Journal of Economics, Management and Trade

Volume 30, Issue 10, Page 58-72, 2024; Article no.JEMT.123489
ISSN: 2456-9216
(Past name: British Journal of Economics, Management & Trade, Past ISSN: 2278-098X)

Economic Valuation of Ecosystem Services of Coastal Area of Kinondoni District, Tanzania

Adili Y. Zella [a*] and Luzabeth J. Kitali [b]

[a] *Department of Economics, Faculty of Leadership and Management Sciences, The Mwalimu Nyerere Memorial Academy, P.O Box 9193, Dar es Salaam, Tanzania.*
[b] *Department of Geography and History, Faculty of Arts and Social Sciences, The Mwalimu Nyerere Memorial Academy, P.O Box 9193, Dar es Salaam, Tanzania.*

Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

Article Information

DOI: https://doi.org/10.9734/jemt/2024/v30i101248

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/123489

Original Research Article

Received: 15/07/2024
Accepted: 17/09/2024
Published: 02/11/2024

ABSTRACT

This study investigates the often overlooked economic values of ecosystem services in the coastal area of Kinondoni District, Tanzania, in the context of spatial and temporal changes in land use and land cover (LULC). The primary objectives were to assess how ecosystem services and functions have been affected by LULC changes over a 30-year period, from 1993 to 2023. The study employs a benefit transfer method, integrating local and global estimations of ecosystem service value (ESV) with field survey, remote sensing and GIS techniques. The findings reveal that the annual changes in ESV during the study period are estimated at US$ 0.024 million and US$ 0.034 million using local and global coefficients, respectively. Over the three decades, there has been a significant annual loss of US$ 0.72 million locally and US$ 2.11 million globally, primarily due to the degradation of

---

**Corresponding author: E-mail: zellahadil@gmail.com, adil.zellah@mnma.ac.tz;*

Cite as: *Zella, Adili Y., and Luzabeth J. Kitali. 2024. "Economic Valuation of Ecosystem Services of Coastal Area of Kinondoni District, Tanzania". Journal of Economics, Management and Trade 30 (10):58-72. https://doi.org/10.9734/jemt/2024/v30i101248.*

mangrove forests and bushland. The decline in ecosystem functions is largely driven by reductions in regulating services, which account for 54.1% of the total decrease in local valuations and 31.6% in global valuations. Supporting services also experienced substantial declines, with reductions of 39.7% in local valuations and 55.8% in global valuations. The study underscores the urgent need to review and enhance management and conservation strategies to ensure the sustainability of the coastal ecosystems in Kinondoni District, Tanzania.

Keywords: Ecosystem services; ecosystem function; Land Use and Land Cover Change (LULCC); Kinondoni.

1. BACKGROUND INFORMATION

The economic assessment of ecosystem services (ES) has garnered considerable interest in recent years due to the essential function these services fulfill in sustaining life on Earth. Ecosystem services include various advantages that humans obtain from nature, comprising provisioning services (e.g., food, water, and raw materials), supporting services (e.g., nutrient cycling and soil formation), regulating services (e.g., climate regulation and flood control), and cultural services (e.g., recreation and spiritual benefits) [1-5]. The economic significance of these services is frequently undervalued or entirely overlooked in commercial markets and decision-making, resulting in insufficient management and possible deterioration of natural capital [6-10, 3].

In Tanzania, especially in the coastal areas of Dar es Salaam, ecosystem services are vital for the welfare of local communities that depend significantly on natural resources for their livelihoods. These services are increasingly jeopardized by land use and land cover changes (LULCC), propelled by urbanization, agricultural development, and population growth [11-15]. These alterations frequently lead to the deterioration of ecosystem functions and services, hence intensifying environmental degradation and compromising sustainable development initiatives.

The economic assessment of ecosystem services, especially in areas experiencing substantial land use and land cover change (LULCC), is essential for various reasons. Initially, it highlights the significance of ecosystem services and their benefits to human well-being [16-18, 11]. Secondly, it offers critical insights into which ecosystem services hold the most value and hence require prioritization for conservation [19-24]. Third, it elucidates decision-makers by emphasizing the trade-offs among various land uses and the prospective costs associated with the loss of ecosystem services [25-28]. Ultimately, it facilitates the formulation of policies and strategies designed to guarantee the sustainable management of ecosystems and the optimal allocation of resources for conservation and restoration [29-32].

Economic valuation techniques, like the benefit transfer method, are frequently employed to assess the monetary worth of environmental services in regions with little primary data. This methodology, which utilizes current value data from one region to another with comparable attributes, is especially beneficial in developing nations such as Tanzania, where information on ecosystem services is scarce [33, 34, 19, 11]. The benefit transfer method, integrated with remote sensing and GIS technologies, facilitates the estimation and mapping of ecosystem service values across various biomes and land use types, offering essential information for sustainable land management to decision-makers [35-38, 3].

Due to the increasing pressures on the coastal ecosystems of Dar es Salaam, it is imperative to assess the economic worth of the ecological services they offer. This study seeks to address the information gap by quantifying the economic value of ecosystem services in the coastal regions of Dar es Salaam, emphasizing the effects of land use and land cover change (LULCC) over the previous thirty years (1993-2023). The study aims to (i) assess the alterations in the economic values of ecosystem services due to land use and land cover change (LULCC), and (ii) examine the variations in the economic values of ecosystem functions according to the types of land use and land cover in the study area. Consequently, by delivering a thorough evaluation of the economic significance of ecosystem services in this vital area, the study seeks to enlighten policy-makers, conservationists, and local stakeholders regarding the necessity of conserving these services and the imperative for sustainable management practices to ensure the ecosystem's long-term viability.

2. MATERIALS AND METHODS

2.1 Description of the Study Area

This research was carried out in the coastal wards of Mbweni and Ununio (Fig. 1) located in the Kinondoni District of Dar es Salaam, Tanzania. Kinondoni, one of the five administrative districts in Dar es Salaam, is strategically situated between latitudes 6° 42' 43" S and longitude 39° 07' 54" E. It is bordered by the Indian Ocean to the east, Ilala District to the south, and Ubungo District to the west, encompassing an area of approximately 531 square kilometers [39]. The choice of Mbweni and Ununio was intentional, owing to their expansive coastline, which is abundant in marine resources and essential for the sustenance of local residents. These regions depend significantly on marine and coastal ecosystem services for economic pursuits like fishing and tourism, rendering them ecologically and economically vital.

