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RESEARCH ARTICLE

Loss of Critical Ecosystem Services in the Osun River Catchment, Southwest Nigeria

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ABSTRACT

Ecosystem services (ES) are critical to human well-being, providing essential resources and ecological support. Despite their importance, ES are declining globally due to factors such as population growth, urbanization, and land use changes. This study focuses on the Osun River Basin in Southwestern Nigeria, examining the impact of land use and land cover (LULC) changes on ES values over a 40-year period. Using economic valuation techniques, the study quantifies the ES provided by different land types, highlighting significant fluctuations in ES values due to changes in vegetation, built-up areas, cultivated lands, and water bodies. Results indicate an overall decline in ES values from 1984 to 2023, with notable decreases in 1994 and 2014, and increases in 2004 and 2023. These trends underscore the importance of sustainable land management practices to maintain and enhance ES provision. The findings emphasize the need for integrating ecological, geographical, and economic considerations in policy-making to support sustainable urban development and ecosystem conservation.

INTRODUCTION

Ecosystem services (ES) are defined as the advantages that humans obtain from nature; hence, ecosystem services are an essential connection between social systems and the environment (Rimal *et al.*, 2019; Sharma *et al.*, 2019). These services support ecological processes and activities while also providing resources to ensure the survival of all creatures (Rotich *et al.*, 2022). Ecosystems provide different benefits depending on the kind and circumstances, and a variety of services of varied types and amounts. Despite the great impacts of ecosystem services on the environment and human well-being, ecosystem services are declining globally as a result of population increase, urbanisation, and the spread of settlements and agriculture (Sharma *et al.*, 2019; Rotich *et al.*, 2022). Unexpected Land Use/Land Cover (LULC) alterations caused by human and natural activity in many regions of the world have had a negative influence on biodiversity and ecosystems, thereby diminishing their potential to provide ecosystem services (Talukdar *et al.*, 2020). ES valuation entails estimating the marginal value of ES which determines the benefit of preserving or the cost of losing a given amount or quality of ES (Rotich *et al.*, 2022). The valuation of ES, therefore, provides an essential tool for creating awareness and influencing policy and decision-making. It provides an easily understandable measure of the true value of ES to prioritize the conservation of ecosystems and biodiversity.

The significance of Ecosystem Services lies in contributing to individual well-being by ensuring security, fulfilling basic needs for daily life, and fostering health and positive social interactions. Urban ecosystems remain a crucial focus of ES research, considering that half of the global population resides in urban areas. As per MEA, approximately 60% of global ES are under threat or mismanaged, with this trend expected to persist in the coming decades. Consequently, ecosystem services have recently gained substantial importance in land use planning, ecological environmental planning, and management (Xia et al., 2021).

According to Shuka et al., (2022) comprehending ecosystem services and their interactions with changing LULC is essential to achieve sustainable urban development and grasp the impact of urban expansion on ecosystems (Hasan *et al.*, 2020). Alterations in LULC lead to modifications in ecosystems, thereby influencing their functions and structure. Tolessa et al., (2017) highlighted various human activities that have negative repercussions on Ecosystem Services. Simultaneously, research on the impact of LULC on ecosystem services is expanding both locally and globally.

The assessment of Ecosystem Services has long been a focal point of academic research, with recent endeavours indicating researchers' willingness to guide policymakers in crucial decision-making processes by integrating ecology, geography, and economics. Owing to continual population growth, urbanization and urban expansion in the form of LULC result in heightened demands for natural resources and increased food and fibre production worldwide. These circumstances lead to the ongoing conversion, degradation, and transformation of ecosystems, consequently impacting the provision of Ecosystem Services (Hasan et al., 2020).

