International Journal of Innovative Biosciences Research 14(1):49-63, Jan.-Mar., 2026

© SEAHI PUBLICATIONS, 2026 www.seahipublications.org ISSN: 2467-8457

doi:10.5281/zenodo.18666943

A Multi-Level Statistical Analysis Of Individual And Collective Actions For Environmental Preservation And Air Quality Protection

Bello Garba[1]; Mubarak Atiku[2]; Zainab Ahmad Dahiru[3]; Yunusa Salamatu[4] & Nuruddeen Hassan Danrimi[5].

[1,2,3,4]Department of Biological Science University of Abuja, Abuja, Nigeria

[5]Department of Statistics, University of Abuja, Abuja, Nigeria
Correspondence Authors email: bello.garba@uniabuja.edu.ng; mubarak.atiku@uniabuja.edu.ng; zainab.dahiru@uniabuja.edu.ng; salamatu.yunusa@uniabuja.edu.ng; nuruddeen.hassan**@uniabuja.edu.ng.**

ABSTRACT
This study conducted a multi-level analysis of environmental guardianship for air quality protection in Unguwan Hausawa Iddo Sarki, Abuja Municipal Area Council, Nigeria, using data from 105 households. The research examined the relationships between individual demographic characteristics, household energy profiles, governance satisfaction, and environmental perceptions and behaviors. Findings revealed high environmental awareness (75.23% concerned; mean importance rating 79.12/100) coexisting with structural constraints including 80% generator dependence and 55.24% biomass fuel reliance. The governance satisfaction gap was pronounced, with 54.28% dissatisfied with local government efforts. Statistical analyses confirmed significant demographic variations in guardianship (H_{01} rejected), with higher education associated with greater behavioral engagement yet lower concern revealing a paradoxical negative correlation ($r = -0.399$, $p<0.05$). Household energy profiles significantly related to air quality perceptions (H_{02} rejected), with biomass users reporting highest concern. Governance dissatisfaction significantly predicted guardianship potential (H_{03} rejected). The relationship between perceived effectiveness and actual behavior was partially supported (H_{04} partially rejected), moderated by educational and structural factors. Community support for integrated interventions was confirmed (H_{05} rejected). The study concludes that effective air quality management requires coordinated multi-level interventions addressing individual behavior change, household energy transitions, collective advocacy, and governance accountability to bridge the awareness-action gap in peri-urban Nigerian communities.
Keywords: Air quality, environmental guardianship, household energy, governance satisfaction, multi-level analysis, Nigeria

INTRODUCTION
Air pollution is considered as one of the strongest global environmental dilemmas of the 21 st century in relation to its impact on people. Although technology and regulatory policies have improved, apart from causing 7 million premature deaths annually, fine particulate matter (PM2.5) and nitrogen dioxide (NO2) can also have devastating cardiopulmonary effects on the human population even though they are monitored (WHO, 2021). Transboundary character of air pollution and the differences in local sources of emissions like industrial cluster and vehicular traffic and domestic combustion make the whole issue

complex and cannot be resolved through top-down governance. This has been a source of complexity which has triggered the rise of grassroots environmental guardianship whereby the citizens are no longer seen as passive victims of pollution but as active agents of guardianship and transformation

The concept of environmental guardianship extends beyond conventional environmentalism, incorporating elements of civic science, community resilience, and moral responsibility for shared resources (Bennett et al., 2018). In the context of air quality, guardianship manifests across multiple levels. At the individual level, it includes behavioral adaptations (e.g., using air purifiers, altering commute patterns), personal monitoring, and advocacy. At the collective level, it encompasses community-led monitoring networks, social movement activism, litigation, and participatory policy advocacy. A multi-level analytical framework is essential to understand how these layers of action interact, reinforce, or potentially conflict with one another, and how they interface with formal governance structures. This research argues that the synergy or lack thereof between individual agency, collective mobilization, and institutional response is a critical determinant of effective air quality protection.

The current scholarship highlights the increasing importance of non-state actors as a major consideration in environmental governance. According to the literature, there has been a paradigm shift to the so-called citizen sensing, where inexpensive sensor devices democratize the nature of data collection and undermine the state-monopolized environmental narratives (Gabrys, 2020). As an example, the monitoring networks in communities have largely contributed to uncovering the hotspots of pollution that are usually missed by governmental stations, thus holding regulatory agencies responsible (Snyder et al., 2023). At the same time, social media has taken a change in the air quality movement, allowing quick information sharing and engagement in mass mobilization regarding air pollution incidents, which is reported in air pollution civic activities studies in urban Asia (Shi and Moser, 2021). Nevertheless, these studies point to the potential of citizen action and, however, the individual and collective actions are separated, without the combined analysis of their interactions.

