

# Investigation of Anthropogenic Pressure on Ecosystem Services for Climate Resilience in Selected Forest-Dependent Communities of Doma Local Government Area, Nasarawa State, Nigeria.

EKPO, A.S.<sup>1</sup>, I.M SAGIR<sup>2</sup>, FATOYINBO. J<sup>3</sup>

<sup>1,2,3</sup>*Department of Environmental Management, Nasarawa State University, Keffi*

*Abstract- This study examined anthropogenic pressure on ecosystem services and their implications for climate resilience in selected forest-dependent communities in Doma Local Government Area of Nasarawa State, Nigeria. The study aimed to identify the major ecosystem services provided by forest ecosystems, assess their economic contributions to household livelihoods, examine stakeholder perceptions of forest management, evaluate the impacts of human activities on ecosystem sustainability, and identify strategies for enhancing conservation. A mixed-methods approach was adopted, combining household surveys, key informant interviews, and field observations. Data were collected from 200 households across five communities and analyzed using descriptive statistics and thematic analysis. The findings revealed that forest ecosystems provide vital provisioning and regulating services that significantly support household income and environmental stability. However, increasing anthropogenic activities such as deforestation, agricultural expansion, and logging threaten ecosystem sustainability. The study concludes that strengthening community-based conservation, promoting agroforestry, and improving environmental governance are essential for enhancing sustainable forest management and climate resilience.*

*Index Terms- Ecosystem Services, Forest, Doma, Anthropogenic Pressure, Climate Resilience and Forest Communities*

## I. INTRODUCTION

Forest ecosystems represent one of the most valuable components of the Earth's natural capital, providing a wide range of ecosystem services that sustain environmental stability and human well-being. Ecosystem services refer to the direct and indirect benefits that humans obtain from natural ecosystems, including provisioning services such as food, timber,

and medicinal plants; regulating services such as climate regulation, water purification, and carbon sequestration; as well as cultural services that support recreation, spiritual values, and traditional knowledge systems (Mengist et al., 2020). These services play a critical role in sustaining ecological processes and maintaining the conditions necessary for life on Earth.

Globally, forests contribute significantly to sustainable development by supporting biodiversity conservation, regulating hydrological cycles, and mitigating climate change through carbon storage and sequestration. In many rural areas, particularly across Sub-Saharan Africa, forest ecosystems also function as vital livelihood support systems by providing food, fuelwood, construction materials, and medicinal resources for local communities (Osewe et al., 2024). These ecosystem services act as natural safety nets that enhance the socio-economic resilience of forest-dependent populations, especially in regions characterized by limited economic opportunities and high vulnerability to environmental change.

Despite their immense ecological and socio-economic value, forest ecosystems worldwide are increasingly threatened by anthropogenic pressures such as agricultural expansion, population growth, infrastructure development, and unsustainable resource exploitation. These pressures contribute significantly to deforestation, biodiversity loss, and land degradation, thereby reducing the capacity of forests to deliver essential ecosystem services (Ola & Benjamin, 2019). The decline of ecosystem services not only threatens ecological stability but also undermines the livelihoods of millions of people who rely on forests for subsistence and income generation.

Studies emphasize the importance of ecosystem service valuation as a tool for understanding the economic and social benefits derived from ecosystems and for informing sustainable environmental governance (Kassie et al., 2024). Ecosystem service valuation enables policymakers to integrate environmental resources into development planning by quantifying their contribution to human well-being and economic systems. The need to examine trade-offs and synergies among ecosystem services in order to design effective forest management strategies that balance conservation goals with socio-economic needs (Tao et al., 2023).

In Sub-Saharan Africa, however, the application of ecosystem service valuation in environmental policy and land-use planning remains relatively limited, particularly at the community level where dependence on forest resources is highest (Mngumi, 2020). Many forest landscapes are therefore managed without adequate empirical understanding of the economic and ecological contributions of ecosystem services. This knowledge gap undermines the development of effective governance frameworks capable of promoting sustainable forest management and climate resilience.