Ecosystem services provided by different types of ecosystems vary in nature and impact. Some services directly influence the livelihoods of nearby human communities, while others affect broader environmental conditions that indirectly impact humans (Rimal *et al.*, 2019; Sharma *et al.*, 2019; Hasan *et al.*, 2020). The literature has identified four main types of ecosystem services over time, namely regulation services (Bosselmann, 2015; Li *et al.*, 2022), provisioning services (Handavu, Chirwa and Syampungani, 2019), cultural services (Birkhofer *et al.*, 2015; Ondiek *et al.*, 2020), and supporting services (DEWHA, 2009).

The LULC dynamics have been significantly altered in recent years. Preceding research also suggests that fast changes in LULC have resulted in changes in climatic patterns, particularly in metropolitan areas (Singh, Kikon and Verma, 2017; Mandal, Ghosh and Mukhopadhyay, 2019). The negative consequences of LULC modifications have previously been established in the following areas; biodiversity (Jin, Jin and Mao, 2019), hydrological systems (Elmahdy and Mohamed, 2016; Dosdogru *et al.*, 2020; Elmahdy, Mohamed and Ali, 2020), urban thermal environment (Zhou and Chen, 2018; Das *et al.*, 2021), urban landscape quality (Ahmad *et al.*, 2016; Naikoo *et al.*, 2020), air quality (Sun *et al.*, 2016), ecosystem services (Cabral *et al.*, 2016; Talukdar *et al.*, 2020), climate change (Abd El-Hamid *et al.*, 2020; Kafy *et al.*, 2020) etc.

The utilization of economic valuation techniques is currently being employed to furnish approximations of the significance of ecosystem services to human well-being in a universal unit, predominantly in monetary denominations (Hasan et al., 2020). Quantifying the value of ecosystem services in monetary terms has increasingly become a prevailing method aimed at raising awareness among stakeholders, offering substantiation for decision/policy makers, determining the opportunity costs of restoration, and facilitating payments for ecosystem services (Costanza *et al.*, 1997; Tolessa, Senbeta and Kidane, 2017). This approach enables crucial decision-makers and policymakers to readily comprehend the trade-offs in the overall benefits of services rendered under various scenarios (Belete, 2017; Aye and Htay, 2019). An inherent advantage of economic valuation lies in its ability to evaluate all ecosystem services based on their impact on human well-being within the coherent structure of welfare economics (Song and Deng, 2017; Talukdar *et al.*, 2020).

Notwithstanding these constraints, endeavours to appraise the values of ecosystem services persist, aiming to enhance our understanding, expertise, and capabilities to address the limitations (Tolessa, Senbeta and Kidane, 2017; Gashaw *et al.*, 2018; Talukdar *et al.*, 2020). Nevertheless, the quantification of ecosystem services' worth has raised concerns due to the controversies surrounding the methodologies employed, the nature of services assessed, and the outcomes derived. Moreover, the valuation of ecosystem services has been confined to particular services, with measurements lacking comprehensiveness on a global scale (Costanza *et al.*, 2014; Hernández-blanco *et al.*, 2020). Over the past few decades, significant strides have been taken to yield promising outcomes, yet substantial efforts are still required to encompass broader ecological regions and services in the future (Hasan et al., 2020).

METHODOLOGY

Study area

The study was carried out in Osun River Basin, in South Western Nigeria. The Osun drainage basin rises in Oke-Mesi ridge, about 5 km North of Effon Alaiye and flows North through Itawure gap to latitude 7°53" before winding westwards via Osogbo and Ede, then southwards to flow into Lagos lagoon about 8 km east of Epe (Oke *et al.*, 2013). The geology of the study area is characterised by Basement complex and sedimentary formations. The basement complex formation includes the Migmatite-Gneiss Complex (quartzites, amphibolites, marble), which dates back to the Liberian (ca 2800 Ma) to Pan African (ca 600 Ma) eras. These rocks are mainly found in the north-central area of Nigeria, including the Jos Plateau, and the southwest of Nigeria. They comprise rock types such as gneisses, migmatites, granites, schists, phyllites and quartzites (Adelana *et al.*, 2008). The Osun River Basin is characterized by Tropical Rainforest to the south and Derived savannah to the north. The derived savannah can be attributed to deforestation which is constantly affecting the forest region (Ogundele, Oladipo and Adebisi, 2016). Hence a mixture of forest trees and grasses now dominates northern part of the basin and also different land uses (such as building and construction, industrial, and commercial) have affected the vegetation of the Osun River Basin. The forest region is characteristically stratified into high/original forest and a shorter/ modified forest (Lamond *et al.*, 2019).

