, 1995; Rakodi, 1999; Hussein, 2002; Moser, 2008). These assets are discrete in measurement but can sometimes overlap. For example, politics can sometimes apply to both political capital and cultural capital. Assets available to households and communities can be stored, accumulated, exchanged or depleted, and put to work to generate a flow of income or other benefits (Norris and Stevens, 2006; Folke et al., 2010; Bennett et al., 2012). Following is a review of these forms of capital assets.

Some studies have argued that the diversification of both social networks and livelihood sources is central to the sustainability of natural resource use as well as create a resilience of social-ecological systems for especially, resource-dependent economies (Besley, 1995; Folke et al., 2010; Goulden et al., 2013). Social capital adaptation in the form of bonding, bridging and linking have the effect of changing livelihood policies, processes and institutions that helps to clarify the impacts of power and powerlessness on food security in Burundi (Vervisch et al., 2013). But, for many communities near Bui Dam, it is difficult to quantify the contributions of social capital because of the complex network of association and reciprocity that exist within and among families and communities. It stands to argue that the need to address issues relating to capital assets, especially for dam impacted communities is critical (Tilt and Gerkey, 2016). Other community resource such as natural capital provide important resources to cope and overcome livelihood challenges such as dam construction (Raven, 2012). In Madagascar, the improvement in

Table 1. Description of community capital assets.

Category	Capital assets description
Social Capital	Refers to collective rules, norms, use of family networks/connection to secure food, clothing, or shelter, use of social networks (e.g., schools and churches) to secure employment and education, use of community-based organizations such as cooperatives, and cultural troops to gain a living
Human capital	Refers to investments and opportunities in wage labour, fishing, and related business such as drying and smoking of fish, farming, livestock rearing, trading, skills training or education in opportunities that provide occupation to the people
Natural capital	Refers to stocks of environmentally provided assets, such as agricultural land for farming and rearing of animals, access to fishing grounds, forest and forestry products, and wildlife resources, access to tourism opportunities
Physical capital	Refers to produced and man-made capital (e.g., access to housing, land for construction of houses, roads, electricity, and communication outlets like a post office)
Financial capital	Refers to incomes, savings, supplies of credit and insurance, access to banks, microfinance institutions, money transfers from family and friends, access to financial support from co-operatives
Cultural capital	Refers to practices, traditions, and resources that are central to people's identity; opportunities to practice cultural activities such as festivals, drumming, and dancing; the use of traditional knowledge and practices such as local ways of farming and fishing to gain a living; respect of customs, traditions, elders, and traditional leaders
Political capital	Refers to family involvement in decision making, respect and support of local administrative institutions such as the assemblies and traditional leadership, effectiveness of traditional leaders to mobilize people for activities that improve their living conditions

Source: Dei (1991), Carney (1995), Rakodi (1999), Ashong and Smith (2001), Hussein (2002), Carpenter et al. (2006), Moser (2008: 50) and Bennett et al. (2012).

agricultural practices, provision of employment through tourism helped to reduce poverty and maintain ecosystem services for shock affected communities (Naughton-Treves et al., 2005). Although, the protection of natural resources including the establishment of protected areas often deprive nearby communities of park resources and land title rights, but the restoration of natural capital is one key direct and effective remedy for addressing worsening socio-economic and political effects of stress on livelihood (Raven, 2012). Other capital in the form of human is argued to provide some shocks in livelihood through the application of multiple livelihoods, intensified exploitation of rivers and lands, non-farm wage employment and livestock farming that transcend to relatively higher incomes welfare strategies (Dzodzi, 2006; Baez et al., 2010).

An improvement in community physical capital such as physical buildings such as community centre, and community infrastructure such as roads, airports, and waste disposal and water treatment plants provide important lessons to improve community livelihood opportunities (Bennett et al., 2012; Independent Evaluation Group (IEG), 2012). Consequent to physical capital is the role of financial capital in the form of access to credit, remittances, or pensions that provide important lessons in efforts to reduce poverty and empower people for economically productive activities (Thiboumery, 2016). In rural communities in Ghana, the absence of financial capital including wage opportunities is argued to be one major reason keeping people in poverty (Korboe, 1998; Nunan et al., 2001).

Some studies have indicated that political and cultural capitals form key capital assets with the potential to positively or negatively impact access to other forms of capital assets, livelihood strategies and opportunities, and to decision-making bodies and sources of influence (Hussein, 2002; Abbink, 2012; Adger et al., 2013). Some studies also suggest that diversification of the livelihoods of individuals or communities can affect their ability to withstand shocks and explore additional income sources needed to make adjustments to practice livelihoods (Bryceson, 2002; Mutenje et al., 2010; Aosoglenang and Bonye, 2013). It is evident that some literature have explored livelihood from the community capital assets perspective, and many have failed to examine these attributes from the perspective of communities whose livelihoods have been affected by the construction of the Bui Dam.

In summary, the Bui Dam seems to have created a number of negative effects on nearby communities. Some efforts have been made to address these issues and develop alternate livelihoods, but it is not clear how effective these efforts have been.

Therefore, this study aims to examine differences in perception in how families navigate through the impacts of Bui Dam construction. The study therefore examines the following research objectives:

1. How communities near Bui Dam perceive the effects of

Table 2. Villages that lost land and natural resources to the Bui Dam.

Construction activity	Village/Community/District		Risk and level of effect of dam
	Banda	Bole	
Two saddle dams and camp construction site	Bungase	-	Major
Quarries	Bungase and Banda Ahenkro	-	Minor
Road upgrading	-	Bamboi, Banda Nkwanta, Teselima, Carpenter, Gyama	Minor-Negligible
Transmission line	Gyama and Teselima	-	Moderate
Creation of the reservoir - total inundation	Bui, Bator, Dam Site, Dokokyina	Lucene, Agbegikro, Brewohodi	Major
Creation of the reservoir - inundation of forest and farmland only	Banda Ahenkro, and Bungase	Banda Nkwanta, Gyama	Major

Source: ERM (2007).

the dam on their capital assets (resources).
2. Show if perceived effects of the Bui Dam different for families in the different communities are impacted by the dam construction.

Study area

This case study is located in the Banda and Bole districts of the Bring Ahafo Region of Ghana. Ghana, a developing country in the west coast of Africa had developed a new dam on the Black Volta to augment hydro power from other major sources of electricity generation.

Administratively, villages in the two districts are under the leadership and direction of Paramount Chiefs (ERM, 2007). The governing systems in the study area include government institutions, chieftaincy systems, and Community Based Organizations (CBOs). Government agencies provide administration through the District Assemblies whilst different categories of chiefs for chieftaincy systems provide traditional leadership.

The two districts of Banda and Bole are located within 8° 45' N, longitudes 2° 52', 0° 28' W (of 2,298.3 km^2) and 1° 50' E, 2° 45' W, latitudes 8° 10' N, 5° 09' N (of 6,169.2 km^2), respectively (Ghana Statistical Service, 2014a, b). The population size is 45,000 for Banda and 61, 593 for Bole (Ghana Statistical Service, 2012a, b).

The dominant people in the Banda district are Nafana-speakers of Nafaara who trace their origin to present day Cote d'Ivoire (Stahl, 2001: p.52). Other ethnic groups in the district include Ligbe, Kuulo/Dumpo, Kologo, Bono, Gonja, Akan, Dagarti and Lobi (Stahl, 2001; Tain District Assembly, 2012). In Bole, the Gonja, Vagla, Safalba and Mo are the major ethnic groups. The dominant people in the Bole District are Gonja or Mo, but Mo and Nafana for Banda (Stahl, 2001: p.189; Ghana Statistical Service 2014b).

Land in the two districts are mainly communally owned and family members have user rights. In Banda district for example, outright land purchase is prohibited but rather tenancy where tenants are entitled to either half or a third of the harvested crops. On the other hand, majority of the lands in the Bole District are family owned where access for construction of houses passes through a procedure and then becomes permanently owned.

Some communities in the study area such as Bator, Bui and Dokokyina have permanently lost some infrastructure such as schools, clinics and roads to the construction of access roads and electricity transmission lines (Table 2) (ERM, 2007).

On the economic front, a large proportion of activities in the Banda District are for subsistence. Some of the common activities for many household include cashew farming, yam cultivation and fishing. The creation of a large dam by the Bui Dam therefore makes fishing an important livelihood threshold for many people living in the communities. The potentials in fishing have therefore encourage a number of indigenous fishermen and fishmongers to expand their livelihood activities for economic purposes, and on the other side increased the level of migration into the district. Other forms of livelihood for the people in the Banda District include carpentry, trading, teaching, masonry, weaving and brewing (Akonor, 2009; Tain District Assembly, 2012; Banda District Assembly, 2013). The economy of the Bole District is mainly agrarian (Bole District Assembly, 2006; Ghana Statistical Service, 2014b). Crops cultivated by people in the Bole District include yam, groundnut, cowpea, pepper, cassava and plantain on large scale. These farm produce are usually marketed in the Sawla, Tuna, Kalba and Wa Districts as well as in the other parts of the country (Bole District Assembly, 2006, 2013).

METHODOLOGY

This study adopted a triangulation approach (Table 3) involving

Table 3. Research questions and associated methods.

Research Question	Method Used
How do communities near Bui Dam perceive the effects of the dam on capital assets?	Key Informant Interviews
Q2. How is the effect of Bui Dam on communities case studies revealed through in-depth case studies of four families (two families from relocated communities, and two families from communities not relocated)?	Case Studies

document analysis, interviews with key informants, and detailed household case studies. Triangulation is applied to check and establish validity in studies by analysing a research question from multiple perspectives in order to arrive at consistency across data sources or approaches, and also provide an opportunity to uncover deeper meaning in the data (Thurmond, 2001; Heale and Forbes, 2013). Information from key informant interviews was used to provide input for the design of a guide for the case studies.

There are 45 communities near the Bui Dam (IUCN, 2010). Eight of these have been relocated and were chosen for the study. Five other villages that were not relocated were selected as comparison villages due to their similarities with the relocated villages. The latest to be relocated is Bui Camp (also called the Wildlife Village). Wildlife Village was created after the establishment of Bui National Park (BNP) to house the staff and families of BNP. The need to include five non-resettled communities located near the dam (Bongaase, Gyama, Banda Ahenkro, Agbelikame North, and South villages) in the study was critical, in order to make comparisons with communities that were forced to relocate.

Eight out of 13 sampled communities (Figure 1) were selected because they are affected by the Bui Dam through resettlement. The other five are communities that will be affected by the dam through loss of lands to flooding, construction of transmission lines, and most closely located communities (as indicated by an Environmental and Social Impact Assessment report) to be impacted by the dam (ERM, 2007).

Generally, the selection of the case studies took into consideration representation for communities in the two districts (Banda and Bole) impacted by the Bui Dam and associated resettlements.

Key informant interviews

Key informants for the study involved a total of 22 people from diverse groups: men and women, family heads, young adults, aged, and researchers that have been involved in some form of livelihood studies. Key informant questions were selected from a mix of options, including consultations with traditional leaders and opinion leaders in the communities, review of literature on community consultation during Bui Dam construction (ERM, 2007), as well as leads provided by people who have conducted some livelihood related research in the study communities. A key informant interview (use of a semi-structured interview) was incorporated into the research design because it is an effective tool to probe for more information on the topic (Creswell, 2007; Robson, 2011), and it gives the respondents freedom of self-expression and opportunities for more detailed answers (Healey, 1998). Interviewees included eight traditional leaders and elders of the resettled communities, four from the main livelihood groups (that is, traders, fishermen, fishmongers and farmers), and representatives of BNP, BPA, school, church, District Assembly and researchers (Table 4).

Research protocols from institutions such as the Wildlife Division (institution responsible for BNP), and Bui Power Authority (institution that coordinated the resettlement process) were sought before conducting interviews. In all of these cases, the confidentiality of respondents' responses was assured. Codes that did not provide a hint to their identity were subsequently used to refer to key informants. As a result, the study did not in any way show the identity of key informants.

Key informant interviews provided information on: (1) the effect of Bui Dam construction and resettlement on community capital assets; (2) the effect of Bui Dam construction and resettlement on traditional leadership; and (3) the effect of Bui Dam and resettled communities on the management of Bui National Park (BNP). Responses were used as primary data, and also to inform the development of a guide for the case study.

Qualitative case study interviews

For this part of the study, four families were purposively selected as case studies (Seawright and Gerring, 2008). Case studies were selected to adopt the most similar and most different methods. This selection procedure requires that sampling be conducted to cover the most similar and most different attributes relating to the research objectives (Seawright and Gerring, 2008). Both methods require the selection of a minimum of two cases for data collection and analysis, as employed in this study (Przeworski and Teune, 1970; Gerring and McDermontt, 2007; Seawright and Gerring, 2008). The application of the "most similar and most different" choice of case studies involved families that are similar in specified experiences and are broadly representative of the views and experiences of the families affected by the construction of the Bui Dam. There is need for caution in interpreting these findings from the in depth interviews as representative of the study population; the method illustrates the more generalized results found in the key informant interview survey findings. Two of the case studies were relocated and two were not as a result of the dam. The choice of the most different method of case study selection was also relevant because these families were affected differently by the Bui Dam construction. Reasons for the different effects include the different sociological backgrounds of the families such as ethnicity, type of livelihoods, as well as the communities in which the families lived before and after the dam construction. For example, the four case studies were from four communities: Bongaase (Nafana), Bui Camp (Fante), Dokokyina (Mo) and Bator (Ewe). These families (Table 5) also engaged in livelihoods such as farming and fishing. The four families selected as case studies provided in-depth feedback on how families navigated through the process of the Bui Dam construction. Selection of the case studies also considered people who have lived for many years close to BNP, those who have passed through the process of migration to live near BNP, those who transitioned through the process of construction of the dam, types of livelihoods, those resettled and those not resettled, as well as geographical locations of communities.

These case studies delved into the personal family experiences during the period of the Bui Dam construction. The four families

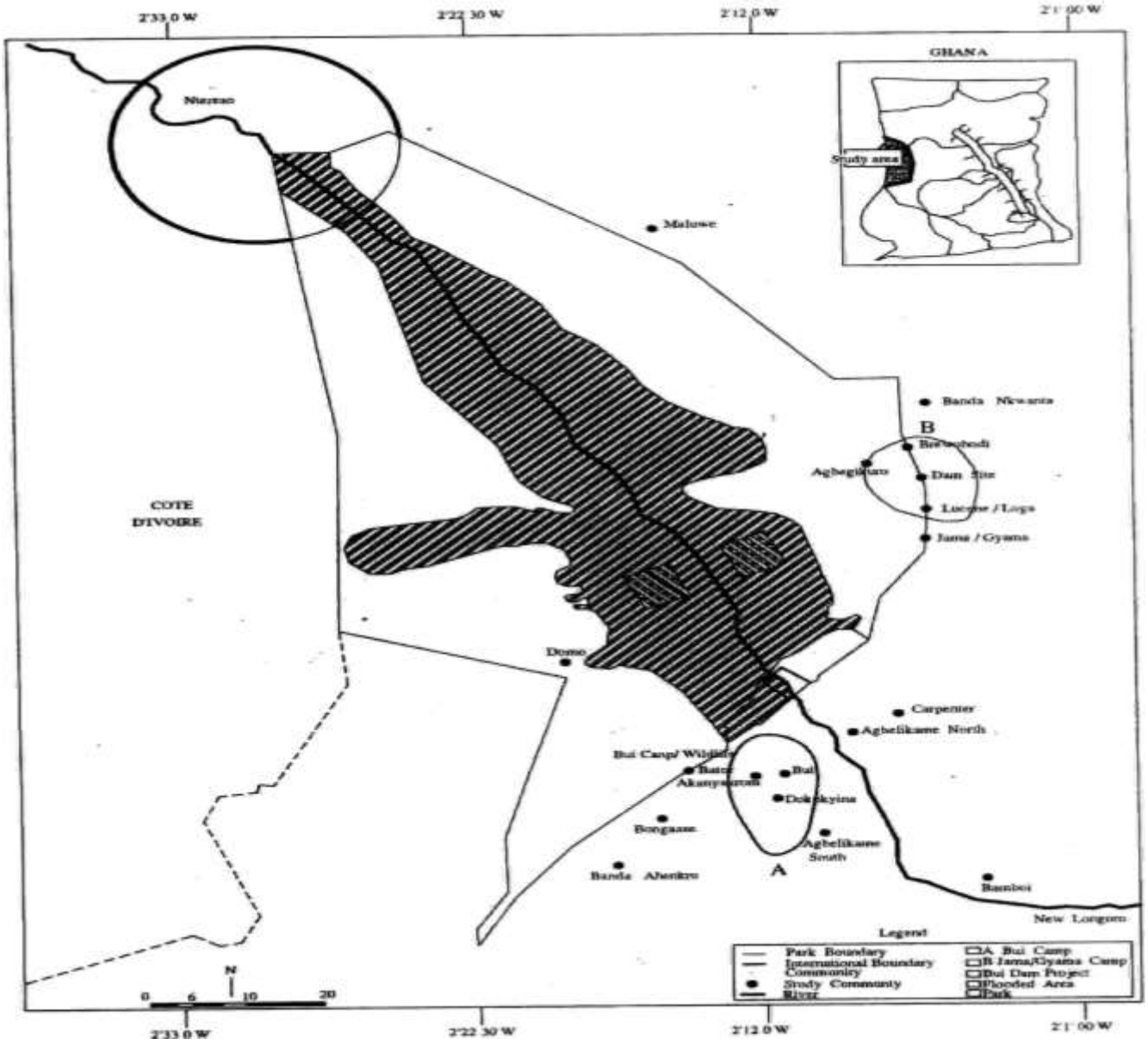


Figure 1. Map of Bui National Park showing dam and resettled communities (Bui National Park - BNP, 2014).

Table 4. Selection of case studies.

In depth Interviews 1-4	Selection criteria for families
Most similar characteristics	Impacted by Bui Dam Nearby Bui Dam and BNP Practices at least one of the main livelihoods (e.g., fishing or farming)
Most different characteristics	- Relocated/Non-relocated - Different livelihoods - Different dam effects on livelihoods - Different ethnic backgrounds - Different experiences

Table 5. List of key informants of the study.