The coastal areas of Kinondoni are experiencing heightened environmental degradation as a result of fast urbanization, population expansion, and unsustainable economic activities. The district's shoreline belongs to the extensive Western Indian Ocean region, celebrated for its significant biodiversity, encompassing vital habitats like coral reefs, mangroves, and seagrass beds. These habitats are crucial for sustaining ecological equilibrium and facilitating economic endeavors [40]. These ecosystems, despite their significance, face considerable stress due to habitat destruction, pollution, and resource overexploitation, intensified by the swift growth of Dar es Salaam [41].

The coastal regions of Mbweni and Ununio have experienced significant environmental degradation, evidenced by erosion, diminishing fish populations, and the removal of mangrove trees. These difficulties underscore the pressing necessity for an economic assessment of the environmental services rendered by these regions. This study seeks to quantify the economic advantages to promote the protection of these habitats, reconciling developmental requirements with environmental sustainability.

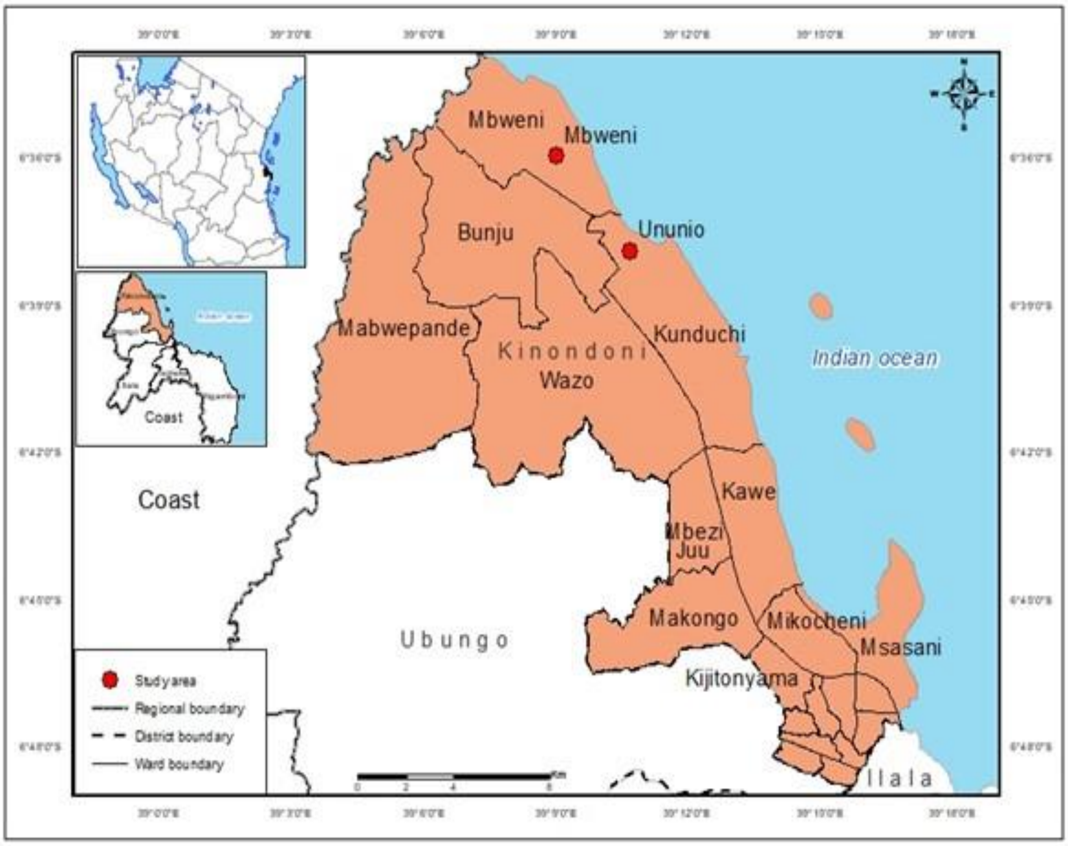

Fig. 1. The Map of the study area

2.2 Data Used and Methods

Fig. 2 shows the flow chart of the methodological approach used in this study for the estimation of the ecosystem service values (ESVs) for 1993, 2003, 2013 and 2023 years and the computation of changes between studies periods.

This study utilized a systematic methodology to evaluate alterations in land use and land cover (LULC) throughout time. The method commenced with the generation of fake color composites (FCC) utilizing visible green, red, and near-infrared bands, hence improving the distinction of vegetation and various land cover types [42]. High-resolution satellite imagery from Google Earth was utilized to gather 200 to 250 training samples for each target year, which were critical for training the Support Vector Machine (SVM) classifier. Support Vector Machine (SVM), recognized for its precision in managing heterogeneous datasets, was employed to categorize the photos, succeeded by post-classification processing to enhance the outcomes. The photos were classified into six land use and land cover (LULC) categories: built-up areas, shrubland, water bodies, forest, farmed land, and bare regions, in accordance with NAFORMA rules.

The concluding phase entailed employing ArcGIS Pro software for change detection analysis, juxtaposing photos from 1993 to 2003 and from 2013 to 2023 [43, 11]. This analysis identified substantial changes in land use and land cover, influenced by urban growth and agricultural intrusion, underscoring the critical role of GIS technologies in environmental surveillance and sustainable management strategies [44]. The LULC datasets and biome equivalents, along with their respective ecosystem service value coefficients (VC) in 1994 US$ ha–1year–1 for local and global VC, are presented in Table 1 and Fig. 3, as derived from Kindu et al. [35]. Constaza et al. [45,46,11] and Zella [47].