The population estimate for the basin in 2015 stood at 6,341,159, and 7,665,991 in 2023 calculated using the 3.2% national growth rate of Nigeria. The drainage basin shape file was overlaid on the local government administrative map of Nigeria to extract the local government areas that covered by the basin (figure 1). However, the whole extent of some local government did not fall within the basin, thus, the locality within such local government area that fall within the basin were identified and used for the basin population estimation. The 1991 locality population data of the basin was later used to estimate the population of the drainage basin for the year 2015, using the 3.2% national growth rate (National Population Commission- NPC, 2022). The reason for adopting the 1991 locality population data for the study was because the last population census in 2006 do not published the locality data for the country.

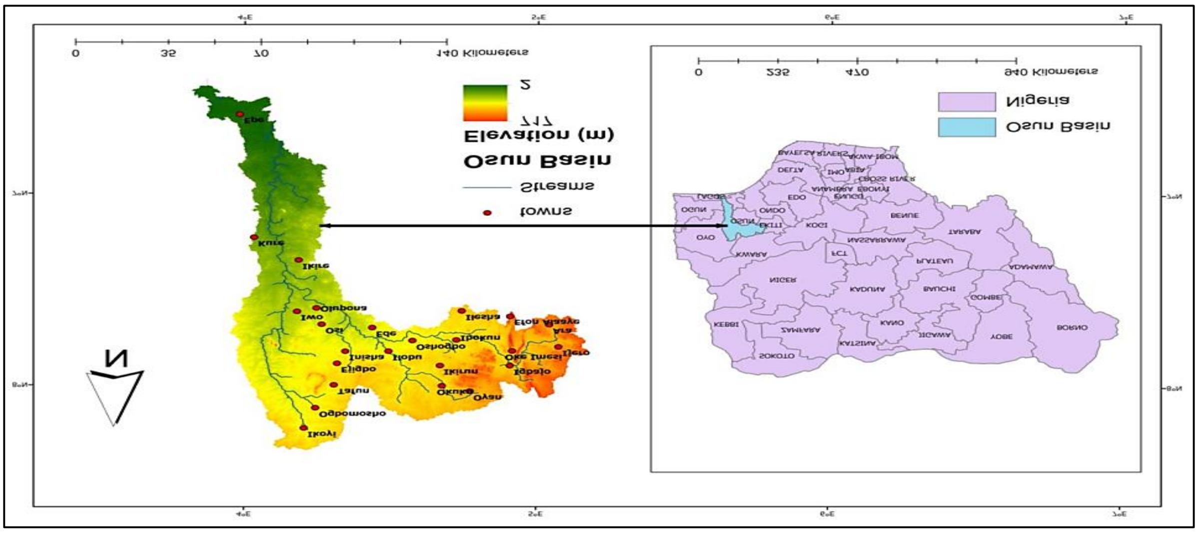

Figure 1: Location of Osun drainage basin, Nigeria.

Source: (Ashaolu, Olorunfemi and Ifabiyi, 2019).

Ecosystem service value (ESV) estimation

The estimation of Ecosystem Services Value (ESV) involved categorizing the Land Use and Land Cover (LULC) of the study area into distinct classes for analysis. A comparison was made between the LULC classes and the biomes as delineated in the ESV model proposed by Costanza et al., (1997). Despite the suitability of the ESVs developed by Costanza et al., (1997) for western countries, concerns have been raised by researchers regarding the applicability of the model in developing nations (Talukdar *et al.*, 2020). Nevertheless, (Costanza *et al.*, 2014) introduced an enhanced approach for estimating global ESVs, involving adjustments to increase the ESV values for certain land use classes while maintaining others unchanged.

