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Forecasting Economic Value of Ecosystem Services of Selous-Niassa Wildlife Corridor, Tanzania and Mozambique

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Abstract

Ecosystem services (ES) and human welfare are inseparable due to needs and wants provided by natural ecosystems. This paper forecast the less known economic value of ecosystem services (ESV) of Selous – Niassa wildlife corridor (SNWC) that expected to occur for a period of 20 years from 2015 to 2035 and their impacts on natural capital. Specifically, the study predicts the changes of economic values of ecosystem services and functions resulted from changes of land use/cover (LULC), amount of ecosystem services of trees that will be lost and expected ecosystem services of wood balance. The study employs benefit transfer method on local and global estimation of ESV combined with field survey, remote sensing, and GIS techniques. The study has revealed that there will be significant transformation of ESV from one LULC class to another till the year 2035. The ESV of bushland and woodlands will dominate by occupying 45.5%/12.2% and 32.4%/71.6% of the corridor respectively using local/global ESV estimation coefficients. Likewise, the prediction indicates SNWC will decrease ESV for about 7% and 5% equivalent to US$ 67.5 million and US$ 43.1 million for local and global ESV estimation respectively from 2015 to 2035. Local/global ESV estimation indicates decrease in ecosystem functions for about US$ 67.5/164.4 million mostly from bushland and woodlands from 2015 to 2035. Also, there will be an increase in ecosystem functions ESV for cultivated land and grassland for about USS 24.5/5.9 million and US$ 4.9/5.9 million using local/global estimations respectively from 2015 to 2035. The gain and loss of ecosystem functions ESV predicted to be accrued from provisioning and regulatory services respectively. Furthermore, for the period 2015 - 2035 there will be a loss of annual ecosystem services of trees for about US$ 16.8/33.6 using local/global ESV estimation. Besides, local, and global ESV of wood supply in SNWC for the year 2035 is below the average demand per year per capita for about US$ 0.5 million and US$ 2.6 million respectively. The trend of wood supply ESV shows dramatic deforestation of the area which implies tragedy of commons and is the public property where there are no control policies or rules. The study recommends an emergence of reviewing management and conservation strategies so as to attain sustainability of SNWC.

Keywords: Ecosystem services; Land use cover change; Trees dynamics; Wood balance

Introduction

Background information

Ecosystem services (ES) and human welfare and livelihood are inseparable due to acquired needs and wants from natural ecosystems [1]. Global research and quantitative evaluation of ecosystem services (ESV) was initially conducted in 1997 and proposed 17 types of ecosystem services [2-4]. ESVs is a financial economized form of ecosystem service functions [5-9]. ESV has become a prioritized ecological research agenda in recent years. Although, ESV decreased in many localities resulted to negative manifested of human welfare and livelihoods [4,8-10]. Scholars and experts suggested integration of "ecosystem services" into resources management decisions; on which, policy makers responding attentively [9,11-13]. Therefore, ESVs research has received enough attention [7-9,14].

Globally, land use/cover change (LULCC) is an extremely dominant factor that changes ESVs [7-9,15]. The current change rate and intensity of LULCC are far greater than any period in history, which is cumulatively a major driver of global environmental change [1,9]. Anthropogenic activities includes population growth, industrial development, urban expansion, and policy factors are the key driving factors of LULCC [1,16,17]. Also, climate variability affect the growth of vegetation and the effectiveness of water resources, and exerted influences on LULC.

LULCC scales, compositions, and patterns, led to rapid alterations in ecosystem composition and structure and resulted in significant changes in the quantity and quality of ecosystem service (ES) supply [1].

There are two kinds of approaches widely used to evaluate ESVs. One is based on primary data, the ecological processes and functions that constitute ES are quantified by the ecological model, and then evaluates the economic values of ES. Such a method is performed on one or a few kinds of services rather than the comprehensive ESVs [1,7-9,15,18]. The other is the equivalent coefficient method, where ESVs are estimated based on the equivalent coefficient of various ecosystem services and combined with the unit area of the ecosystem [1,2,4,9]. The later approach is more convenient to evaluate the spatial-temporal distribution of ESVs using LULC [1,19-22].

Selous – Niassa and Nyerere -Niassa ecosystems are largest connected trans-boundary natural dry forest eco-regions covering approximately 154.000 km^2 connected by the corridors that stretches for about 120 – 180 km and extending across southern Tanzania and Mozambique. The ecosystems connected with the eastern and western corridors are known as Selous-Niassa Wildlife Corridor (SNWC) and Nyerere – Niassa Wildlife Corridor (NNWC) respectively. Currently, the ecosystem network consist of protected areas (PAs) of various categories of protection amounted 110,000 km^2 under conservation. Wildlife migration and richness in the area constitutes one of the largest elephant ranges in the world and contains half of the world remaining wild dog population, supports a large number of other globally significant, threatened and CITES listed fauna and flora species. There was no legal protection of wildlife corridors before enaction of Wildlife Act No. 5 of 2009. However, the current government notice (GN) number 459 of 25th June 2021 announces Selous Game Reserve (18, 020.50 km^2) after divide the former area to the established Nyerere National Park. Besides, the corridors remain non- priories in conservation agenda.