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)					Local (VC) 1994 US$ ha^{-1}year^{-1}	Global (VC) 1994 US$ ha^{-1}year^{-1}
	1993	2003	2013	2023	Equivalent Biome	a	b
Mangrove forest	1837.99	1062.96	1502.09	1100.37	Tropical Forest	987	2008
Shrub land	739.47	479.31	502.34	193.06	Tropical Forest	987	244
Bare area	515.86	812.09	169.91	113.75	Sand	0	0
Water	2171.41	2264.01	2214.18	2243.63	Fresh water	8103	8498
Built up area	124.20	797.75	1136.17	1905.14	Urban	0	0
Cultivated land	172.90	145.71	37.13	5.88	Cropland	226	92

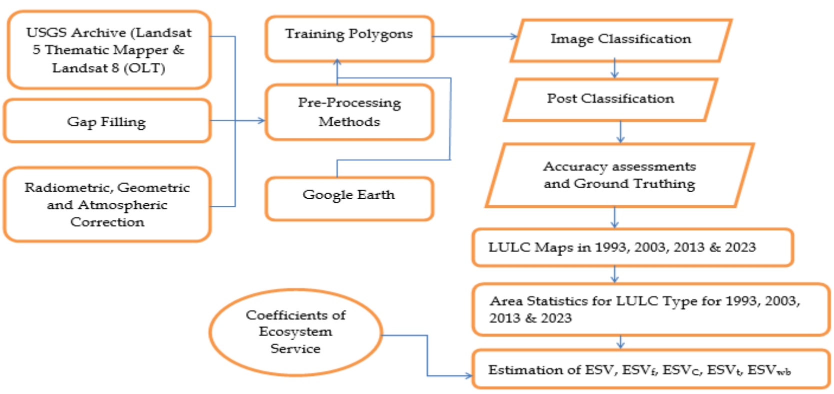

Fig. 2. Flowchart of the methodological approach for this study

Table 2. Details of the ecosystem service functions and their modified local value coefficients for each LULC type (adapted from Zella,[47])

Ecosystem Services	Mangrove forest	Shrub land	Water	Cultivated land
Provisioning services:				
Water supply	8	8	2117	
Food production	32	32	41	187.56
Raw material	51.2	51.2		
Genetic resources	41	41		
Medical services				
Sub-total	132.2	132.2	2158	187.56
Regulating services:				
Water regulation	6	6	5445	
Waste treatment	136	136	431.5	
Erosion control	245	245		
Climate regulation	223	223		
Biological control				24
Gas regulation	13.68	13.68		
Disturbance regulation	5	5		
Sub-total	628.68	628.68	5876.5	24
Supporting services:				
Nutrient cycling	184.4	184.4		
Pollination	7.27	7.27		14
Soil formation	10	10		
Habitat/refugia	17.3	17.3		
Sub-total	218.97	218.97		14
Cultural services:				
Recreation	4.8	4.8	69	
Cultural	2	2		
Sub-total	6.8	6.8	69	
Grand-total	986.69	986.69	8103.5	225.56

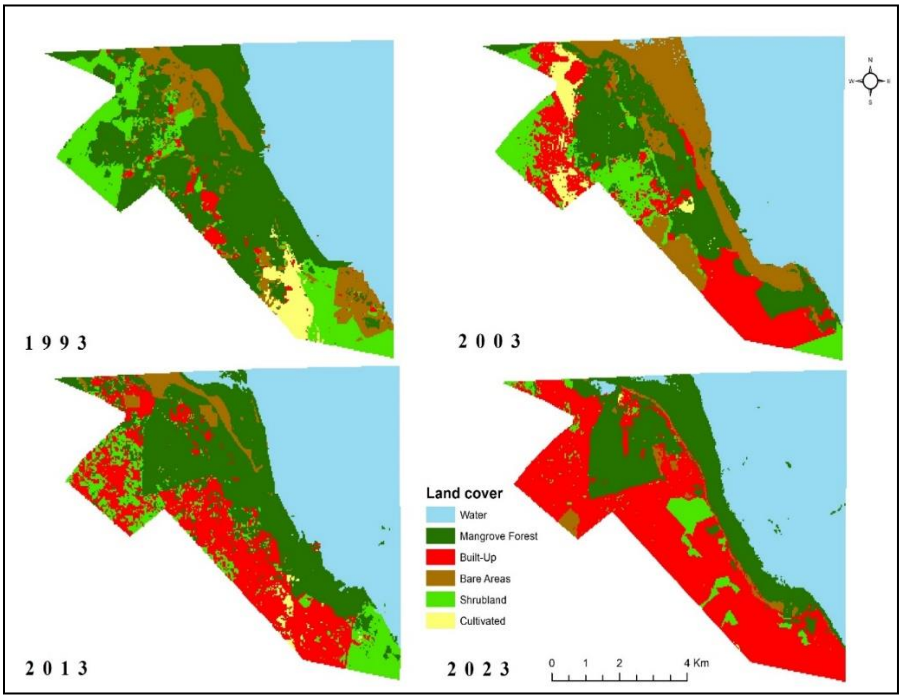

Fig. 3. LULC for the years 1993, 2003, 2013 and 2023

Table 3. Details of the ecosystem service functions and their global value coefficients for each LULC type (adapted from Constaza et al.,[45])

Ecosystem services	Mangrove forest	Shrub land	Water	Cultivated land
Provisioning services:				
Water supply	8	8	3800	
Food production	32	32	258	54
Raw material	315	315		
Genetic resources	41	41		
Medical services				
Sub-total	396	396	4058	54
Regulating services:				
Water regulation	6	6	15	
Waste treatment	87	87	4177	
Erosion control	245	245		
Climate regulation	223	223		
Biological control				24
Gas regulation			133	
Disturbance regulation	5	5	4539	
Sub-total	566	566	8864	24
Supporting services:				
Nutrient cycling	922	922		
Pollination				14
Soil formation	10	10		
Habitat/refugia			304	
Sub-total	932	932	304	14
Cultural services:				
Recreation	112	112	574	
Cultural	2	2	881	
Sub-total	114	114	1455	0
Grand-total	2008	2008	14681	92

This study utilized the benefit transfer method to assess the economic benefits of ecosystem services, relying on the modified local and global value coefficients for the specified land use and land cover types. The comprehensive ecosystem service functions and their corresponding global and adjusted local value coefficients for each Land Use/Land Cover (LULC) category are presented in Tables 2 and 3, as derived from Zella [47] and Constaza et al. [45,46].