Nigeria's forest ecosystems face significant environmental pressures due to rapid population growth, agricultural expansion, fuelwood demand, and weak institutional enforcement of environmental regulations. In Nasarawa State, forest-dependent communities rely heavily on ecosystem services for livelihood support, yet increasing human activities continue to threaten the sustainability of these ecosystems. Despite the importance of forest ecosystems within the region, there remains limited empirical research assessing the diversity, economic value, and sustainability of ecosystem services within local forest landscapes.

Doma Local Government Area represents a typical forest-dependent socio-ecological system where rural livelihoods are closely linked to forest resources. However, growing anthropogenic activities such as land-use conversion, logging, and resource extraction pose significant challenges to the long-term sustainability of these ecosystems. This study

therefore examines the ecosystem services provided by forest ecosystems in Doma Local Government Area of Nasarawa State, Nigeria. Specifically, the research evaluates the diversity and socio-economic value of ecosystem services, assesses local community perceptions and dependence on forest resources, and investigates the impacts of anthropogenic activities on ecosystem service sustainability. By integrating ecological and socio-economic perspectives, the study contributes to the growing body of literature on ecosystem service valuation and provides policy-relevant insights for strengthening sustainable forest governance and climate resilience in forest-dependent communities.

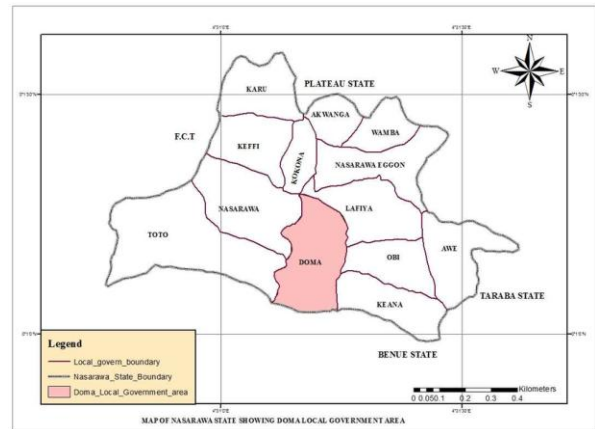


Figure 1: Doma Local Government Area of Nasarawa State

Source: Author's Fieldwork, 2024.

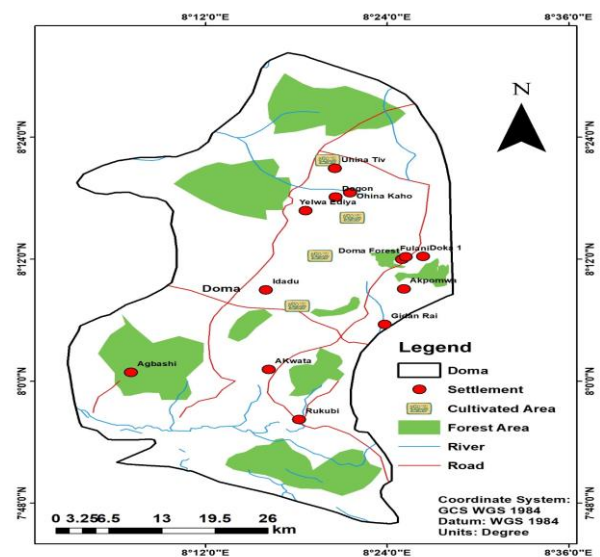


Figure. 2: Doma local government showing the forest communities of the Study Area

Source: Author's Fieldwork, 2024.

## II. METHODOLOGY

This study employed a mixed-methods research approach that integrated quantitative and qualitative techniques to examine ecosystem services, community dependence on forest resources, stakeholder perceptions, and the impacts of human activities on forest ecosystems in Doma Local Government Area of Nasarawa State, Nigeria. This approach designs are widely recommended in environmental and sustainability research because they facilitate the integration of empirical measurement with contextual interpretation, which is essential for understanding complex ecosystem service dynamics (Creswell & Plano Clark, 2018).

The quantitative component of the study focused on measuring the diversity of ecosystem services, the extent of household dependence on forest resources, and the economic benefits derived from these services. While the qualitative component explored stakeholder perceptions of ecosystem services, local environmental management practices, and the conservation challenges affecting forest sustainability in the study area.