Respondent's number	Town	Key characteristics	Respondent's number	Town	Key characteristics	Case study
V001	Bui	Male	L013	Bator	Fishing, Male, Youth	√
V002	Bator	Male, Elder	L014	Dokokyina	Farmer, Male, Elder	√
V003	Dokokyina	Male, Elder	S015	Bator	Teacher, Male, Elder	
V004	Bui Camp/ Wildlife	Male, Elder	S016	Bator	Catechist, Male, Elder	
V005	Dam site	Female, Elder	S017	Bongaase	Male, Farmer	√
V006	Brewohodi	Male, Elder	G018	Bui Camp/ Wildlife	BNP, Male, Head	√
V007	Lucene,	Male, Elder	G019	BPA camp	BPA, Male,	
V008	Agbegikro	Male, Elder	G020	Bator	District Assembly, Male, Youth	
L009	Bator	Fisherman, Male, Youth	R021	Sunyani	Researcher A, Male, Lecturer (with years of research experience in communities near BNP)	
L010	Bator	Fish monger, Female, Youth	R022	Sunyani	Researcher B, Female, Lecturer (with years of research experience in communities near BNP)	
L011	Dokokyina	Farmer, Male, Elder				
L012	Bator	Trader, Female, Youth				

provided details of their experience as they transitioned into a new livelihood as a result of the Bui Dam.

Analysis of data

Qualitative data obtained through key informant interviews, in-depth interview surveys and document analysis were analysed descriptively by the use of themes and categories from the data (Robson, 2011). Themes were developed to guide the analysis of the qualitative data. These themes were built around issues relating to dam effects on community capital assets. The findings were given to other researchers to review, to confirm the accuracy of the developed interpretations. The analysis was done along theme such as description of life before the dam with attention on assets and livelihoods, effects of the dam including other factors that mediate effects of the dam, and description of life after the dam, with attention on assets and livelihoods. Analysis was done under these themes for the four families who underwent an in-depth interview.

RESULTS

Presentation of results includes details on family history; description of life before the dam during the early days of dam construction; promises made (Table 6); levels of community involvement incorporated into the resettlement process; other factors mediating the effects of the dam (such as access to training); and description of life after the dam with attention on assets and livelihoods. In most cases, experiences of the respective families were compared between families since each family has somewhat different experience.

The results of the case studies were also compared with the results of the survey. The names used to represent each family are fictional in order to respect confidentiality protocols.

In depth interview No. 1: Opanin Kwasi's family

Introduction

Opanin Kwasi's extended family formed part of the Dokokyina community that migrated from Kakala in La Cote d'Ivoire to settle approximately 200 years ago near the area that is now BNP. Opanin Kwasi is a Mo with the main source of livelihood for his family being farming, and sale of farm produce. Farming was mainly done using traditional cutlass and hoe. His family did not engage in any formal employment with the government.

Opanin Kwasi's extended family (of more than eight) before the dam construction was very united and collectively undertook many household activities, such as farming, cooking and raising of the young, as one big family. Extended family covers an extension of the nuclear family to include other family members such as uncles and aunts, cousins, nieces and nephews, as well as grandparents. They cooked, shared food and work, and supported each other. His family, which was instrumental in the formation and activities of a local youth association, helped to liaise with the chiefs and constructed a school for the youth, helped in the payment of the wages of the teachers in the school, and also provided free accommodation to support the teachers.

This family resides in Dokokyina (Figure 1). Opanin Kwasi is male, 46-55 years old, and has lived most of his life near the dam site. His family was resettled as part of

Table 6. Provisions and promises made/implemented.

Provisions/promises made	Provisions/promises fulfilled (√) or not (X)
Housing units	
Compensation for loss of rooms, 4 rooms before and 3 rooms after, and so on...	√
Kitchens in new housing units	√
Bathrooms (with toilets) in new housing units	√
Community Infrastructure	
KVIP toilet facilities	In school
Hand pump boreholes	√
Support to build new place	In the form of cash compensation
Infrastructure for entire township	
School (primary and junior high school)	With kindergarten
Street lights	2-4 units
Clinic	Including community-based health and planning services (CHPS) for treating minor ailments
Market stall	√
Police station	X
Lorry park	X
Community centre	√
Religious building (one mosque and one non-denominational church)	In the form of cash compensation provided -devalued due to delay in payment
Financial support	
One-time resettlement grant of ₵100	√
Land development grant of ₵50 (payment after 2010 since people will have access to old farmlands until 2010)	₵70 - one-time payment...to clear 1 acre of land
Compensation for loss of economic assets - payment determined by assessment of Land Valuation Board	X
Household income of ₵100 per month for one year (payment starts after relocation)	May 2011-April 2012
Livelihood Improvement	
Livelihood improvement programs by Faculty of Human Settlement, KNUST-Ghana	Covered only the identification of livelihood groups
Others requests made by Bui Chief and accepted by BPA	
Football park	But in school
Library	X
Fish pond	₵6,500 cash support
Visitors centre	₵8,500 cash support
Irrigation dam	X
Other voluntary provisions by BPA	
Traffic light	√
Integrated water system	√

the dam construction process. He was selected because of the significant effect farming has on the livelihood opportunities available to his family.

Some prior consultations with opinion leaders in the community, such as the Assemblyman and chiefs, agreed that Opanin Kwasi has been resettled by the Bui Dam and also has an in-depth knowledge and experience on life before and after the Bui Dam. His family has also been significantly affected by the dam in the form of loss of farmlands, and displacement from his village.

Description of life before the dam, with attention on assets and livelihoods

Before the dam, Opanin Kwasi's family cultivated yam, maize, cassava and vegetables. Farmlands, which were usually freely acquired from the indigenous owners, Bui Chief, ranged from 8 to 15 acres (3.24-6.07 ha) per person in the village, but his family was able to farm on about 30 acres (12.14 ha) of yams as compared to the average farm size of about 10 acres (4.45 ha) cultivated by other farmers. Tenant farmers (farmers whose farmland were allocated by the Banda Chief), such as his family members, contributed a token of 20 to 30 tubers of yam, one cockerel and 20 Ghana Cedis to the indigenous landowners (the Banda Chief) per year or for each farming season.

Cultivation of food crops was active in the rainy season, and generally for subsistence use. In the case of Opanin Kwasi, his large cultivated land allowed for the surplus produce to be sold in nearby markets, such as Wenchi and Techiman, to generate revenue for his family. The heavy rainfall with fairly warm temperatures provided appropriate weather conditions to support the cultivation of both food and cash crops. Drinking water for his family was accessed through streams near his community.

In the Dokokyina community in which Opanin Kwasi lived, there were carpenters, masons, drivers, three teachers (with two staying in nearby towns), more farmers and fishermen, but no health care worker. The diversity of people in the community provided the needed support to the larger community because the people lived as one big family of 165 people in 36 households, supporting each other in terms of providing free apprenticeship for the youth, and ensuring that the needs of other members of the community are met. Prior to the construction of the Bui Dam, several consultations relating to livelihoods were organized by stakeholders such as Bui Power Authority (BPA), the Tain District Assembly, and Bui National Park (BNP). Many of the issues discussed are centred on compensation for relocation, preparations needed to support the new resettlement arrangement, and the need to address the concerns of people affected by the relocation. Many promises were made, such as providing comfortable living conditions for the people, to motivate them to relocate. Such promises included the provision of fertilizer and irrigation to support farming, especially because the land in the new settlement is less fertile. Additional livelihood resources, such as the provision of a fish pond to support fishing, fertile lands for farming, schools, clinic, and better housing facilities were assured by BPA, but these were never provided. In other cases of consultation, BPA asked the people, including his family, to cease construction of additional houses starting from 2005 (later changed by BPA to 2008) since their village was to be relocated and so any new house would not receive any compensation. BPA confirms that some of these projects, such as the provision of a fish pond to support fishing and fertile lands for farming, are still part of their plans, but the clinic has been constructed and has been operational since 2013.

Effects of the dam, including other factors that mediated effects of the dam

According to Opanin Kwasi, construction of the Bui Dam caused some major changes to the livelihoods of his family. As a result of the dam, he and his family have been moved from their ancestral home and resettled in a camp. Although, his family has been provided with a new block house, this can never replace the attachment to his ancestral home lost to the whole process leading to their resettlement. His family has experienced a major shake-up in their livelihoods. Their old farmland were destroyed, and replaced with a smaller 4 to 5 acre farm (1.78 to 2.225 ha). Unfortunately, the fertility of the current farmland is far worse than what prevailed in the old Dokokyina settlement. Moreover, the aftermath of the changes in his family's livelihood as a result of the construction of the Bui Dam has negatively affected the income of his family, and limited his ability to properly and adequately provide for his family. This has resulted in some hardships for his family, especially in relation to making a decent living.

The state of hardship faced by his family is also worsened by the fact that they were not provided with proper training to help them prepare for and overcome the potential effects of the construction. The limited training support entailed some agricultural extension services provided by the Ministry of Food and Agriculture (MoFA) prior to the relocation. The training included how to apply improved farming technologies in their back yard gardens, as well as how to effectively till new farmlands that may not be as fertile as the old ones. As a result, his family is faced with lack of skills to deal with small farm size and poor fertility of farmlands allocated to them. Previously, his family's farmland was large and allowed shifting cultivation practices that allowed exhausted farmlands to fallow. The small farm size (about 4 acres) allocated to his family does not allow for such a farming practice. Again, he had to contend with pressure from his children who must share in his allocated land as they begin to be faced with the challenge of starting and fending for their own families. The lack of adequate preparation towards the resettlement has resulted in a dire situation for the livelihoods of his family.

Description of life after the dam construction, with attention on assets and livelihoods

After the dam construction, livelihoods became

complicated (having to live in a small, new living environment, being unable to fend for his family due to allocation of small farmland that has lost its fertility, and dealing with the inability to adequately provide for his family). As a result, he struggles to meet the livelihood needs of his family, a situation similar to majority of people living in the new Dokokyina community. Most families in the community, including his, were allocated farmlands near the resettlement camps A and B (Figure 1) that have lost their fertility because they were left barren after over-cultivation, as well as the practice of shifting cultivation by other farmers (including farmers from Bongaase and Jama). Currently, his family and many other families have to resort to the use of fertilizers to improve soil fertility and yield from the allocated farmlands. The challenge, however, is how to access unavailable funds to purchase fertilizer to support his farming activities. Unfortunately, BPA does not provide support in this regard.

Information from other key informants indicated that other people in the community, aside from Opanin Kwasi's family, have gained revenue and employment with Sinohydro (the Chinese company that constructed the Bui Dam) as masons, carpenters, steel benders, drivers, foremen, and cooks (S013). Some key informants also revealed that at the peak period of the dam construction, more than 4,000 people were employed by Sinohydro and 50 by BPA. Informants added that, at the end of the construction, majority of the people who were engaged with Sinohydro were laid off, but those engaged by BPA increased to more than 150 people. Opanin Kwasi stated that his family did not benefit from such employment opportunities because (unlike the large number of employees of Sinohydro who were not from the local community) they are mainly farmers, and also did not have the requisite skills to obtain employment from Sinohydro.

A challenge faced by Opanin Kwasi's family centres on the limited availability of farmland in resettled villages. Currently, his family has access to about 4 acres of land for farming, which is a reduction from 20-30 acres before his family was resettled. This pattern was consistent with trends in the wider Dokokyina community. According to respondent L011, average farm size decreased from 8-15 acres (3.24 to 6.07 ha) before the dam to less than 3 acres (1.215 ha) per family. Opanin Kwasi revealed that the initial plan was to allocate farmlands based on a community's previous involvement in farming activities. As a result of the plan, farming communities such as Dokokyina and Bui were targeted to receive larger allocations of farm land than Bator, which is mainly a fishing community, but this did not materialize. He stated that another factor (besides the scarcity of farmlands) that has affected his family's livelihood is the difficulty of accessing farmlands due to their distance from the community. Available farmland is now farther away than before the dam construction when they lived near the Black Volta (also corroborated by V006). As a way to compensate for the scarcity of farmlands, Opanin Kwasi's family had to consult with leaders of some distant communities, such as Jama and surrounding communities (over 10 km away) to secure additional farmlands for cultivation. These lands are secured by making a request from people such as the Jama Chief. In some instances, the farmers have to consult the owners to access the land for farming. Sometimes, they have to part with some of their harvest to settle with the land owners.

Opanin Kwasi reiterated that major challenges were created for many of the people who engaged in farming because the resettlement process failed to provide opportunities for farmers to plan and cultivate new lands, prior to their relocation. He noted, for example, how several truck-loads of yam sets (whole tubers or tuber pieces used for planting) transported to the new settlement for planting rotted because the farmland allocated to his family in the resettlement camp was small. The farmlands allocated to him as well as other farmers were mostly lands that have been abandoned by previous farmers due to loss of fertility (V004). He adds:

"Our livelihoods have changed after the Bui Dam. In our old village, food was abundant and livelihoods were good except for our poor roads. Farmlands were unlimited and even settlers were given enough land to farm at virtually no cost.

I could farm 30 acres and sometimes engage some farm labourers to expand my farmlands to cultivate more. I can say that I was rich and did not need any support from anybody, including the government. But, now I have access to a mere 4-5 acres of farmland to cultivate. I cannot cultivate much and even yam sets I brought from my old Dokokyina village got rotten because of limited and poor fertility of farmlands allocated to me. How do you expect me to farm and obtain any appreciable yield when I am allocated farmlands that have been heavily cultivated and abandoned after they had lost their fertility? Indeed, this resettlement has cost us a lot, and made many of us farmers poor. How do you say you have made life better for us? This is never true" (L011).

For his part and that of his family, the resettlement has made life difficult due to worsened livelihoods. He blamed this on poor planning associated with the resettlement process. Opanin Kwasi added that BPA failed to ensure that farmers were allocated adequate and fertile farmlands to complement farmlands lost to the displacement and subsequent resettlement. This, therefore, culminated in low harvest and the general shortage of foodstuff just after their relocation in 2011. As a result of these challenges created by the dam, an

unknown number of indigenous farmers from some communities have abandoned farming to engage in other competitive livelihood opportunities, such as fishing, trading, and also illegal small-scale mining in places located deep within the park enclave (L011). Opanin Kwasi has diversified his livelihood opportunities to include the sale of pre-mix fuel (for outboard motors), and the construction and rental of housing facilities for visitors who come to the communities. This approach to sourcing livelihood has helped his family to mobilize additional resources to improve their livelihood stakes.

On the social front, Opanin Kwasi added that his family was previously very united, but is now bedevilled with conflict that has left its toll of disunity in the bigger Dokokyina family. For example, a misunderstanding that ensued on whether to relocate during the dam construction has resulted in a divided community, with a few families refusing to relocate and remaining behind in the old Dokokyina village. Others had to return to their kinsmen in neighbouring Cote d'Iviore.

In the resettlement, Opanin Kwasi's family was provided with a new house constructed with blocks and aluminum roofing sheets (an improvement over the earthen houses with thatched roofs they occupied in the old settlement). He has also expanded his house with the construction of additional rooms to rent out for an additional source of income that helps meet the costs of maintenance, such as painting, replacement of locks, and window nets for his new accommodation.

Although, Opanin Kwasi agrees that the Bui Dam has brought some improvement in their livelihoods, he also believes that the Dam and its resettlement process has resulted in many untold hardships, such as weakening his family farming business due to the scarcity and poor fertility of farmlands, as well as the failure on the part of the resettlement process to provide better livelihoods for his family.

Some improvements have included the provision of a decent block house, access to roads, a community centre, and a clinic by the BPA (although many of the community roads are not tarred, and the shorter routes to other communities such as Banda Ahenkro-Manji could have served their interest better than routes along Wenchi-Tingakrom and Wenchi-Tesilima). His family has explored other income-generating opportunities, such as renting rooms and retailing in pre-mix fuel, to lessen the dire implications of the Bui Dam and its associated resettlements (Table 7). In the view of Opanin Kwasi, the Bui Dam construction was not a bad idea, but the effects on his family were negative due to the loss of their farmlands, as well as the small size and poor fertility of the newly allocated farmlands. He believes that the situation of their livelihood can be improved if appropriate measures, including the provision of farming inputs such as seeds and fertilizer, improvement in agricultural extension services, and allocation of additional farmlands to the farmers are implemented by BPA in their role as the resettlement organization. Table 7 provides a summary of the experiences of Opanin Kwasi's family regarding the effects of Bui Dam on capital assets.

In depth interview #2: Yaw Adjei

Introduction

Yaw Adjei a Fante, from Winneba, is a male and 36-45 years old. He has resided near the Bui area for less than 10 years, and currently lives in Bui Camp (Figure 1), which was resettled quite recently, with his four member family (his wife and children). His village is scheduled to be relocated, but at the time of the interview, this had not yet occurred. As of 2016, the Bui Camp was relocated to a new resettlement camp purposefully constructed to house the workers and family of BNP. Yaw Adjei was selected to be interviewed because he has lived through the period of planning, development, and construction of the Bui Dam and related resettlements. Other reasons for selecting Yaw Adjei included: he has a youthful family and therefore provides a different perspective regarding dam effects; his family is relatively small (which is generally about six in the community); and he works with BNP and can therefore provide in-depth information on the living conditions in the park and the effects of the Bui Dam on the park. He also added that he is among the elders responsible for the interest of a large majority of the people in Bui Camp by virtue of his work with Wildlife Village (Bui Park) and the park, which falls under BNP.

Description of life before the dam construction, with attention on assets and livelihoods

Before the dam construction, Yaw Adjei lived in the Bui Camp, but was born in the central region of Ghana and was transferred to the community to work with BNP. Yaw Adjei holds a university degree and also participated in a number of training programs organized by the Ghana Government. He joined Wildlife Division after going through a successful application and selection process.

The Bui Camp (also known as the Wildlife Village) was constructed in the early 1960s for Soviet workers under President Dr. Kwame Nkrumah during a failed attempt to construct the Bui Dam. The camp has been left for decades, without any proper maintenance, and is almost tumbling down. The area of the camp where Yaw Adjei lived had no electricity or running water, but was served by a bore hole and an old public toilet. His main source of livelihood and that of his family was income derived from working for the park (under the Division of Game and Wildlife), the governmental agency responsible for managing the park. Although, Yaw Adjei could not

Table 7. Comparison of in-depth interview results with survey results, regarding effects of Bui Dam on capital assets for interview #1.