2.3 Data Analysis

To determine changes of economic values of ecosystem services resulted from LULCC of the study area for the period 1993 - 2023

The Land Use and Land Cover (LULC) statistics in Table 1 were utilized to compute the total value of ecosystem services in the research area for the years 1993, 2003, 2013, and 2023. The calculation involved multiplying the area of each LULC type by the respective updated ecosystem service value factors. The coefficients were obtained from the ecosystem service value per hectare for each biome, as delineated in equation (1), modified from Zella [47]and Costanza et al. [46,47].

$$\text{ESV} = \sum_{k=0}^{k}(\text{Ak} + \text{VCk}) \quad (1)$$

In this context, ESV denotes the total estimated ecosystem service value, Ak signifies the area (in hectares) of land use/land cover type 'k,' and VCk represents the value coefficient (US$ ha^{-1} $year^{-1}$) linked to that specific land use/land cover type. The ESVs for all land use and land cover types were calculated appropriately. Moreover, alterations in the ESVs were ascertained by computing the discrepancies between the estimated values for each LULC category in 1993, 2003, 2013, and 2023. The percentage variations in ESVs over these years were calculated using the subsequent equation:

$$\text{Percentange ESV} = \frac{(\text{ESVt}_2 - \text{ESVt}_1)}{\text{ESVt}_1} \text{ x } 100 \quad (2)$$

where $ESVt_2$ (US$ ha−1 year−1) represents the estimated ecosystem service value for the most recent year, and $ESVt_1$ (US$ ha−1 year−1) denotes the estimated ecosystem service value for the preceding year. Positive numbers indicate an augmentation in the ESVs, whereas negative values signal a reduction in the ESVs.

To analyse changes of economic values of ecosystem functions based on LULC type of the study area for the period 1993 - 2023

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

$$\mathrm{ESVf} = \sum_{k=0}^{k} (\mathrm{Ak} * \mathrm{VC_{fk}}) \;\ldots\ldots \quad (3)$$

ESV_f represents the estimated ecosystem service value of function f, Ak denotes the area (ha), and VC_{fk} signifies the value coefficient of the function (US$ ha−1 year−1) for land use and land cover category 'k'. The annual contributions of individual ecosystem functions to the overall value of ecosystem services were computed and summarized in the tables.

3. RESULTS AND DISCUSSION

3.1 Changes of Economic Values of Ecosystem Services (ESV) Resulted from LULCC of the Study Area for the Period 1993 – 2023

3.1.1 Status of ESV for study area's biomes for the period 1993 – 2023

This section analyzes the economic values of ecosystem services (ESV) across several biomes and land use and land cover (LULC) types in the research area from 1993 to 2023. The research employs both local and global value coefficients to evaluate the ESV, emphasizing changes and trends that have developed over the last thirty years. Table 4 delineates the economic values of ecosystem services, utilizing local value coefficients for each biome across various land use and land cover (LULC) categories for the years 1993, 2003, 2013, and 2023. The analysis indicates a progressive decrease in the overall economic value of ecosystem services in the studied area. The overall ESV diminished by around 3.7% over the 30-year period, resulting in a decline of about US$ 720,000. This drop illustrates the aggregate effect of land use alterations, resource exploitation, and environmental deterioration on the ecosystem's ability to deliver essential functions.

Conversely, Table 5 displays the economic values of ecosystem services derived from global value coefficients. The results indicate greater fluctuations in ESV than those observed with local coefficients. During the same timeframe, the total ESV diminished by almost 4.5%, resulting in a loss of nearly US$ 1.02 million. The global ESV statistics exceeded the local ESV values by 10.71% (US$ 2.16 million) in 1993, 8.06% (US$ 1.60 million) in 2003, and 10.19% (US$ 2.03 million) in 2013. By 2023, the worldwide ESV had decreased by 9.59% (US$ 1.87 million) compared to the local ESV.

The discrepancies noted between local and global ESV estimations highlight the intricacies and ambiguities inherent in decision-making for sustainable ecosystem management. The elevated worldwide ESV estimates in previous years indicate that global value frameworks may prioritize the extensive, frequently intangible, advantages that ecosystems offer at regional or global levels. These advantages encompass climate regulation, biodiversity preservation, and additional services that may not be readily apparent at the local level. The reduction in global ESV compared to local ESV by 2023 indicates a possible undervaluation of local ecosystem services when utilizing global coefficients. This mismatch highlights issues over the sufficiency of global valuation models in encompassing the complete spectrum of ecosystem services vital for local communities, especially in areas where livelihoods are intricately linked to the health and productivity of local ecosystems. The disparity between local and global ESV underscores the necessity for a balanced strategy in ecosystem management that considers both local and global viewpoints. Local value coefficients are crucial for comprehending the immediate economic advantages to local communities, whereas global coefficients offer a more comprehensive perspective on the biological and environmental importance of these ecosystems. Effective decision-making must account for both scales to guarantee that conservation initiatives sufficiently safeguard ecosystem services essential at both local and global levels.

Due to the uncertainties inherent in ESV assessments, especially when contrasting local and global values, it is essential for decision-makers to prioritize the preservation of natural capital. This strategy will alleviate the risks linked to the possible undervaluation of ecosystem services and guarantee that the advantages of ecosystem conservation are completely actualized. By incorporating both local and global Ecosystem Services Valuation (ESV) into environmental policies and planning, stakeholders can formulate more holistic plans that promote the sustainable management of ecosystems, reconciling social, economic, and environmental requirements.

3.1.2 Changes in ESV of the study area's biomes for the period 1993 – 2023

The economic values of ecosystem services (ESV) related to land use and land cover change (LULC) biomes were examined from 1993 to 2023. The investigation encompassed alterations in ESV, percentage variations in ESV, and the yearly percentage rate of change, as detailed in Tables 6 and 7. Positive (+) and negative (-) symbols were employed to denote gains and declines, respectively. The data in Table 6 indicate a decline in total ESV from 1993 to 2003, totaling a drop of roughly US$ 278,000. During the interval from 2003 to 2013, this trend had a tiny reversal, marked by a modest rise in total ESV of around US$ 27,000. Nonetheless, the interval from 2013 to 2023 experienced a more pronounced reduction, with the overall ESV dropping by almost US$ 470,000. Table 7 exhibits a comparable pattern, indicating a significant alteration, with the ESV diminishing approximately fourfold from 1993 to 2003, 17-fold from 2003 to 2013, and 1.4-fold from 2013 to 2023, relative to the figures in Table 6.