The research was conducted in Doma Local Government Area of Nasarawa State, Nigeria, an area characterized by predominantly rural communities whose livelihoods are strongly linked to natural resource utilization. The area lies within the Guinea Savannah ecological zone and contains forest landscapes that provide important ecosystem services such as soil protection, biodiversity conservation, water regulation, and climate moderation. Local households rely extensively on forest resources for activities including fuelwood collection, medicinal plant harvesting, small-scale timber extraction, and agricultural production. The agrarian nature of the local economy and the close interaction between communities and forest ecosystems make the area particularly suitable for investigating ecosystem service utilization and sustainability under increasing anthropogenic pressure.

A multi-stage sampling procedure was adopted to select respondents for the study. In the first stage, reconnaissance surveys and consultations with community leaders and local authorities were conducted to identify forest-dependent communities located within or adjacent to forest ecosystems in Doma Local Government Area. Agbashi, Uhina-TIV, Yelwa-Ediya, Rukubi and Akwata communities that demonstrated significant interaction with forest resources were purposively selected for the study. In the second stage, systematic sampling was used to select households within the identified communities using household lists provided by community leaders. Based on the estimated household population of the selected communities, the sample size was determined using the Cochran sample size formula for large populations, which ensures statistical representativeness in social science research (Cochran, 1977). Using a 95% confidence level and a 5% margin of error, a total sample size of 220 households was determined, out of which 200 completed questionnaires were successfully retrieved and used for analysis.

In addition to the household survey, purposive sampling was employed to select 15 key informants with relevant knowledge and experience in forest resource management and environmental governance. These key informants included community leaders, forestry officials, environmental officers, local government representatives, and members of environmental organizations operating within the study area. Their inclusion enabled the study to obtain expert perspectives on forest governance, conservation initiatives, and environmental management challenges.

Multiple data collection methods were employed to obtain comprehensive information on ecosystem services and environmental conditions within the study area. Primary data were collected through the administration of structured questionnaires to the selected households. The questionnaire captured information on respondents' socio-demographic characteristics, types of ecosystem services utilized, frequency of forest resource use, economic benefits derived from forest products, perceptions of forest ecosystem management, and perceived

environmental changes and drivers of forest degradation.

Qualitative data were obtained through semi-structured interviews conducted with the selected key informants. The interviews focused on issues such as existing forest governance structures, environmental management practices, drivers of ecosystem degradation, conservation initiatives within the study area, and strategies for improving sustainable ecosystem management. The interviews provided important contextual information on institutional arrangements and policy challenges influencing the sustainability of ecosystem services.

Field observations were also conducted within the selected communities and surrounding forest areas to document environmental conditions and land-use practices. Particular attention was given to forest resource extraction activities, agricultural expansion, evidence of deforestation, and other indicators of environmental degradation. These observations served to validate information obtained from surveys and interviews while providing direct evidence of ecosystem conditions in the study area.

Geospatial data were collected using Global Positioning System (GPS) devices to record the geographic coordinates of selected environmental features, including forest areas, water sources, and locations experiencing visible environmental degradation. The spatial data helped identify geographic patterns of forest resource utilization and environmental pressure across the study communities.

Quantitative data obtained from the household surveys were analyzed using the Statistical Package for Social Sciences (SPSS) version 26 and R statistical software. Descriptive statistical techniques such as frequencies, percentages, and mean values were used to summarize the socio-demographic characteristics of respondents and the types of ecosystem services utilized. Inferential statistical techniques, including chi-square tests and correlation analysis, were employed to examine relationships between ecosystem service utilization patterns and perceived environmental changes within the study area. Qualitative data obtained from interviews and

field observations were analyzed using thematic analysis. This process involved coding the data and identifying recurring themes related to ecosystem service management, environmental challenges, and conservation strategies. The integration of quantitative and qualitative findings enabled a comprehensive interpretation of ecosystem service dynamics and forest governance in the study communities.