Capital asset	Summary of survey findings	Summary of in depth interview #1 - farmer, male, 46-55 years old, resettled
Natural capital	1. Worse for all aspects of asset 2. Worse for relocated 3. Farmers least affected; fishers most affected 4. Ewe most affected; Nafana least affected	1. Worse on many fronts 2. Worse for relocation due to loss of farmlands and current infertile lands
Financial capital	1. Worse for many aspects 2. Worse for relocated 3. Farmers least affected; fishers most affected 4. Ewe most affected; Nafana least affected	1. Worse due to loss of revenue from previously cultivated large farmlands 2. Inability to source financial support from family members who refused to relocated
Social capital	1. Mixed effects 2. Worse for relocated 3. Farmers least affected; fishers most affected 4. Ewe most affected; Nafana least affected	1. Family fragmented with part left in old Dokokyina settlement 2. Increased family conflict due to disagreements on whether to relocate before the resettlement 3. Farming most affected due to inability to secure support from other family members
Political capital	1. Mixed effects 2. Worse for relocated 3. Farmer least affected; fishers most affected 4. Ewe most affected; Nafana least affected	1. Worse due to loss of income 2. Loss of indigenous ownership and control of farmlands because lands have been relocated to other communities
Human capital	1. Resilient for many aspects including improvement in fishing and farming 2. Worse for relocated 3. Farmers least affected; fishing most affected 4. Ewe most affected; Nafana least affected	1. Mixed impact 2. Diversified livelihoods to include fishing 3. Farming is no longer lucrative due to small size and poor fertility of allocated farmlands
Physical capital	1. Resilient with improvements in housing, electricity, roads, and clinic and school buildings 2. Worse for relocated 3. Farmers least affected; fishing most affected 4. Ewe most affected; Nafana least affected	1. Resilient with improvements in housing, electricity, school 2. Worse for relocated 3. Livelihood: worsened due to absence of skills training before relocation, farming most affected
Cultural capital	1. Resilient for many variables 2. Worse for relocated 3. Farmers least affected; mixed most affected 4. Ewe most affected; Nafana least affected	1. Worse for many aspects 2. Worse for relocated since they have lost the cultural support from part of the community that did not relocate

disclose his earnings from BNP for the said-period, he was quick to add that his earnings were significant in providing some level of decent livelihood for his family. He added that his family, together with many others in Bui Camp, engaged in farming, animal rearing, trading and hairdressing to support the livelihoods of their family. The people of Bui Camp obtained their livelihoods mainly through employment with BNP, and through mixed livelihoods involving farming, fishing and charcoal burning (V004).

Another form of resource that supported the livelihoods of Yaw Adjei's family was the type of accommodation provided by BNP. The management of BNP provided a three bedroom apartment for him and his family, because he was employed by BNP. The house contained a kitchen, living room and washroom. However, he and his family shared a common public toilet with the Wildlife community.

Other colleagues in BNP who were at lower ranks than him were housed in two bedroom apartments. Although,

his family did not have electricity, they enjoyed decent accommodation as compared to the kind of accommodation available to majority of the people in the villages near the park. The provision of decent accommodation by BNP provided his family the needed peace to go about their daily activities without worrying about where his family would live.

Before the dam construction, Yaw Adjei's family relied on the cordial relationship they had with people living near the park as a means to promote a high level of cooperation in addressing issues related to park management- the source of his livelihood. Although, Yaw Adjei's family resided in a nuclear household (like most families in Bui Camp), they found the opportunity to cooperate and share the pains and happiness of the extended family members. This practice helped his family to obtain support they may have required from other members of Bui Camp.

Effects of the dam, including other factors that mediated effects of the dam

In the view of Yaw Adjei, construction of the Bui Dam has both positive and negative effects on his family. The effects have included the relocation of his community, livelihoods and incomes of his family, as well as opportunities to develop resilience towards the potential challenges of the Bui Dam construction.

According to Yaw Adjei, the Bui Camp is in the process of relocation because his community forms part of the communities to be either cut off or inundated by the flooding of the Bui Dam. As a result of the planned relocation, his housing in Bui Camp has not received any form of renovation or expansion. This has worsened the previous poor state of the accommodation facilities provided for him and his family, although such accommodation was considered better in the eyes of people in the nearby communities. But the family has some good hope "at the end of the tunnel" because he has observed and inspected the new accommodation in the resettlement camp to be provided for his people by the BPA. His family will receive a 3-bedroom apartment with a kitchen, living room, and proper toilets (water closets linked to septic tanks), something that eludes them at the present resettlement or park camp.

Although, he maintains his employment with BNP after the construction of the Bui Dam, his family's livelihood has still been affected by the dam due to losses of incomes from other forms of additional livelihoods, such as farming. This occurred because people living in the Bui Camp were asked by BPA not to expand any existing construction activities, or the scope and size of additional forms of livelihood, such as farms. This directive was intended to reduce any future claims for compensation for additional lands to be cultivated or new houses to be constructed. The delays in relocating the community also means that the people cannot start to develop some of these additional and alternative sources of livelihoods in the to-be-allocated resettlement camp.

On the eve of the flooding of nearly a quarter of BNP by the Bui Dam construction process in June 2011, some training opportunities in areas such as animal rescue were conducted for workers of BNP.

This training was particularly important in helping to rescue some animal species, such as some monkey species that ordinarily would have drowned in the floods. But it is also important to note that some species of animals were lost because of the low capacity of the park staff and institutional capacity to save all animals that faced a risk. The training opportunities received also improved the capacity of staff of the park to explore and use other opportunities in tourism created by the Bui Dam. This included the purchase of a new boat powered by an outboard motor to support boat cruising that is gradually developing tourism in the park, a development Yaw Adjei believes has positively contributed to the sustainability of the park, as well as the security of his employment with BNP.

Description of life after the dam construction, with attention on assets and livelihoods

After the dam construction, Yaw Adjei continued to support his family with his income from working with BNP. He revealed that currently, the park has witnessed an improvement in tourism opportunities, and this is boosting the morale and work engagement of many in his village who work in the park. This is because the visit of tourists provides opportunities to offer services as tour guides, and also educate people about BNP. Services currently improved by BNP, and also having a positive effect on his livelihood outcomes, include increases in the frequency of tourist activities to watch hippos (now relocated upstream of the Bui Dam). Tour activities also include boat cruises along the 444 km^2 lake created by the Bui Dam. Yaw Adjei adds that few people in the Bui Camp, including his family, are currently engaged in the fishing industry, especially in the areas of smoking and sale of fish caught in the lake. This helps in generating some income to support what is gained from formal employment with the park. As a result of his formal employment with BNP, he is able to mobilize some financial capital to help the family engage in the fishing business. In this regard, the park and the dam are providing an improved fishing livelihood for Yaw Adjei's family.

Yaw Adjei added that access roads are virtually absent, and he and his family had to obtain water from a borehole located at some distance from their residence. Although, there are plans to provide new accommodation for Yaw

Table 8. Comparison of in depth interview results with survey results regarding effects of Bui Dam on capital assets for interview #2.

Capital asset	Summary of survey findings	Summary of in depth interview #2 - farmer, male, 36-45 years old, not resettled
Natural capital	1. Worse for all aspects of asset 2. Worse for relocated 3. Farmers least affected; fishing most affected 4. Ewe most affected; Nafana least affected	1. Worse for many aspects 2. Part of park was inundated 3. Worse for farming since the people were prevented from expanding farmlands
Financial capital	1. Worse for many aspects 2. Worse for relocated 3. Farming least affected; fishing most affected 4. Ewe most affected; Nafana least affected	1. Less affected 2. Able to access bank credit as a result of the formal employment with BNP 3. Receive stable incomes from government 4. Improved revenue from lake cruising 5. Lost revenue from hippo watching
Social capital	1. Mixed effects 2. Worse for relocated 3. Farmers least affected; fishing most affected 6. Ewe most affected; Nafana least affected	1. Mixed effects 2.Community has not yet been relocated 3. Lost some family networks with nearby communities that were relocated
Political capital	1. Mixed effects 2. Worse for relocated 3. Farmers least affected; fishing most affected 4. Ewe most affected; Nafana least affected	1. Less affected 2. Still under the control and management of BNP
Human capital	5. Resilient for many aspects including improvement in fishing and farming. 6. Worse for relocated 7. Farmers least affected; fishing most affected 8. Ewe most affected; Nafana least affected	3. Less affected 4. Still employed by BNP 5. Less impacted because not relocated 6. Worst for mixed livelihoods 7. Directed by BPA to halt any expansion of farmlands due to impending relocation
Physical capital	1. Resilient with improvements in housing, electricity, roads, clinic and school buildings 2. Worse for relocated 3. Farmers least affected; fishing most affected 4. Ewe most affected; Nafana least affected	1. Worse effects 2. Cannot expand/construct new settlements in the old settlement 3. Worse because housing units have not been renovated over a long period of time 4. Hopeful of moving to new and better residences
Cultural capital	1. Resilient for many variables 2. Worse for relocated 3. Farmers least affected; mixed most affected 4. Ewe most affected; Nafana least affected	Less affected

Adjei's family and that of the many families in the Wildlife village, at the time of this study, people remained in the old accommodation at the Wildlife village. The new Wildlife quarters had been constructed but some infrastructure remained to be completed, including sinking of boreholes, improvement of access roads, and landscaping of the site. Yaw Adjei reiterated that the Bui Dam and its attendant relocation process has a marginal effect on his family, because his family continues to gain income from employment with BNP. The dam has introduced some livelihood opportunities in the areas of fishing, and it makes a lot of sense if his family can diversify livelihood opportunities to explore the benefits perceived to have been introduced by improvements in fishing. However, this has become challenging because his family does not have the requisite skills to engage in the available fishing opportunities. The experiences of Yaw Adjei regarding the effects of Bui Dam on capital assets for his family are summarized in Table 8.

In depth interview #3: Kwame Fosu

Background

Kwame Fosu is a male, 36-45 years old, who has lived

near BNP for 37 years. He indicated that for the past 98 years, his extended family and the Bator community have settled around BNP. He is Ewe born in the old Bator village of Akaiyakrom and is a member of the resettled Bator community (Figure 1). He has a family of six made up of his wife and two children, and two siblings. He has some secondary level of education and is currently seeking the opportunity to pursue his education at the tertiary level. He is a member of the Banda District Assembly and a fisherman. Kwame Fosu has worked as a fisherman in his entire life, and also supported his livelihood with an additional meagre allowance he receives for his constituency services for the District Assembly.

Kwame Fosu's family was selected because of their engagement in fishing, one of the key livelihood activities in the community. He is also an opinion leader who coordinates activities between governmental institutions and their local counterparts such as traditional leaders, clan and family heads. He is very knowledgeable in issues of community livelihoods, and also quite instrumental in the processes leading to the development and construction of Bui Dam and the general resettlement process. He is influential and also interacts substantially with government officials and institutions such as the District Assembly, BPA and BNP, traditional leadership, and community-based organizations. His input stands to enrich the documentation of experiences towards navigating livelihoods before, during and after the Bui Dam construction.

Kwame Fosu's ancestors migrated from the Volta region of Ghana to the Bui area to engage in their fishing activities. The migration occurred many years before the establishment of BNP in 1971. Their movement was motivated by the search for areas of abundant fish to support their main source of livelihood. Kwame's wife also engages in the fishing business by drying and smoking fish for sale to retailers from cities such as Accra and Kumasi. He lives with two of his paternal brothers, who also support themselves through fishing and transport service- carrying goods and sometimes passengers. The selection of Kwame Ofosu was critical to the in depth interview because he is popular amongst the people, and works in nearly all facets of community engagement, especially in areas affecting the sustenance and welfare of people in the community.

Description of life before the dam construction, with attention to assets and livelihoods

Before the dam construction, Kwame Fosu's family was engaged in fishing in a natural river. Although, he could not easily provide figures, he indicated that the river (Black Volta) was a key source of livelihood for his family because it provided them with adequate fish, money from the sale of fish, and generally made life comfortable for his family. The fishing grounds provided enough food for the fish through the decay of plant parts that fell into the river. These conditions provided a sustained livelihood for his family, as well as people of the main Bator community of Akaiyakrom that lived very close to the river and actively engaged in fishing. Other activities supporting the livelihoods of Kwame Fosu's family were similar to that of the majority of people in the Bator village: fishing and fish mongering, and brewing of local gin called "akpeteshie."

Methods of fishing applied by his family were simple and involved little capital and equipment, but yields were adequate for consumption and processing for sale at nearby markets. The basic equipment was a canoe, a set of paddles, and a fishing net. The fish the family caught was mainly large in size and high in quantity, and included mudfish (*Protopterus* spp.), tiger fish (*Hydrocynus* spp.) and tilapia (*Coptodon rendalli*). In addition, his family and other members of the Bator community gained livelihoods through the provision of boat services and rest stops for tourists, acting as tour guides to ferry people to watch hippos, and patrolling the park in exchange for periodic access to fish in park areas.

His family has never owned land. However, land for purposes of settlement was accessed through collaboration with Banda Traditional Council and the District Assembly. Kwame Fosu added that farmlands were freely provided for his family as a member of the Bator community. In contribution to the growth and development of the broader Banda community, Bator people were entitled to allocations of land by the Paramount Chief. Kwame Fosu reported enjoying strong family ties in the pre-dam period, which ensured that people brought together food to share and availed themselves to discuss and share experiences which indirectly sustained his family's livelihood. His family cooked food that included a variety of fish that benefited all, including those who could not engage in fishing due to ill health or failure to secure a better catch during their fishing expeditions.

Effects of the dam, including other factors that mediated effects of the dam

The effect of Bui Dam on the family of Kwame Fosu is both positive and negative (Table 9). The effects include the relocation of their village, employment incomes, and opportunities to engage in additional and alternative livelihoods.

Village of Akaiyakrom was flooded and its people relocated to the Bui Resettlement Camp (labelled as A in Figure 1). As a result, he and his family and some paternal relatives, have been resettled in a new block house. The quality of the building is far better than that in the old settlement. The Bui Dam has affected the

livelihoods of his family through the destruction of their fishing grounds and landing sites that provided opportunities for bumper fishing harvest and safe landing, respectively. Positive effects include the creation of a wider fishing ground in the lake formed by the dam, and the opportunity to use bigger boats to conduct fishing in the dam. However, he is challenged by the difficulty of mobilizing financial resources to secure a bigger boat and outboard motor to fully explore the current opportunities in fishing livelihoods.

Other alternative livelihoods, such as selling of fish, trading, and provision of some unregulated forms of boat services for tourists have been enhanced by the construction of the Bui Dam. However, this has also come with some challenges, such as competition from migrants to the Bui area.

The failure on the part of the BPA and other relevant stakeholders to provide training opportunities to prepare his family for the effects of the Bui Dam has made it difficult to develop resilience against the effects of the dam. His family could have been provided with training in alternative livelihoods, as well as other potential opportunities in livelihoods to be created by the Bui Dam. For example, currently, it has become quite difficult for his family to adequately explore some of the potential opportunities in fishing, to improve the livelihood stakes of his family. His family could have been supplied equipment such as outboard motors and fishing nets on credit. Further, some low interest credit facilities could have been mobilized for fishermen including his family to help them to meet the challenges associated with lake fishing.

Description of life after the dam construction, with attention on assets and livelihoods

The experience of Kwame Fosu's family after the dam construction is summed up as:

"People were comfortable with the simple livelihoods and uncomplicated rural lifestyles in their mud houses with thatched roofs, because they enjoyed the peace within their own compounds. Nobody paid for utility bills, but people directed their livelihoods activities at their pleasure, had enough to eat and even spare, and stream water was clean and freely available at all times. But after the dam construction, we have lost everything and what has been given to the community has brought along the high cost to maintain houses, extreme hot weather conditions during the day, no trees to provide shade, dusty roads…" (L013).

Kwame Fosu argued that the dam has increased fish stocks for the fishing industry but the industry is unable to adequately provide for the livelihood needs of his family as well as the main fishing communities of Bator, Dam Site, and Agbegikro because of competition from other settler fishermen. He adds that, currently, there is a free-for-all (unregulated) type of fishing industry practiced in the Bui area. However, the indigenous fishers are disadvantaged because of the in-migration of other fishers who seem far better equipped to take advantage of the new conditions in that they have the larger boats and outboard motors needed to cope with lake conditions. Further, the sudden weather changes on the lake, as he describes the situation, can make the small canoes adapted to river fishing subject to capsizing in the lake.

Immediately after the dam construction, Kwame Fosu's family, as well as majority of the over 200 indigenous fishermen in the resettled area, could earn more than 1,000 Ghana Cedis from fishing per month, but this has currently decreased to 520-780 Ghana Cedis per month. His family's current low income from fishing is the result of the low fish catch experienced by some of the fishermen from the dam-affected communities. This is basically related to the challenge of accessing larger boats and outboard motors that can help such fishermen to increase their fishing activities to harvest more fish, as evident with the in-migrant fishermen who enjoy a booming fish business due to their resourcefulness to engage in robust fishing trade with merchants from Kumasi and Accra.

These changes in earning from fishing have greatly affected the livelihoods of Kwame Fosu's family, and the majority of people from the Bator community, which has a total fishermen population of about 120 people. Currently, his family's fishing livelihood is undermined by an aggressive competition from migrant fishermen and their families from Ghana and the West African sub-region. Kwame Fosu added that there is currently a large illegal settlement close to Jama (and at the embankment of the Bui Lake) where in-migrants from downstream on the Volta, and other places such as Nigeria, Mali and Cote d'Ivoire, have settled and actively engaged in the booming fishing business. The negative effects of the activities of the migrant fishers on his family occur in tandem with other direct effects from the hydro dam and associated resettlements. Unlike Kwame Fosu's family that still engages in subsistence and low capital intensive type of fishing, some people from the communities have improved revenue from the fishing industry by purchasing large outboard motors to increase their fishing expeditions, and also selling fish in the community and other large markets in Kumasi and Accra. His inability to enjoy the potential opportunities in the fishing industry is related to his lack of skills in fishing, and the poor financial capacity of his family to invest in the fishing related industry.