Table 1: Land use land cover and ecosystem service valuation

Land Use Type	**Equivalent Biome**	**Ecosystem Service Coefficient (US$/ha/yr)**	
		Constanza et al., 1997	**Constanza et al., 2014**
Vegetation	Forests	969	3800
Bare land	Barren land	0	0
Built up	Urban	0	6661
Sand bar	Barren land	0	0
Agricultural land	Cropland	92	5568
Water body	Wetlands and river	8498	12,512

Source: (Talukdar *et al.*, 2020) after (Costanza *et al.*, 1997, 2014)

Computation of ESV

The ESVs shall be computed through formulas that are derived from the theoretical model put forward by (Costanza *et al.*, 1997) and further modified by (Song and Deng, 2017).

$$\boldsymbol{ESV_t = \sum^{A_k} * V_k} \qquad (1)$$

$$\boldsymbol{V_{k=\sum_{i=1}^{n} ESV_{ki}}} \qquad (2)$$

Where:

ESV_t = total ESV

A_k = area of LU/LC type k

V_k = ESV of LU/LC type k

ESV_{ki} = i kind of ESV for LU/LC type k.

The changes in ESV in the study area will then be calculated using the equation derived from (Song and Deng, 2017).

$$\boldsymbol{C_i = \frac{E_{end} - E_{start}}{E_{start}} * 100\%} \qquad (3)$$

where C_i is changing in the ESV in grid i, E_{start} is the ESV at the beginning of the study period for grid i, and E_{end} is the ESV at the end of the study period.

RESULTS AND DISCUSSION

The explanation provided delineates the outcomes (depicted in figure 2) of a supervised image classification carried out on Landsat TM (1984), Landsat TM (1994), Landsat 7 (2004), Landsat 8 (2014), and Landsat ETM/OLI for 2023 within a specific study area spanning four decades. The analysis conducted in 1984 revealed a diverse distribution of land cover types in the study region. Approximately 38.4% of the area was covered by vegetation, while a mere 0.9% was designated as built-up areas. Cultivated lands accounted for 29.9% of the total area, with 30.7% identified as bare ground/floodplains/hills, and 0.1% comprising water bodies such as rivers, lakes, and streams. Subsequent assessments using the 1994 Landsat TM data unveiled significant changes over the following ten years. Bare ground/floodplains/hills expanded to 47.1%, built-up areas increased to 1.2%, reflecting population growth and urban sprawl. Cultivated lands decreased to 26.9%, vegetation covers slightly decreased to 25%, and water bodies marginally increased to 0.2%, indicating minimal change.

In 2004, analysis utilizing Landsat 7 imagery indicated a decrease in bare ground/floodplains/hills to 42.2%, while built-up areas rose to 1.9%, signalling rapid urban expansion due to population growth. Natural vegetation saw a notable decline to 25.5%, cultivated lands notably increased to 30.02%, and water bodies increased to 0.3%. By 2014, utilizing Landsat 8 imagery, bare ground/floodplains/hills, built-up areas, and vegetation increased to 45.3%, 2.2%, and 31.4%, respectively. However, cultivated lands decreased significantly to 20.9%, and water bodies decreased to 0.2% compared to 2004. The most recent data from 2023 depicts a substantial rise in built-up areas to 4.8% and cultivated lands to 43.5%. Conversely, bare ground/floodplains/hills decreased significantly to 42.2%, with vegetation decreasing to 9.4%. Water bodies remained unchanged at 0.2%.

These findings exemplify the dynamic changes in land cover and land use patterns over time, encompassing processes such as urbanization, agricultural expansion, and alterations in natural landscapes. The escalation in built-up areas and cultivated lands signifies ongoing human development and agricultural intensification, while the decline in vegetation and bare ground/floodplains/hills raises concerns about potential environmental impacts such as deforestation or land degradation. Understanding these evolving trends is crucial for effective land management, conservation efforts, and sustainable development planning within the study area.