These findings emphasize the necessity of integrating local and global value coefficients into national environmental policy to formulate effective decision-making models. The general trend demonstrates a decrease in total ESV, with a fall of US$ 720,000 and US$ 1.03 million for the local and global coefficients, respectively, from 1993 to 2023. This equates to an annual drop rate of US$ 24,000 and US$ 34,000, respectively. The data indicates that mangrove forests and bushland were the most dynamic land use and land cover types during this era. The rise in ESV from 2003 to 2013 can be ascribed to collaborative initiatives by stakeholders to safeguard marine resources, with the fluctuations in aquatic environments induced by climate change. The oscillations indicate that focused interventions and adaptive management strategies are crucial for preserving the economic value of ecosystem services, especially in light of evolving environmental circumstances and human-induced stressors.

Table 4. Local ESV (Million US$ year^{-1}) distribution for the period 1993 – 2023

LULC	1993		2003		2013		2023	
	(ESV)	(%)	(ESV)	(%)	(ESV)	(%)	(ESV)	(%)
Mangrove forest	1.81	8.99	1.05	5.27	1.48	7.44	1.09	5.58
Shrub land	0.73	3.62	0.47	2.38	0.50	2.49	0.19	0.98
Bare area	0	0.00	0	0.00	0	0.00	0	0.00
Water	17.60	87.20	18.35	92.19	17.94	90.03	18.18	93.43
Built up area	0	0.00	0	0.00	0	0.00	0	0.00
Cultivated land	0.04	0.19	0.03	0.17	0.01	0.04	0.01	0.01
Total	20.18	100.00	19.90	100.00	19.93	100.00	19.47	100.00

Table 5. Global ESV (Million US$ year^{-1}) distribution for the period 1993 – 2023

LULC	1993		2003		2013		2023	
	(ESV)	(%)	(ESV)	(%)	(ESV)	(%)	(ESV)	(%)
Mangrove forest	3.69	16.52	2.13	9.93	3.02	13.74	2.21	10.36
Shrub land	0.18	0.81	0.12	0.54	0.12	0.56	0.05	0.22
Bare area	0	0.00	0	0.00	0	0.00	0	0.00
Water	18.45	82.60	19.24	89.47	18.82	85.69	19.07	89.41
Built up area	0	0.00	0	0.00	0	0.00	0	0.00
Cultivated land	0.02	0.07	0.01	0.06	0.03	0.02	0.01	0.00
Total	22.34	100.00	21.50	100.00	21.99	100.00	21.34	100.00

Table 6. Changes in Local ESV (in 10^5 US$) for the period 1993 - 2023

LULC	1993 – 2003			2003 – 2013			2013 – 2023		
	Change in ESV	% change	ARC	Change in ESV	% change	ARC	Change in ESV	% change	ARC
Mangrove forest	7.65	275.62	0.76	-4.33	1556.81	-0.43	3.97	84.33	0.40
Shrub land	2.57	92.52	0.26	-0.23	81.65	-0.02	3.05	64.92	0.30
Bare area	0	0.00	0	0	0.00	0	0	0.00	0
Water	-7.50	-270.35	-0.75	4.04	-1450.32	0.40	-2.39	-50.75	-0.24
Built up area	0	0.00	0	0	0.00	0	0	0.00	0
Cultivated land	0.06	2.21	0.01	0.25	-88.14	0.03	0.07	1.50	0.01
Total	2.78	100.00	0.28	-0.27	100.00	-0.02	4.70	100.00	0.47

ARC = Annual Rate of Change (ESV $year^{-1}$)

Table 7. Changes in Global ESV (in 10^5 US$) for the period 1993 - 2023

LULC	1993 – 2003			2003 – 2013			2013 – 2023		
	Change in ESV	% change	ARC	Change in ESV	% change	ARC	Change in ESV	% change	ARC
Mangrove forest	15.56	186.31	1.56	-8.82	194.25	-0.88	8.06	127.09	0.81
Shrub land	0.64	7.60	0.06	-0.56	1.24	-0.06	0.76	11.89	0.07
Bare area	0	0.00	0	0	0.00	0	0	0.00	0
Water	-7,87	-94.20	-0.79	4.25	-93.28	0.42	-2.50	-39.43	-0.25
Built up area	0	0.00	0	0	0.00	0	0	0.00	0
Cultivated land	0.03	0.30	0.03	1.00	-2.20	0.10	0.03	0.45	0.01
Total	8-35	100.00	0.84	-4.54	100.00	-0.45	6.35	100.00	0.64

ARC = Annual Rate of Change (ESV $year^{-1}$)

The significant reduction in ecosystem service value over the last thirty years necessitates immediate incorporation of ecosystem service valuation into environmental legislation. The integration is essential for preserving the ecological and economic viability of the study area's land use and land cover biomes, ensuring that the advantages offered by these ecosystems persist in supporting local communities and biodiversity conservation initiatives.

3.2 Changes of Economic Values of Ecosystem Functions of the Study Area for the Period 1993 – 2023

This section examines alterations in the economic worth of ecosystem functions within the research region from 1993 to 2023. The assessment, employing both local and global biome coefficients, concentrates on various land use and land cover (LULC) categories within the research region. The results, presented in Tables 8 and 9, underscore substantial changes in the economic values linked to diverse ecological services during the thirty-year span. The findings reveal a significant reduction in the economic value of ecosystem functions, amounting to a decrease of US$ 720,000 for local biome coefficients and US$ 2.108 million for global biome coefficients. The decline was primarily noted in mangrove forests and shrubland, which are essential for ecological equilibrium and biodiversity in the area. In contrast, there was a financial benefit linked to water-related ecosystem processes, possibly indicating an enhanced valuation or rehabilitation of water bodies throughout the study period.