Currently, Kwame Fosu's family has shifted from river to lake fishing, and this takes place a short distance from

Table 9. Comparison of in depth interview results with survey results regarding effects of Bui Dam on capital assets for interview #3.

Capital Asset	Summary of survey findings	Summary of in depth interview #3 - fisherman, male, 36-45 years old, resettled
Natural capital	1. Worse for all aspects of asset 2. Worse for relocated 3. Farming least affected; fishing most affected 4. Ewe most affected; Nafana least affected	1. Worse for many aspects 2. Lost access to old fishing grounds 3. Worse for fishing livelihood 4. Worse for relocated
Financial capital	1. Worse for many aspects 2. Worse for relocated 3. Farming least affected; fishing most affected 4. Ewe most affected; Nafana least affected	1. Worse for many aspects 2. Lost access to financial support from tourism opportunities
Social capital	1. Mixed 2. Worse for relocated 3. Farmers least affected; fishing most affected 4. Ewe most affected; Nafana least affected	1. Worse for many aspects 2. Fragmented family network 3. Lost livelihoods gained from networks
Political capital	1. Mixed effects 2. Worse for relocated 3. Farmers least affected; fishing most affected 4. Ewe most affected; Nafana least affected	1. Mixed effects 2. Weakened traditional governance structures 3. New leaders have emerged due to the control of livelihoods resources, such as fishing
Human capital	1. Resilient for many aspects including improvement in fishing and farming 2. Worse for relocated 3. Farmers least affected; fishing most affected 4. Ewe most affected; Nafana least affected	1. Mixed effects for many aspects 2. Improved fishing grounds-wider lake 3. Large boats are used for fishing on lake 4. Increased cost of fishing 5. Loss in fish catch 6. Reduced income from fishing 7. Loss of tourism opportunities 8. Increased competition in fishing in the Lake created by the dam 9. Encourage diversification of livelihoods
Physical capital	1. Resilient with improvements in housing, electricity, roads, and clinic and school buildings 2. Worse for relocated 3. Farmers least affected; fishing most affected 4. Ewe most affected; Nafana least affected	1. Resilient with improvements in housing, roads, clinic, school, community centre 2. Worse because relocated 3. Worse for his community who rely on fishing and who are mainly Ewe who practice patrilineal inheritance
Cultural capital	1. Resilient for many variables 2. Worse for relocated 3. Farmers least affected; mixed most affected 4. Ewe most affected; Nafana least affected	1. Worse for many aspects 2. Livelihood challenges have weakened cultural norms and practices 3. Worse because relocation has fragmented his resettlement

the dam. According to Kwame Fosu, lake fishing does not provide a favourable alternative to river fishing for his family. Lake fishing has differential effects: the poor are unable to cope with the increased cost of fishing; and the aged and less physically active are unable to access fishing activities because communities are located far from the lake, and need to commute over rocky cliffs to access fishing sites. Further, fishing is threatened by competition from migrant fishers from Ghana and the West African sub-region. At the time of interviewing, Kwame Fosu was exploring an opportunity to secure 7,500-8,000 Ghana Cedis to purchase an outboard

motor, aside from the purchase of additional equipment such as fishing nets to fish in the lake created by the Bui Dam.

Further undermining his fishing livelihood is increased competition in fishing due to the absence of any effective regulations in the fishing business. In all, over 20,000 migrant fishermen located in about 53 illegal communities are engaged in active fishing, and therefore compete with his family and other indigenous fishermen for the available opportunities in fishing livelihoods. The only assurance his family has in arresting the challenge is the completion of fishing regulations that will include specifications about access (who can conduct fishing).

Kwame Fosu's family has lost the small but important additional income previously gained from tourism in BNP. These lost livelihoods from BNP included boat services, provision of a rest stop, sale of fish, and sale of some cultural artefacts such as beads to tourists. These services are now provided by BNP because BNP has improved its capacity to provide such services whilst the family is unable to benefit from tourism as a result of being located further away from the park.

Kwame Fosu's family, together with a host of other families from the Bator resettlement, feel that the relocation process is disappointing. Kwame Fosu adds that his family is unhappy because they believe that BPA has deceived them by failing to honour promises made during the relocation process. He noted that "my family is no longer interested in honouring meetings with stakeholders such as BPA since we do not hope to receive any good assurance for our diminishing livelihoods."

Unlike in the old Bator Village, where participation in social events such as naming ceremonies attracted a compulsory contribution of 5 Ghana Cedis (less than US $2) to support the affected family, Kwame Fosu and his family have difficulty in supporting or gaining support from other families due to the increased difficulty in accessing livelihoods for his families as a result of the adverse dam effects on their fishing livelihoods.

Kwame Fosu's extended family no longer enjoy the pleasures of the past, such as sitting to chat and enjoy folk stories after fishing expeditions, due to the adverse changes that the Bui Dam has caused to the livelihoods of his family. This has left in its wake, a large number of families who are perceived to have become more selfish and self-centred due to their struggle to meet the needs of their nuclear families. Many people, including the heads of families such as Kwame Fosu's, have had to share authority with the youth, because many of them are now breadwinners for the larger families.

According to Kwame Fosu, Bui Dam has failed to provide the required alternatives to the adverse changes in his livelihood caused by the dam. Overall, Kwame Fosu thinks that some people have benefited from improvements in fish stocks and a wider lake, but the perceived benefits have been negated by the influx of an aggressive migrant population who compete vigorously for the few opportunities in the fishing livelihood. Unfortunately, the few over-competed fishing resources also serve as the only source of livelihood available to support the life of his family. Table 9 provides comparison of Kwame Fosu's situation with findings from the community survey.

In depth interview #4: Agya Koo Kusi

Background

Agya Koo Kusi is a male, aged between 46 and 55 years, and of Nafana ethnicity. He has lived near BNP for 21 to 30 years, and his village, Bongaase will not be resettled. He has a family of seven, made up of a wife and five children. Agya Koo Kusi sources the livelihood of his family from his farming activities. He and the family have lived in Bongaase for the entire period of the development, construction and after the construction of Bui Dam and related resettlements. They live in a decent accommodation and regulate their livelihoods together with the family's farming activity.

Agya Koo Kusi's family was selected as part of the case studies because they have witnessed most of the events associated with construction of the Bui Dam, including blasting of rocks and other excavation works, construction of a saddle dam, flooding of some communities by the dam, and the dam-related resettlement process. However, his community will not be resettled. The family lives at the fringe of the dam, where effects are perceived to include loss of farmlands to construction of settlements, roads and transmission lines. Agya Koo Kusi was selected for the in depth interview because he is knowledgeable about his community's history, and also serves as an elder and is a family head. His inclusion is particularly significant to the study as he provides information for a comparative study of dam effects for communities that will not be resettled.

Description of life before the dam construction, with attention on assets and livelihoods

Agya Koo Kusi and his family have witnessed majority of the events leading to the construction of the Bui Dam. Before the dam construction, the family's cashew plantation provided most of the family income. In addition to cashew farming, his family also engaged in cultivation of food crops such as yams and cassava for both household consumption and for sale as cash crops.

These forms of income were instrumental in funding his children's education, as well as providing for the daily sustenance of his family. His family was, however, unable

to engage in other forms of livelihood such as fishing due to limited skills in practicing these livelihoods. But other members of his community engaged in a variety of livelihoods and professions, including teaching, masons, carpentering, butchering, hairdressing, and trading. Although, Agya Koo Kusi's livelihood activities were simple, it was relevant in providing for the livelihoods of his family and those of most people in Bongaase community.

Before (and after) the dam construction, Agya Koo Kusi's family lived in an extended family household that included his nuclear family and a mixture of other nuclear families related by matrilineal kinship (primarily through the mother's line). The extended family provided support in a variety of ways: practicing their livelihoods, adulthood initiation rites, naming ceremonies and funerals. After a day's work activities, the extended family cooks and shares meals. Agya Koo Kusi's family was instrumental in providing for the needs of other family members who could not adequately provide for the needs of their nuclear families. Livelihood support provided by his family included feeding the children of other extended family members, and supplying some food stuffs for other family members in need.

Before the dam, the flow of authority and decision making was swift, well organized, and effective in supporting the livelihoods of his family and that of the larger family. The youth looked up to the direction and guidance of the elderly in the family and this helped in preparing his children for adult life, including how to provide and fend for themselves. Respect and discipline were the hallmark of his family since the authority of the elderly, such as family heads, was greatly revered. As a result, Agya Koo Kusi's children, including a large number of the youth from the community, grew up to become responsible people with some having completed their education, and others also engaged in different forms of income generating activities. Agya Koo Kusi's family, like many in his village, lived in block houses and shared a public toilet facility.

Effects of the dam construction, including other factors that mediated effects of dam

The effect of the Bui Dam on Agya Koo Kusi's family is a mix of positive and negative factors (Table 10). Agya Koo Kusi's family and their community were not be affected through resettlement, but rather through road construction and loss of some community lands (144 km^2 of land, including parts of BNP) to flooding by the dam.

The scope of his livelihood has not changed since his family still practices farming. However, his income options have been reduced by flooding of part of the communal lands that served as part of his farmland. His family has also been negatively affected by the dam because of lack of preparedness in the form of the failure of BPA to provide training in alternative livelihood opportunities. This meant that his family could not properly exploit new livelihood opportunities such as trading, and the potential in fishing livelihoods.

Description of life after the dam construction, with attention on assets and livelihoods

The coming of the Bui Dam has less effect on the livelihood of Agya Koo Kusi's family, as compared to many other families in his community (Table 10). He continued to practice his profession, and still depends on his cashew farms (which was not inundated), as well as his subsistence cultivation of food crops. However, he is now limited in his farm labour due to his old age and occasional ill health. As a result, he has to sometimes, depend on hired labour to support his cash crop farming, which comes with cost.

After the dam construction, his family has benefited from improvement in infrastructure, which includes construction of roads and expansion of existing road networks, extension of electricity to his house and the community at large, and construction and rehabilitation of new schools and existing school infrastructure, respectively. Improvements in infrastructure have positively contributed to his livelihood because he can now easily cart his farm produce to sell in nearby markets. Nonetheless, he is disappointed with the number of failed promises relating to his family's livelihood, particularly the promise by BPA to provide alternative livelihood support programs, and create local jobs to absorb the ever increasing number of the unemployed youth.

According to Agya Koo Kusi, many of the promises by the Banda Chief and including those of the resettled communities (Table 6) have been left unfulfilled. These include provision of an irrigation dam, a community zoo (an example of a Community Resource Management Area, or CREMA), a mausoleum, and funds to start small businesses. Specifically, before the Bui Dam construction, BPA reached an agreement with the communities to provide support to develop a community zoo to keep some of the wildlife threatened by the flooding of the Bui Dam. The animals will be kept to serve as a tourist site and to generate revenue for the communities. Moreover, the CREMA will protect wildlife resources and serve as a legacy to be bequeathed to the younger generation who may not be privileged to have witnessed the park before the intended impoundment and flooding of nearly a quarter of BNP. Other unfulfilled promises include: support for a tie and dye business; a vehicle to transport traders to and from the market; training in alternative livelihoods; construction of tarred roads within the resettled communities; and providing

Table 10. Comparison of in depth interview results with survey results regarding effects of Bui Dam on capital assets for interview #4.

Capital asset	Summary of survey findings	Summary of in depth interview #4 - farmer, male, 46-55 years old, not resettled
Natural capital	1. Worse for all aspects of asset 2. Worse for relocated 3. Farmers least affected; fishing most affected 4. Ewe most affected; Nafana least affected	1. Mixed effects 2. Lost access of farmlands to flooding, and construction of access roads
Financial capital	1. Worse for many aspects 2. Worse for relocated 3. Farmers least affected; fishing most affected 4. Ewe most affected; Nafana least affected	1. Mixed effects 2. Difficulty in accessing bank credits
Social capital	1. Mixed 2. Worse for relocated 3. Farmers least affected; fishing most affected 4. Ewe most affected; Nafana least affected	1. Less affected 2. Family networks still support livelihoods of his family
Political capital	1. Mixed effects 2. Worse for relocated 3. Farmers least affected; fishing most affected 4. Ewe most affected; Nafana least affected	1. Mixed 2. Failed promises from local governance institutions such as BPA
Human capital	1. Resilient for many aspects including improvement in fishing and farming 2. Worse for relocated 3. Farmers least affected; fishing most 4. Ewe most affected; Nafana least affected	1. Mixed effects 2. Improvement in fishing livelihoods 3. Inability to access fishing livelihood due to poor skills 4. Migration of youth for employment in nearby communities
Physical capital	1. Resilient with improvements in housing, electricity, roads, and clinic and school buildings 2. Worse for relocated 3. Farmers least affected; fishing most affected 4. Ewe most affected; Nafana least affected	Resilient with improvements in existing road networks, electricity, new and rehabilitated schools
Cultural capital	1. Resilient for many variables 2. Worse for relocated 3. Farmers least affected; mixed most affected 4. Ewe most affected; Nafana least affected	1. Resilient for many aspects 2. Cultural practices are still held

supplies of fertilizer. Therefore, his hope of securing livelihood for his family has been dashed and this has made it difficult for him to adequately provide for the sustenance of his family.

Among the implications of these unfulfilled promises is the loss of expectations. According to Agya Koo Kusi, a number of the youth as well as other families have migrated and relocated from the Bongaase community to seek greener pastures in nearby large towns such as Wenchi and Nsawkaw. Others have also pitched camp in places near Jama where settlements have sprung up. These settlements are mainly for migrants engaged in fishing livelihoods. He added that these people are mainly involved in fish mongering, and in a few cases in actual fishing in the large lake created by the Bui Dam. As outlined in Table 8, the impact of the dam on Agya Koo Kusi's capital asset situation resembles, in many ways, the impact experienced by many other people, even though his family has not been relocated. Agya Koo Kusi's family is not happy about the Bui Dam and related resettlement processes because it has failed to initiate any significant change in their livelihoods. He believes

there are major opportunities created, such as improved access to fishing, which can enhance the livelihood options. Unfortunately, Agya Koo Kusi and his family are badly placed to secure any significant benefit from the opportunities in fishing because they lack the essential fishing skills and capital required for fishing.

DISCUSSION

Before the construction of the Bui Dam, the people were self-sufficient, augmented in some cases, by the income from selling excess food stuff and fish. This is confirmed by responses from key informants who also indicated that livelihoods before Bui Dam construction was more by cultivation of crops for food (L015), and fishing, to provide for the nutritional needs of the families (L013 and L014). In many cases, the livelihood options that people engaged in were capable of providing the general livelihood needs of the people (G022). More so, it was evident that there were minimal levels of community consultation prior to the dam construction. The arguments also suggested that the community inputs were less integrated into the overall process of the dam construction and aftermath. These actions and to some extent, inactions have culminated into community dissatisfaction with aspects of the dam construction process including resettlements and provision of alternative livelihoods. The significance of community inputs in local development agency as identified by this study is supported by many arguments (le Roux and White, 2004; The World Bank, 2004; Bennett and McDowell, 2012; Peter, 2013) because the contributions of community members to local development discourse is critical for gaining local acceptance and support but, this is usually ignored since the voices of people such as those displaced by dams are rarely highlighted.

The case studies demonstrated that effect of the dam on community livelihoods was mixed for different families. The in depth interview results, however, corroborate that of the household survey to suggest that the construction of the Bui Dam has resulted in both negative and positive effects, with the exception of natural capital. The study results indicate that some positive effects of dams such as improvement in housing facilities for the resettled communities, expansion of access routes to Bui communities and its environs, access to a clinic, and expansion of water sources do exist.

The results of the case studies show that effects of the dam involved issues of resettlement, loss of farmlands for farmers, loss of fishing grounds and changes in the needed methods for fishing in a lake environment, as well as worsening livelihood options. These results are also corroborated by many of the key informants, who indicated the following: few villages (as compared to the Akosombo Dam resettlement) have been inundated by the Bui Dam and resettled in Bui and Jama camps (V001-V008 except V004); and communities have generally lost their fertile farmlands to the flooding and subsequent relocation. Moreover, the newly allocated farmlands are small in size and poor in fertility (V003, L015, G018); fishing communities oriented towards river fishing have lost their fishing grounds to flooding, and fishing cost has increased due to the need to purchase large boats and outboard motors needed for lake fishing, as well as need to commute long distances on-land and on-lake to engage in fishing. The case studies further show that dams and resettlement can undermine livelihoods of people through reduced access and size of farmlands, and create changes in access to opportunities in new livelihoods such as fishing. Key informant interviews suggest worse impacts of the Bui dam construction. Some adverse effects of the Bui Dam include loss of community lands such as farmlands, loss of both food and cash crops, an increase in the cost of conducting some livelihood activities such as fishing, and the influx of migrants who compete for available opportunities in community livelihoods. The study results is similar to the arguments advanced by several literature (Ofori-Amanfo, 2005; Dzodzi, 2006; Cave et al., 2010; Miller, 2011; Ansar et al., 2014; Chen et al, 2016; Fernside, 2016). The Bui study also confirms the results of WCD (2000), Galipean et al. (2013) and Nusser (2014), by showing that dams can negatively affect livelihoods of people and families living near dams, and those who in some cases have gone through resettlements. However, dams and associated resettlements can also positively affect fishing livelihoods such as improved marketing opportunities, and lake-caught fish for people with the requisite fishing skills and equipment. The few people who have the capacity to explore the opportunities in fishing have improved livelihoods for their families.