Problem statement

Forecasting future ESVs depends on future LULC that mirrored effects of anthropogenic activities on global environmental change and sustainable development [1,4,9,19-22]. LULCC has severely affected the value, benefits, and regional ecological security of ecosystem services [1,7,8,23-25]. Ecosystems that connect two or more PAs using corridors like Selous – Niassa ecosystem affected much due to different policies, priorities, culture, economic status, and other regional integration agendas. SNWC and NNWC land uses can lead to dysfunctional ecosystems and unbalanced ecosystem structures, leading to many environmental problems, such as environmental pollution, land degradation, biodiversity decline, and soil erosion [1,8,26-28].

Continuous wildlife habitat loss is an inhibited phenomenon because much of connected PAs ecosystems in Tanzania and Mozambique are unfenced [8,29-31]. SNWC and NNWC consists of living dwellers who utilize the natural capital without considering sustainable supply of ecosystem [8,29,31,32]. This study will concentrate to the SNWC which given less conservation priority compared to NNWC. SNWC is an extremely important ecological function area, which plays an important role in regulating climate, balancing carbon dioxide in the atmosphere, conserving water, preventing soil erosion, and protecting the ecological environment in the connected PAs [8,31]. Therefore, it is essential to explore the connection between ESV and LULC to reveal and forecast the future effect of human activities on the ecosystem services and natural capital [1,8,9,18]. Thus, there is an urgent need to carry out this research.

Based on the research gap identified above this research is essential for the rational use, protection, and management of land resources in SNWC, promotion of the sustainable development of ecosystem services, and the realization of the coordinated development of economic and ecological protection. These results will provide a scientific reference for scientifically formulating ecological protection measures in the Selous-Niassa and Nyerere – Niassa ecosystems, Tanzania and Mozambique and other countries with related scenarios.

Objectives

Main objective

The main objective of this study was to forecast economic value of ecosystem services of Selous-Niassa wildlife corridor for the period, 2015 - 2035.

Specific objectives

Specifically, the study intends to:

a. predict changes of economic value of ecosystem services resulted from LULCC Selous-Niassa wildlife corridor for the period, 2015 - 2035

b. predict changes of economic value of ecosystem functions based on LULC type of Selous-Niassa wildlife corridor for the period, 2015 - 2035

c. predict changes of economic value of ecosystem services of trees loss/gain of Selous-Niassa wildlife corridor for the period, 2015 - 2035

d. predict economic value of ecosystem services of wood balance of corridor dwellers of Selous-Niassa wildlife corridor in 2035

Materials And Methods

Materials

Description of the Study Area

The study was carried out in Selous-Niassa wildlife corridor (SNWC) with an area of 1, 462, 560 hectares which extends

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across southern Tanzania into northern Mozambique between 100S to 110 40'S with north-south length of 160 to 180 km. Administratively the study area comprises three districts namely Liwale, Nachingwea, and Nanyumbu (Figure 1).