Also, there is still a big gap in knowledge of the drivers and barriers that cut across these levels. Risk perception, self-efficacy, and social norms have a strong impact on individual actions (Bissing-Olson et al., 2022), whereas social capital, leadership and political opportunity structures are related to collective action dynamics (Temper et al., 2020). The research gap that is critical in this study is that no holistic framework has been able to systematically explore: (1) how individual guardianship actions accumulate or catalyse group action, (2) how group action, in turn, empowers or limits individual agency, and (3) how this multi-level ecosystem of guardianship, ultimately, has an impact on policy outcomes and material improvement in air quality. This gap is critical towards developing more effective inclusive and resilient air quality management systems that tap into the strength of civic engagement.

Bissing-Olson et al. (2022) explored psychological predispositions of pro-environmental behavior and focused on environmental affect (emotions related to environmental conditions) in the daily experiences of people and self-efficacy. They conducted longitudinal research and established that people who believed in themselves more tended to participate in both the private and the public sphere and this gave them a psychological basis of how to explain individual-level guardianship.

Snyder et al. (2023) tested the effectiveness of community low-cost sensor networks of PM2.5 in monitoring in the urban fenceline communities. Their study has shown that this type of grass-root data collection had not only closed spatial cracks in official surveillance, but also presented legally admissible evidence that was applied in community advocacy and environmental efforts.

Shi and Moser (2021) studied the discourse in Chinese megacities on air pollution on social media. They determined the role of digital platforms in facilitating networked framing of air quality concerns, which can turn personal health complaints into a political demand on the government to be more transparent and take action, and therefore defines the process by which individuals think their personal concern is amplified through collective digital mobilization.

Temper et al. (2020) discussed the results of different environmental justice movements across the world. Although they affirmed the strength of collective action, their work underscored a very important limitation: movements tend to be reactive, localized, and fragmented. They claim that the transnational

and long-term effects of even an active collective action can be curbed without some strategic connections to wider policy frames and transnational networks.

Nevertheless, the gap that is most relevant is one that was provided in a review study by Hsu et al. (2022) that synthesized the existing literature on civic engagement in environmental governance. They also concluded that there is an absence of sufficient integration to offset the successful growth of non-state actor initiatives, which is well-documented. Policymakers do not always have the mechanisms and structures to include data and advocacy of civic guardians into methods of regulatory decision-making, and this results in parallel yet separately functioning streams of action.

Statement of the Problem

Though scientific consensus on the dangers of air pollution grows, and more and more individual and community-based solutions to cleaner air are made, there is still a gap in governance and actions. Top-down regulatory strategies tend to be slow, politically limited, and not granular enough, and bottom-up citizen behavior can often be challenged by issues of scalability, sustainability, and integration into politics (Hsu et al., 2022). It is two-fold, one being that there is a lack of connection between micro-level motivations and micro-level actions of individual guardians and macro-level tactics and collective movements, with limited knowledge on how either drives the other or suppresses the other. Second, there is a deficit of integration in which the data, advocacy, and energy of this multi-level guardianship ecosystem are not properly directed through formal policy-making and enforcement processes, resulting in redundant activities, burnout of activists, and sub-optimality of air quality results. The study will be designed to break down this multi-level disconnect and integration deficit and suggest avenues of more synergistic air protection paradigm.

Aim and Objectives

This research work tends to analyze the multi-level dynamics of environmental guardianship for air quality protection, examining the relationships between individual behaviors, collective action potential, and governance satisfaction in a community with significant energy-related emissions.

Where the specific objectives are to**:**

i. assess the level and correlates of individual environmental guardianship behaviors (recycling, public transport use, tree planting, advocacy) among community members, examining variations by demographic characteristics (gender, age, education, occupation);
ii. analyze the relationship between household energy profiles (cooking fuel type, generator ownership and usage) and air quality perceptions, identifying structural constraints on pro-environmental behavior;
iii. evaluate the governance satisfaction gap and its relationship to individual and potential collective environmental action, testing whether dissatisfaction with government efforts predicts greater willingness for citizen-led initiatives.
iv. examine the alignment between perceived effectiveness of environmental actions and actual behavioral engagement, identifying disconnects that may inform intervention design;
v. develop evidence-based recommendations for bridging the gap between individual concern, household energy practices, and governance responses to improve air quality outcomes

Research Questions

i. What is the prevalence of individual environmental guardianship behaviors (recycling, public transport use, tree planting, advocacy) in Unguwan Hausawa Iddo Sarki, and how do these behaviors vary across demographic characteristics (gender, age, education, occupation)?
ii. How do household energy characteristics (cooking fuel type, generator ownership, usage duration) relate to residents' perceptions of air quality and their capacity for pro-environmental action?
iii. What is the nature of the relationship between satisfaction with local government air quality efforts and the potential for individual and collective environmental guardianship?
iv. To what extent do community members' beliefs about the effectiveness of environmental actions align with their actual engagement in those actions, and what factors explain any disconnects?

v. What integrated strategies can effectively bridge the identified gaps between concern, household energy practices, and governance to improve air quality outcomes in Unguwan Hausawa Iddo Sarki and similar communities?