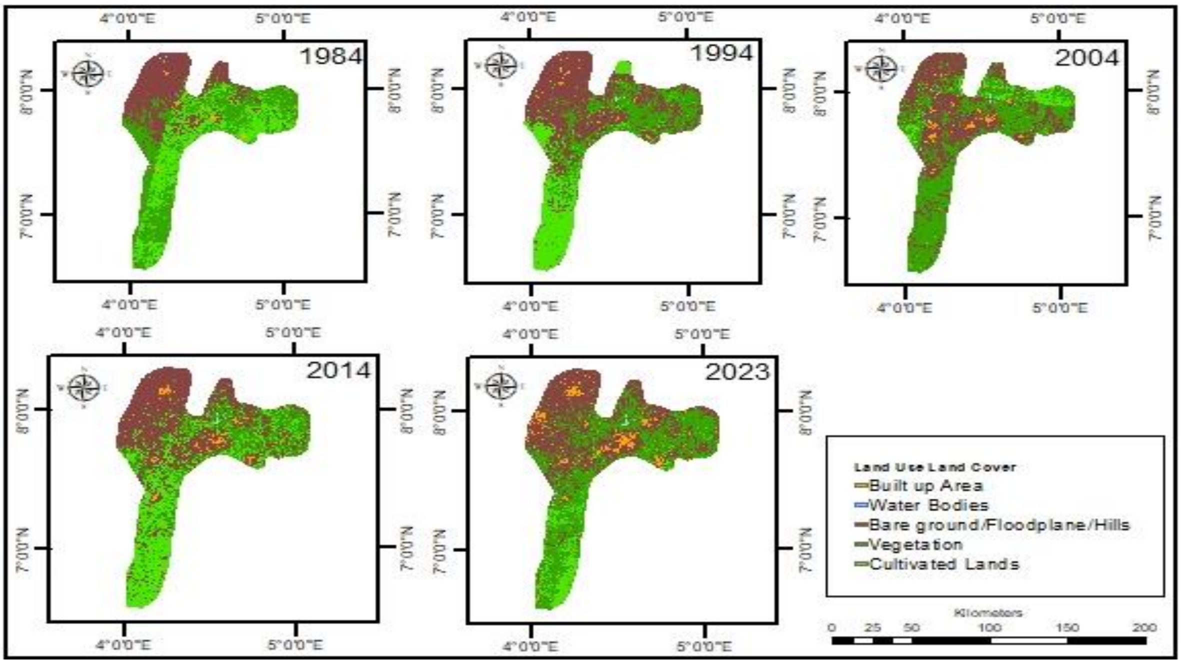

Figure 2: Land use and land cover change of Osun river Basin between 1984 and 2023

Moreover, in relation to the temporal examination of Land Use and Land Cover (LULC) alteration, it is evident in the data presented in table 1, that the category encompassing Bare Ground/Floodplains/Hills exhibited a notable increase in area coverage over the course of the studied years, potentially attributed to activities such as deforestation and land clearance. The act of removing trees and vegetation for purposes of agriculture, logging, or urban development results in the emergence of bare ground, consequently contributing to heightened erosion levels and facilitating the expansion of floodplains and hills. Additionally, the phenomenon of climate change emerges as a significant contributing factor to the escalation of these particular LULC categories; alterations in weather patterns, characterized by heightened intensity and frequency of rainfall events, can precipitate more frequent and severe instances of flooding, thereby prompting the further expansion of floodplains and the creation of additional bare ground areas.