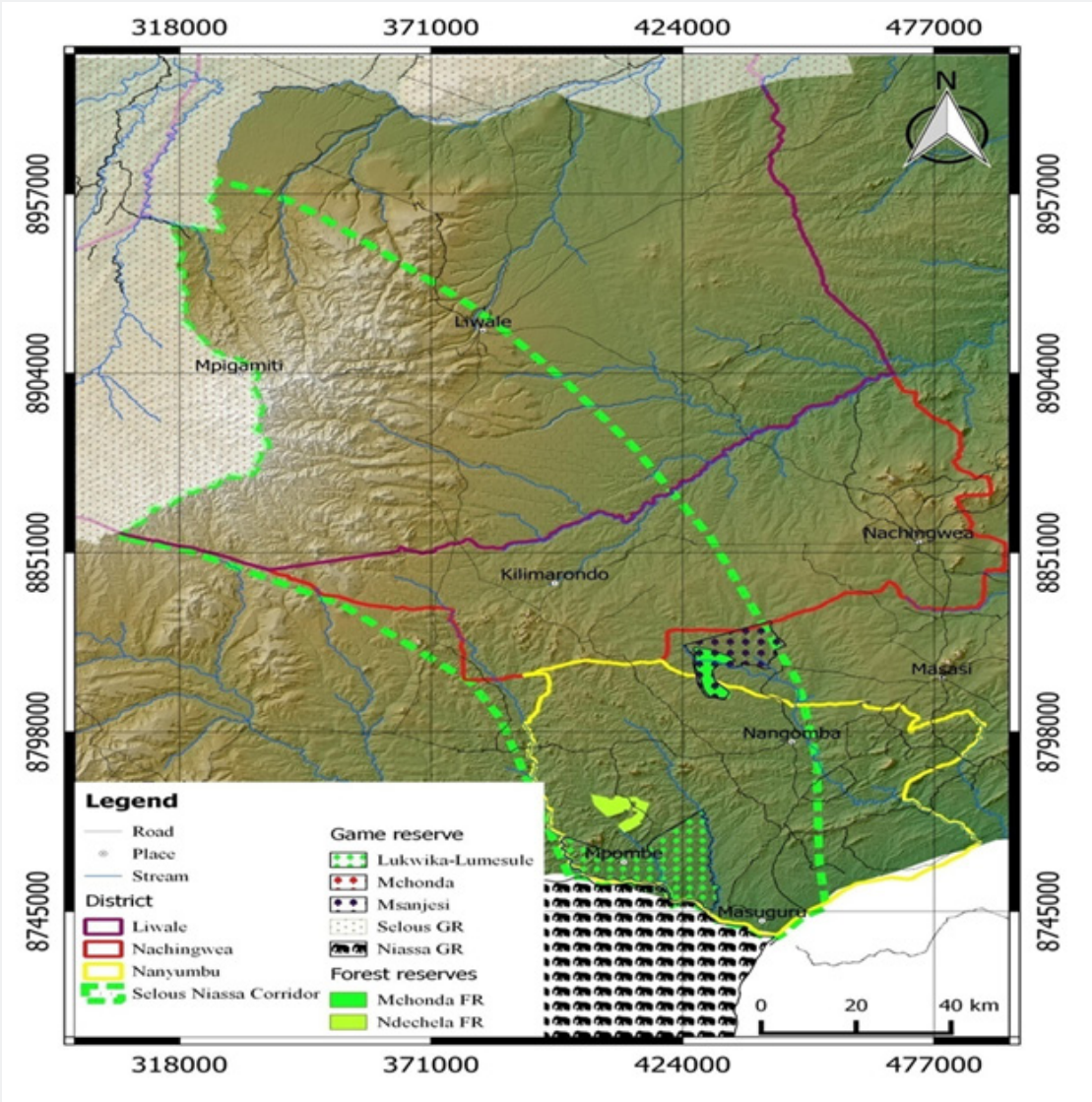

Figure 1: The Map of the study area.

Data Used and Methods

(Figure 2) below shows the flow chart of the methodological approach used in this study for the estimation of the ecosystem service values (ESVs) for 1990 and 2015; and predicted ESVs for 2035 and the computation of changes between studies periods. The LULC datasets in (Table 1) were acquired from [31] who utilized Markov Chain Analysis and Cellular Automata Analysis, jointly called CA–Markov, to predict and simulate the future change of land use and land cover in the SNWC by the year 2035. Furthermore, biome equivalents with their corresponding ecosystem service value coefficients (VC) in 1994 US$ ha–1year–1 for local and global VC shown in (Table 1) were adapted from [2,7,8,33].

This study employed the benefit transfer approach to estimate economic values of ecosystem services based on the adapted local and global VC of the ecosystem services for the targeted LULC types. Detailed ecosystem service functions and their global and modified local value coefficients of each LULC type are shown in (Tables 2 & 3) below as adapted from [2,4,7].

Data analysis

To predict changes of economic value of ecosystem services resulted from LULCC of Selous-Niassa wildlife corridor from 2015 to 2035. The LULC datasets shown in (Table 1) used and

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the total value of ecosystem services in the study area for years 2015 and 2035 were calculated by multiplying the area of a given LULC type by the corresponding modified ecosystem service value coefficients that were extracted from weight factors of the ecosystem services per hectare of each biome, see equation (1) adapted from [2,4,7,8] as follows:

$$ESVf = \sum_{k=0}^{k} \left(Ak * VC_{fk} \right)$$

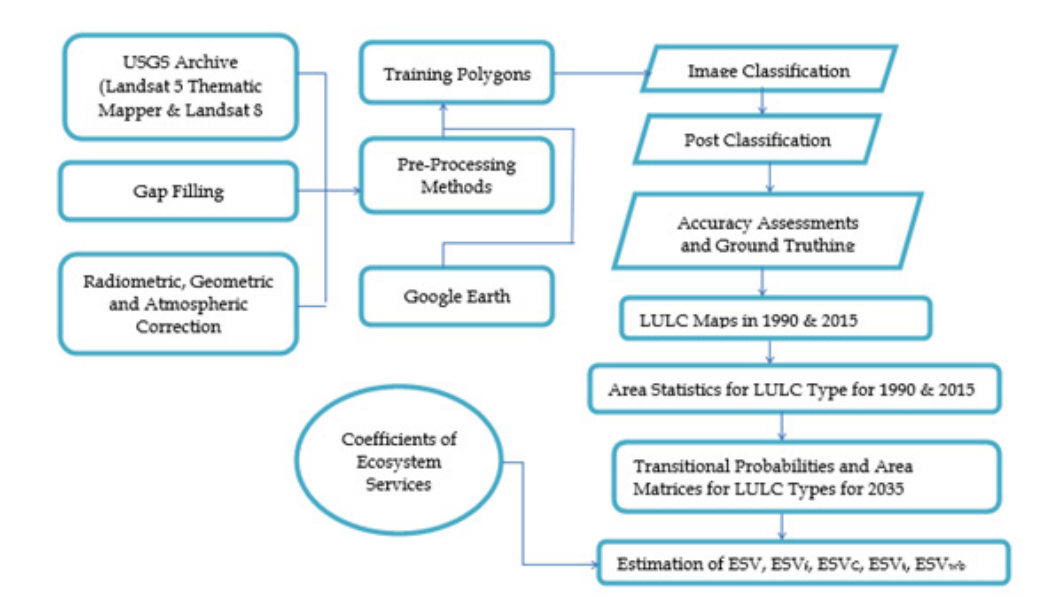

Figure 2: Flowchart of the methodological approach for this study.

Table 1: Land use and land cover (LULC) types and biome equivalents with their corresponding ecosystem service value coefficients (VC).

LULC Type	Year & Area (ha)		Equivalent Biome	Local (VC)1994 US$ $ha^{-1}year^{-1}$	Global (VC) 1994 US$ $ha^{-1}year^{-1}$
	2015	2035		a	b
Closed woodland	89923	81981	Tropical Forest	987	2008
Open woodland	220217	211690	Tropical Forest	987	2008
Bushland	480269	411950	Tropical Forest	987	244
Grassland	394461	411272	Grasslands	293	244
Water	646	242	Fresh water	8103	8498
Built up area	8851	12749	Urban	0	0
Cultivated land	268193	332676	Cropland	226	92

Table 2: Details of the ecosystem service functions and their modified local value coefficients for each LULC type (adopted from [8]).

