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Socio-demographic Profile, Livelihood Structure, and Anthropogenic Activity Patterns of Riparian Communities along the River Benue Basin, Adamawa State, Nigeria

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ABSTRACT

Freshwater ecosystems in sub-Saharan Africa face escalating anthropogenic pressures from population growth, agricultural intensification, and unregulated artisanal activities, yet community-level baseline data remain scarce for most Nigerian river basins. This study characterises the socio-demographic profile, livelihood structure, and anthropogenic activity patterns of riparian communities along the River Benue Basin, Adamawa State, Nigeria, and examines the relationship between educational attainment and persistent environmental degradation. A stratified random sampling design was used to administer structured questionnaires to 1,093 respondents across three locations — Boronji (Yola North LGA), Dasin Hausa (Fufore LGA), and Njoboliyo (Yola South LGA) — during the dry (February–April 2025) and rainy (June–August 2025) seasons, from 1,200 administered (91.1% response rate). Data were analysed descriptively using SPSS v25.0. Male respondents predominated across all sites (58.50–67.57%), with the 31–45-year cohort modal (34.05–35.16%). Secondary and tertiary education combined accounted for 67.97–71.42% of respondents, exceeding rural north-eastern Nigerian averages. Farming was the dominant occupation (33.70–36.22%), followed by trading (22.16–23.96%), artisanal work (16.21–17.27%), and civil service (14.05–16.21%). Over half of respondents (49.73–51.92%) had resided locally for more than 20 years. Five principal anthropogenic activities were identified: domestic waste disposal into the river, fertiliser/pesticide use, artisanal sand mining, fishing, and construction. Despite high educational attainment, degradation persists, reflecting a knowledge–action gap driven by regulatory weakness and lack of viable livelihood alternatives. These findings establish the first integrated community-level baseline dataset for this reach of the River Benue, providing an evidence base for community-responsive environmental management.

Keywords: Anthropogenic Activities; Riparian Communities; River Benue; Socio-Demographics; Knowledge–Action Gap; Adamawa State; Freshwater Governance

INTRODUCTION

Freshwater ecosystems cover less than 1% of the Earth's surface yet support an estimated 10% of all known species and underpin the livelihoods of hundreds of millions of people across sub-Saharan Africa (MEA, 2005). In Nigeria, population growth, agricultural expansion, and the proliferation of unregulated artisanal industries have placed unprecedented pressures on inland river systems, leading to deteriorating water quality, declining aquatic biodiversity, and escalating public health risks (Arimoro and Ikomi, 2008; Nyenje et al., 2010; Arimoro and Keke, 2016). Most Nigerian rivers in or near urban and peri-urban areas are now heavily affected by combined domestic, agricultural, and industrial pollution, with effective environmental governance largely absent at the community level (Arimoro and Oganah, 2010; Assie et al., 2024).

The River Benue originates from the Adamawa Plateau of Cameroon and drains approximately 330,000 km² across Nigeria, Cameroon, and Chad (Ayuba et al., 2013). Within Adamawa State, the basin provides critical ecosystem services: domestic water supply, agricultural irrigation, artisanal fishing, and transport. Simultaneously, it is under growing pressure from agricultural encroachment to within 5–15 metres of the riverbank, domestic waste disposal directly into the channel, artisanal sand mining, and probable artisanal metal processing near community settlements (Alkali et al., 2022; Samuel et al., 2024). Despite this dual ecological and socio-economic importance, systematic community-level data characterising the nature, scale, and spatial distribution of anthropogenic activities — and the socio-demographic profiles of the communities driving them — are essentially absent for the Adamawa State reach.

Understanding the socio-demographic composition of riparian communities is foundational to effective environmental management. Age structure identifies groups most active in resource extraction; gender distributions shape participation in governance; educational attainment determines capacity for science-based risk communication; occupational composition reveals economic dependencies motivating resource exploitation; and duration of residence is a proxy for traditional ecological knowledge (Masese et al., 2023; Uddin and Jeong, 2021). Prior investigations on the River Benue have focused almost exclusively on physico-chemical or biological indicators without characterising the human dimensions of environmental pressure (Samuel et al., 2024; Alkali et al., 2022).