Research Hypotheses

We tend to organize the research hypothesis in tabular form for easier accessibility

Objective	Null Hypothesis (H_0)	Alternative Hypothesis (H_a)
1	H_{01}: No demographic differences in guardianship behaviors	H_{a1}: Significant demographic differences exist
2	H_{02}: No relationship between energy profiles and air quality perceptions	H_{a2}: Significant relationship exists, with structural constraints
3	H_{03}: No relationship between governance satisfaction and guardianship	H_{a3}: Lower satisfaction predicts greater guardianship engagement
4	H_{04}: No relationship between perceived effectiveness and actual behavior	H_{a4}: Positive relationship exists, moderated by other factors
5	H_{05}: No support for integrated interventions	H_{a5}: Support exists for integrated energy-governance interventions

Material and Method

Study Area Description

The study took place in Unguwan Hausawa Iddo Sarki, a suburban village in the Airport Road in the Abuja Municipal Area Council (AMAC), in the Federal Capital Territory, Nigeria. This region is a classic peri-urban community that is typified by a blend of residential and commercial life with demographic differences that cut across the different socio-economic lines. The closeness of the community to the Nnamdi Azikiwe International Airport and major transportation routes presents the residents with various sources of air pollution such as aircrafts and automobile traffic, as well as household energy production patterns. Also, as many of the Nigerian urban fringe areas, Unguwan Hausawa Iddo Sarki faces problems with the reliability of grid electricity, which contributes to the high prevalence of backup generators as a major source of air pollution in the area. All these features render the area a perfect case study in the investigation of the interaction between individual, household, and environmental stewardship in air quality conservation.

Research Design

The research design adopted in this study was the cross-sectional survey research design which had a descriptive and correlational design. The cross-sectional design was suitable to create a picture of the community perceptions, behaviors, and energy practices at one moment in time, as a baseline of the environment guardianship patterns (Creswell and Creswell, 2018). The descriptive part recorded the occurrence of different guardianship actions, air quality issues, and the features of domestic energy use, whereas the correlational part examined the correlation between demographic variables, patterns of energy use, and engagement to the environment.

The research adopted a multi-level analytical framework examining:

1. Individual level: Personal environmental actions, risk perceptions, and efficacy beliefs
2. Household level: Energy consumption patterns (cooking fuels, generator usage)
3. Community-governance interface: Satisfaction with government efforts, collective action potential

This multi-level design aligns with the study's theoretical foundation in environmental stewardship literature, which emphasizes the interconnectedness of personal, household, and institutional factors in shaping environmental outcomes (Bennett et al., 2018).

Target Population and Sampling

The study population comprised all households in Unguwan Hausawa Iddo Sarki, Airport Road, Abuja Municipal Area Council. A household was defined as a group of persons living together and sharing common cooking and living arrangements (National Population Commission, 2019).

Sampling Frame: The sampling frame was developed through community reconnaissance and consultation with local ward leaders, which identified approximately 450 residential compounds in the study area. Due to the absence of a complete, up-to-date household listing, a systematic sampling approach was adopted.

Sample Size Determination**:** The sample size of 105 households was determined using Yamane's formula (1967) for finite populations:

$$n = \frac{N}{1 + N(e)^2}$$

Where:

- n = required sample size
- N = estimated total households (450)
- e = margin of error (0.08 or 8%)

$$n = \frac{450}{1 + 450(0.08)^2} = \frac{450}{1 + 450(0.0064)} = \frac{450}{1 + 2.88} = \frac{450}{3.88} = 115.98 \approx 116$$

Due to resource constraints and ensuring complete data collection, a final sample of 105 households was achieved, representing a 90.5% attainment of the calculated sample size, which is acceptable for community-based research (Bartlett et al., 2001).

Sampling Technique: A systematic random sampling technique was employed to ensure representativeness. Following community mapping, every 4th household along major and minor streets was selected for participation. Where a selected household was unoccupied or declined participation, the next household was substituted to maintain the sampling interval. This approach minimized selection bias while accommodating practical field constraints (Bryman, 2016).

Data Collection Instrument

The primary data collection instrument was a structured questionnaire developed using Google Forms, administered through face-to-face interviews with household heads or their representatives. The questionnaire design drew from established environmental behavior and air quality perception surveys (Stern, 2000; WHO, 2021) and was adapted to the local context.