Biological control	Each LULC Types of Ecosystem Service Values (1994 US$ $ha^{-1}year^{-1}$)					
	Closed wood-land	Open woodland	Bushland	Grassland	Water	Cultivated land
Provisioning services:						
Water supply	8	8	8		2117	
Food production	32	32	32	117.45	41	187.56
Raw material	51.2	51.2	51.2			
Genetic resources	41	41	41			
Medical services						

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Sub-total	132.2	132.2	132.2	117.45	2158	187.56
Regulating services:						
Water regulation	6	6	6	3	5445	
Waste treatment	136	136	136	87	431.5	
Erosion control	245	245	245	29		
Climate regulation	223	223	223			
Biological control				23		24
Gas regulation	13.68	13.68	13.68	7		
Disturbance regulation	5	5	5			
Sub-total	628.68	628.68	628.68	149	5876.5	24
Supporting services:						
Nutrient cycling	184.4	184.4	184.4			
Pollination	7.27	7.27	7.27	25		14
Soil formation	10	10	10	1		
Habitat/refugia	17.3	17.3	17.3			
Sub-total	218.97	218.97	218.97	26		14
Cultural services:						
Recreation	4.8	4.8	4.8	0.8	69	
Cultural	2	2	2			
Sub-total	6.8	6.8	6.8	0.8	69	
Grand-total	986.69	986.69	986.69	293.25	8103.5	225.56

Table 3: Details of the ecosystem service functions and their global value coefficients for each LULC type (adapted from [2,4]).

Ecosystem Services	Each LULC Types of Ecosystem Service Values (1994 US$ $ha^{-1}year^{-1}$)					
	Closed woodland	Open woodland	Bushland	Grassland	Water	Cultivated land
Provisioning services:						
Water supply	8	8	8		3800	
Food production	32	32	32	67	258	54
Raw material	315	315	315	106		
Genetic resources	41	41	41			
Medical services						
Sub-total	396	396	396	173	4058	54
Regulating services:						
Water regulation	6	6	6	3	15	
Waste treatment	87	87	87	87	4177	
Erosion control	245	245	245	29		
Climate regulation	223	223	223			
Biological control				23		24
Gas regulation				7	133	
Disturbance regulation	5	5	5		4539	
Sub-total	566	566	566	149	8864	24
Supporting services:						
Nutrient cycling	922	922	922			

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Pollination				25		14
Soil formation	10	10	10	1		
Habitat/refugia					304	
Sub-total	932	932	932	26	304	14
Cultural services:						
Recreation	112	112	112	2	574	
Cultural	2	2	2		881	
Sub-total	114	114	114	2	1455	0
Grand-total	2008	2008	2008	350	14681	92

where ESV = the total estimated ecosystem service value, Ak = the area (ha) and VC_k = the value coefficient (US$ ha^{-1} $year^{-1}$) for LULC type 'k'. The ESVs for all land use and land cover (LULC) types were calculated. Besides, the change in the ESVs was determined by calculating the differences between the estimated values for each LULC category in 2015 and 2035. The percentage changes in the ESVs between the years were calculated based on the equation below:

where ESV_{t2} (US$ ha^{-1} $year^{-1}$) = the estimated ecosystem service value in the most recent year, and ESV_{t1} (US$ ha−1 year−1) = the estimated ecosystem service value in the previous year. Positive values suggest an increase in the ESVs, whereas negative values imply a decrease in the ESVs.

$$\text{Percentage ESV} = \frac{(\text{ESV}t_2 - \text{ESV}t_1)}{\text{ESV}t_1} \times 100$$

To predict changes of economic values of ecosystem functions based on LULC type of Selous-Niassa wildlife corridor from 2015 to 2035

Estimated values of the services provided by individual ecosystem functions within the study area using the following equation:

$$\text{ESVf} = \Sigma_{k=0}^{k}\left(\text{Ak} * \text{VC}_{fk}\right)$$

where ESV_f is the estimated ecosystem service value of function f, Ak is the area (ha) and VCf_k is the value coefficient of the function (US$ ha^{-1} $year^{-1}$) for LULC category 'k'. The contributions of the individual ecosystem functions to the overall value of the ecosystem services per year were calculated and summarized in the tables.

To predict changes of economic value of ecosystem services of trees loss/gain of Selous-Niassa wildlife corridor from 2015 to 2035. Estimated amount of land (in hectares) in the study area that expected to be converted from closed and open woodlands to other socio-economic activities was used to estimate number of trees loss. The study area belongs to southern zone as classified by [34]. The number of trees and volume per hectare of the distribution of forest and woody vegetation resources have been classified by employing methodology used by NAFORMA in [34] as described much by [8,31] of having average mean volume (m^3/ha) and average number of trees/ha of 49.3 and 1,654 respectively. Then average mean volume (m^3/ha) and average number of trees/ha were assigned modified ecosystem service value coefficients that were extracted from weight factors of the ecosystem services per hectare as adopted from Zella (2020). This was used also to estimate ecosystem service value of individual tree expected to be found in the study area.