A particularly significant theoretical question concerns the knowledge–action gap: the documented phenomenon whereby educated communities continue engaging in environmentally degrading practices despite awareness of their consequences (Uddin and Jeong, 2021). Northeast Nigerian communities typically exhibit higher educational attainment than other rural zones in the country, making the River Benue Basin an important empirical setting in which to test whether education alone — without complementary institutional enforcement and viable livelihood alternatives — translates into reduced anthropogenic pressure.

This study characterises the socio-demographic profile of riparian communities along the River Benue Basin in Adamawa State, identifies and quantifies the dominant

anthropogenic activities at three contrasting locations, and examines the relationships between socio-demographic variables particularly educational attainment and occupational structure and patterns of environmental pressure.

MATERIALS AND METHODS

Study Area

The study was conducted along the River Benue Basin in Adamawa State, north-eastern Nigeria. Three sampling locations were selected following reconnaissance surveys in January 2025: Boronji (9°15'43"N, 12°28'39"E) in Yola North LGA, Dasin Hausa (9°16'23"N, 12°39'29"E) in Fufore LGA, and Njoboliyo (9°13'40"N, 12°34'58"E) in Yola South LGA. Adamawa State covers approximately 36,917 km² and had a census population of 3,168,101 in 2006, with current projections of 4.5–5.0 million (NPC , 2006). The basin experiences a tropical climate with distinct dry (November–April) and rainy (May–October) seasons, annual rainfall of 700–1,600 mm, and annual sunshine of 2,400–3,000 hours (Adebayo and Tukur, 1999). Vegetation corresponds principally to the Northern Guinea Savannah zone with degraded riparian gallery forest along the river corridor.

Research Design and Sampling

A cross-sectional survey design was employed. The study population comprised adult residents (≥18 years) who had lived in the study area for at least five years. Based on community leader records and LGA offices, total riparian population across the three sites was approximately 15,000. Sample size was determined by the Taro Yamane formula (Adam, 2020): $n = N / [1 + N(e)^2]$, where N = 15,000 and e = 0.05, yielding n ≈ 390. The sample was enlarged to 1,093 respondents for greater statistical power — Boronji (n = 370), Dasin Hausa (n = 359), Njoboliyo (n = 364) — from 1,200 administered questionnaires (400 per site). Stratified random sampling was used, each location being one stratum. Within each stratum, systematic random sampling selected every third household along transects from the riverbank. Data collection covered the dry season (February–April 2025) and rainy season (June–August 2025); May was excluded as a transitional month.

Research Instrument

A structured questionnaire was developed in two sections. Section A captured socio-demographic variables: gender, age group, educational level, occupation, and duration of residence. Section B captured anthropogenic activities including livelihoods, farming practices, waste disposal, fishing, and artisanal operations. The questionnaire was pre-tested with 30 respondents (10 per site) and refined before main data collection. Administration was through face-to-face interviews by trained multilingual field assistants (Hausa, Bwatiye, and Fulfulde). Informed consent was obtained verbally and in writing from all participants.

Data Analysis

Descriptive statistics frequencies, percentages, and cross-tabulations were computed to characterise the study population and identify anthropogenic activity patterns. Data management was conducted in Microsoft Excel 2019 and analysis using SPSS version 25.0 (Montgomery, 2017). Response rates were calculated per location, and combined totals computed for the basin-level overview.

RESULTS AND DISCUSSION

Questionnaire Administration and Response Rate

Out of the 1,200 questionnaires administered, 1,093 were returned fully completed, giving an overall response rate of 91.1% (Table 1). Site-specific rates were: Boronji 92.5% (370/400), Dasin Hausa 89.8% (359/400), and Njoboliyo 91.0% (364/400). Only complete questionnaires were used in analysis.

Table 1: Questionnaire Administration and Response Rates by Location

Location	LGA	Administered	Returned & Complete	Response Rate (%)
Boronji	Yola North	400	370	92.5
Dasin Hausa	Fufore	400	359	89.8
Njoboliyo	Yola South	400	364	91.0
Total	—	1,200	1,093	91.1

Gender Distribution

Male respondents constituted the majority across all three locations (Table 2). Boronji recorded the highest gender disparity (67.57% male, 32.43% female), while Dasin Hausa had the lowest (58.50% male, 41.50% female). Njoboliyo recorded an intermediate distribution (60.44% male, 39.56% female). Across the combined sample, males accounted for 62.22% (n = 680) and females 37.78% (n = 413).