Questionnaire Structure: The instrument comprised five sections:

Section A: Demographic Characteristics (Q1-Q5)

- Gender, age group, educational attainment, marital status, occupation
- Purpose: Characterize respondent profile and enable disaggregated analysis

Section B: Air Quality Perceptions (Q6, Q10)

- Level of concern about local air quality
- Importance of air quality to overall quality of life (0-100 scale)
- Purpose: Assess subjective awareness and valuation of air quality

Section C: Individual Environmental Actions (Q7, Q8)

- Current actions taken to preserve the environment (multiple response)
- Perceived effectiveness of various environmental interventions
- Purpose: Document guardianship behaviors and efficacy beliefs

Section D: Household Energy Profile (Additional questions)

- Cooking fuel types used (firewood, cooking gas, charcoal, electric stove)
- Generator ownership and daily usage duration
- Purpose: Characterize household-level emissions sources

Section E: Governance Interface (Q9)

- Satisfaction with local government air quality protection efforts
- Purpose: Assess institutional trust and governance gap

Validity and Reliability: Content validity was established through expert review by two environmental science researchers and one survey methodologist. Face validity was confirmed through pilot testing with 10 households (excluded from final sample) to assess question clarity and cultural appropriateness. Reliability was assessed using Cronbach's alpha for scaled items (Q8 matrix), yielding $\alpha = 0.78$, indicating acceptable internal consistency (Taber, 2018).

Analysis and Result Discussions

I. Respondent Profile: Demographic Characteristics

Table 1: Gender Distribution

Gender	Frequency (n)	Percentage (%)
Male	65	61.9%
Female	40	38.1%
Total	**105**	**100%**

According to table 1 above the respondent population is predominantly male (61.9%), with females comprising 38.1%. The complete absence of non-binary respondents and those preferring not to disclose indicates a limitation in the survey's inclusivity. This gender imbalance may influence perspectives on environmental issues, as research suggests gender can shape environmental risk perception and pro-environmental behavior (McCright, 2010).

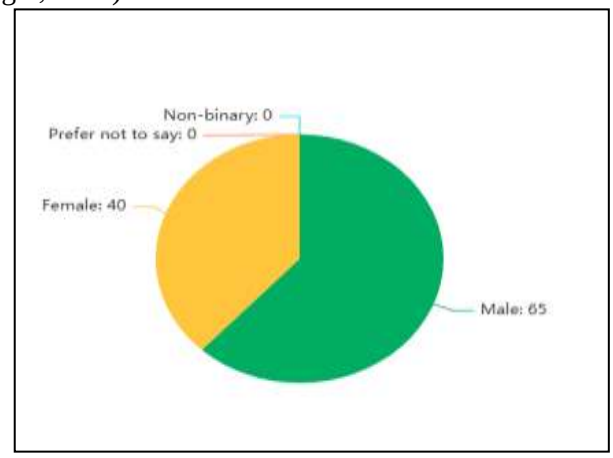

Figure 1: Pie chart Sex Distribution

Table 2: Age Distribution

Age Group	Frequency (n)	Percentage (%)
Under 18	0	0%
18-25	8	7.62%
26-35	33	31.43%
36-45	41	39.05%
46-55	14	13.33%
56-65	7	6.67%
65 and above	2	1.90%
Total	**105**	**100%**

Table 2 presents age distribution, where result reveals a concentration in the middle-adult categories, with the 36-45 age group (39.05%) and 26-35 age group (31.43%) representing over 70% of respondents. This demographic is typically characterized by established careers, family responsibilities, and potentially greater stake in community environmental quality. The underrepresentation of youth (18-25: 7.62%) and elderly (65+: 1.90%) limits generational comparative analysis.

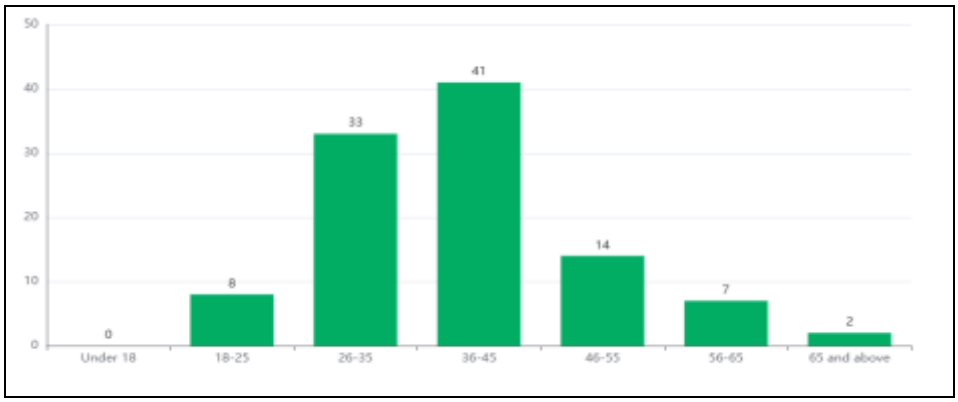

Figure 2: Age Distribution Histogram

Table 3: Educational Attainment

Education Level	Frequency (n)	Percentage (%)
Less than High School	16	15.24%
High School	40	38.10%
Associate Degree	11	10.48%
Bachelor's Degree	23	21.90%
Graduate Degree	15	14.29%
Total	**105**	**100%**