To predict economic value of ecosystem services of wood balance of corridor dwellers of Selous-Niassa wildlife corridor in 2035. Projected human population of corridor dwellers in 2035 was estimated based on National Bureau of Statistics (2012) census and computing average demand for wood compared with supply from the corridor ecosystem as described much by [8,31]. Then obtained information of wood balance were assigned modified ecosystem service value coefficients and get ecosystem services of wood balance of corridor dwellers of SNWC. The study employed NAFORMA [34] baseline information that estimates Tanzania's average demand for wood as 1.39 m^3/year/capita while the annual allowable cut (the sustainable supply) is estimated at 0.95 m^3/year/capita to convert into annual local and global ESV amounted to US$ 27.7 and US$ 57.1 per capita respectively. Furthermore, one tree with Dbh of one cm and above estimated to have local and global ESV of US$ 0.6 and US$ 1.2 respectively.

Results and Discussion

Future change in economic value of ecosystem services resulted from LULCC of Selous-Niassa wildlife corridor from 2015 to 2035

Present and predicted status of economic values of ecosystem services for Biome in each LULC type of Selous-Niassa wildlife corridor from 2015 to 2035

Present and predicted economic values of ecosystem services using local and global value coefficients for biome in each LULC type for the years 2015 and 2035 are presented in (Table 4). Analyzed statistical results show variations in ecosystem services values between two periods under consideration. ESV of the study area dominated by Bushland in the year 2015 for 49.3% and 13.5% followed by woodlands for about 31.8% and 71.8% using local and global ESV estimation respectively. Predicted ESV in the year 2035 indicates Bushland will dominate the study area for about 45.5% and 12.2% followed by woodlands for about 32.4%

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and 71.6% using local and global ESV estimation. The differences in local and global ESV estimation caused by assigned ESV coefficients which differ in LULC types depends on geographical area and value given by indigenous locality and their socio-culture environment compared to global values.

Table 4: Ecosystem services values (ESV) year-1distribution between 2015 and 2035.

LULC Type	Local ESV (Million US$)				Global ESV (Million US$)			
	2015		2035		2015		2035	
	(ESV)	(%)	(ESV)	(%)	(ESV)	(%)	(ESV)	(%)
Closed woodland	88.8	9.2	80.9	9	180.6	20.8	164.6	20
Open woodland	217.4	22.6	208.9	23.4	442.2	51	425.1	51.6
Bushland	474	49.3	406.6	45.5	117.2	13.5	100.5	12.2
Grassland	115.6	12	120.5	13.5	96.2	11.1	100.4	12.2
Water	5.2	0.5	2	0.2	5.5	0.6	2.1	0.2
Built up area	0	0	0	0	0	0	0	0
Cultivated land	60.6	6.3	75.2	8.4	24.7	2.8	30.6	3.7
TOTAL	961.6	100	894.1	100	866.4	100	823.2	100

Predicted changes of economic values of ecosystem services of LULCC biomes' of Selous-Niassa wildlife corridor from 2015 to 2035

The extent of changes of economic values of ecosystem services of land use land cover change (LULC) biomes including change in ESV, percentage ESV change, and percentage annual rate of change summarized on (Table 5). The increased and decreased amount is represented by negative (-) and positive (+) signs respectively.

Table 5: Changes in local and global ESV of SNWC from 2015 to 2035.

	Local ESV (Million US$)			Global ESV (Million US$)		
	Change in ESV	% change	ESV annual rate of change	Change in ESV	% change	ESV annual rate of change
Closed woodland	7.8	11.6	0.4	15.9	37	0.8
Open woodland	8.4	12.5	0.4	17.1	39.7	0.9
Bushland	67.4	100	3.4	16.7	38.6	0.8
Grassland	-4.9	-7.3	-0.2	-4.1	-9.5	-0.2
Water	3.3	4.9	0.2	3.4	8	0.2
Built up area	0	0	0	0	0	0
Cultivated land	-14.6	-21.6	-0.7	-5.9	-13.8	-0.3
TOTAL	67.5	100	3.4	43.1	100	2.2

The prediction indicates decrease in economic value of ecosystem services for about 7% and 5% equivalent to US$ 67.5 million and US$ 43.1 million for local and global ESV estimation respectively from 2015 to 2035. The annual decrease rate of ESV predicted to be US$ 3.4 million and US$ 2.2 million for local and global ESV estimation respectively from 2015 to 2035. The decrease in ESV for local ESV estimation will be dominated by bushland (100%) followed by woodlands (24.1%) and increase of ESV predicted to be on grassland (7.3%) and cultivated land (21.6%). Likewise, the global ESV estimation indicates the decrease in ESV dominated by woodlands (76.7%) followed by bushland (38.6%) and increase in ESV predicted to be in grassland (9.5%) and cultivated land (13.8%). The decrease in bushland and woodlands will negatively affect water sources which also predicted to decrease in ESV for 4.9% and 0.2% using local and global ESV estimation respectively. The results concur with that of [30] in western Tanzania miombo woodlands ecosystem who explained that, decrease in natural forest cover impact water resources and sometimes dries up; and this has been revealed in this study due to projected decrease in water bodies and wetland. The decrease in woodlands ESV acerbated mostly by encroachment of the valuable hardwoods from natural miombo ecosystem like pterocarpus angolensis), Afzelia quanzesis and others due to increasing demand and price of aforementioned wood tree species as supported by [31].