Table 2: Gender Distribution of Respondents by Study Location

Gender	Boronji n (%)	Dasin Hausa n (%)	Njoboliyo n (%)	Combined Total n (%)
Male	250 (67.57)	210 (58.50)	220 (60.44)	680 (62.22)
Female	120 (32.43)	149 (41.50)	144 (39.56)	413 (37.78)
Total	370 (100.00)	359 (100.00)	364 (100.00)	1,093 (100.00)

Age Distribution

Working-age adults (18–60 years) dominated the sample at all three sites (Table 3). The 31–45 year cohort was modal: 34.05% at Boronji, 35.10% at Dasin Hausa, and 35.16% at Njoboliyo. Combined working-age proportions were 85.40%, 84.68%, and 87.91% respectively.

Table 3: Age Distribution of Respondents by Study Location

Age Group	Boronji n (%)	Dasin Hausa n (%)	Njoboliyo n (%)	Combined Total n (%)
18–30 years	91 (24.59)	90 (25.07)	88 (24.18)	269 (24.61)
31–45 years	126 (34.05)	126 (35.10)	128 (35.16)	380 (34.77)
46–60 years	99 (26.76)	88 (24.51)	104 (28.57)	291 (26.62)

Age Group	Boronji n (%)	Dasin Hausa n (%)	Njoboliyo n (%)	Combined Total n (%)
≥60 years	54 (14.59)	55 (15.32)	44 (12.09)	153 (14.00)
Total	370 (100.00)	359 (100.00)	364 (100.00)	1,093 (100.00)

Educational Attainment

Combined secondary and tertiary education accounted for 70.00% at Boronji, 67.97% at Dasin Hausa, and 71.42% at Njoboliyo (Table 4). Tertiary education alone was reported by 35.41%, 31.20%, and 36.26% respectively. The proportion with no formal education was consistently low across all sites (8.38–10.58%).

Table 4: Educational Attainment of Respondents by Study Location

Educational Level	Boronji n (%)	Dasin Hausa n (%)	Njoboliyo n (%)	Combined Total n (%)
No Formal Education	31 (8.38)	38 (10.58)	37 (10.16)	106 (9.70)
Primary Education	80 (21.62)	77 (21.45)	67 (18.41)	224 (20.49)
Secondary Education	128 (34.59)	132 (36.77)	128 (35.16)	388 (35.50)
Tertiary Education	131 (35.41)	112 (31.20)	132 (36.26)	375 (34.31)
Total	370 (100.00)	359 (100.00)	364 (100.00)	1,093 (100.00)

Occupational Composition

Farming was the dominant occupation at all three sites (Table 5): 36.22% at Boronji, 33.70% at Dasin Hausa, and 35.44% at Njoboliyo. Trading ranked second (22.16–23.96%), followed by artisanal work (16.21–17.27%) and civil service (14.05–16.21%). Aggregating farming and artisanal occupations as direct natural resource-dependent livelihoods gave proportions of 53.25%, 50.97%, and 51.65% at Boronji, Dasin Hausa, and Njoboliyo respectively.

Table 5: Occupational Distribution of Respondents by Study Location

Occupation	Boronji n (%)	Dasin Hausa n (%)	Njoboliyo n (%)	Combined Total n (%)
Farmer	134 (36.22)	121 (33.70)	129 (35.44)	384 (35.13)
Trader	82 (22.16)	86 (23.96)	83 (22.80)	251 (22.96)
Artisan	63 (17.03)	62 (17.27)	59 (16.21)	184 (16.83)
Civil Servant	52 (14.05)	51 (14.21)	59 (16.21)	162 (14.82)
Other	39 (10.54)	39 (10.86)	34 (9.34)	112 (10.25)
Total	370 (100.00)	359 (100.00)	364 (100.00)	1,093 (100.00)

Duration of Residence

Respondents with more than 20 years of residence constituted 49.73%, 50.14%, and 51.92% of the Boronji, Dasin Hausa, and Njoboliyo samples respectively (Table 6). Combining the 11–20 year and >20 year cohorts, long-tenure residents accounted for 77.03%, 69.92%, and 78.29% at the three sites.