To ensure the reliability of the research instrument, Cronbach's alpha reliability testing was conducted to assess the internal consistency of questionnaire items measuring ecosystem service utilization and environmental perceptions. A reliability coefficient of 0.72 was obtained, indicating an acceptable level of internal consistency for social science research. Content validity was ensured through expert review of the questionnaire by environmental researchers and forestry specialists. In addition, a pilot survey involving 20 respondents from a neighboring community was conducted to test the clarity and effectiveness of the questionnaire prior to the main data collection exercise. The feedback obtained from the pilot study was used to refine the research instrument and improve its suitability for the final survey.

### III. RESULTS AND DISCUSSION

#### 1. Ecosystem Services in Forest Communities of the study area

This objective examined the diversity and abundance of ecosystem services provided by forest ecosystems across five forest-dependent communities in Doma Local Government Area—Agbashi, Uhina-TIV, Yelwa-Ediya, Rukubi, and Akwata. Data obtained from the household survey (n = 200), supported by field observations and key informant interviews, revealed that local communities depend on a broad range of provisioning, regulating, and cultural ecosystem services derived from surrounding forest landscapes.

The results indicate that provisioning ecosystem services were the most frequently utilized across all five communities. Fuelwood was identified as the most widely used forest resource, particularly in

Agbashi, Uhina-TIV, and Yelwa-Ediya, where households rely heavily on wood-based energy for cooking and heating. Similarly, medicinal plants and wild food resources such as fruits, nuts, and edible leaves were commonly harvested, reflecting the continued role of forests in supporting traditional healthcare systems and supplementary food supply. Timber and poles for house construction were also reported as important forest products, particularly in Rukubi and Akwata where small-scale building activities and farm infrastructure development depend on forest materials.

Beyond provisioning services, respondents also acknowledged the regulating ecosystem services provided by forest ecosystems. These include soil protection, erosion control, and water regulation functions that support agricultural productivity in surrounding farmlands. Field observations confirmed that forest vegetation helps maintain soil stability and protect watersheds that supply water to nearby settlements and farms. Cultural ecosystem services were also identified, particularly in Yelwa-Ediya and Agbashi, where certain forest areas are associated with traditional practices, sacred groves, and community identity.

The distribution of ecosystem services across the study communities demonstrates the multifunctional role of forest ecosystems in sustaining both environmental stability and rural livelihoods. The widespread dependence on provisioning services observed in the study aligns with global findings that rural communities in developing countries rely heavily on forests as a source of subsistence resources, energy, and income (Díaz et al., 2018). Similarly, ecosystem service assessments emphasize that provisioning services remain the most visible and frequently utilized ecosystem services in forest-dependent communities, particularly where alternative livelihood opportunities are limited (Martín-López et al., 2019).

The presence of multiple ecosystem service categories within the study communities highlights the ecological importance of forest landscapes in the Guinea Savannah region. In addition to providing direct livelihood resources, these forests contribute to ecological processes such as carbon storage,

biodiversity conservation, and hydrological regulation. Such multifunctionality underscores the importance of integrated forest management approaches that balance community livelihood needs with environmental sustainability.

Table 1: Distribution of Major Ecosystem Services Across Forest Communities in Doma LGA

Ecosystem Service	Agbashi (%)	Uhina-TIV (%)	Yelwa-Ediya (%)	Rukubi (%)	Akwata (%)
Fuelwood	92	89	85	81	78
Medicinal Plants	76	72	70	65	63
Timber / Construction Materials	68	64	60	74	71
Wild Fruits / Food Resources	74	69	72	61	59
Water Regulation	55	52	57	49	46
Soil Protection / Erosion Control	61	58	60	54	51
Cultural / Traditional Uses	43	38	46	32	29



Plate 1: Logging in the Study Area

## 2. Economic Effects of Identified Ecosystem Services in the Study Area

The second objective assessed the economic contributions of forest ecosystem services to household livelihoods across five forest-dependent

communities, Agbashi, Uhina-TIV, Yelwa-Ediya, Rukubi, and Akwata. Survey results indicate that forest-derived resources significantly supplement household income, both through direct cash earnings from the sale of forest products and savings from reduced household expenditure on energy, medicinal plants, and construction materials.