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Predicted changes of economic values of ecosystem functions based on LULC type of Selous-Niassa wildlife corridor from 2015 to 2035

The results in (Table 6) shows predicted local and global annual economic value of the ecosystem functions (EF) and their relative changes from 2015 to 2035 in SNWC (Table 6). The prediction revealed that, for upcoming two decades there will be a loss of US$ 67.5/164.4 million of ecosystem functions using local/global estimations mostly from bushland and woodlands from 2015 to 2035. Also, there will be increased in ecosystem functions for cultivated land and grassland for about USS 24.5/5.9 million and US$ 4.9/5.9 million using local/global estimations respectively from 2015 to 2035. The results further projects SNWC to gain ecosystem functions from provisioning services for about US$ 2.0 million and the degradation of ecosystem functions from regulatory services (US$ 51.6/47.5 million), supporting services (US$ 17.2/77.8 million) and cultural services (US$ 0.6/10.2 million) using from local/global estimation. These results again imply that, there is encroachment of natural capital in SNWC mostly on woodlands for valuable wood resources and for changes of land uses due to anthropogenic activities and reliance of dwellers to natural resources for their livelihoods as supported by [7,8,31].

Table 6: Local and global economic values of ecosystem functions from 2015 to 2035.

		Local EF (Million US$)			Global EF (Million US$)		
LULC	**Ecosystem services**	**2015**	**2035**	**Relative change**	**2015**	**2035**	**Relative change**
Closed wood-land	Provisioning services	11.9	10.8	1	35.6	32.5	3.1
	Regulating services	56.5	51.5	5	50.9	46.4	4.5
	Supporting services	19.7	18	1.7	83.8	76.4	7.4
	Cultural services	0.6	0.6	0.1	10.3	9.3	0.9
	Sub-total	88.7	80.9	7.8	180.6	164.6	15.9
Open wood-land	Provisioning services	29.1	28	1.1	87.2	83.8	3.4
	Regulating services	138.4	133.1	5.4	124.6	119.8	4.8
	Supporting services	48.2	46.4	1.9	205.2	197.3	7.9
	Cultural services	1.5	1.4	0.1	25.1	24.1	1
	Sub-total	217.3	208.9	8.4	442.2	425.1	17.1
Bushland	Provisioning services	63.5	54.5	9	190.2	163.1	27.1
	Regulating services	301.9	259	43	271.8	233.2	38.7
	Supporting services	105.2	90.2	15	447.6	383.9	63.7
	Cultural services	3.3	2.8	0.5	54.8	47	7.8
	Sub-total	473.9	406.5	67.4	964.4	827.2	137.2
Grassland	Provisioning services	46.3	48.3	-2	68.2	71.2	-2.9
	Regulating services	58.8	61.3	-2.5	58.8	61.3	-2.5
	Supporting services	10.3	10.7	-0.4	10.3	10.7	-0.4
	Cultural services	0.3	0.3	0	0.8	0.8	0
	Sub-total	115.7	120.6	-4.9	138.1	143.9	-5.9
Water	Provisioning services	1.4	0.5	0.9	2.6	1	1.6
	Regulating services	3.8	1.4	2.4	5.7	2.1	3.6
	Supporting services	0	0	0	0.2	0.1	0.1
	Cultural services	0	0	0	0.9	0.4	0.6
	Sub-total	5.2	2	3.3	9.5	3.6	5.9

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Cultivated land	Provisioning services	50.3	62.4	-12.1	14.5	18	-3.5
	Regulating services	6.4	8	-1.5	6.4	8	-1.5
	Supporting services	3.8	4.7	-0.9	3.8	4.7	-0.9
	Cultural services	0	0	0	0	0	0
	Sub-total	60.5	75	-14.5	24.7	30.6	-5.9
GRAND TOTAL		961.3	3106.3	67.5	1759.4	5671.5	164.4

Predicted changes of economic value of ecosystem services of trees loss/gain of Selous-Niassa wildlife corridor from 2015 to 2035

The results in (Tables 7) indicates predicted economic value of the ecosystem services of trees loss/gain from 2015 to 2035 in SNWC (Table 7). The results indicate that for the period 2015 - 2035 there will be a loss of annual ecosystem services of trees of US$ 16.8/33.6 using local/global ESV estimation. The results predicts degradation of ecosystem services of trees under business-as-usual scenario. Involvement of community in conservation of fauna and flora in SNWC using formulated Wildlife Management Areas (WMAs) of MAGINGO, proposed NDONDA and MCHMALU WMAs in Liwale, Nachingwea and Nanyumbu districts plus Joint Forest Management (JFM) and Participatory Forest Management (PFM) in these districts are not enough strategies for conservation and preservation of ecosystem services. The results promise negativity in future if immediate action will not be injected to reverse the encroachment and degradation of forest cover through curbing illegal lumbering and formulation of sustainable utilization of available forest resources. Supply of ecosystem services from trees should exceed demand so as to sustain the ESV of the SNWC as supported by [1,8,9,18].

Table 7: Predicted economic value of ecosystem services of trees loss from 2015 to 2035.

Years	Total area converted (ha)	Number of trees loss/gain (in millions)	Local ESV (Million US$)	Global ESV (Million US$)
2015 – 2035	164697	28	16.8	33.6

Predicted economic value of ecosystem services of wood balance of corridor dwellers of Selous-Niassa wildlife corridor in 2035

Predicted number of trees in 2035 (Table 8) used to estimate local and global ESV of wood balance by using estimated population of the study area in 2035. The results reveled in (Table 8) shows that, local and global ESV of wood supply in SNWC for the year 2035 is below the average demand per year per capita for local ESV estimation which is US$ 27.7 capita-1year-1 and for global ESV estimation is slightly higher than average demand capita-1year-1 which is US$ 57.1. This implies that the area will degrade its forest cover if the existing anthropogenic activities for SNWC dwellers livelihoods will remain unchanged. If business as scenario exists, then ESV of wood balance will change the area ecologically. However, the trend of ESV of wood supply from 2015 to 2035 shows dramatic disintegration of the SNWC ESV which implies tragedy of common and is the public property where there is no control policies or rules. The emergence of reviewing management and conservation strategies is of utmost action if we need sustainability of SNWC [35,36].