The statistics indicate a notable reduction in regulatory services, including 54.1% of the total loss based on local assessments and 31.6% based on worldwide assessments. Supporting services experienced significant decreases, with local valuations reflecting a 39.7% reduction and global valuations indicating a 55.8% decrease. These services encompass essential ecological processes including nitrogen cycling, soil formation, and habitat provision. The decline in the economic value of regulatory and supporting services clearly indicates the degradation of natural capital in the coastal ecosystems of the Kinondoni District. The declines are primarily ascribed to heightened human-induced pressures, such as urbanization, pollution, and unsustainable resource extraction. The local inhabitants' significant dependence on these coastal resources for their livelihoods exacerbates the impact, resulting in overexploitation and environmental degradation. The documented declines in ecosystem functioning highlight the pressing necessity for improved management strategies and legislative

Table 8. Local economic values of ecosystem functions (in 10^5 US$) for the period 1993 – 2023

LULC	Ecosystem services	1993	2003	2013	2023	Relative change
Mangrove forest	Provisioning services	2.43	1.42	1.99	1.46	0.97
	Regulating services	11.56	6.68	9.44	6.92	4.64
	Supporting services	4.03	2.33	3.29	2.41	1.62
	Cultural services	0.13	0.07	0.10	0.08	0.05
	Sub-total	18.15	10.50	14.82	10.87	7.28
Shrub land	Provisioning services	0.98	0.64	0.67	0.26	0.72
	Regulating services	4.65	3.01	3.16	1.21	3.44
	Supporting services	1.62	1.05	1.10	0.42	1.20
	Cultural services	0.05	0.03	0.03	0.01	0.04
	Sub-total	7.30	4.73	4.96	1.90	5.40
Water	Provisioning services	46.86	48.88	47.78	48.42	(1.56)
	Regulating services	127.60	133.05	130.12	131.85	(4.25)
	Supporting services	-	-	-	-	-
	Cultural services	1.50	1.56	1.53	1.55	(0.05)
	Sub-total	175.96	183.49	179.43	181.82	(5.86)
Cultivated land	Provisioning services	0.33	0.29	0.07	0.01	0.32
	Regulating services	0.04	0.04	0.01	-	0.04
	Supporting services	0.02	0.02	-	-	0.02
	Cultural services	-	-	-	-	-
	Sub-total	0.39	0.35	0.08	0.01	0.38
Grand Total		201.80	199.07	199.29	194.60	7.20

Table 9. Global economic values of ecosystem functions (in 10^5 US$) for the period 1993 – 2023

LULC	Ecosystem services	1993	2003	2013	2023	Relative change
Mangrove forest	Provisioning services	7.28	4.21	5.95	4.36	2.92
	Regulating services	10.40	6.02	8.50	6.23	4.17
	Supporting services	17.13	9.91	13.20	10.26	6.87
	Cultural services	2.10	1.21	1.71	1.25	0.85
	Sub-total	36.91	21.35	29.36	22.10	14.81
Shrub land	Provisioning services	2.93	1.20	1.99	0.77	2.16
	Regulating services	4.19	2.71	2.84	1.09	3.10
	Supporting services	6.89	4.47	4.68	1.80	5.09
	Cultural services	0.84	0.55	0.57	0.22	0.62
	Sub-total	14.85	8.93	10.08	3.88	10.97
Water	Provisioning services	88.12	91.87	89.85	91.05	(2.93)
	Regulating services	19.25	20.07	19.63	19.89	(0.64)
	Supporting services	6.60	6.88	6.73	6.82	(0.22)
	Cultural services	31.59	32.94	32.22	32.65	(1.06)
	Sub-total	145.56	151.76	148.43	150.41	(4.85)
Cultivated land	Provisioning services	0.09	0.08	0.02	-	0.09
	Regulating services	0.04	0.04	-	-	0.04
	Supporting services	0.02	0.02	0.01	-	0.02
	Cultural services	-	-	-	-	-
	Sub-total	0.15	0.14	0.03	-	0.15
Grand total		197.47	182.18	187.90	176.39	21.08

measures focused on the conservation and restoration of these vital regions. The findings indicate that, absent substantial measures to alleviate these effects, the ecological integrity and economic sustainability of the region's ecosystems may persist in declining, resulting in enduring repercussions for both biodiversity and community welfare.

The study emphasizes the necessity of incorporating ecosystem function values into local and national environmental planning and policy formulation. Quantifying the economic losses and gains in ecosystem services offers decision-makers a precise understanding of where intervention is most essential and where investments in conservation and restoration might produce substantial economic and environmental benefits. The Kinondoni District serves as a significant case study for comprehending the dynamics of coastal ecosystems under stress. This study's findings provide significant insights into the sustainable management of coastal resources in Tanzania and comparable regions with similar issues. These insights are crucial for formulating strategies that harmonize economic development with environmental sustainability, safeguarding critical ecosystem functions for future generations.

4. CONCLUSION AND RECOMMENDATIONS

4.1 Conclusion

The study offers a thorough evaluation of the economic values linked to several ecosystem services in this crucial coastal region over a 30-year span, from 1993 to 2023. The results highlight the substantial economic benefits of ecosystem services in preserving local livelihoods, fostering biodiversity, and ensuring ecological equilibrium. Nonetheless, the analysis indicates concerning trends of degradation, especially in critical ecosystems like mangrove forests and shrublands, which have undergone significant reductions in their economic value due to land use and land cover changes (LULCC). The reduction in ecosystem service values, especially in regulating and sustaining functions, underscores the increasing susceptibility of the coastal ecosystems in the Kinondoni District. These services are essential for the region's resilience to environmental issues, including climate change, coastal erosion, and biodiversity loss. The decline in economic value not only indicates ecological degradation but also suggests probable socio-economic consequences, as local residents rely significantly on these ecosystems for their livelihoods.

Furthermore, the study reveals inconsistencies between local and global assessments of ecosystem services, highlighting the complexity and uncertainties inherent in assessing these services at various scales. Global valuations emphasize the overarching ecological importance of these services, whereas local valuations more accurately represent the direct advantages to the populations dependent on them. The identified discrepancies among these assessments necessitate a more sophisticated strategy for ecosystem management that effectively reconciles local requirements with global environmental objectives. The economic valuation of ecosystem services in the Kinondoni District demonstrates the substantial value these ecosystems offer and the considerable threats they encounter from persistent environmental stresses. The study underscores the imperative to prioritize the conservation and sustainable management of coastal ecosystems to guarantee their ongoing provision of important services for present and future generations.

4.2 Recommendations

This study presents seven essential recommendations to improve the conservation and sustainable management of coastal ecosystems in the Kinondoni District.

Firstly, enhancing policy integration is essential; the economic merits of ecosystem services must be incorporated into national and local environmental laws. By integrating these values into decision-making processes, policymakers can enhance the prioritization of conservation initiatives, optimize resource allocation, and enact policies that reconcile development with environmental sustainability. This integration must account for the disparities between local and global valuations to guarantee that both local requirements and overarching ecological effects are met.