Results of the Bui study are similar to those described by Dzodzi (2006: 144-146), because the study suggests that dam construction can increase access and opportunities in fishing-related livelihoods for people who live near dams. However, the study provides some differing results with Dzodzi (2006), in part, because people around Bui Dam are unable to explore other promising livelihoods such as fishing (due to the inability to access lake-appropriate equipment and the requisite capital outlays), unlike the case of communities near Akosombo Dam who gladly embraced fishing livelihood through the process of diversification of livelihoods. The positive impacts of dam construction as suggested by this research are further corroborated by the findings of Alhassan (2009), Kyei-Dompreh (2012), Kabo-Bah et al. (2016), Obour et al. (2016) and Prado et al. (2016). More so, the finding is similar to that of Dzodzi (2006) on the long term responses of downstream and lakeside communities of Ghana's Volta River Project, suggesting that dams and associated resettlement can positively

affect fishing livelihoods by increasing fish catch and revenue generated from fishing for people and families who have the requisite skills and financial resources to purchase larger boats and outboard motors for lake fishing. Communities near Akosombo Dam gladly embraced fishing through the process of diversification of livelihoods. In a similar vein, the Bui study suggested that dam construction increased access and opportunities of fishing for people who live near the Bui dam. The Bui study however, differs from that of Dzodzi (2006) because people living near the Bui dam are unable to take advantage of the fishing opportunities given the financial limitation of accessing financial resources to purchase outboard motors and boats to facilitate fishing on the rather large but stormy lake created by the Bui Dam. In some cases, some people are unable to explore fishing opportunities due to their personal or cultural disposition against doing so.

Some key informants (G020, L010-L014) provided similar views as found in the in depth interview scenarios by noting the failure of BPA (the main resettlement body) to provide adequate training in livelihood options, including alternative livelihoods. This development has negatively affected the capacity of the dam-affected communities to develop some forms of resilience in their livelihoods after the Bui Dam. The outcome of the case studies is also supported by the interviews, which shows a worsening of human and natural capital after the dam construction. The results of the Bui study suggest that future resettlement of communities near dams should be based on commitment to fulfil their promises that integrate policies and programs to build the capacity of communities to develop, sustain or improve community livelihoods. Generally, one can infer that policy makers and dam-affected communities have not adequately explored lessons of the Akosombo Dam (Kalitsi, 2004; Dzodzi, 2006; Kabo-Bah et al., 2016), but repeated the many mistakes of the processes associated with that project. The lessons learned revolve around the need for people affected by dams and related settlements to proactively source and engage in new and emerging livelihood opportunities as a way to absolve the weaknesses in other livelihoods. The argument on improving livelihoods to overcome dam impacts as identified by the study is similar to studies by Bryceson (2002), Mutenje et al. (2010) and Aasoglenang and Bonye (2013) that explored rural livelihood diversity as a coping strategy for adverse impacts of development projects. For example, individuals can organize themselves into cooperatives to improve the capacity to source bigger loans to invest in such livelihoods, whilst the government and contractors also step up and fulfil their promises to the people. These cooperatives can also support process of pulling resources together to generate a revolving fund to be accessed by members who may be in need of capital for their business. Training in multiple livelihoods will therefore be an important step to maintain or secure improved livelihoods and effectively navigate people through the potential adverse effects of dams and related resettlements on community livelihoods. However, there is hope for the people since BPA asserts that they are in the process of sourcing funds and an institution to conduct training on building the capacity of the people in the development of alternative livelihoods.

Conclusion

In depth interviews were conducted with four families: two families that were relocated, and two families that were not relocated. Results indicated that dams and resettlement can undermine livelihoods of people through reduced access and size of farmlands, and create both positive and negative changes in access to opportunities in new livelihoods such as fishing. Nevertheless, dams and associated resettlements can have positive effect on fishing for people and families who have the financial resources to invest in larger boats, outboard motors, and premix fuel to engage in the newly emerging opportunities in lake fishing and its associated processing activities. The results also suggest failure on the part of the government to actively integrate policies and programmes that could build the capacity of communities to mitigate the effects of dam construction and associated resettlement process. The intended programmes were planned by the Bui Power Authority, Bui National Park and representatives of the affected communities. Reasons for the unfulfilled promises were mainly lack of funds to execute the promises. Other reasons relating to the uncompleted projects for the communities centred on the fact that many of the 'failures' are based on failure in planning and commitment and failure to learn from past experiences.

The Bui study revealed that the resettlement process focused on the provision of facilities (such as electricity, boreholes, schools and clinic) to stimulate growth and improve community livelihoods. However, little emphasis was laid on providing some of the key needs of the affected communities: training in alternative livelihood opportunities, provision of fishing and farming equipment, provision of various forms of financial support, and provision of fertile farmlands and fishing grounds. Conservation efforts, including the establishment of Bui National Park, will not always have positive effects on people's livelihoods, because conservation efforts limited community access to livelihood resources such as fishing grounds, arable land for farming, and game. However, the findings also drew attention to the fact that effective PA management should be in line with processes that seek to provide other options for communities to receive compensation options for livelihood resources lost to PA

management. Such options can include the provision of effective compensation for loss of community resources, and the provision of alternative livelihood resources that can build on community livelihoods.

On the issue of establishing conservation sites near or on community lands, the Bui study reaffirms studies such as that of Nelson and Agrawal (2008) and Naughton-Treves (2010) that support the need to improve community benefits such as revenue from conservation sites. This argument is also supported by Agyare's (2013) study on polycentric governance and socio-ecological performance of community resource areas in Ghana that suggests that Community Resource Managed Areas (CREMAs), a variant of community-based natural resource management, influence communities to have positive attitudes towards parks and tolerate wildlife because of the benefits they have, or perceive they will potentially gain. Similar to these studies, the Bui study calls for the need to improve livelihoods of communities near parks, and create opportunities to compensate for lost community resources through an increased community involvement in the ownership and management of community conservation sites such as CREMAs. The study also suggests that dams can worsen the effects of PAs on rural communities by further restricting community access to resources that have sustained their livelihoods.

CONFLICT OF INTERESTS

The author has not declared any conflict of interests.

REFERENCES

Aasoglenang AT, Bonye SZ (2013). Rural Livelihoods Diversity: Coping Strategies in Wa West District in Northern Ghana. Eur. Sci. J. 9:35.

Bryceson D (2002). The scramble in Africa: Reorienting Rural Livelihoods. World Dev. 30(5):725-739.

Abbink J (2012). Dam Controversies: Contested Governance and Developmental Discourse on the Ethiopian Omo River Dam. Soc. Anthropol. 20(2):125-144.

Adger NW, Barnett J, Brown K, Marshall N, O'Brien K (2013). Cultural dimensions of climate change impacts and adaptation. Nat. Clim. Chang. 3:112-117.

Agyare A (2013). Polycentric Governance and Social-Ecological Performance of Community Resource Management Areas in Ghana. A Dissertation Submitted in Partial Fulfilment of the Requirements for the Degree of Doctor of Philosophy in the Department of Geography. Victoria: University of Victoria.

Akonor S (2009). Inundation of Bui National Park. (J. L. Arthur, Interviewer).

Alhassan H (2009). Viewpoint-Butterflies vs. Hydropower: Reflections on Large Dams in Contemporary Africa. Water Altern. 2(1):148-160.

Andam K, Ferraro P, Simsc KR, Healyd R, Hollande MB (2010). Protected areas reduced poverty in Costa RIca and Thailand. PNAS 107(22):9996-10001.

Ansar A, Flyvbjerg B, Budzier A, Lunn D (2014). Should we build more large dams? The actual costs of hydropower megaproject development. Energy Pol. 69:43-56.

Baez J, De la Fuente A, Santos IV (2010). Do natural disasters affect human capital? An assessment based on existing empirical evidence. IZA Discussion Paper No. 5164, Institute for the Study of Labor (IZA).

Baird E, Dearden P (2003). Biodiversity conservation and resource tenure regimes: A case study from Northern Cambodia. Environ. Manag. 32:541-550.

Banda District Assembly (2013). District Profile, Brong Ahafo Region. Accra: Ministry of Local Government and Rural Development.

Bartolomé LJ, De Wet C, Mander H, Nagraj VK (2000). Displacement, resettlement, rehabilitation, reparation and development. WCD Themat. Rev. 1(2000).

Bennett O, McDowell C (2012). Displaced: The human cost of development and displacement. Palgrave: Macmillan.

Besley T (1995). Property Rights and Investment Incentives: THeory and Evidence from Ghana. J. Polit. Econ. 103:903-937.

Billington DP, Jackson DC (2017). Big dams of the new deal era: A confluence of engineering and politics. University of Oklahoma Press.

Biswas AK (2012). Impacts of Large Dams; Issues, Opportunitites and Constraints. In Impacts of Large Dams: A Global Assessment, Berlin: Spinger. pp. 1-18.

Bole District Assembly (2013). District Profile, Northern Region. Accra: Ministry of Local Government and Rural Development.

Braimah L (2001). Lake Volta Fisheries Management Plan. Yeji-Accra: Integrated Development of Artisanal Fisheries (IDAF).

Carney D (1995). Implememnting the Sustainable Rural Livelihoods Approach. *DFID* Natural Resource Advisers Conference, 5-9 July.

Carney T (1997). Introduction: Competence. Int. J. Law Psychiatry 20(1):1-4.

Carpenter S, Bennett E, Peterson G (2006). Scenarios for ecosystem services: An overview. Ecol. Soc. 11:1.

Cave A, Gao RE, Joynes E, Mgbako C, Mikhailevich J (2010). Forced eviction and resettlement in Cambodia: Case studies from Phnom Penh. Washington Univ. Glob. Stud. Law Rev. P 39.

CBD (2010). Linking biodiversity conservation and poverty alleviation: A state of knowledge review. CBD Technical Series, No. 55. CBD.

Chambers R, Conway G (1992). Sustainable rural livelihoods: Practical concepts for the 21st century. IDS Discussion Paper 296. Brighton: IDS.

Chen J, Shi H, Sivakumar B, Peart MR (2016). Population, water, food, energy and dams. Renew. Sustain. Energy Rev. 56:18-28.

Convention on Biological Diversity (2014). Global Biodiversity Outlook 4. Montreal: Secretariat of the Convention on Biological Diversity.

Creswell J (2007). Research Design: Qualitative, Quantitative, and Mixed Methods Approaches. London: Sage Publications.

De Haan L, Zoomers A (2003). Development geography at the crossroads of livelihood and globalization. Tijdschrift voor Economische en Sociale Geografie 94(3):350-362.

Dornelas M, Gotelli N, McGill B (2014). Assemblage time seried reveal biodiversity change but not ystematic loss. Science 344:296-299.

Dudley N (2008). Guidelines for Applying Protected Area Management Categories. Gland: IUCN.

Dzodzi N (2006). Living in the shadow of the large dams: Long term responses of downstream and lakeside communities of Ghana's Volta River Project. Leiden: Koninklijke Brill NV.

Dzorgbo D (2001). Ghana in search of development: The challenge of governance, economic management, and institution building. Aldershot, UK: Ashgate.

Energy Commission (2005). Strategic National Energy Plan 2005-2025: Part 1 electricity. Accra: Energy Commission.

ERM (2007). Environmental and Social Impact Assessment of the Bui Hydropower Project. Retrieved October 23, 2012, from Ministry if Energy/Bui Development Committee, Ghana: http://www.library.mampam.com

Ferraro P, Hanauer M, Katharine R, Sims K (2011). Conditions associated with protected area success in conservation and poverty reduction. PNAS 108(34):13913-13918.

Folke C, Carpenter S, Walker B, Scheffer M, Chapin T, Rockstrom J(2010). Resileince thinking: Integrating resilience, adaptability and transformability. Ecol. Soc. 15(4):20.

Food and Agricultural Organization (FAO) (2005). FAO Year Book of

Fisheries 2005. Rome: Food and Agricultural Organization.
Food and Agriculture Organization (1991). FAO Year Book of Fisheries Statistics 1991. Rome: Food and Agricultural Organization.
Fratkin E (2014). Ethiia's Pastoralist Policies: Development, displacement and resettlement. Nomad. Peoples 18:94-114.
Galipean BA, Ingman M, Tilt B (2013). Dam-Induced Displacement and Agricultural Livelihoods in China's Mekong Basin. Hum. Ecol. 41:437-446.
Gerring J (2006). Case Study Research: Principles and Practice. Cambridge: Cambridge University Press.
Ghana News Agency (2012). Parliament adopt Intruments to establish 100 new new assemblies. Retrieved June 13, 2014, from Ghana News Agency: http://www.ghananewsagency.org/politics/parliament-sdopt-instrument-to-establish-100-new-assemblies-40613
Ghana News Agency (2012). Bui Authority resettled affected communities. Ghana News of Sunday, Accra. Retrieved September 20, 2012, from Ghana Web: http://www.ghanaweb.com/GhanaHomePage/NewsArchieve/artikel.php?ID
Ghana News Agency (2012a). Parliament Adopt Instruments to Establish 100 New Assemblies. Retrieved June 13, 2014, from Ghana News Agency: http://www.ghananewsagency.org/politics/parliament-sdopt-instrument-to- establish-100-new-assemblies-40613
Ghana Statistical Service (2012a). 2010 Population and Housing Census. Accra: Ghana Statistical Service.
Ghana Statistical Service (2012b). 2010 Population and Housing Census, National Analytical Report. Accra: Ghana Statistical Service.
Ghana Statistical Service (2014a). 2010 Population and Housing Census: District Anaytical Report, Bole District. Accra: Ghana Statistical Service.
Ghana Statistical Service (2014b). 2010 Population and Housing Census: District Analytical Report, Banda District. Accra : Ghana Statistical Service.
Gordon C, Amatekpor J (1999). The sustainable integrated development of the Volta Basin in Ghana. Accra: Volta Basin Research Project.
Goulden MC, Adger WN, Allison EH, Conway D (2013). Limits to resilience from livelihood diversification and social capital in lake social–ecological systems. Ann. Assoc. Am. Geogr. 103(4):906-924.
Green GP, Haines A (2012). Asset Building and Community Development. California: Thousand Oaks.
Hall CJ, Jordaan A (2011). THe historic influence of dams on diadromous fish habitat with a focus on river herring and hydrologic longitudinal connectivity. Landsc. Ecol. 26(1):95-107.
Heale R, Forbes D (2013). Understanding triangulatiion in research. Evid. Based Nurs. 16(4):98.
Healey J (1998). Statistics: A tool for social reserach. California: Wadsworth Publication Company.
Hussein K (2002). Livelihood Approaches Compared: A Multi-Agency Review of Current Practice. London: DFID.
Independent Evaluation Group (IEG) (2012). Involuntary Resettlement. Retrieved May 2013, from The World Bank Group: http://www.ieg.worldbankgroup.org
International Rivers (2013). Human Impacts of Dams. Retrieved July 17, 2014, from International Rivers; Rivers in Crisis: http://www.internationalrivers.org/human-impacts-of-dams
IUCN (2010). Parks and Reserves in Ghana. Gland: IUCN.
Jachmann H, Blanc J, Nateg C, Balangtaa C, Debrah E, Damma F, Atta-Kusi E, Kipo A (2011). Protected Area Performance and Tourism in Ghana. South Afr. J. Wildl. Res. 41(1):95-109.
Kabo-Bah AT, Diji CJ, Nokoe K, Mulugetta Y, Obeng-Ofori D, Akpoti K (2016). Multiyear rainfall and temperature trends in the Volta River Basin and their potential impact on hydropower generation in Ghana. Climate 4(4):49.
Kalitsi E (2004). Social aspects of hydropower development perspectives and experiences: Hydropower development and resettlement (Ghana). United Nations Symposium on hydropower and sustainable development Beijing International Convention Centre 27-29 October, 2004. Beijing: United Nations.
Kirchherr J, Disselhoff T, Charles K (2016). Safeguards, financing, and employment in Chinese infrastructure projects in Africa: The case of Ghana's Bui Dam. Waterlines 35(1):37-58.
Klein GK, Beusen A, Van DG, Vos M (2011). The HYDE 3.1 spatially explicit database of human-induced global land-use change over the past 12,000 years. Glob. Ecol. Biogeogr. 20:73-86.
Korboe D (1998). Handing Over the Stick: Synthesised Report on the Ghana SocialAssessment, Study Commissioned by the World Bank in collaboration with the National Development Planning Commission. Kumasi: Faculty of Environmental and Development Studies, University of Science and Technology.
Krueger L (2009). Protected areas and human displacement: Improving the Interface between policy and practice. Conserv. Soc. 7(1):21-25.
Kyei-Dompreh F (2012). Management of VRA Resettlement Towns: Case Study, West Kpong Resettlement Town. Kumasi: Institute of Distance Learning, Kwame Nkrumah University of Science and Technology.
le Roux W, White A (2004). Voices of the San: Living in Southern Africa Today. Cape Town: Kwela Books.
Leadley PW, Krug CB, Alkemade R, Pereira HM, Sumaila UR, Walpole M, Marques A, Newbold T, Teh LS, van Kolck J, Bellard C (2016). Progress towards the Aichi biodiversity targets: An assessment of biodiversity trends, policy scenarios and key actions. Montreal: Secretariat of the Convention on Biological Diversity, 2014. CBD Technical Series No. 78.
Lees A, Peres CA, Fearnside PM, Schneider M, Zuanon JA (2016). Hydropower and the future of Amazonian biodiversity. Biodivers. Conserv. 25:451-466.
Lerer LB, Scudder T (1999). Health impacts of large dams. Environ. Impact Assess. Rev. 19(2):113-123.
Masud MM, Kari F, Rohani S, Yahaya B, Al-Amin AQ (2016). Livelihood assets and vulnerability context of Marine Park Community development in Malaysia. Soc. Indicators Res. 125(3), 771.
Maxwell SL, Milner-Gulland EJ, Jones JP, Knight AT, Bunnefeld N, Nuno A, Bal P, Earle S, Watson JE, Rhodes JR (2015). Being smart about SMART environmental targets. Science 347(6226):1075-1076.
Miine LK (2014). Sustainability of Resettlement Scheme in Ghana. Kumasi: College of Achitecture and Planning of the Kwame Nkrumah University of Science and Technology.
Miller T, Minteer B, Malan L (2011). The new conservation debate: The view from practical ethics. Biol. Conserv. 144:948-957.
Moser C (2008). Assets and Livelihoods: A Framework for Assets-Based Social Policy. In C. Moser, & A. A. Dani (Eds.), Assets, Livelihoods, and Social Policy Washington D.C.: IBRD/World Bank. pp. 43-84.
Mutenje G, Ortmann G, Ferrer S, Darroch M (2010). Rural Livelihood Diversity to Manage Economic Shocks: Evidence from South-East Zimbabwe. Agrekon 49(3):338-357.
Naab FZ, Nunbogu AM, Dinye RD, Dongzagla A (2016). Resettlement and livelihood sustainability in Sub-Saharan Africa: The case of Bui hydro-power dam project, Ghana. World Acad. Sci. Eng. Int. J. Soc. Behav. Educ. Econ. Bus. Indus. Eng. 10(5):1780-1788.
Naughton-Treves L (2010). Participatory zoning to balance conservation and development in protected area. In J. Ing, Integrating Ecology and Poverty Reduction: The application of ecology in development solutions pp. 235-251.
Nelson F (2010). Introduction: The politics of natural resource governance in Africa. In Community rights, conservation and contested land: The application of natural resource governance in Africa London: Earthscan. pp. 3-31.
Nelson F, Agrawal A (2008). Patronage or participation? Community-based natural resource management reform in Sub-Saharan Africa. Dev. Change 39(4):557-585.
Norris FH, Stevens S (2006). Community Resilience as a Metaphor, Theory, Set of Capacities, and Strategy Readiness. Ann. J. Comm. Psychol. 41(1-2):127-150.
Nunan F, Brook R, Williams K, Thomas G, Martin A, Adam M, Pender J, Longbottom J, Kasanga K, Nkrumah KO, Gyamfi VA, Agbenyega O (2001). Further knowledge of livelihoods affected by urban transition, Kumasi (Vol. 7854). Ghana. Final Technical Report for project.