The increase in built-up lands over the years is not an unexpected phenomenon, albeit the growth was marginal, it did indeed manifest. This trend can be predominantly attributed to the escalating human activities within the urban setting, encompassing processes such as urbanisation, industrialisation, and the development of infrastructural facilities, among others (refer to figure 1). The observed expansion aligns cohesively with the conclusions drawn by Ashaolu, Olorunfemi and Ifabiyi, (2019), who highlighted the extensive substitution of natural vegetation with annual and perennial crops in numerous regions of the basin. The alterations in land use and land cover, notably the surge in built-up areas and cultivated lands, which consequently led to the transformation of natural vegetation into agricultural plots, can be primarily ascribed to the burgeoning population and the progression of settlement establishments throughout the past 39 years. Over this period, there was merely a negligible shift in the extent of water bodies.

Table 2: LULC change of Osun River Basin over the period of 40 years

LULC Class	**Area (Sqkm) (1984)**	**Area (%)**	**Area (Sqkm) (1994)**	**Area (%)**	**Area (sqkm) (2004)**	**Area (%)**	**Area (Sqkm) (2014)**	**Area (%)**	**Area (Sqkm) (2023)**	**Area (%)**
Bare Ground/Floodplains /Hills	2907.6	**30.69**	3458.3	**36.50**	4000.8	**42.23**	4088.8	**43.15**	3994.3	**42.16**
Built-up Areas	86.1	**0.91**	70.5	**0.74**	180.6	**1.91**	211.9	**2.24**	455.9	**4.81**
Vegetation	2833.3	**29.91**	2372.5	**25.04**	715.8	**7.55**	975	**10.29**	886.5	**9.36**
Cultivated Lands	3635.6	**38.37**	3556.6	**37.54**	4545.1	**47.97**	4181.2	**44.13**	4116.9	**43.45**
Water Bodies	11.5	**0.12**	15.9	**0.17**	32.4	**0.34**	18.4	**0.19**	21.2	**0.22**

ESV estimation analysis

A land use analysis was first carried out to determine the size and level of change of the different classes of land use in the study area collectively referred to as biomes in the ESV analysis. The result of the LULC analysis (Table 2) were then employed in the ESV computation. The provided result (table 3) presents the Ecosystem Service Value (ESV) of different land use types within the study area across five points in time: 1984, 1994, 2004, 2014, and 2023. ESV quantifies the economic benefits derived from ecosystem services provided by various land cover types.

In 1984, the total ESV amounted to $3,172,696,090.00. Vegetation contributed significantly to this value, accounting for $1,076,654,000.00, followed by cultivated lands with $2,024,302,080.00. Built-up areas and water bodies contributed $57,351,210.00 and $14,388,800.00, respectively. This reflects the substantial economic value of natural ecosystems and agricultural lands in providing services such as carbon sequestration, soil fertility, and water regulation. By 1994, the total ESV decreased to $2,391,919,010.00. Although the values for built-up areas and water bodies remained relatively stable, there were declines in vegetation and cultivated lands. This decrease may indicate environmental degradation or changes in land use practices affecting the provision of ecosystem services.

In 2004, the total ESV slightly increased to $2,963,552,220.00. Notably, there were significant increases in built-up areas and cultivated lands, reflecting urban expansion and agricultural intensification. Despite this, there were slight declines in vegetation and water bodies, potentially due to land conversion and habitat loss. In 2014, the total ESV decreased to $2,862,760,830.00. This reduction was primarily driven by decreases in cultivated lands and vegetation, offsetting the slight increases in built-up areas and water bodies. Changes in land cover and land use during this period may have impacted the provision of ecosystem services, affecting the overall economic value of the landscape.

By 2023, the total ESV remained relatively stable at $2,959,360,350.00. There were notable increases in built-up areas and cultivated lands, indicating continued urbanization and agricultural expansion. However, there were declines in both vegetation and water bodies, underscoring potential ecological concerns and highlighting the need for sustainable land management practices to maintain the provision of ecosystem services over time. This table allows for a comparative analysis of ESV estimates over different years and land use types, providing valuable insights into changes or consistencies in ecosystem service values across various land categories.

Table 3: Ecosystem service value estimation for Osun river Basin (1984 to 2023).