Secondly, improved conservation initiatives; specific conservation plans must be formulated to safeguard the most at-risk habitats, especially mangrove forests and shrublands. These ecosystems are essential for controlling environmental processes and sustaining biodiversity. Conservation initiatives must encompass the rehabilitation of damaged regions, the creation of protected areas, and the advocacy of sustainable land use practices that mitigate environmental effect.

Thirdly, community involvement and education; the local populations in the Kinondoni District serve as both recipients and stewards of coastal ecological services. Consequently, it is imperative to engage people in conservation initiatives via educational and awareness activities. Enhancing community awareness of the significance of ecosystem services and sustainable resource management can promote improved stewardship and mitigate the pressures on these ecosystems from unsustainable activities.

Fourthly, the advancement of sustainable livelihoods is essential to diminish local people' dependence on environmentally detrimental practices; thus, it is imperative to cultivate and advocate for alternative, sustainable livelihoods. This may encompass eco-tourism, sustainable aquaculture, and other revenue-generating endeavors that do not undermine the integrity of coastal ecosystems. Facilitating these alternatives via training, financial incentives, and market access will be essential for their success.

Fifthly, monitoring and evaluation; it is imperative to build a comprehensive framework for monitoring and evaluation to effectively track alterations in ecosystem service values over time. Systematic evaluations must be performed to assess the efficacy of conservation and management measures, recognize emerging threats, and modify plans accordingly. This paradigm must encompass both biophysical and socio-economic indicators to deliver a thorough comprehension of ecosystem health and community welfare.

Sixthly, adapting to climate change; the coastal regions of the Kinondoni District are especially susceptible to the effects of climate change, including sea-level rise, heightened storm strength, and alterations in precipitation patterns. Incorporating climate change adaption methods into the management of coastal ecosystems is essential. This may entail augmenting natural coastal defenses such as mangroves, optimizing water management, and constructing infrastructure resilient to climate-related hazards.

Seventhly, international collaboration and support should be enhanced to bolster conservation efforts in the Kinondoni District, considering the worldwide significance of coastal habitats. This encompasses technical and financial assistance from international organizations, knowledge sharing with other coastal regions with analogous issues, and involvement in global environmental programs that advocate for sustainable coastal management.

Consequently, the sustainable management of coastal ecosystems in the Kinondoni District is crucial for maintaining biodiversity and ecosystem services, as well as for ensuring the livelihoods and welfare of local residents. Implementing the proposed measures can preserve these vital ecosystems for future generations while fostering sustainable development in the region. The results and suggestions of this study should provide a basis for informed policy formulation and coordinated efforts to attain these objectives.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Millennium Ecosystem Assessment. Ecosystems and human well-being: Synthesis. Washington, DC.: Island Press; 2005.
2. Raudsepp-Hearne C, Peterson GD, Tengo M, Bennett EM, Holland T, Benessaiah K. Untangling the Environmentalist's Paradox: Why Is Human Well-being Increasing as Ecosystem Services Degrade? BioScience. 2010;60(8):576–89.
3. Schmidt S, Manceur AM, Seppelt R. Uncertainty of Monetary Valued Ecosystem Services– Value Transfer Functions for Global Mapping. Plos One. 2006;11(3):e0148524.
4. COP. Report of the tenth meeting of the conference of the parties to the convention on biological diversity. Nagoya. Contract No. 27; 2010
5. Ecosystem Assessment M. Ecosystems and Human Well-being: General Synthesis; In Island Press: Washington, DC, USA; 2005
6. Kahn JR. The economic approach to environmental and natural resources. Thomson South-Western; 2005.
7. Pascual U, Muradian R, Brander L, Gómez-Baggethun E, Martín-López B, Verma M. The economics of valuing ecosystem services and biodiversity. In: Kumar P, editor. The Economics of Ecosystems and Biodiversity Ecological and Economic Foundations. London and Washington: Earthscan; 2010.
8. Martin-Lopez B, Gomez-Baggethun E, Garcia-Llorente M, Montes C. Trade-offs across value-domains in ecosystem services assessment. Ecological Indicators. 2013;37:220–8
9. SEEA System of Environmental-Economic Accounting Website 2015; 2020. [Accessed July 2020]. Available:http://unstats.un.org/unsd/envaccounting/seea.asp.
10. WAVES. Wealth Accounting and the Valuation of Ecosystem Services Website 2015; 2020. [Accessed On:July 2020]. Available:http://www.wavespartnership.org/en
11. Msofe NK, Sheng L, Lyimo J. Land use change trends and their driving forces in the Kilombero Valley Floodplain, Southeastern Tanzania. Sustainability. 2010;12(6):2598. Available:https://doi.org/10.3390/su12062598
12. Tolessa T, Senbeta F, Kidane M. The impact of land use/land cover change on ecosystem services in the central highlands of Ethiopia. Ecosystem Services. 2017;23:47-54. Available:https://doi.org/10.1016/j.ecoser.2016.11.010
13. Hein L, Van Koppen K, Groot RS, Van Ierland E. Spatial scales, stakeholders and the valuation of ecosystem services. *Ecol. Econ.* 2006;57:209–228.
14. Kreuter UP, Harris HG, Matlock MD, Lacey RE. Change in ecosystem service values in the San Antonio area, Texas. Ecol. Econ. 2001;39:333–346.
15. Zorrillamiras P, Palomo I, Gómezbaggethun E, Martínlópez B, Lomas PL, Montes C. Effects of land use change on wetland ecosystem services: A case study in the Doñana marshes (SW Spain). Landsc. Urban Plan. 2014;122 :160–174.