Nusser M (2014). Technological hydroscopes in Asia. In N. M (Ed.), Large Dams in Asia: Contested Environments between technological hydroscopes and social resistance New York: Springer Dordrecht Heidelberg. pp. 1-14.
Obour PB, Owusu K, Agyeman EA, Ahenkan A, Madrid ÀN (2016). The impacts of dams on local livelihoods: A study of the Bui Hydroelectric Project in Ghana. Int. J. Water Resour. Dev. 32(2):286-300.
Ofori-Amanfo R (2005). Hippopotamun Census in Bui National Park. Accra: Ghana Wildlife Division.
Owusu K, Obour PB, Nkansah MA (2017). Downstream effects of dams on livelihoods of river-dependent communities: The case of Ghana's Kpong Dam. Geografisk Tidsskrift-Dan. J. Geogr. 117(1):1-10.
Pereira HM, Navarro LM, Martins IS (2012). Global biodiversity change: The bad, the good, and the unknown. Ann. Rev. Environ. Resour. 37:25-50.
Peter J (2013). Dam history repeating. Dawson Creek: Infomart.
Piman T, CochraneTA, Arias ME (2016). Effect of Proposed Large Dams on Water Flows and Hydropower Production in the Sekong, Sesan and Srepok Rivers of the Mekong Basin. River Res. Appl. 32(10):2095-2108.
Porter-Bolland L, Ellis E, Guariguata M, Ruiz-Mallen I, Negrete-Yankelevich S, Reyes-Garcia V (2012). Community managed forests and fores protected areas: An assessment of their conservation effectiveness across the tropics. For. Ecol. Manag. 268:6-17.
Prado FA, Athayde S, Mossa J, Bohlman S, Leite F, Oliver-Smith A (2016). How much is enough? An integrated examination of energy security, economic growth and climate change related to hydropower expansion in Brazil. Renew. Sustain. Energy Rev. 53:1132-1136.
Przeworski A, Teune H (1970). The logic of comparative social inquiry. New York: John Wiley.
Rakodi C (1999). A capital assets framework for analysis household livelihood strategies: Implications for policy. Dev. Pol. Rev. 17:315-342.
Rakodi C (2014). Urban livelihoods: A people-centred approach to reducing poverty. Routledge.
Raven PH (2012). Restoring Natural Capital: Science, Business, and Practice. J. Aronson, S. J. Milton, & J. N. Blignaut (Eds.). Island press.
Robson C (2011). Real WOrld Research. West Sussex: John Wiley & Sons Ltd.
Sá-Oliveira JC, Hawes JE, Isaac-Nahum VJ, Peres CA (2015). Upstream and downstream responses of fish assemblages to an Eastern Amazonian hydroelectric dam. Freshw. Biol. 60(10):2037-2050.
Sarpong D, Quaatey S, Harvey S (2005). The economic and social contribution of fisheries to gross domestic product and rural development in Ghana. Final Report. Accra.
Seawright J, Gerring J (2008). Case selection techniques in case study research: A menu of qualitative and quantitative options. Polit. Res. Q. 61(2):294-308.
Scoones I (1998). Sustainable and rural livelihoods: A framework for analysis. Brighton: Institute of Development Studies (IDS) Working Paper 72.
Scoones I (2015). Sustainable livelihoods and rural development. Rugby, UK: Practical Action Publishing.
Spalding MD, Meliane I, Milam A, Fitzgerald C, Hale LZ (2013). Protecting marine spaces: Global targets and changing approaches. Ocean Yearbook Online *27*(1):213-248.
Stahl A (2001). Making history in Banda: Anthropological visions of Africa's past. Canbridge: Cambridge University Press.
Syagga P, Olima W (1996). The impact of compulsory land acquisition on displaced. Habitat Int. 20:61-75.
Teyssedre A, Robert A (2015). Biodiversity trends are as bad as expected. Biodivers. Conserv. 24(3):705-706.
The World Bank (2004). Involuntary resettlement sourcebook. Washington: The International Bank for Reconstruction and Development/The World Bank.
Thurmond VA (2001). The point of triangulation. J. Nurs. Scholarsh. 33(3):253-258.
Tilt B, Gerkey D (2016). Dams and population displacement on China's Upper Mekong River: Implications for social capital and social–ecological resilience. Glob. Environ. Chang. 36:153-162.
Tobón W, Urquiza-Haas T, Koleff P, Schröter M, Ortega-Álvarez R, Campo J, Lindig Cisneros R, Sarukhán J, Bonn A (2017). Restoration planning to guide Aichi targets in a megadiverse country. Conserv. Biol. March 1.
Turner WR, Brandon K, Brooks TM, Gascon C, Gibbs HK, Lawrence KS, Mittermeier RA, Selig ER (2012). Global biodiversity conservation and the alleviation of poverty. BioScience 62:85-92.
United Nations Development Programme (UNDP) (2011a). Towards Human Resilience: Sustaining MDG Progress in an age of Economic Uncertainty. New York: UNDP.
Vervisch TG, Vlassenroot K, Braeckman J (2013). Livelihoods, power, and food insecurity: Adaptation of social capital portfolios in protracted crises—Case study of Burundi. Disasters 37(2):267-292.
World Commission on Dams (WCD) (2000). Water resources sector strategy: Strategic directions for World Bank Engagement. London: Earthscan.
Zhang X, Liu J, Li M (2008). Hydropower development on the Lancang: A recommendation for affected ethnic minorities. In D. L. McCaskill, & S. He (Eds.), Living in a Globalized World; Ethnic Minorities in the Greated Mekong Subregion. Chiang Mai: Mekong Press.

academicJournals

Vol. 10(1), pp. 39-51, January 2018
DOI: 10.5897/IJBC2017.1113
Article Number: E89274067127
ISSN 2141-243X

http://www.academicjournals.org/IJBC

International Journal of Biodiversity and Conservation

Full Length Research Paper

A cost-benefit analysis of protecting Lake George wetland resources in Queen Elizabeth National Park, South Western Uganda

Nabalegwa M. Wambede* and Asaba Joyfred

Department of Geography and Social Studies, Kyambogo University, Kyambogo, Uganda.

Received 15 May, 2017; Accepted 12 October, 2017

This study estimates the full range of benefits for protecting the use and non-use values of the Lake George wetlands, and the costs of maintaining the benefits flowing from them, so as to derive an estimate of its economic performance. The results indicated that, the Lake George wetlands supplied tangible benefits to the fishing communities, amounting to 0.44% only of all the annual economic benefits of Lake George wetlands in 2004. The intangible but nonetheless important services to the peoples' livelihoods in the fishing villages accounted for about 99.56% during the same period. Management accounted for at least 3% while wildlife related damage costs (borne by the villages) were the highest at 53.5%. The net social cost benefit of conserving the Lake George wetlands in 2004 was USD 56.4 million or UGS 101.2 billion while the NPV (R = 10.64; t = 25) was USD 491 million. Whereas protection of the Lake George wetlands still remains a viable option, the tangible benefits from the wetlands still remain to be fully realized; the tangible benefits of wetlands are minimal and the local peoples' interest in protecting the wetland is therefore low. It is recommended that in Uganda Wildlife Authority (UWA), 1) tangible benefits as further motivation and creation of local interest in the wetland should be considered, 2) the linkages between use values and ecosystem functions of the wetland must be stressed, and 3) ways of reducing wildlife related damage to the fishing village community lives and property should be discovered.

Key words: Use and non-use values, costs and benefits, net present value.

INTRODUCTION

In 1971, Ramsar Convention provided an international framework for conservation of waterfowl and wetlands. Different states and governments have constructively used the convention, to strengthen wetland conservation and wise use. As a result, wetlands now represent a well-recognised ecosystem of extreme significance to human

*Corresponding author. E-mail: nabalegwaa@gmail.com.

beings and biodiversity at the local, national and international levels. Natural resources such as wetlands yield many benefits to society, including goods, services and environmental attributes, which relate directly to the characteristics of the wetlands (Turpie et al., 1998). Wetland characteristics, therefore, contribute to economic activity and enhance human welfare. The aggregate contribution of wetlands to household output, welfare and utility constitutes their Total Economic Value (TEV) (Haskoning, 2001d).

The World Bank and many others make a distinction between the use value of a resource and its non-use value. The use value of a wetland is derived from its goods and services. Wetlands produce resource stocks such as fish, woody biomass, animals, and fibre, which are usually harvested to serve human needs. They also perform ecological functions, which maintain and protect human systems. The non-use values which relate to the benefits of the wetlands may be provided from their ecosystem attributes, but are neither used directly or indirectly. Such values may include the premium placed on possible future, with yet unknown uses and applications (pharmaceutical, etc.); and their intrinsic significance (biodiversity, cultural, aesthetic, etc.).

Historically, those benefits were not monetarily valued and not accounted for, in the market system as a cost of production nor were able to monetarily quantify the value of their loss or benefits to production or society. Since many policy and development decisions are based on monetary benefit-cost analysis, the value of wetland benefits (as non-commodities) was absent from policy and development discussions and as a result, wetlands were significantly degraded and destroyed (Springate et al., 2009; Russi et al., 2013). The destruction of so many wetlands has resulted in losses in wildlife populations, water quality, flood storage and a host of other benefits valued by society.

The loss of those benefits has had both environmental and economic consequences. Governments and the local communities are likely to succeed in achieving the goal of sustainable development in wetland areas when, conservation measures are seen by rural communities as, being in the interest of those products and services essential for their livelihoods which are designed in close consultation with them. Thus, documenting wetland ecosystem benefits up-front provides decision makers the ability to factor the value of wetlands into benefit-cost analyses, which may ultimately lead to greater emphasis on actions that restore and protect wetlands (Stelk and Christie, 2014).

Nearly 30,000 km^2, about 13% of the total land area of Uganda, is wetland. They are widespread and complex and their water regimes are determined by many factors of which rainfall is the most important (Bakema and Iyango, 2000). Land subsidence which created Lake Kyoga, Vitoria and the rift valley grabens together with the high and relatively well-distributed rainfall in the south and west of the country, have resulted in a heavily vegetated wetland core, often covered by *Cyperus papyrus, Typha* and *Phragmites* species, or swamp forest complexes. Their wide distribution makes it possible for large proportion of the population to have access to utilization of wetlands, which result in their extensive degradation (The Republic of Uganda, 1995).

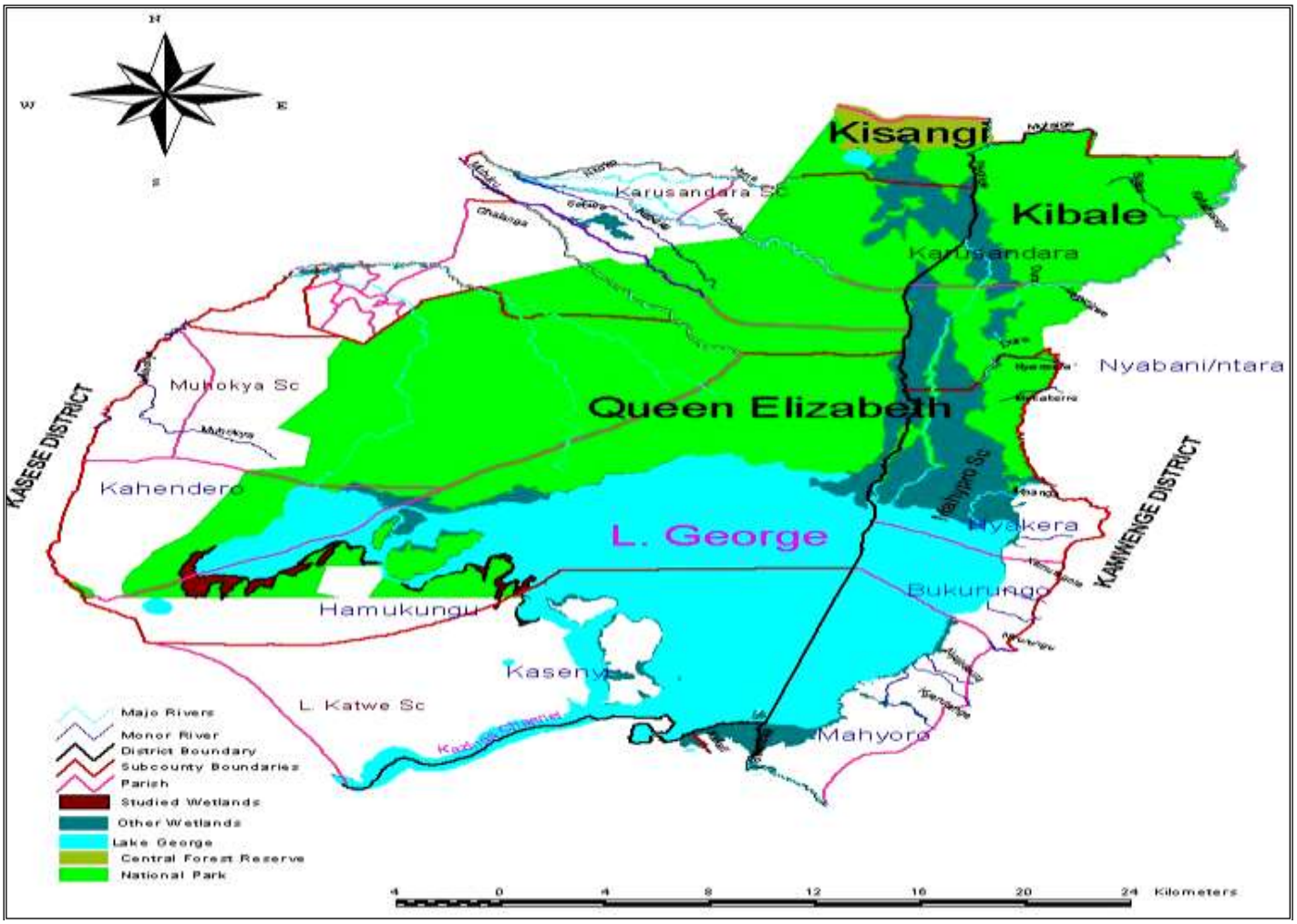
In the late 1980s, pressure on wetlands was mounting and in rural areas small, but continuous, nibbling at wetland edges reduced the seasonal wetlands. Exceptions to this trend appeared to be the wetlands in protected areas where, Lake George wetland is one of such areas. As such, the objectives of this study were: to estimate the monetary benefits derived from the direct use of wetlands, estimate the monetary benefits derived from indirect and non-use value of wetlands, and provide an estimate of the economic cost in maintaining the benefits flowing from the wetlands.

Study area

The Lake George wetland system is located in Queen Elizabeth National Park (QENP) adjacent to Lake George. Although Lake George is not part of the national park, its location, physiographic setting, hydrology and water quality, and biodiversity form an integral part of its ecosystem and thus an integral part of the study area description.

Lake George is a shallow and fresh water Lake located in the Albertine Rift Valley in Western Uganda. The Lake lies at an altitude of 914 m above sea level, found in Kasese district about 450 km west of the city Kampala. It is located between 0°02'S to 0°20'N and 30°00'E to 30°18'E. The Lake covers an area of about 250 km^2, while the Lake and its related wetlands cover 500 km^2. Most of the wetland is located in the Queen Elizabeth National Park (QENP) north of Lake George. A small northeast portion of the wetland is located in the Kibale Wildlife corridor (Map 1).

Lake George is shallow with a mean depth of 3 m. It is a depression Lake with radial affluent streams flowing into it, mainly from the Rwenzori Mountains and River Katonga system. Studies made by the International Biological Programme (IBP) between 1966 and 1973 demonstrated that, the biological processes in the Lake were little affected by seasonal changes. Instead of diurnal cycles in solar radiation, temperature, oxygen saturation and pH had far greater effects on the flora and fauna. The Lake has a very high productivity with a standing algal biomass of 100 g m^{-2} evidenced, in the



Map 1. Study area.

greenish colour of the water. The result of this high productivity is, low light penetration.

Ganf (1969) cited in Ministry of Natural Resources (1998), estimated the eutrophic zone at 50 cm. Because inflows and outflows balance water are removed by evaporation, Lake George is a fresh water lake with none of the excesses of alkalinity or salinity, found in some of the nearby lakes. Rivers Mubuku, Rukooki, Rwimi, Nyamwamba, Mpanga and Dura feed the Lake from the Rwenzori Mountains with other inflows from Katonga system. This Lake water drains into Lake Edward by Kazinga Channel. Lake George waters are considered as an integral part of the wetland system that forms part of QENP (Dunn, 1989).