Analysis of weekly household income shows that households in Agbashi and Uhina-TIV derived the highest average weekly income from forest ecosystem services, estimated at ₦4,500–₦5,000, largely from fuelwood sales, non-timber forest products (NTFPs), and small-scale timber. Yelwa-Ediya households reported an average weekly income of ₦3,800, while Rukubi and Akwata generated ₦3,200 and ₦2,900, respectively. These figures indicate that forest resources contribute between 25% and 40% of total weekly household income, highlighting their critical role in sustaining rural livelihoods.

Fuelwood emerged as the most significant contributor, representing approximately 30% of the income from ecosystem services, followed by NTFPs such as medicinal plants, fruits, and edible leaves (25%). Timber and poles for construction contributed 20%, while agricultural support functions such as soil fertility enhancement and micro-climate regulation indirectly increased household income by reducing costs associated with fertilizers and crop losses (15%). Cultural and other services, including traditional rituals and community-based forest products, accounted for 10% of household economic benefits. Households in Agbashi and Uhina-TIV earn the highest weekly income from forest products (₦4,500–₦4,800), while Akwata households earn the least (₦2,900). This demonstrates the economic significance of forest ecosystem services, particularly for communities closer to accessible forest patches, and emphasizes their role as a vital source of income and livelihood security.

The economic dependence on forests aligns with global findings that highlight the monetary value of ecosystem services in supporting rural livelihoods. Studies indicate that households in forest-dependent regions often rely on ecosystem services as a natural safety net, particularly where formal employment

opportunities are limited (Costanza et al., 2017; Díaz et al., 2018). In Doma Local Government Area, these resources enable households to meet essential needs, buffer against market fluctuations, and support supplementary income generation, illustrating the tangible economic effect of forest ecosystems on community well-being and can inform programs that incentivize sustainable resource use, community conservation initiatives, and alternative livelihood options.

Table 2: Distribution of Ecosystem Services and Average Weekly Income Across Forest Communities

Ecosystem Service	Agbashi (₦)	Uhina-TIV (₦)	Yelwa-Ediya (₦)	Rukubi (₦)	Akwata (₦)
Fuelwood	1,350	1,440	1,140	970	870
Medicinal Plants	1,140	1,200	950	700	630
Timber / Construction Materials	900	960	760	640	580
Wild Fruits / Food Resources	1,050	1,080	760	600	550
Agricultural Support (soil, microclimate)	675	720	570	480	420
Cultural / Traditional Uses	450	480	420	320	290



Plate 2: Food Processing in the Study Area

### 3. Stakeholder Perceptions of Forest Ecosystem Services Management

This objective explored the perceptions and awareness of key stakeholders including household heads, community leaders, environmental officers, forestry personnel, and representatives of local NGOs, regarding ecosystem services and the management of forest resources in the five forest-dependent communities of Doma Local Government Area: Agbashi, Uhina-TIV, Yelwa-Ediya, Rukubi, and Akwata.

Survey results indicate that most respondents recognize the environmental, economic, and socio-cultural benefits of forests, though the depth of understanding regarding the concept of ecosystem services varied across stakeholders and communities. Community members in Agbashi and Yelwa-Ediya demonstrated a higher awareness of both provisioning and regulating services, including fuelwood, medicinal plants, soil protection, and water regulation. In contrast, some households in Rukubi and Akwata perceived forests primarily as sources of tangible products such as timber and fuelwood, suggesting a narrower understanding of the multifunctional role of forest ecosystems.

Stakeholders also reported mixed perceptions regarding current forest management practices. While environmental officers and community leaders acknowledged ongoing conservation efforts, household respondents frequently expressed concerns about weak enforcement of environmental regulations, insufficient community involvement in decision-making, and limited conservation initiatives. Field observations corroborated these concerns, showing areas of illegal logging, unmanaged grazing, and encroachment on forest lands.

The findings align with global studies emphasizing that community participation is central to effective forest governance. Participatory management approaches not only enhance compliance with conservation rules but also integrate local knowledge and cultural practices into sustainable resource management strategies (Berkes, 2018; Folke et al., 2016). Communities that understand and value the multiple benefits of forests are more likely to adopt

sustainable harvesting practices and support local conservation initiatives.