16. Gashaw T, Tulu T, Argaw M, Worqlul AW. Evaluation and prediction of land use/land cover changes in the Andassa watershed, Blue Nile Basin, Ethiopia. Environmental Systems Research. 2018; 7(1):1-15. Available:https://doi.org/10.1186/s40068-018-0106-0
17. Food and Agriculture Organization Agriculture and Climate Change: FAO Role; In Viale delle Terme di Caracall; FAO: Rome, Italy; 1997.
18. Wang X, Dong X, Liu H, Wei H, Fan W, Lu N, Xu Z, Ren J, Xing K. Linking land use change, ecosystem services and human well-being: A case study of the Manas River Basin of Xinjiang, China. Ecosyst. Serv. 2017;27:113–123.
19. De Groot R, Brander L, van der Ploeg S, Costanza R, Bernard F, Braat L, van Beukering P. Global estimates of the value of ecosystems and their services in monetary units. Ecosystem Services. 2012;1(1):50-61. Available:https://doi.org/10.1016/j.ecoser.2012.07.005
20. Liu S, Costanza R, Farber S, Troy A. Valuing ecosystem services: Theory, practice, and the need for a transdisciplinary synthesis. Annals of the New York Academy of Sciences. 2010; 1185(1):54-78. Available: https://doi.org/10.1111/j.1749-6632.2009.05167.x
21. Elliot S, Duncan S, Malone N. New Nature of Business: How Business Pioneers Support Biodiversity and Ecosystem Services; 2014. Available:https://static.squarespace.com/static/534a63bde4b0dd67a16348ac/t/535f0c6ae4b09cd4e2b067e4/1398738026432/New_Nature_of_Business_Report.pdf.
22. Kubiszewski I, Costanza R, Anderson S, Sutton P. The future value of ecosystem services: Global scenarios and national implications. Ecosyst. Serv. 2017; 26:289–301.
23. Miller DL. Federal Emergency Management Agency of the USA Mitigation Policy -FP-108-024-01, Consideration of Environmental Benefits in the Evaluation of Acquisition Projects under the Hazard Mitigation Assistance (HMA) Programs. 2013;7.
24. Wang Y, Dai E, Yin L, Ma L. Land use/land cover change and the effects on ecosystem services in the Hengduan Mountain region, China. Ecosyst. Serv. 2018;34:55–67.
25. Costanza R, Groot RD, Sutton P, Ploeg SVD, Anderson SJ, Kubiszewski I, Farber S, Turner RK. Changes in the global value of ecosystem services. Glob. Environ. Chang. 2014;26:152–158.
26. TEEB. The economics of ecosystems and biodiversity: Ecological and economic foundations. Earthscan; 2010.
27. Hanson C, Ranganathan J, Iceland C, Finisdore J. The Corporate Ecosystem Services Review: Guidelines for Identifying Business Risks & Opportunities Arising from Ecosystem Change. Washington, DC: World Resources Institute; 2012.
28. Laurans Y, Rankovic A, Bille R, Pirard R, Mermet L. Use of ecosystem services economic valuation for decision making: Questioning a literature blindspot. J Environ Manage. 2013; 119:208–19.
29. Turner RK, Schaafsma M. (Eds.). Coastal zones ecosystem services: From science to values and decision making. Springer; 2015.
30. Farber SC, Costanza R, Wilson MA. Economic and ecological concepts for valuing ecosystem services. Ecological Economics. 2006;41(3):375-392. Available:https://doi.org/10.1016/S0921-8009(02)00088-5
31. Costanza R, d'Arge R, de Groot R, Farber S, Grasso M, Hannon B, van den Belt M. The value of the world's ecosystem services and natural capital. Nature. 1997;387(6630):253-260. Available:https://doi.org/10.1038/387253a0
32. ten Brink P, Hansjürgens B, Kettunen M, Lehmann M, Neßhöver C, Schröter-Schlaack C, et al. The Economics of Ecosystems and Biodiversity in National and International Policy Making. ten Brink P, editor. London and Washington: Earthscan; 2011.
33. Downing M, Ozuna T. Testing the reliability of the benefit function transfer approach. JEnvironEcon- Manage. 1996;30(3):316–22.
34. Richardson L, Loomis J, Kroeger T, Casey F. The role of benefit transfer in ecosystem

service valuation. Ecol. Econ. 2015;115:51–58

35. Kindu M, Schneider T, Teketay D, Knoke T. Changes of ecosystem service values in response to land use/land cover dynamics in Munessa-Shashemene landscape of the Ethiopian Highlands. Science of the Total Environment. 2016; 547:137-147. Available:https://doi.org/10.1016/j.scitotenv.2015.12.127
36. TEEB. The Economics of Ecosystems and Biodiversity (TEEB) for Agriculture & Food: Interim Report. UN Environment Programme; 2015.
37. Troy A, Wilson MA. Mapping ecosystem services: Practical challenges and opportunities in linking GIS and value transfer. Ecol. Econ. 2007; 60:435–449.
38. Zhang F, Yushanjiang A, Jing Y. Assessing and predicting changes of the ecosystem service values based on land use/cover change in Ebinur LakeWetland National Nature Reserve, Xinjiang, China. Sci. Total Environ. 2019;656:1133–1144
39. United Republic of Tanzania (URT). Kinondoni District Socio-Economic Profile. Dar es Salaam: National Bureau of Statistics; 2020.
40. Turner RK, Paavola J, Cooper P, Farber S, Jessamy V, Georgiou S. Valuing nature: Lessons learned and future research directions. Ecol. Econ. 2002; 46: 493–510.
41. Mohammed SM, Francis J, Machiwa JF. Environmental degradation and management in coastal areas of Tanzania. *Journal of Coastal Conservation*. 2021;*25*(4):789-804. Available:https://doi.org/10.1007/s11852-021-00815-3
42. Smith KV, Pattanayak SK. Is Meta-Analysis a Noah's Ark for Non-Market Valuation? Environmental and Resource Economics. 2002;22:271–96.
43. Jones KR, Wang Y. Advances in remote sensing applications for land use and land cover change analysis. Remote Sensing Applications: Society and Environment. 2023; 28:100814. Available:https://doi.org/10.1016/j.rsase.2022.100814
44. Katikiro, RE. The role of geospatial technologies in sustainable environmental management. Journal of Environmental Management. 2023;330:117152. Available:https://doi.org/10.1016/j.jenvman.2023.117152
45. Costanza R, Darge R, de Groot R, Farber S, Grasso M, Hannon B, Limburg K, Naeem S, Oneill RV, Paruelo J. The value of the world's ecosystem services and natural capital. Nature. 1997;387: 253–260.
46. Costanza R, de Groot R, Sutton P, van der Ploeg S, Anderson SJ, Kubiszewski I, Farber S, Turner RK. Changes in the global value of ecosystem services. Global Environmental Change. 2014;26:152-158. Available:https://doi.org/10.1016/j.gloenvcha.2014.04.002
47. Zella A. Economic valuation of ecosystem services in Tanzania: Adapting global value coefficients to local contexts. African Journal of Environmental Economics and Management, 2021;12(4):259-273.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/123489