Table 8: Predicted economic value of ecosystem services of wood balance in 2035.

Year	Number of trees	Estimated human population	Local ESV (US$) of Wood balance	Global ESV (US$) of Wood balance
	(In millions)		(US$/capita/year)	(US$/capita/year)
2035	486	535, 446	27.2	54.5

Conclusion and Recommendations

Conclusion

This paper forecast economic values of ecosystem services of Selous – Niassa wildlife corridor. The findings revealed that the study area will undergo notable changes in terms of ecosystem services for the period between 2015 and 2035. Local knowledge revealed anthropogenic activities is the main contributing factors includes fire, cultivation, and deforestation. Factors for fire contribution are beekeeping, hunting activities, and local beliefs; while deforestation include commercial logging and timbering, charcoals production, population growth, expansion of commercial farming and food crops production

The results indicate that land use and land cover change has a significant impact to the management of biodiversity and maintaining ecosystem services of the Selous-Niassa ecosystem.

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The greater increase of land use conversion alters ecosystem services, wildlife movements, gene flow and stochastic events like fire and climate change. The study concludes that the modification of the land use and land cover will results in changes of ecosystem functions which influence behavioral changes of some wild animals due to changes of their habitats. The study predicts the effects of land use and land cover on changes of ecosystem services of trees loss/gain and ecosystem services of wood balance of the corridor dwellers which shows unsustainable supply.

Recommendations

This study contributes to the understanding of the land use/cover change effects on ecosystem services for decision-makers and provide a relevant scientific reference and support for ecosystem protection and integrated management in SNWC. Specifically, the study provides the following recommendations for sustainable supply of ecosystem services of SNWC

a) The Government through responsible Ministry has to formulate user friendly guidelines for protection of wildlife corridors as stipulated in Tanzania Wildlife Conservation Act No. 5 of 2009.

b) The Government through responsible Ministry has to formulate new and enhancing existing wildlife management areas (WMAs), participatory forests managements (PFMs) and joint forests managements (JFMs) so as accrued benefits should be higher than protection costs of the natural capital.

c) The Government through responsible Ministry has to formulate land use plans of the corridors so as to protect wildlife routes and traits within the corridors.

d) The public have to use alternatives wood resources so as offset the supply deficit of ecosystem services and attain sustainability; and

e) The Government through responsible Ministry has to formulate national guidelines to be used by the Conservation Army formulated in 2021 in protection of natural resources in all categories of protected areas.

Compliance with Ethical Standards

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The author has no conflict of interest for publishing this paper.

References

1. Hou J, Qin T, Liu S, Wang J, Dong B (2021) Analysis and Prediction of Ecosystem Service Values Based on Land Use/Cover Change in the Yiluo River Basin. Sustainability 13: 6432.
2. Costanza R, D Arge R, de Groot R, Farber S, Grasso M, et al. (1997) The value of the world's ecosystem services and natural capital. Nature 387 253-260.
3. Costanza R, D'Arge R, de Groot R, Farber S, Grasso M, et al. (1998) The value of the world's ecosystem services and natural capital. Ecol Econ 25: 3-15.
4. Costanza R, De Groot R, Sutton PC, Van Der Ploeg S, Anderson SJ (2014) Changes in the global value of ecosystem services. Glob. Environ. Chang 26: 152-158.
5. Anaya Romero M, Muñoz Rojas M, Ibáñez B, Marañón T (2016) Evaluation of forest ecosystem services in Mediterranean areas. A regional case study in South Spain. Ecosyst. Serv 20: 82-90.
6. Gashaw T, Tulu T, Argaw M, Worqlul AW, Tolessa T (2018) Estimating the impacts of land use/land cover changes on Ecosystem Service Values: The case of the Andassa watershed in the Upper Blue Nile basin of Ethiopia. Ecosyst. Serv 31: 219-228.
7. Msofe NK, Sheng L, Li Z, Lyimo J (2020) Impact of Land Use/Cover Change on Ecosystem Service Values in the Kilombero Valley Floodplain, Southeastern Tanzania. Forests 11: 109.
8. Zella AY (2020) Economic valuation of ecosystem services of eastern corridor of Selous- Niassa ecosystem, Tanzania and Mozambique. World Journal of Advanced Research and Reviews 08(03): 108-124.
9. Wang Y, Zhang X, Peng P (2021) Spatio-Temporal Changes of Land-Use/Land Cover Change and the Effects on Ecosystem Service Values in Derong County, China, from 1992–2018. Sustainability 13: 827.
10. Alamgir M, Turton SM, MacGregor CJ, Pert P (2016) Assessing regulating and provisioning ecosystem services in a contrasting tropical forest landscape. Ecol. Indic 64: 319-334.
11. Nelson E, Mendoza G, Regetz J, Polasky S, Tallis H (2009) Modeling multiple ecosystem services, biodiversity conservation, commodity production, and tradeoffs at landscape scales. Front. Ecol. Environ., 7: 4-11.
12. De Groot R, Alkemade R, Braat L, Hein L, Willemen L (2010) Challenges in integrating the concept of ecosystem services and values in landscape planning, management and decision making. Ecol Complex 7: 260-272.
13. Koschke L, Fürst C, Frank S, Makeschin F (2012) A multi-criteria approach for an integrated land-cover-based assessment of ecosystem services provision to support landscape planning. Ecol. Indic 21: 54-66.
14. Zheng W, Cai F, Chen S, Zhu J, Qi H (2020) Ecological Suitability of Island Development Based on Ecosystem Services Value, Biocapacity and Ecological Footprint: A Case Study of Pingtan Island, Fujian, China. Sustainability 12: 2553.
15. Rai R, Zhang Y, Paudel B, Acharya BK (2018) Land Use and Land Cover Dynamics and Assessing the Ecosystem Service Values in the Trans-Boundary Gandaki River Basin, Central Himalayas. Sustainability 10: 3052.
16. Bohn TJ, Vivoni ER, Mascaro G, White DD (2018) Land and water use changes in the US-Mexico border region, 1992–2011. Environ. Res. Lett 13: 114005.