Year	Land Use Type	Area (km²)	Area (Ha)	ESC ($/ha/ yr⁻)	ESV ($)
1984	Bare Ground/Floodplains/Hills	2907.6	290,760	-	-
	Built-up Areas	86.1	8,610	6,661	57,351,210.00
	Vegetation	2833.3	283,330	3,800	1,076,654,000.00
	Cultivated Lands	3635.6	363,560	5,568	2,024,302,080.00
	Water Bodies	11.5	1,150	12,512	14,388,800.00
	Total ESV				**3,172,696,090.00**
1994	Bare Ground/Floodplains/Hills	3458.3	345,830	-	-
	Built-up Areas	70.5	7,050	6,661	46,960,050.00
	Vegetation	2372.5	237,250	3,800	901,550,000.00
	Cultivated Lands	3556.6	355,660	5,568	1,423,514,880.00
	Water Bodies	15.9	1,590	12,512	19,894,080.00
	Total ESV				**2,391,919,010.00**
2004	Bare Ground/Floodplains/Hills	4000.8	400,080	-	-
	Built-up Areas	180.6	18,060	6,661	120,297,660.00
	Vegetation	715.8	71,580	3,800	272,004,000.00
	Cultivated Lands	4545.1	454,510	5,568	2,530,711,680.00
	Water Bodies	32.4	3,240	12,512	40,538,880.00
	Total ESV				**2,963,552,220.00**
2014	Bare Ground/Floodplains/Hills	4088.8	408,880	-	-
	Built-up Areas	211.9	21,190	6,661	141,146,590.00
	Vegetation	975	97,500	3,800	370,500,000.00
	Cultivated Lands	4181.2	418,120	5,568	2,328,092,160.00

	Water Bodies	18.4	1,840	12,512	23,022,080.00
	Total ESV				**2,862,760,830.00**
2023	Bare Ground/Floodplains/Hills	3994.3	399,430	-	-
	Built-up Areas	455.9	45,590	6,661	303,674,990.00
	Vegetation	886.5	88,650	3,800	336,870,000.00
	Cultivated Lands	4116.9	411,690	5,568	2,292,289,920.00
	Water Bodies	21.2	2,120	12,512	26,525,440.00
	Total ESV				**2,959,360,350.00**

Temporal fluctuations in ESV

Furthermore, the changes in ESV in the study area were then calculated following the method of . The change is usually expressed as a percentage (Table 3).

$$C_i = \frac{E_{end} - E_{start}}{E_{start}} * 100\% \qquad (4)$$

where C_i is changing in the ESV in grid i, E_{start} is the ESV at the beginning of the study period for grid i, and E_{end} is the ESV at the end of the study period.

Table 4.6 illustrates the fluctuation in the Total Ecosystem Service Value over the years, with a notable decrease from 1984 to 1994, a slight increase between 1994 to 2004, and another significant decline between, 2004 to 2014, and finally an increase between 2014 to 2023. The positive percentage change between 2014 and 2023 indicates a significant gain in ecosystem service value compared to the preceding years of 2004 to 2014, following the method of Costanza et al., (1997) and modified by Song & Deng, (2017). This data highlights the importance of monitoring and understanding changes in ecosystem services over time to inform conservation and management strategies.

In addition to the foregoing, the provided results (table 4), outlines the intriguing dynamics of Total Ecosystem Service Value (ESV) over a span of about four decades (1984 to 2023), along with the associated percentage changes of ESV in Osun River Basin. The ESV for the beginning year 1984, was $3,172,696,090, and for 1994 it stood at $2,948,719,010, which give rise to a difference of about $223,977,080. Hence, between 1984 and 1994, the calculated Total ESV change stood at a -7.06% decrease, marking a negative percentage change (C%). This substantial decline suggests that ecosystem services experienced a large degradation over the course of that decade, highlighting potential developmental processes and urban expansion activities within the study area at that period, which in turn signalled a waning in the environment's capacity to provide essential services.