Table 3: Stakeholder Perceptions of Ecosystem Services and Forest Management in Doma LGA

Community	Stakeholders	Ecosystem Services	Awareness	Perception	Management
Agbashi	Households, Community Leaders, Environmental Officers	Fuelwood, Medicinal Plants, Timber, Water Regulation, Soil Protection	High	Mode rate	Limited enforcement, low community participation
Uhina-TIV	Households, Forestry Personnel, NGO Reps	Fuelwood, Timber, Non-Timber Forest Products, Soil Protection	Medium	Mode rate	Weak regulation enforcement, insufficient conservation
Yelwa-Ediya	Households, Community Leaders	Fuelwood, Medicinal Plants, Water Regulation, Cultural Sites	High	Mode rate	Low awareness of conservation policies, resource overuse
Rukubi	Households, Environmental Officers	Fuelwood, Timber, NTFPs	Medium	Ineffective	Encroachment, unsustainable harvesting
Akwata	Households	Fuelwood	Low	Ineffective	Illegal

a	lds, Commu nity Leaders	ood, Timbe r		ctive	logging, limited forest governance
---	----------------------------------	--------------------	--	-------	---



Plate 3: Research Assistant seeking the perception of stakeholders in the study area.

#### 4. Anthropogenic Activities and Forest Ecosystem Service Sustainability in the Study Area

The influence of human activities on the sustainability of ecosystem services in forest communities within Doma Local Government Area, specifically in Agbashi, Uhina-TIV, Yelwa-Ediya, Rukubi, and Akwata. Survey responses, key informant interviews, and field observations consistently identified several anthropogenic activities that contribute to forest degradation and reduced ecosystem service provision.

The most frequently reported drivers of environmental change include deforestation, agricultural expansion, logging and timber extraction, uncontrolled grazing, and infrastructure development or settlement expansion. The intensity of these activities varies across communities, with Agbashi and Uhina-TIV reporting higher pressures from fuelwood collection and agricultural expansion, while Rukubi and Akwata face significant timber extraction and encroachment for settlement. These activities have collectively led to declining forest cover, biodiversity loss, and a reduction in both provisioning and regulating ecosystem services,

particularly in areas experiencing rapid population growth and high demand for forest resources.

The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES, 2019) notes that land-use change, including deforestation and agricultural expansion, remains the leading cause of ecosystem degradation worldwide, particularly in tropical forest regions. Similar to global findings, the degradation in these communities compromises the capacity of forests to deliver critical regulating services such as soil protection, water regulation, and climate moderation. Consequently, unsustainable land-use practices threaten both ecological integrity and the resilience of forest-dependent households to climate change and livelihood shocks.

Stakeholders emphasized that these human pressures are exacerbated by weak enforcement of environmental regulations, limited alternative livelihood options, and insufficient community-based forest management structures.

Table 4: Human Activities and Their Impacts on Ecosystem Service Sustainability Across Communities

Community	Key Human Activities	Primary Ecosystem Services Affected	Observed Impact on Sustainability	Notes
Agbashi	Deforestation, Agricultural Expansion, Fuelwood Collection	Fuelwood, NTFPs, Soil Protection, Water Regulation	High reduction in forest cover; moderate biodiversity loss	Proximity to large forest patches increases extraction pressure
Uhina-TIV	Agricultural Expansion, Timber Extraction, Grazing	Timber, Soil Protection, Water Regulation	Significant decline in provisioning and regulating services	Frequent forest encroachment for farms
Yelwa-	Fuelwood	Fuelwo	Moderate	Strong

Ediya	Collection, NTFP Harvesting	Medicinal Plants, Wild Fruits	ecosystem degradation; some soil erosion	cultural use helps protect some forest areas
Rukubi	Logging, Timber Extraction, Settlement Expansion	Timber, Soil Protection, Water Regulation	High loss of forest cover and biodiversity; reduced regulating services	Urban expansion pressures forest edges
Akwata	Timber Extraction, Grazing, Infrastructure Development	Timber, Soil Protection, Fuelwood	Severe ecosystem degradation; reduced NTFPs and regulating services	Limited community participation in forest governance