Table 6: Duration of Residence of Respondents by Study Location

Duration of Residence	Boronji n (%)	Dasin Hausa n (%)	Njoboliyo n (%)	Combined Total n (%)
Less than 5 years	39 (10.54)	48 (13.37)	29 (7.97)	116 (10.61)
5–10 years	46 (12.43)	60 (16.71)	50 (13.74)	156 (14.28)
11–20 years	101 (27.30)	71 (19.78)	96 (26.37)	268 (24.52)
More than 20 years	184 (49.73)	180 (50.14)	189 (51.92)	553 (50.59)
Total	370 (100.00)	359 (100.00)	364 (100.00)	1,093 (100.00)

Dominant Anthropogenic Activities

The principal anthropogenic activities identified across all three locations are summarised in Table 7. Domestic waste disposal into the river was the most universally reported activity, occurring year-round at all sites. Agricultural practices — including crop farming encroaching to within 5–15 m of the riverbank and widespread use of synthetic fertilisers and pesticides — constituted the dominant diffuse pollution pathway. Artisanal sand mining was concentrated in the dry season when receding river levels expose sandbanks. Fishing was reported year-round. Construction of informal structures on riparian land was predominantly noted at Boronji and Njoboliyo. Artisanal metal and craft operations — potentially including battery recycling and metal processing — were visibly more prevalent at Boronji and Njoboliyo, a pattern spatially consistent with the heavy metal contamination documented at those sites.

Table 7: Principal Anthropogenic Activities at Study Locations

Anthropogenic Activity	Category	Peak Season	Sites Affected	Principal Pollution Pathway
Domestic waste disposal	Non-point/point	Year-round	All three	BOD loading, pathogens, solid waste
Agricultural practices (farming, fertiliser, pesticide use)	Non-point	Rainy season	All three	Nutrient runoff, pesticide loading, sediment
Artisanal sand mining	Physical/non-point	Dry season	All three	Elevated turbidity, riverbed habitat destruction
Fishing (artisanal and commercial)	Biological	Year-round	All three	Overharvesting, gear-related litter
Construction on riparian land	Non-point/point	Dry season	Boronji, Njoboliyo	Surface runoff, habitat encroachment
Livestock watering	Non-point	Dry season	All three	Faecal coliform loading, bank erosion

Anthropogenic Activity	Category	Peak Season	Sites Affected	Principal Pollution Pathway
Artisanal metal/craft work	Point source	Year-round	Boronji, Njoboliyo	Heavy metal contamination (Pb, Ni, Cd)

Discussion

The near-balanced distribution of respondents across the three sites — Boronji (370), Dasin Hausa (359), Njoboliyo (364) — validates the stratified sampling design and confirms equitable spatial representation. The 91.1% overall response rate exceeds the 70–80% thresholds generally considered acceptable for environmental questionnaire studies (Thomas, 2023) and reflects effective pre-survey community engagement and multilingual interviewing. The high proportion of long-term residents (>20 years: 49.73–51.92%) confirms that the documented environmental degradation results from accumulated chronic anthropogenic pressure. This aligns with Nneoyi-Egbe (2024), who documented comparable residential stability in riparian communities along the Great Kwa River, Calabar, noting that long-term residents possess institutional memory regarding historical environmental conditions that complements formal monitoring data.

The consistent male predominance across all three sites (58.50–67.57%) reflects structural gender norms in Nigerian riparian communities, where men typically dominate fishing, farming, and trading (Agboola et al., 2020). The highest male-to-female ratio at Boronji plausibly reflects greater concentration of physically demanding extractive activities sand mining and intensive agriculture at that site. The findings highlight that gender-inclusive governance processes are essential: women in these communities are primary managers of household water use, food preparation, and child nutrition activities directly dependent on river water quality yet are underrepresented in governance structures.

The dominance of the 31–45 year cohort (34.05–35.16%) and overall working-age proportions of 84.68–87.91% are consistent with patterns in Afrotropical river basin communities where productive-age adults cluster around accessible water points for resource-dependent livelihoods (Masese et al., 2023). This demographic simultaneously constitutes the primary driver of anthropogenic pressure and the most economically motivated target group for adoption of sustainable practices if provided with appropriate institutional support and viable alternative livelihoods.