Between 2004, the ESV is recorded at $2,963,552,220, which is higher than that of the preceding decade marking year, 1994 ($2,948,719,010). This gives rise to a difference of $14,833,210 between the two-decade markers (ESV 2004 – ESV 1994), with a percentage change (C%) of approximately 0.5% in relation to the preceding year 1994, the ESV still maintains an upward trajectory when compared to the base year 1984. This suggests that despite a slight increase, the ecosystem services' value remains lower than it was at the start of the observed period. Arowolo et al., (2018), supports this position, stating that the increase in the total ESV in Nigeria can be associated with the huge increase in cultivated land expansion which induce land-use changes.

However, a significant shift occurs by 2014, with the Total ESV dropping remarkably to about $2,862,760,830, reflecting a substantial negative percentage change (C%) of approximately -3.40% when compared to preceding decade marked by 2004, giving a difference of $-100,791,390. This sharp decline points to a significant reduction in the value of ecosystem services over the entire forty-year span. The decrease could be attributed to various factors such as habitat degradation, climate change impacts, land use changes, or shifts in ecosystem functionality. This agrees with the position of Adeyemi and Owolabi, (2021), who stated that fragmented forests and vegetation appear to be on the decline.

Buttressing the above, a significant shift occurs by 2023. The Total ESV rose notably to $2,959,360,350, reflecting a substantial positive percentage change (C%) of approximately 3.37% when compared to year 2014, yielding a difference of $96,599,520 between both years. This upsurge is reflective of different land use especially vegetation and cultivated areas which promote and enhance ecosystem value appreciation. The increase could be attributed to various factors such as establishment of new agricultural lands, afforestation and reforestation initiatives, land use changes, or positive shifts in ecosystem functionality.

Lastly, between the ending year, 2023 and the base year, 1984, the change in ESV was also estimated which following the methods of Song & Deng, (2017), yielded a difference spanning the entire study timeframe, of about $-213,335,740, and a negative percentage change (C%) of approximately -6.72%.

Inferences drawn from this data emphasize the importance of maintaining healthy ecosystems to ensure the provision of essential services to both the environment and society (Everard *et al.*, 2020). The positive change observed until in 2004 and in 2023 underscores the potential benefits of sustainable practices. However, the notable declines in 1994 and 2014, as well as the overall decline between 1984 and 2023, highlights the vulnerability of ecosystems and underscores the urgency of conservation and sustainable management efforts to mitigate further degradation and loss of ecosystem services (Adeyemi *et al.*, 2021). This data is a reminder of the intricate linkages between the environment's health and human well-being, urging the adoption of measures that promote the long-term health and resilience of ecosystems.

Table 4: Change in ESV estimation for Osun river Basin.

Year	Total ESV ($)	Change in ESV	C (%)
1984	3,172,696,090.00	-	-
1994	2,948,719,010.00	-223,977,080.00	-7.06
2004	2,963,552,220.00	14,833,210.00	0.50
2014	2,862,760,830.00	-100,791,390.00	-3.40
2023	2,959,360,350.00	96,599,520.00	3.37
ESV change between 1984 - 2023		-213,335,740	-6.72

CONCLUSION

The analysis of ecosystem service values (ESV) in the Osun River Basin over a 40-year period reveals significant fluctuations influenced by land use and land cover changes. The overall decline in ESV from 1984 to 2023 highlights the impact of urbanization, agricultural expansion, and environmental degradation on ecosystem functionality. Despite periods of increase in 2004 and 2023, the negative trends observed in 1994 and 2014 emphasize the vulnerability of ecosystems to anthropogenic pressures. These findings underscore the necessity for sustainable land management practices to mitigate further degradation and enhance the provision of ecosystem services. Policymakers must prioritize the integration of ecological, geographical, and economic insights to develop strategies that balance development needs with environmental conservation. The study's outcomes reinforce the critical role of healthy ecosystems in supporting human well-being and the urgent need for concerted efforts to preserve and restore natural landscapes for future generations.

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