Rukubi (80%), and Akwata (72.5%). This indicates a strong preference for participatory forest governance, where local residents actively take part in forest management through community monitoring, forest committees, and shared decision-making processes. Strengthening protected forest areas was the second most supported strategy, receiving 73.5% support overall. The recommendation was especially strong in Agbashi (80%) and Yelwa-Ediya (77.5%), followed by Uhina-TIV (75%), Rukubi (70%), and Akwata (65%), suggesting that communities experiencing greater pressure on forest resources recognize the need for stricter protection to prevent over-exploitation and preserve ecosystem services.

Other strategies also received considerable endorsement from the communities. Agroforestry and reforestation programs were supported by 69.0% of respondents overall, with relatively higher support in Yelwa-Ediya (72.5%) and Agbashi and Akwata (70% each), while Uhina-TIV recorded 67.5% and Rukubi 65%. This demonstrates that many households recognize the benefits of integrating tree planting with farming activities as a way of restoring degraded land while improving livelihoods. Environmental awareness and education programs were supported by 62.0% of respondents overall, with higher emphasis in Yelwa-Ediya (67.5%) and Agbashi (65%), while Uhina-TIV and Akwata each recorded 60% and Rukubi 57.5%. Enforcement of environmental policies received the least support, though still significant, with 56.5% overall endorsement. Support was highest in Yelwa-Ediya (62.5%) and Agbashi (60%), followed by Uhina-TIV and Akwata (55% each) and Rukubi (50%). Overall, the findings suggest that while education and policy enforcement are recognized as important, communities tend to prioritize strategies that combine direct participation and livelihood benefits, particularly community-based conservation and agroforestry initiatives.



Plate 4: Timber Products from Doma Forest

#### 5. Strategies for Enhancing Conservation and Sustainable Ecosystem Management

The final objective examined strategies for enhancing conservation and sustainable ecosystem management across the forest communities of Agbashi, Uhina-TIV, Yelwa-Ediya, Rukubi, and Akwata. The results show strong support for several conservation approaches among the communities. Community-based conservation emerged as the most widely supported strategy, with 81.5% of respondents across all communities recommending it. Support was particularly high in Yelwa-Ediya (87.5%) and Agbashi (85%), followed by Uhina-TIV (82.5%),

Table 5: Community Recommendations for Ecosystem Management Strategies

Strategy	Agbashi (n=40)	Uhina-TIV (n=40)	Yelwa-Ediya (n=40)	Rukubi (n=40)	Akwata (n=40)	Total (n=200)	Total (%)
Strengthening protected forest areas	32	30	31	28	26	147	73.5
Community-based conservation	34	33	35	32	29	163	81.5
Agroforestry & reforestation programs	28	27	29	26	28	138	69.0
Environmental awareness & education	26	24	27	23	24	124	62.0
Enforcement of environmental policies	24	22	25	20	22	113	56.5

The findings highlight the critical importance of integrating community participation into forest management strategies. The strong endorsement of community-based conservation initiatives reflects the willingness of local residents to actively engage in sustainable practices, suggesting that policies should formally recognize and support participatory management mechanisms, such as co-management agreements and community forest committees (Berkes, 2018; Ostrom, 2009). Similarly, the emphasis on strengthening protected forest areas and promoting agroforestry and reforestation programs indicates that interventions combining ecosystem restoration with livelihood generation are likely to achieve the greatest impact. Communities with high dependence on forest resources, such as Agbashi and Yelwa-Ediya, are particularly receptive to initiatives that provide alternative income streams while

maintaining ecological integrity (FAO, 2018; Scherr & McNeely, 2008).