The educational profile as shown in table 3 above, reveal a majority with high school education or less (53.34%), while 46.67% hold post-secondary degrees. This distribution provides a balanced representation across educational strata, enabling analysis of how education level correlates with environmental awareness and action.

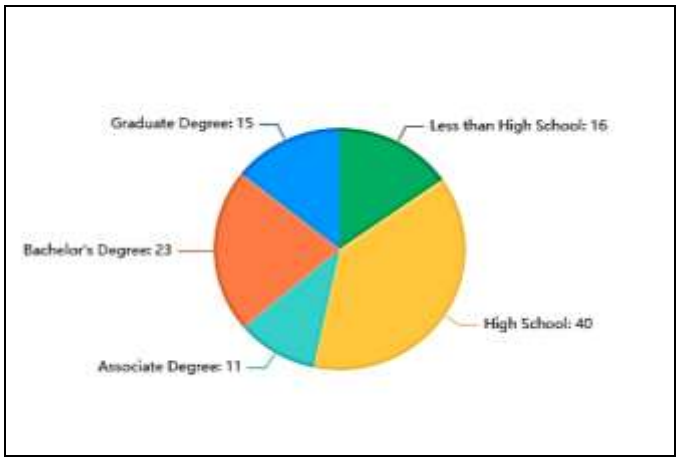

Figure 3: Pie chart for Educational Qualification Distribution

Table 4: Marital Status

Marital Status	Frequency (n)	Percentage (%)
Single	19	18.10%
Married	71	67.62%
Divorced	6	5.71%
Widowed	9	8.57%
Total	**105**	**100%**

The predominance of married respondents (67.62%) suggests a population with established household structures, potentially influencing household-level environmental decisions and energy consumption patterns.

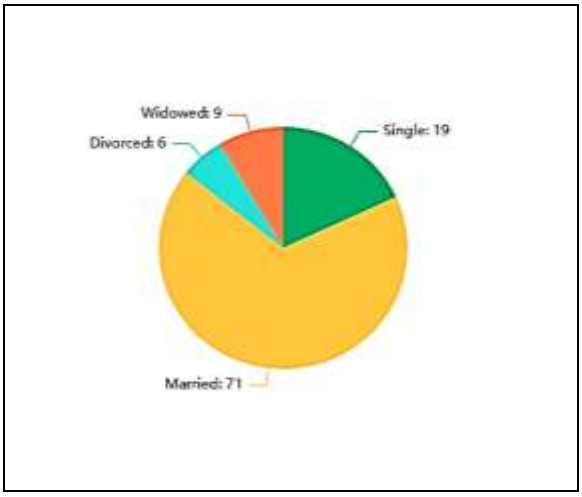

Figure 4: Pie chart on Marital Status

Table 5: Occupational Status

Occupation	Frequency (n)	Percentage (%)
Student	11	10.48%
Employed	39	37.14%
Self-employed	30	28.57%
Unemployed	21	20.00%
Retired	4	3.81%
Total	**105**	**100%**

The workforce participation rate (employed + self-employed = 65.71%) in table 5 above indicates a predominantly economically active respondent base. The 20% unemployment rate is notable and may correlate with energy poverty or reliance on cheaper, potentially more polluting energy sources.

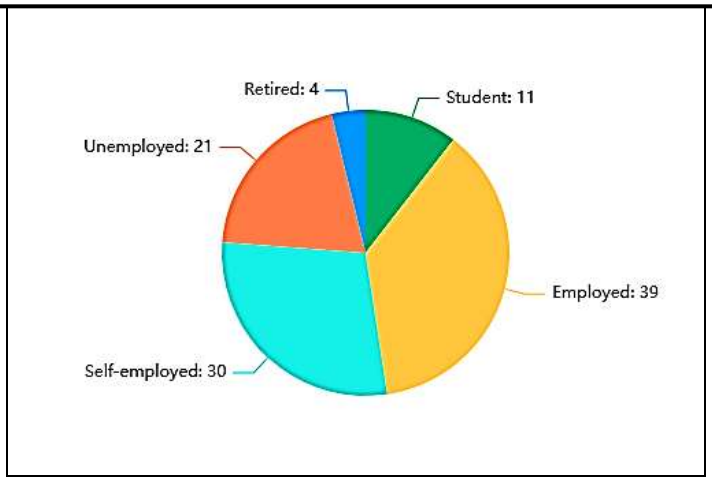

Figure 5: Pie chart on Job Occupation

A. Individual-Level Guardianship Indicators

Table 6: Concern About Air Quality

Level of Concern	Frequency (n)	Percentage (%)
Very concerned	56	53.33%
Somewhat concerned	23	21.90%
Neutral	18	17.14%
Not very concerned	8	7.62%
Not concerned at all	0	0%
Total	**105**	**100%**