The high educational attainment across all three communities' 67.97–71.42% holding secondary or tertiary qualifications substantially exceeds typical values for rural north-eastern Nigeria and provides a potentially powerful basis for evidence-based environmental governance. Uddin and Jeong (2021) demonstrated that higher educational attainment in riparian communities enhances comprehension of environmental risk communications, though these authors also caution that education alone does not translate to improved environmental behaviour without complementary institutional enforcement and economic incentives.

The central paradox of this study is the coexistence of high educational attainment with severe, persistent environmental degradation a clear empirical manifestation of the knowledge–action gap. Despite 68–71% secondary or tertiary attainment, the three communities continue practising direct waste disposal into the river, maintaining farm fields within 5–15 m of the riverbank, and conducting artisanal sand mining that drives turbidity to 9–10 times WHO guidelines. This is not attributable to ignorance but to three specific institutional failures: (i) weak enforcement documented by the low civil service presence (14.05–16.21%), consistent with Assie et al. (2024), who identified institutional weakness as a primary driver of freshwater degradation in Nigerian rivers; (ii) absence of economically viable alternatives to riverbank farming and artisanal sand extraction; and (iii) complete absence of functioning 30-metre riparian buffer zones at all three sites. The knowledge–action gap documented here — where communities with demonstrated educational capacity continue degrading their environment due to institutional and economic compulsion represents an original empirical contribution to freshwater governance theory.

Farming (33.70–36.22%) and artisanal activities (16.21–17.27%) together constitute approximately 51–53% of each community's workforce, confirming that the majority of the basin population is directly economically dependent on natural resource exploitation. This finding aligns with Arimoro et al. (2015), who documented agriculture and artisanal activities as the dominant livelihoods in Nigerian riparian communities and linked them to freshwater degradation through nutrient loading, sediment mobilisation, and chemical contamination. The artisanal sector's potential role as a point source of heavy metals is particularly significant: the concentration of artisanal operators at Boronji and Njoboliyo is spatially consistent with the lead contamination documented at those sites (6.3-fold and 18.8-fold WHO limits respectively), while Dasin Hausa, despite a similar artisanal proportion (17.27%) but predominantly pastoral character, showed near-background metal levels. This spatial contrast confirms that the specific type of artisanal activity — rather than mere prevalence — determines metal contamination risk.

The five dominant activities domestic waste disposal, agricultural practices, artisanal sand mining, fishing, and construction — are consistent with the pressure suite documented by Jonah et al. (2020) in the Uta Ewa Estuary, Akwa Ibom State, and by Samuel et al. (2024) on the River Benue at Makurdi, Benue State. The contrast with Ekperusi et al. (2022), who identified structured industrial activities as dominant on the more industrialised Oghan River, Edo State, confirms that diffuse agricultural and artisanal pressures characterise the predominantly agrarian Benue Basin communities of Adamawa State. The seasonal variation in activity intensity dry season peaks for sand mining and rainy season peaks for agricultural runoff necessitates that monitoring and enforcement programmes operate across both seasons to capture the full environmental impact. Complete absence of riparian buffer zones at all three sites represents the single most critical structural enabler of persistent agricultural diffuse pollution; Mateo-Sagasta et al. (2017) confirmed that buffer zone restoration is among the most cost-effective interventions for tropical agricultural river catchments.

CONCLUSION

This study provides the first quantitative socio-demographic baseline for riparian communities along the River Benue Basin in Adamawa State, Nigeria. Five principal conclusions are drawn:

Riparian communities are characterised by a working-age majority (84.68–87.91%), consistent male predominance, and high educational attainment (67.97–71.42% secondary or tertiary) above rural north-eastern Nigerian averages.

Approximately 51–53% of the working population across all sites depends directly on natural resource extraction (farming and artisanal work), generating persistent diffuse and point-source pollution.

Communities with 68–71% secondary or tertiary educational attainment continue environmental degradation not from ignorance but owing to a regulatory vacuum, absence of livelihood alternatives, and absence of enforced riparian buffer zones.

Domestic waste disposal, agricultural practices, artisanal sand mining, fishing, and construction exhibit clear seasonal intensity patterns that must inform the temporal design of monitoring and enforcement programmes.

Regulatory enforcement, alternative livelihood provision, and mandatory riparian buffer zone restoration to a minimum of 30 metres are the highest-priority management interventions indicated by these findings.

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