The lake surface supports the dense floating vegetation, and the peripheral swamps are dominated by *C. papyrus* (Uganda Wildlife Authority, 2000). The importance of the papyrus swamps is manifested not only in the provision of habitats, but also in filtering pollutants (heavy metals) generated by industrial activities in Kasese and Kilembe urban centres. *C. papyrus* forms extensive fringing swamps. It is commonly regarded as a monoculture but supports a wide diversity of plants especially climbers such as *Ipomoea rubens* and *Cyperus latifolius* swamps to the northwest of the Lake. *Cladium mariscus* var. *jamaicense* forms floating permanent swamps which mainly occur in the northeast of the Lake and are nearly inaccessible. *Nymphaea* spp. (Water lilies) forms a dense cover along the Nsonge River which enters Lake George especially in waters of about 3 m deep. The floating ficus forest is mostly in water and inaccessible, hence little is known about it. *Phoenix reclinata* swamp forest, covering an area of 25 km^2 to the north of the Lake, is believed to occupy wet but

firm ground which is inaccessible. *Aeschynomene elaphroxylon* (ambatch) is widespread in small clumps and a very lightwood used for fish floats.

Aquatic fauna are generally more prevalent in wetlands than other ecosystems. Some of these are specialists because they are adapted, and vulnerable to, wetland destruction (Schreiber et al., 1995). Others are generalists and can continue existing in other habitats. The fish fauna make a significant contribution to the livelihoods of the communities which generate substantial income for thousands of people in Kasese district. Fishing is carried out throughout the year in two peak seasons September to December and March to May which concur with the peak seasons. Dunn (1989) identified the most important commercially valuable fish species which include: *Oreochromis* (*Sarotherodon*) *niloticus* (ngege), tilapia; *Bagrus docmac* (*semutundu)*, catfish; *Clariaslazera* (*male),* catfish; *Protopterus aethiopicus* (*mamba*), lungfish; *Barbus attianalis* (*junguli),* barbell; *Labeo forskalii* (lingo) *Mormyrus kannume* (*kasulubama)*, elephant – snout fish; *Orechromis leucosticta* (*ngege),;* and *Haplochromis* species.

Lake George wetlands are known for their richness in bird species, due to a wide variety of habitats (swamp and marsh) which provide important habitats for threatened of shoebill stork and papyrus yellow warbler (Uganda Wildlife Authority, 2000). Birds associated with water can be divided into two categories; the specialists who cannot survive without water, and the generalists which are found near water but can survive even if the swamps and Lakes are drained. The total number of 606 birds recorded for QENP is probably the highest for any East African wetland, compared to the 450 bird species of the Kenya lake system which includes, Lake Bogoria, Lake Nakuru and Lake Elementaita and their surroundings. Lake George wetlands provide habitat with over 150 species of birds including some rare species. These include the Saddle-billed Stork Ephippiorhynchussenegalensis, seven 'papyrus endemics' including Papyrus Gonolek Laniarius mufu mbiri, Papyrus Canary Serinuskoliensis, and the threatened Papyrus Yellow Warbler Chloropetagracilirostris (IUCN Red List, 1994). Two Red Data Book Species of the western rift are also recorded that is Shoebill stock (*Balaenicepsrex*) and the papyrus yellow warbler (*Calamonastides gracilirostris*).

These wetlands provide an important wildlife migration corridor linking QENP and Kibale National Park (KNP). The large mammals associated with the wetlands include; elephant *(Loxodontaafricana*), hippopotamus (*Hippopotamus amphibious*) and sitatunga, aquatic antelope (*Tragelaphusspekei*).

Population living adjacent to the Lake George wetlands

According to 2014 population and housing census, the population of the two enclave fishing villages of Kahendero and Kasenyi were summarised as follows:

These enclave villages comprise a complex mix of ethnic groups drawn within and outside the country. In each village the dominant ethnic group is drawn from the surrounding communities. As reported by Infield (1989), an ethnic group represented in most villages is *Abanyanja* – "the people who stay near water" with tribe divided into three clans as shown in Table 1. Government in 1952 gazetted QENP at a time when several fishing villages existed in the area were gazette. A decision was made to allow these existing enclave villages to remain. Lake George supported a significant artisanal Fishing industry and indeed, these Lake was reported as one of the most productive inland waters for fisheries in Africa which could not be left unexploited (Infield, 1989).

Three fishing villages lie within the Lake George wetland system that exists within the QENP boundaries. All these villages are now established as wildlife sanctuaries with borders defined by statutory instruments. These give the villagers legal status which enable the communities obtain titles within the boundaries of the sanctuaries. Kahendero had no legal status until September, 2003. The Uganda Wildlife Authority recently undertook boundary surveys and boundary demarcations which eventually established this village as a wildlife sanctuary.

Activities of people living adjacent to the Lake George wetlands

In 1979, QENP was designated as a biosphere reserve under UNESCO's Man and Biosphere (MAB) Programme to demonstrate a balanced relationship between humans and the environment. QENP promotes the MAB–concept, by providing opportunity to demonstrate sustainable resource utilisation in the fishing villages. The human population in fishing villages is engaged in various forms of natural resource exploitation, including fishing and fish processing, livestock grazing, hunting or poaching, collection of firewood, medicinal plants, building materials, and harvesting of salt. During the early years, attempts were made by QENP to retain control of the village populations and the activities that were carried out in them. The park authorities viewed the fishing villages as *work camps* for fishing industry rather than real communities (Infield, 1989). Fishermen and their helpers were expected to leave their families behind when entering the fishing villages to work.

As such, fishing is one of the most important economic activities in the villages. All fish must be officially landed at the landing site of the village where fishing licence has been allocated to. Fish is purchased by buyers or retained by boat owners. A considerable amount of fish is consumed within the villages, both by *barias* (fishermen) who are generally given fish as part of their pay, and the

Table 1. Clans of a Banyanja ethic group.

S/N	Clans	Description
1	*Banyabatumbi*	These are subsistence hunters and river fishermen, also probably gathering wild foods to some degree.
2	*Bagabo*	These are largely subsistence fishermen occupying permanent settlement on the Lake shores.
3	*Basongora*	Are cattle herders who followed water courses and maintained their herds close to the Lake to ensure permanent access to water.

villagers who purchase it at the landing. *Barias* may sell to traders and private buyers but, it is common for them to work for 2 to 3 days and spend the same days resting and enjoying themselves.

Cultivation and livestock rearing were not permitted. However, the concept of *work camps* was quickly lost and the villages were reverted to more normal communities. As a result, the park authorities and fishing villages had conflict interests. The cause of the conflict was apparently, mutual in exclusive objectives. The park's over-riding objective has been to conserve flora and fauna of QENP, while that of the fishing villages was to use all resources (including flora and fauna), which could ease their existence within the park.

Trading is another important part of the village life. It is common for the *barias* and boat owners to invest their profits from the fishing industry in opening up shops, as it seems there is more profit in shop keeping than fishing. Thus many of the village traders are also fishermen. The villages provide an opening for retailers, a variety of household goods and foodstuffs. Agricultural practice is prohibited hence all food is imported into the village.

Natural resource management

Conservation of this wetland was justified because of its ecosystem functions and services. This wetland provides important habitat for the threatened shoebill stork and papyrus yellow warbler (Uganda Wildlife Authority, 2000). It is an important wildlife migration corridor linking QENP and Kibale Forest National Park (KNP). The Lake is regarded as one of the most important centers of biological diversity in Uganda (The National Ramsar Committee, 1998). The Lake surface supports dense floating vegetation, and the peripheral swamps are dominated by *C. papyrus*. The importance of the papyrus swamps is manifested in filtering pollutants (heavy metals), generated by industrial activities in Kasese from water before it arrives to Lake George.

According to the Queen Elizabeth Protected Area General Management Plan (2011 to 2021), the National Park is divided into management zones in which resource management arrangements are specified. In Preservation zone, the north of Lake George does not allow resource extraction/utilization, except for regulated extraction of papyrus. In the wetland areas, a limited number of activities including fishing, ambatch cutting, and firewood harvesting are done under semi-formal arrangements with Uganda Wildlife Authority. Little or no monitoring of resource extraction takes place. The scale of exploitation highlights the need for clearer policies, management strategies and monitoring, to determine what is sustainable especially with eleven fishing villages containing 30,000 people within the national park.

The setting of Lake George in the National Park presents particular challenges and opportunities for fishing village communities, to access natural resources (other than fish) which are extracted illegally. This formed the potential for Integrated Lake Management (ILM) to bring both the government and communities together, in other to plan and manage the Lake George basin resources through an integrated and co-management approach. As a result of this, the Lake George Basin Integrated Management Organization (LAGBIMO) was formed in 2003. LAGBIMO developed Lake George Basin Management Plan (LGBMP), which was approved in 2003. LGBMP is the operational management plan of LAGBIMO, developed through a participatory process to ensure wide ownership, poverty focus, gender sensitivity and inclusion of community priorities. Implementation of plan is primarily through an integration of components, into the local government development plans. The vision of LGBMP is: Sustainable management and use of Lake George natural resources for the improved livelihoods of low-income communities within the basin by 2013.

METHODOLOGY

General approach

This study used a cost-benefit analysis (CBA) to focus on the typical wetland products and services which support socio-economic development within the wetlands, while at the same time conserving their ecological and hydrological functions and attributes.

Valuation was used as a key exercise in the analysis which provided information on the benefits, alongside with costs associated with the Lake George wetlands protection. Due to this fact, the annual productivity as net-benefit, in protecting the Lake

George wetlands was estimated that is the sum of the benefits is less than the sum of the costs as is shown in the algorithm below:

$$NB_{LG} = B_{DU} + B_{IU} + B_{OP} + B_E - C_M - C_{LO} - C_A \quad (1)$$

Where:

NB_{LG} = Net Benefit to society for protecting the Lake George wetlands.
B_{DU} = Benefits derived from direct use of marketed and non-marketed products.
B_{IU} = Benefits derived from indirect uses of wetlands.
B_{OP} = Benefits derived from option values.
B_E = Benefits derived from existence values.
C_M = Costs of management operations.
C_{LO} = Costs of protection, in terms of lost opportunities for alternative development.
C_A = Cost of other activities resulting from species of wildlife presumed to originate from the wetland.

Most data in this study was related to 2014 before the study was carried out. It focused only on the typical wetland values stemming from activities permitted in the National Park, with the indirect use values which were most significant in economic terms to the fishing villages.

Water monetary benefit

This, along with total value [TV] for water was calculated and computed using the equation:

$$TV = T \times f \times MF \times P \quad (2)$$

Where

T = Time taken to fetch water.
F = Frequency /number of respondents.
MF = Monetary factor which is estimated at USD 0.11/h by Howard, (1995) and using the rate of population increase of 3.4% per annum for Uganda as the scarcity factor derives a 2015 estimate of USD 0.15 (UGS 450) per hour.
P = Estimated household size (P)

Average monetary Benefits (AMB)

Average Monetary befits were estimated using the Equation 3 this as stated below:

$$AMB = \Sigma TV / n \quad (3)$$

Where AMB is the average monetary benefits, ΣTV is the sum total value; n is the number of respondents.

Fish monetary benefits

Equation two was modified by removing the “estimated household size [P]” to compute the Fish monetary benefit for people around Lake George. The “estimated household size [P]” factor was removed on the assumption that fishing was not done by everybody within the household. This gave birth to the third equation (Equation 3) as follows:

$$TV = T \times f \times MF \quad (4)$$

This is on the assumption that, average monetary benefit for fish is computed on six man-days per week.

Sampling

In order to obtain data representative of the communities living adjacent to the wetlands, two fishing villages - Kasenyi and Kahendero were selected on the basis of their location in Queen Elizabeth National park (QENP). A major factor which sets Kahendero apart from Kasenyi is its proximity to the edge of the National Park. The presence of fuel wood in plentiful supply in the northern area of the park boundary, removes one of the major sources of conflict between the park and the fishing village communities in Kahendero. Kasenyi fishing village is also situated on the Lake George shores. It is bordered by Lake George to the east and entirely enclosed by the park to the north, south and west. Both villages are wildlife sanctuaries.

This economic valuation was primarily based on randomly selected household heads’ conceptions of the use-value of particular goods and services from, the Lake George wetlands. The costs and benefits were derived from the household point of view and a conversion factor is used to reflect them from the society point of view which reflects from the social costs and benefits, respectively. This study reflects on the monetary values in Uganda shillings (UGS) and the equivalent in United States dollars (USD) at an exchange rate of UGS 2,500/= for USD.

The ultimate aim was to determine the net present value of the Lake George wetlands that is the annual equivalent of social net benefits received each year over a period of 25 years, which discount them back to 2011. They were discounted using discount rates, to reflect the real interest rate (net of inflation) to an adjusted time of dimension.

Data collection methods

The methods used in this study were to obtain information which includes field observations, focus group discussions and household surveys as described next.

Household survey

In an attempt to obtain data representative of the social economy of wetland dependent communities, representatives of the two fishing villages Kahendero and Kasenyi were interviewed using a questionnaire.

The local leaders in the two fishing villages were very instrumental, in providing information about the socio-economics of the village. Each village/parish is organised in cells/local councils (LCs) with a local village committee (LCI). The study used the parish register as the sampling frame, households as the sampling units and the household heads or their spouses as the specific units of inquiry. The names in the parish registers were numbered with the numbers subjected to a random selection. Thirty-six (36) households were sampled from 294 households in Kasenyi and another from 271 cells I and II that are within 1 km of the wetlands in Kahendero. Despite all these precautions, some respondents could not be traced at home, either because they were away from fishing or had shifted from the parish. In such cases other random selections were made.

Focus group discussions

Focus group discussions involved the gathering groups of, five to ten people who included representatives of village committees (LCs), Beach Management Units (BMUs), Community Protected Area Institutions (CPIs), and opinion leaders. The focus group discussions aimed at determining: resource descriptions – where all species were named and described, rules of access to the wetland resources and people involved, equipment used, seasonality for

Table 2. Water monetary benefit for Kasenyi.

Time (h)	Frequency (f)	%	Monetary Factor (MF)	Population (P)	Total Value = T × f × MF × P
0.5	30	83.3	375	4	22.500
0.75	6	16.7	375	4	6.750
Over 1	0	0	375	4	0
Total	36	-	-	-	29.250

Household size was estimated at 4 persons.

Table 3. Water monetary benefit for Kahendero.

Time (h)	Frequency (f)	%	Monetary Factor (MF)	Population (P)	Total Value = T × f × MF × P
0.5	24	66.7	375	7	31.500
0.75	10	27.8	375	7	19.688
Over 1	2	5.6	375	7	5.250
Total	36	-	-	-	56.438

Household size was estimated at 7 persons.

and harvesting of resources, returns of effort, indicative prices of goods/services, and changes in the availability of the resources.

RESULTS

Wetland products benefits from the human direct use values of the wetlands

Direct benefits from wetlands are the raw materials and physical products that are used directly for production and consumption, and constitute the most tangible benefits from wetlands. The study reveals that there were a number of resources that could be collected from the protected area. The most significant ones were water, fish, papyrus, medicinal plants (herbs), and firewood. Other resources around Lake George included salt and Ambatch (*Aeschnomene elaphroxyton*).

Annual monetary benefits per household

Analysis of benefits from direct use values was determined from typical wetland resources harvested and the time taken to harvest them, and the household sizes of the respondents determined from the survey.

In order to compute the annual monetary benefits for the households in two villages around Lake George, a number of assumptions were made after estimating the average household size. These assumptions were derived from observations and focus groups' discussions. The different average household sizes for the two villages affect the total value of the benefits derived from the protected area per household. The following assumptions were made:

1) Water – is fetched every day for domestic use.
2) Fish – fishing is done on average, 6 days a week.
3) Papyrus – is harvested twice a year (a total of 14 days) during the wet season.
4) Medicinal plants – are harvested once a month.
5) Total number of households determined for the two fishing villages/wildlife sanctuaries, adjacent to the Lake George wetlands were 565.

Water monetary benefits

The water monetary benefits were estimated using the Equations 2 and 3. The results are as presented in Table 2. Table 2 shows the sum total value (ΣTV) of UGS 21,060 (n = 36), which was divided by the sample size [n] to get the average monetary benefit per household per day [AMB] as UGS 585.

Therefore, the water average monetary benefit per household per day for the people of Kasenyi was UGS 585 only. Equation 3 (from methodology) was applied in the data for Kahendero (Table 3), to obtain the following results.

ΣTV = UGS 56,438, (n = 36); 56,438/36 = UGS 1,568

The comparison of AMB for the two villages clearly shows that AMB for Kahendero was almost as twice as

Table 4. Water monetary benefit for both Kasenyi and Kahendero.

Time (h)	Frequency (f)	%	Monetary Factor (MF)	Population (P)	Total Value = T × f × MF × P
0.5	54	75.0	375	7	70.875
0.75	16	22.2	375	7	31.500
Over 1	2	2.8	375	7	5.250
Total	72	-	-	-	107.625

Household size was estimated at 7 persons.

Table 5. Fish monetary benefit for Kasenyi.

Time (h)	Frequency (f)	%	Monetary Factor (MF)	Total Value T × f × MF
3	0	0	375	0
4.5	5	13.9	375	8.437.5
9	12	33.3	375	40.500
Over 12	5	13.9	375	22.500
Total	22	-	-	71.437.5

Table 6. Fish monetary benefit for Kahendero.

Time (h)	Frequency (f)	%	Monetary Factor (MF)	Total Value T × f × MF
3	2	5.6	375	2.250
4.5	4	11.1	375	5.750
9	11	-	30.6	37.125
Over 12	9	25.0	375	40.500
Total	26	-	-	77.625.4

that of Kasenyi. With combination of the two sub-samples, Kasenyi and Kahendero, and application of Equation 3, the following results were obtained (Table 4):

ΣTV = UGS 107,625 (Table 3), (n = 72); 107,625/72 = UGS 1,494.79

Taking into account the assumptions made, the total monetary value accruing to the two villages were: UGS 1,076.25 × 565 households × 365 days= UGS 257,697,300= (USD 103,078.92) per year.

Fish monetary benefits for Kasenyi

Fish monetary benefits were estimated using Equation 4 in the methodology. The results are as presented in Table 5. Here, the sample size was reduced to 22 because; some people were not involved directly in the fishing activity. Putting all that is in mind and applying both Equations 3 and 4, respectively the average monetary benefit for fish in Kasenyi was computed as follows:

ΣTV = UGS 71,437.5, (n = 22); 71,437.5/22 = UGS 3,247
Fish monetary benefits in Table 6 have details generated after applying Equation 3. With application of Equation 4, the following results for Kahendero village was obtained.