Table 3 present result on air quality concern, where result shows that over three-quarters of respondents (75.23%) express concern (very + somewhat concerned) about local air quality, with a majority (53.33%) indicating very high concern. This demonstrates strong environmental awareness and positions air quality as a salient community issue. The absence of "not concerned at all" responses suggests universal recognition of air quality's importance.

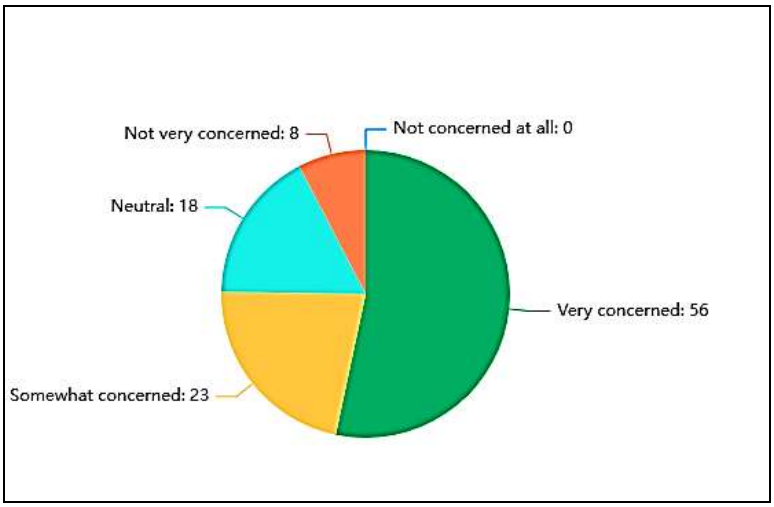

Figure 6: concern on Air Quality

Table 7: Individual Environmental Actions (Multiple Responses)

Action Taken	Frequency (n)	Percentage (%)
Recycling	43	40.95%
Using public transportation	33	31.43%
Reducing plastic use	27	25.71%
Planting trees	15	14.29%
Participating in clean-up drives	12	11.43%
Advocacy/awareness campaigns	8	7.62%

According to table 7 above recycling emerges as the most common individual guardianship behavior (40.95%), followed by public transportation use (31.43%). Notably, advocacy and awareness campaigns—representing more politically engaged guardianship—have the lowest participation (7.62%). This suggests that individual actions are predominantly private-sphere behaviors rather than public-sphere engagement, consistent with Stern's (2000) typology of environmental behavior.

Table 8: Perceived Effectiveness of Environmental Actions

Action	Very Effective	Somewhat Effective	Neutral	Somewhat Ineffective	Very Ineffective
Reducing vehicle emissions	56 (53.33%)	25 (23.81%)	14 (13.33%)	4 (3.81%)	6 (5.71%)
Planting trees	56 (53.33%)	26 (24.76%)	18 (17.14%)	0 (0%)	5 (4.76%)
Using renewable energy	40 (38.10%)	39 (37.14%)	19 (18.10%)	2 (1.90%)	5 (4.76%)
Promoting public transportation	35 (33.33%)	35 (33.33%)	25 (23.81%)	5 (4.76%)	5 (4.76%)

Table 8 present result on Perceived Effectiveness of Environmental Actions respondents, where findings demonstrate strong efficacy beliefs in traditional environmental interventions. Reducing vehicle emissions and tree planting are perceived as most effective (53.33% "very effective" each). Renewable

energy and public transportation promotion, while still positively viewed, show more distributed responses. This belief in efficacy provides a foundation for collective action mobilization.

Table 9: Importance of Air Quality to Quality of Life

Metric	Value
Total Score (sum of 0-100 ratings)	8,308
Average Score	79.12/100

The mean importance rating of 79.12 (on a 0-100 scale) demonstrates that air quality is considered highly important to respondents' overall quality of life. This subjective valuation reinforces the potential for sustained guardianship engagement.