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17. Kalantari Z, Santos Ferreira CS, Page J, Goldenberg R, Olsson J (2019) Meeting sustainable development challenges in growing cities: Coupled social-ecological systems modeling of land use and water changes. J. Environ. Manag 245: 471-480.

18. Gedefaw A, Atzberger C, Bauer T, Agegnehu S, Mansberger R (2020) Analysis of Land Cover Change Detection in Gozamin District, Ethiopia: From Remote Sensing and DPSIR Perspectives. Sustainability 12: 4534.

19. Riao D, Zhu X, Tong Z, Zhang J, Wang A (2020) Study on Land Use/Cover Change and Ecosystem Services in Harbin, China. Sustainability 12: 6076.

20. Mortoja MG, Yigitcanlar T (2020) Local Drivers of Anthropogenic Climate Change: Quantifying the Impact through a Remote Sensing Approach in Brisbane. Remote Sens 12: 2270.

21. Hu Z, Wang S, Bai X, Luo G, Li Q (2020) Changes in ecosystem service values in karst areas of China. Agric. Ecosyst. Environ 301: 107026.

22. Woldeyohannes A, Cotter M, Biru W, Kelboro G (2020) Assessing Changes in Ecosystem Service Values over 1985–2050 in Response to Land Use and Land Cover Dynamics in Abaya-Chamo Basin, Southern Ethiopia. Land 9: 37.

23. Ma X, Zhu J, Zhang H, Yan W, Zhao C (2020) Trade-offs and synergies in ecosystem service values of inland lake wetlands in Central Asia under land use/cover change: A case study on Ebinur Lake, China. Glob. Ecol. Conserv 24: e1253.

24. Jiang W, Lü Y, Liu Y Gao W (2020) Ecosystem service value of the Qinghai-Tibet Plateau significantly increased during 25 years. Ecosyst Serv 44: 101146.

25. Talukdar S, Singha P, Mahato S, Praveen B, Rahman A (2020) Dynamics of ecosystem services (ESs) in response to land use land cover (LU/LC) changes in the lower Gangetic plain of India. Ecol. Indic. 2020, 112: 106121.

26. Schirpke U, Tscholl S, Tasser E (2020) Spatio-temporal changes in ecosystem service values: Effects of land-use changes from past to future (1860–2100). J. Environ. Manag 272: 111068.

27. Liu Y, Hou X, Li X, Song B, Wang C (2020) Assessing and predicting changes in ecosystem service values based on land use/cover change in the Bohai Rim coastal zone. Ecol. Indic 111: 106004.

28. Wu C, Chen B, Huang X, Dennis Wei YH (2020) Effect of land-use change and optimization on the ecosystem service values of Jiangsu province, China. Ecol. Indic 117: 106507.

29. WWF (2014) Tanzania's wildlife management areas: A 2012 status report. Dar es Salaam.

30. Lobora A, Nahonyo C, Munishi L, Caro T, Foley C (2017) Modelling habitat conversion in miombo woodlands: insights from Tanzania, Journal of Land Use Science 12(5).

31. Zella AY, Saria J, Lawi Y (2017) Forecasting Habitat Conversion of Eastern Corridor of Selous-Niassa Transfrontier Conservation Areas (TFCA). International Journal of Environmental Sciences and Natural Resources 8(1): 555726.

32. Jewitt D, Goodman PS, Erasmus BF, O'Connor TG, Witkowski ET (2015) Systematic land-cover change in KwaZulu-Natal, South Africa: Implications for biodiversity. South African Journal of Science 111(9-10): 01-09.

33. Kindu M, Schneider T, Teketay D, Knoke, T (2016) Changes of ecosystem service values in response to land use/land cover dynamics in Munessa-Shashemene landscape of the Ethiopian highlands. Sci Total Environ 547: 137-147.

34. URT (United Republic of Tanzania) (2015) National Forest Resources Monitoring and Assessment of Tanzania Mainland. Ministry of Natural Resources and Tourism, Dar es Salaam.

35. Ligate EJ, Chen C, Wu C (2018) Evaluation of tropical coastal land cover and land use changes and their impacts on ecosystem service values. Ecosyst. Health Sustain 4: 188-204.

36. Xie GD, Zhen L, Lu CX, Xiao Y, Chen C (2008) Expert Knowledge Based Valuation Method of Ecosystem Services in China. J. Nat. Resour 23: 911-919.

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