#### IV. CONCLUSION

Forest ecosystems in Doma Local Government Area of Nasarawa State play a critical role in sustaining rural livelihoods, supporting environmental stability, and strengthening climate resilience among forest-dependent communities. The findings reveal that communities such as Agbashi, Uhina-TIV, Yelwa-Ediya, Rukubi, and Akwata rely extensively on a wide range of ecosystem services including fuelwood, medicinal plants, timber, wild food resources, and regulating services such as soil protection and water regulation. These ecosystem services provide both direct livelihood benefits and indirect ecological functions that sustain agricultural productivity and local environmental balance. The economic analysis further demonstrates that forest resources contribute significantly to household income and livelihood security, serving as an important natural safety net for rural households in areas where formal economic opportunities are limited. However, despite the substantial benefits derived from these ecosystems, the study reveals that increasing anthropogenic pressures such as deforestation, agricultural expansion, logging, uncontrolled grazing, and settlement expansion are gradually degrading forest landscapes and reducing the sustainability of ecosystem services in the study communities.

#### REFERENCES

- [1] Berkes, F. (2018). *Sacred ecology* (4th ed.). Routledge.
- [2] Cochran, W. G. (1977). *Sampling techniques* (3rd ed.). John Wiley and Sons.
- [3] Costanza, R., de Groot, R., Braat, L., Kubiszewski, I., Fioramonti, L., Sutton, P., Farber, S., & Grasso, M. (2017). Twenty years of ecosystem services: How far have we come and how far do we still need to go? *Ecosystem Services*, 28, 1–16.
- [4] Creswell, J. W., & Plano Clark, V. L. (2018). *Designing and conducting mixed methods research* (3rd ed.). SAGE Publications.

- [5] Díaz, S., Pascual, U., Stenseke, M., Martín-López, B., Watson, R., Molnár, Z., Hill, R., Chan, K. M. A., Baste, I., Brauman, K., Polasky, S., Church, A., Lonsdale, M., Larigauderie, A., Leadley, P., van Oudenhoven, A., van der Plaats, F., Schröter, M., Lavorel, S., ... Shirayama, Y. (2018). Assessing nature's contributions to people. *Science*, 359(6373), 270–272.
- [6] Food and Agriculture Organization. (2018). *The state of the world's forests 2018: Forest pathways to sustainable development*. FAO.
- [7] Folke, C., Biggs, R., Norström, A., Reyers, B., & Rockström, J. (2016). Social-ecological resilience and biosphere-based sustainability science. *Ecology and Society*, 21(3), 41.
- [8] Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. (2019). *Global assessment report on biodiversity and ecosystem services*. IPBES Secretariat.
- [9] Kassie, M., Teklewold, H., Jaleta, M., Marenza, P., & Erenstein, O. (2024). Ecosystem services and sustainable land management in Sub-Saharan Africa. *Environmental Development*, 50, 101012.
- [10] Martín-López, B., Balvanera, P., Manson, R., & Moreno-Mateos, D. (2019). Ecosystem services and human well-being: A comprehensive framework. *Ecosystem Services*, 36, 100938.
- [11] Mengist, W., Soromessa, T., & Legese, G. (2020). Ecosystem services research in mountainous regions: A systematic literature review on current knowledge and research gaps. *Science of the Total Environment*, 702, 134581.
- [12] Mngumi, L. E. (2020). Application of ecosystem services valuation in environmental management and policy in Sub-Saharan Africa. *Environmental Management*, 66(3), 365–377.
- [13] Ola, O., & Benjamin, E. (2019). Forest resource exploitation and its implication for environmental sustainability in Nigeria. *Journal of Environmental Management*, 248, 109273.
- [14] Osewe, K., Ndunda, E., & Mutune, J. (2024). Forest ecosystem services and livelihood support in rural African communities. *Ecological Economics*, 218, 108045.
- [15] Ostrom, E. (2009). A general framework for analyzing sustainability of social-ecological systems. *Science*, 325(5939), 419–422.
- [16] Scherr, S. J., & McNeely, J. A. (2008). Biodiversity conservation and agricultural sustainability: Towards a new paradigm of ecoagriculture landscapes. *Philosophical Transactions of the Royal Society B*, 363(1491), 477–494.
- [17] Tao, Y., Li, F., Wang, R., & Zhao, D. (2023). Trade-offs and synergies among ecosystem services in forest ecosystems. *Ecological Indicators*, 147, 109866.