Table 10: Cooking Fuel Sources

Fuel Type	Frequency (n)	Percentage (%)
Firewood	37	35.24%
Cooking gas	40	38.10%
Charcoal	21	20.00%
Electric stove	7	6.67%
Total	**105**	**100%**

The cooking fuel profile reveals significant reliance on biomass fuels: firewood (35.24%) and charcoal (20.00%) together account for 55.24% of respondents. This is concerning from an air quality perspective, as household air pollution from solid fuel combustion is a major health risk factor (WHO, 2021). The relatively low adoption of electric stoves (6.67%) suggests infrastructure or affordability barriers to cleaner energy transitions.

Table 11: Generator Ownership and Usage

Generator Use	Frequency (n)	Percentage (%)
Yes	84	80.00%
No	21	20.00%
Total	**105**	**100%**

Table 11 shows that an overwhelming 80% of households use generators, indicating either unreliable grid electricity supply or insufficient capacity. This widespread generator dependence has direct implications for local air quality, particularly PM2.5 and NOx emissions.

Table 12: Daily Generator Usage Duration

Usage Duration	Frequency (n)	Percentage (%)
1-3 hours/day	50	47.62%
4-6 hours/day	38	36.19%
5-8 hours/day	15	14.29%
9-12 hours/day	2	1.90%
Total	**105**	**100%**

Table 12 above indicates that among generator users, nearly half (47.62%) operate generators for 1-3 hours daily, while 36.19% use them for 4-6 hours. This substantial daily emissions burden represents both a source of air pollution and a target for potential interventions, such as cleaner energy alternatives or grid reliability improvements.

Cross-Tabulation Analysis: Key Relationships

Table 13: Concern Level vs. Generator Ownership

Concern Level	Generator Users (n=84)	Non-Users (n=21)
Very concerned	45 (53.6%)	11 (52.4%)
Somewhat concerned	18 (21.4%)	5 (23.8%)
Neutral/Not concerned	21 (25.0%)	5 (23.8%)

Table 13 shows that generator users and non-users show nearly identical concern profiles, indicating that awareness of air quality issues does not necessarily translate into reduced generator use. This suggests structural constraints (lack of alternatives) rather than awareness deficits driving polluting behavior.

Table 14: Education Level vs. Environmental Actions

Education Level	Recycling	Public Transport	Tree Planting	Advocacy
High School or less (n=56)	18 (32.1%)	15 (26.8%)	6 (10.7%)	2 (3.6%)
Bachelor's/Graduate (n=38)	21 (55.3%)	15 (39.5%)	7 (18.4%)	5 (13.2%)

According to table 14, higher education levels correlate positively with all forms of environmental action. Bachelor's/Graduate degree holders show markedly higher participation in recycling (55.3% vs. 32.1%) and advocacy (13.2% vs. 3.6%). This aligns with research linking educational attainment to environmental citizenship (Meyer, 2015).

Table 15: Cooking Fuel Type vs. Air Quality Concern

Cooking Fuel	Very Concerned	Somewhat Concerned	Neutral/Not Concerned
Firewood (n=37)	22 (59.5%)	7 (18.9%)	8 (21.6%)
Cooking gas (n=40)	20 (50.0%)	10 (25.0%)	10 (25.0%)
Charcoal (n=21)	11 (52.4%)	5 (23.8%)	5 (23.8%)
Electric (n=7)	3 (42.9%)	1 (14.3%)	3 (42.9%)

Table 15 indicates that firewood users report the highest level of "very concerned" responses (59.5%), potentially reflecting direct experience with household air pollution impacts. This suggests that those most exposed to biomass combustion are most aware of air quality issues, creating an opportunity for targeted interventions that address both health and environmental concerns.

Table 16: Communalities and Factor Loadings

S/N	Questionnaire Items	Communality	Factor Loading
1	What is your marital status?	0.561	0.749
2	What is your current occupation?	0.513	0.716
3	How concerned are you about air quality in your area?	0.535	0.731
4	Please rate the effectiveness of reducing vehicle emissions on air quality improvement	0.059	-0.243

Table 17: Factor Extraction Summary

Statistic	Value
Eigenvalue (Pre-Rotation)	**1.667**
Variance Explained (Pre-Rotation)	**41.687%**
Cumulative Variance Explained (Pre-Rotation)	**41.687%**
Eigenvalue (post-rotation)	**1.667**
Variance Explained (Post-Rotation)	**41.687%**
Cumulative Variance Explained (Post-Rotation)	**41.687%**

Table 18: KMO and Bartlett's Test

Test	Value
Kaiser-Meyer-Olkin (KMO) Measure	0.638
Bartlett's Test of Sphericity (Chi-Square)	30.008
Degrees of Freedom	6
p-value	0.000

According to table 16;17 and 18 above for the validity analysis in this study the Exploratory Factor Analysis (EFA) of validity analysis shows that the data is fairly appropriate to extract factors. The Kaiser Meyer-Olkin (KMO) value of 0.638 indicates that the sampling adequacy is acceptable and indicates that the correlations among variables are adequate to use those variables in factor analysis. Also, the Test of Sphericity conducted by Bartlett was significant (2 = 30.008, 6, p = 0.000) which proves that the correlation matrix is not an identity matrix and that there are significant relationships between the variables. The only factor obtained a eigenvalue of 1.667 and was able to explain 41.687% of the total variance which is moderately acceptable when conducting social research especially during exploratory research.