UGS 77,625.4 (n = 26); 77,625.4/26 = UGS 2,985.6

Also, combination of the two sub-samples (Kasenyi and Kahendero) and application of Equations 3 and 2 gave the following results (Table 4):

UGS 156,375, (n = 48); 156,375/48 = UGS 3,257.8 (Table 7)

The annual value of fish is as follow: UGS 2,371 × 565 households × 312 days= UGS 417,959,880 (USD 232,200).

Table 7. Overall fish monetary benefit for Kahendero and Kasenyi.

Time (h)	Frequency (f)	%	Monetary Factor (MF)	Total value T × f × MF
3	2	2.8	375	2.250
4.5	9	12.5	375	13.500
9	23	31.9	375	77.625
Over 12	14	19.4	375	63.000
Total	48	-	-	156.375

Table 8. Papyrus monetary benefit for Kasenyi.

Time (h)	Frequency (f)	%	Monetary Factor (MF)	Population (P)	Total value T × f × MF × P
0.5	8	22.2	375	4	6.000
0.75	6	16.7	375	4	6.300
Over 1	5	13.9	375	4	7.500
Total	19	-	-	-	19.800

Source: Primary data; Household size was estimated at 4 persons.

Table 9. Medicinal monetary benefit for Kasenyi.

Time (h)	Frequency (f)	%	Monetary Factor (MF)	Population (P)	Total Value T × f × MF × P
0.5	6	16.7	375	4	4.500
0.75	10	27.8	375	4	11.250
Over 1	5	13.9	375	4	7.500
Total	21	-	-	-	23.250

Household size was estimated at 4 persons.

Papyrus monetary benefit

Equation 2 was used on papyrus data for Kasenyi respondents to generate data in Table 8. To obtain average monetary benefit (AMB) computed per season, Equation 3 was applied to this table.

UGS 19,800, (n = 19); 19,800/19 = UGS 1,042

Bearing in mind assumptions earlier made, the annual value of papyrus to Kasenyi's 294 households would be UGS: 1,042 × 294 households × 14 days = UGS 4,288,872 (USD 1,715.55). According to the results, Kahendero residents did not harvest papyrus, hence no computation.

Medicinal plants monetary benefit

Table 9 presents the details generated after applying Equations 3 and 4 to obtain the average medicinal plant monetary benefit for Kasenyi village. Here the average monetary benefit was computed on a monthly basis.

UGS = 23,250, (n = 21); 23,250/21 =UGS 1,107

Bearing in mind the assumptions earlier made, the annual value of medicinal plants would be: UGS 1,107×294 households × 12 months = UGS 3,905496 (USD 1,562.2) for Kasenyi only, since Kahendero respondents did not use medicinal plants, hence no computation.

Table 10 summarizes the mean values of the monetized benefits per household. It combines the average values for water, fish, papyrus and medicinal plants for two villages. The Kahendero village does not have swamps while the biggest part of the village is outside the national park.

Total monetized values of the typical wetland products used by the respondents

Since the benefits were derived from the respondents'

Table 10. Mean values of monetized benefits per household/day.

Village	Product values in UGS			
	Water	Fish	Papyrus	Medicinal plants
Kasenyi	813	17.140.3	1.065.3	1.107
Kahendero	1.568	3.332	Nil	Nil
Overall	1.494.79	3.293.1	1.067.3	1.107

Table 11. Total monetized financial benefits from the human direct use values for Lake George wetlands per annum.

Resource	Value in UGS	Value in USD
Water	308.263.400	123.305.36
Fish	580.500.000	232.200
Papyrus	4.384.675*	1.753.87
Medicinal plants	3905.300*	1.562.12
Total	1.283.701.450	358.821.35

* These computations are for Kasenyi only because respondents in Kahendero did not use papyrus and medicinal plants.

Table 12. Total monetized economic benefits from the human direct use values per annum**.**

Resource	Value in UGX per year	Value in USD per year
Water	231.197.500	92.479
Fish	435.375.000	174.150
Papyrus	3.288.525	1.315.41
Medicinal plants	2.929.000	1.171.6
Total	672.790.025	269.116.01

point of view, a conversation factor of 0.75 suggested by Haskoning (2001d) was used to reflect the opportunity cost of time as reflected from the society. They therefore reflect on the financial and economic benefits, respectively. This study reflected on the monetary values in Uganda shillings (UGS) and the equivalent in United States dollars (USD) at an exchange rate of UGS 2500/= for USD. The total financial values of the wetland products used by the respondents are in Table 11.

This study computed the monetized economic values of the human direct use benefits, by applying a conversion factor of 0.75 by HASKONING (2001d) to the monetized financial values in Table 10. Hence economic values are shown in Table 12.

Benefits from human indirect use and non-use values of the wetlands

The Lake George wetlands consist of a complex system of ecological and hydrological functions, each with an economic benefit (and some costs). Their benefits were not the same. They also consist of attributes (scenic, aesthetic, cultural and religious) from which, benefits can be derived without using the wetland directly or indirectly. In the absence of data on the study area, the benefits transfer technique was used. However, all transferred benefits and costs are corrected to constant values which reflect in the year 2004. The rate of population growth 3.4% per annum was used to reflect annual wetland resources scarcity.

According to Turpie et al. (1998), USD 50/ha/yr for wetland carbon sequestration was estimated with Swamp *macrophyte*s which provide a large sink for atmospheric carbon. Computing for resource scarcity, a value of USD 61.1 was given in the year 2011. For Lake George wetlands, 25000 hectares is therefore translated into an economic value of USD 1,527,500 (UGS 3,818,750,000) per annum.

As reported by Emerton et al. (1998), a review of the

role of wetlands in the removal of sediments, pollutants and nutrients indicate that, the economic value of water treatment and purification from Nakivubo Urban wetland was UGS 3.02 to 5.04 million/ha/yr. If the minimum of UGS 3.0 million which is applied and standardized by the annual rate of scarcity 3.4% is reflected in 2011, a value of UGS3.67 per annum is derived but when applied to Lake George wetlands, an economic value of UGS 1.275 billion (USD 51 million) is computed. Wetlands are distinguished by the presence of excess water, which exerts an influence on the climate. Application of the estimate by Constanza et al. (1997) of USD 265/ha/yr was corrected in 2011 to give a value of USD 455/ha/year. This gave an estimate of the financial value of microclimate regulation of USD 11,375,000 (UGS 28,437,500,000) per annum for Lake George wetlands.

Wetland hydrology is closely linked to interflow or ground water flow. Boreholes in the study sites have been reported to be a source of the exact salty water not suitable for human use, which implies that the ground water function is not being used. Therefore no value is attributable to this ecosystem function through the provision of wells and borehole infrastructure. Most water is obtained from the wetlands and/or Lake in the study sites, or through a gravity flow scheme in Kahendero. This study assumes that, the value of this ecosystem function is already captured in water treatment function above. Table 11 summarises the indirect use values of the Lake George wetlands.

Considering the human non-use values of the wetlands, a figure of USD 0.2/ha/yr for species including those in wetland systems (Howard, 1995) was used to derive a constant estimate of 0.261/ha/year in the year 2004. This gave a conservative option economic value of UGS 16,312,500 (USD 6,525) for Lake George wetlands 25,000 ha.

Costs of protecting the Lake George wetlands resources

The protection of the Lake George wetlands resources involves costs. These costs were analysed and constitute of, the direct costs of managing the wetlands, opportunity costs foregone, and the association of livestock and human losses caused by species, which is believed to originate from wetlands (Table 14).

Management costs

There are direct management costs expended on the implementation of the Lake George Basin Management Plan (LGBMP). The total actual cost of implementing this plan was UGS 169,444,450 million (USD 67,777.78) in the financial year 2010/11, and the predicted costs for 20011/12 were UGS 144,444,450 million (USD 57,777.78).The total of the national park support in the two districts of Kasese and Bushenyi in 2012 was UGX 172,788,325 (USD 69,115.33).

The indicative management cost of the Lake George wetlands in financial terms UGS 342,232,778 (UGS 169 million + UGS 124,407,600) or USD 136,893.11 per year was estimated. This translates into UGS 184,805,700 (USD 172,788,333) in economic terms.

Opportunity costs

The average opportunity cost of maintaining biodiversity in Uganda is UGS 120,600/ha/yr (Emerton and Muramira, 1999). If 3.4% annual increase is computed for scarcity per annum, a value of UGS 199,562 /ha/year for 2011 is obtained but, when applied to the strictly protected 25,000 hectares of Lake George wetlands, the foregone income and other benefits would amount to UGS 4,949,454,750 (USD 1,979,781.9) per annum.

Wildlife damage cost

According to Howard (1995), crop damage attributed to wildlife at UGS 116 million per kilometre of boundary line for protected areas in Uganda were estimated. Applying a 3.4% increase to cater for scarcity, an estimate of UGS 167.06 million/km was derived in the year 2011.

Using GIS techniques, the total boundary line between the Lake George wetlands and cropland in Kasese, Bushenyi and Kamwenge was estimated at 28 km. The maximum estimated crop damage due to wetland-based vermin would be UGS 6,094.8 million, when applied to the derived estimate.

Net benefit of protecting the Lake George wetlands

The summary of values in the economic terms, for the benefits and costs of protecting Lake George wetlands in 2011 is shown in Table 13. The gross benefits are amounted to USD 60.99 million or UGS 152 billion while gross costs are amounted to USD 4.6 million or UGS 11.5 billion. The net benefit to the society (net social benefit) in conserving Lake George wetlands in 2011 was therefore estimated at USD 56.4 million or UGS 141 billion.

Conclusion

These results have demonstrated that, the Lake George wetlands supplied tangible benefits to the fishing communities which account 0.44% annual economic benefits of the Lake George wetlands in 2011. The intangible but nonetheless important services to the peoples' livelihoods, in the fishing villages are accounted for 99.56% during the same period. Because of the

Table 13. Economic values of the environmental services (indirect use) of Lake George.

Environmental Service	Value (UGS)	Value (USD)	Value per ha (UGS)	Value per ha (USD)
Sequestration of carbon	3.818.750.000	1.527.500	152.750	61.1
Removal of sediments, nutrients and pollutants	127.500.000.000	51.000.000	5.097.500	2.039
Stabilization of micro-climate	20.312.500.000	8.125.000	812.500	325
Total	151.631.250.000	60.652.500	6.065.250	2.426.1

Table 14. Summary of economic benefits and costs of protecting the Lake George wetland resources for 2004.

Benefits/Costs	Value (UGS)	Value (UDS)
Direct benefits	+672.790.0255	+269.116.01
Indirect benefits	+15.163.1250.000	+60.652.500
Non-use benefits	+16.312.500	+6.525
Gross total benefits	+152.470.352.500	+60.988.141.01
Management costs	-342.232.775	-136.893.11
Opportunity costs	-4.949.452.775	-1.979.781.90
Wildlife related costs	-6.094.861.100	-2.437.944.44
Gross total costs	-113.865.486.300	-4.554.619.45
Net economic value of benefits	+140.933.803.900	+56.373.521.57

minimal tangible benefits from the wetlands to the local people, and the high costs from wildlife related damage to their lives and property, their interest in protecting the wetland is low. The characteristics of the local people further compound the problem through the need for economic development by creating scarcity for wetland resources. This is because, the response to all these situations leads to an unregulated resource extraction in QENP including the wetland. These results highlight the need for UWA to ensure that in future, more tangible economic benefits should accrue from the wetlands to the local communities, as an incentive to conserve the wetlands.

The agitation for tangible benefits from the direct use (consumptive and extractive) of the wetland to ease the socio-economic development of the fishing villages should not however remain the only attractive option to government and other stakeholders. This is because, the results indicate the existence of a wide range of benefits from the Lake George wetland at local, national and global levels and a positive net annual benefit for 2004, which indicated that protecting the Lake George wetlands was still a viable option. The loss and degradation of the aggregate value of the benefits of wetland would constitute real economic costs equivalent to its NPV, which justifies the efforts and economic instruments for its conservation.

Management costs are accounted for about 3% opportunity cost including an alternative uses of wetlands for livestock and agricultural development of 43.47%, while crop damage due to wetland-based vermin is 53.53%, of the total estimated annual cost used in protecting the Lake George wetlands. Despite the annual economic values of USD 296 per household from the typical wetland resources of residents from two villages, they incurred an annual opportunity cost of USD 52.76/ha/yr. This study observes that UWA bears minimum costs relative to local communities.

RECOMMENDATIONS

Benefits derived from the human direct use values of the Lake George wetlands

(a) UWA should endeavor to ensure that tangible benefits are used to motivate and create local interest in wetland by re-designating specific wetland areas for each village where resource extraction can be monitored and controlled, to ensure sustainability of harvests while at the same time maintaining wetland functions.

(b) UWA should initiate an up to date vegetation inventory survey with the object of assessing the availability of wetland products that can be harvested and processed to tap the lucrative tourist market in Queen Elizabeth National Park (QENP). This should be done prior to the preparation of wetland wise use plans and allocation of seasonal harvesting plots.

(c) The extraction of resources from the wetland should attract a fee to act as a premium for resource scarcity. The revenues should be partitioned to cater for wetland management and community development programmes.
d) UWA should give the opportunity to the extractors to learn how these revenues are distributed and to link them with wetland conservation.

Benefits derived from the human indirect use and non-use values of the Lake George wetlands

(a) It would be in UWA's interest to stress the linkages between use values and ecosystem functions which ensure that appropriate incentives could be developed once the values derived from ecosystems are recognized.
(b) The wetlands Inspection division should champion the cause of ensuring that the values of non-monetary benefits of the Lake George wetlands are adequately highlighted and accounted for in the national budget. This will ensure that government allocation to the management of these wetlands will be more readily justified because the benefits derived will become tangible after valuation.

Economic costs of maintaining the benefits flowing from the wetland

(a) UWA's ranger posts in the fishing villages should be re-enforced to monitor and respond quickly to threats of wildlife damage. The local people should be involved and if possible trained to become village scouts.
(b) LAGBIMO should initiate a long-term plan in reinstituting a tree cover on the foothills of Rwenzori Mountains, that is, to initiate agro-forestry in preventing massive soil erosion and massive deposits into the Lake George area.

Protecting the Lake George wetlands benefits

(a) UWA should strengthen its environmental education programmes with a view of enriching indigenous knowledge in managing the wetland goods and services. Respected village individuals can be selected to liaise between the local residents and QENP.
(b) UWA should develop an organization structure in fishing villages with a long-term view of developing sound and viable wetland wise-use plans. This should be through discussions and workshops that should include the different interest groups. The existing community protected area institutions (CPIs) could be tied into village structures as a starting point.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

REFERENCES

Bakema RJ, Iyango L (2000). Engaging Local Users in the Management of Wetland Resources: The case of the National Wetlands Programme, Uganda.

Costanza R, d'Arge R, de'Groot R, Farber S, Grasso M, Hannon B, Limburg K, Naeem S O'Neill RV, Paruelo J, Raskin RG, Sutton P (1995). In Muramira, E. (2004). Assessment of the economic value of the wetlands of Bushenyi District in Western Uganda. IUCN, Uganda.

Dunn I (1989). Fisheries Management Study in the Queen Elizabeth National Park, Uganda. Agriconsulting Economic Analysis: Final Report. Lake Victoria Environnent Management Project.

Emerton L (1998). Economic Tools for Valuing Wetlands in Eastern Africa. IUCN Eastern Africa Programme, Economics and Biodiversity Programme, IUCN.

Emerton L, Muramira E (1999). Uganda Biodiversity: Economic Assessment. A report Prepared by IUCN with the National Environment Management Authority as Part of Uganda National Strategy and Action Plan. IUCN, Nairobi.

Ganf GG (1969). Physiological and Ecological Aspects of the Phytoplankton of Lake George, Uganda. Ph. D Thesis, University of Lancaster. Convention on Wetlands in the Conservation and Wise-Use of Biodiversity. Ramsar Convention Bureau, Ministry of Environment and Forests, India.

Haskoning (2001d). Cost Benefit Analysis of Wetland Resources, Uganda, Part IV.

Howard P (1995). The Economics of Protected Areas in Uganda: Costs, Benefits and Policy Issues. M.Sc Dissertation. University of Edinburgh.

Infield M (1989).Socio Economic Survey in the Queen Elizabeth National Park, Uganda, AGRICONSULTING.

Ministry of Natural Resources (1998). National Ramsar Convention Committee Report.

Russi D, ten Brink P, Farmer A, Badura T, Coates D, Förster J, Kumar R, Davidson N (2013). The Economics of Ecosystems and Biodiversity For Water and Wetlands. London and Brussels: The Institute for European Environmental Policy.

Schreiber U, Endo T, Mi H, Asada K (1995). Cited in Litlere, T. and A. O. Pedersen (1995). Sustainable Utilization of Papyrus Swamps (Cyperus papyrus) by fishing communities in Queen Elizabeth National Park. M.Sc Thesis. Agricultural University of Norway.

Springate-Baginski O, Allen D, Darwall WRT (eds.) (2009). *An* Integrated Wetland Assessment Toolkit: A guide to good practice. Gland: IUCN Species Programme.

Stelk MJ, Christie J (2014). Ecosystem Service Valuation for Wetland Restoration: What It Is, How To Do It, and Best Practice Recommendations. Association of State Wetland Managers, Windham, Maine.

The Republic of Uganda (1995). The National Policy for the Conservation and Management of Wetland Resources.

Turpie J, Smith B, Emerton L, Barnes J (1998). Economic Value of the Zambezi Basin Wetlands. Phase I Report of the Network and Capacity Building Project and Zambezi Basin Wetlands Conservation and Resource Utilization Project. IUCN ROSA, Harare.

Uganda Wildlife Authority (2000). Queen Elizabeth National Park, Kyambura Wildlife Reserve, Kigezi Wildlife Reserve. General Management Plan. Uganda.

International Journal of Biodiversity and Conservation

Related Journals Published by Academic Journals

- *Journal of Ecology and the Natural Environment*
- *African Journal of Environmental Science and Technology*

academicJournals