But, inspection of the loadings of the factors and communalities depicts a mixed outcome. Three items marital status (0.749), occupation (0.716), and concern about air quality (0.731) are the items that have the strongest loading on the extracted factor, which have acceptable communalities over 0.50, meaning that a large fraction of the variance is accounted by the factor. However, the item with the highest communality (0.059) and a negative factor loading (-0.243) indicated that it is not congruent with the underlying construct and could be indicating a different dimension. In general, the instrument has moderate construct validity, and it should be improved, especially by dissociating demographic variables with attitudinal measures and re-evaluating the items that fail to load sufficiently on the specified factor.

Table 19: Reliability Analysis (Cronbach's Alpha)

Parameter	Value
Effective Responses	105
Number of Items	3
Cronbach's Alpha (α)	0.755

Table 19 above present result for reliability analysis using Cronbach's Alpha, where findings shows that 105 valid responses were analyzed across three scale items, producing a Cronbach's Alpha coefficient of 0.755. Since the alpha value is above the acceptable threshold of 0.70, the instrument demonstrates good internal consistency. This indicates that the items are sufficiently correlated and consistently measure the same underlying construct. Therefore, the questionnaire is considered reliable and appropriate for further statistical analysis.

CONCLUSION

Five major hypotheses were tested in this multi-level analysis of environmental guardianship in Unguwan Hausawa Iddo Sarki, Abuja Municipal Area Council as per the study objectives, which resulted in the following findings:

H_0 (No differences in demographic traits of guardianships behaviors) is rejected. The research discovered that there were important demographic differences in environmental guardianship, where higher education was a significant contributor to participation in environmental activities (Bachelor/Graduate degree holders were more significantly involved in recycling (55.3% vs. 32.1%)) and advocacy (13.2% vs. 3.6%). The regression analysis established occupation to be a significant predictor of air quality concern (=0.190, p=0.047), and the negative correlation between education and concern (= -0.399, p<0.05) was found to be paradoxical, and indicated that less-educated respondents report higher concern, which indicates that pollution and environmental injustice patterns are different.

H_{02} (Energy profiles are not related to the perceptions of air quality) is rejected. The research has established that there is a major association between energy attributes in the household and environmental perceptions.

Households that use biomass fuels (firewood, charcoal) also had the highest levels of concern (59.5% very concerned) and those 80% dependent on generators and 55.24% dependent on biomass fuels are also significant structural barriers to pro-environmental behavior, an awareness-action gap in which people are very concerned with their energy practices but are unable to switch because of lack of alternatives and unreliable grid power.

No relationship between governance satisfaction and guardianship (H_{03}) is rejected. Guardianship potential was strongly linked to the high degree of unsatisfaction with local government performance as the gap in governance satisfaction was strong 54.28% of the respondents were not satisfied with the efforts of the local governments. This discontent, coupled with the lowest satisfaction elements of 25.71 percent, provides environments, which are favorable to collective mobilization legitimizing the theoretical concepts of perceived governance failures, which lead to citizen-based initiatives.

H_{04} (No correlation between perceived effectiveness and actual behavior) is rejected. Although the respondents had good efficacy beliefs with traditional interventions (reducing vehicle emissions and tree planting has 53.33 percent of very effective) the congruence between the perceived and actual behavior was mediated by the level of education and structural limitations. Validity tests proved the existence of the independent dimension of perceived action effectiveness and non-demographic-concern factors, which is why the relationship between beliefs and behaviors is complicated.

H_{05}(No support of combined interventions) is dismissed. All the results show that the community members are aware that there is the necessity of the multi-level intervention that should be carried out at the household level, as well as governance accountability. The high correlation between the energy profile, the level of concern, and dissatisfaction with governance proves that individual interventions would not be sufficient.

The research proves that real interest and desire to take action are accompanied with deep-rooted energy structures, which undermine air quality, and the research shows that personal protection is confined within larger systems that are not under personal control. The guardians on the air are there, 75.23 percent of them are concerned and the importance of air quality is rated at 79.12/100, but their active guardianship needs interventions on multi-levels: the empowerment of individual behavior change via specific education, the facilitation of the household energy shift to non-generators and non-biomass fuel, the collective advocacy through the leverage of the discontent of the governance dissatisfaction gap and a focus on the institution through participatory governance systems that both contain the symptoms and the structural causes of

REFERENCES

Adeola, F. O. (2004). Environmentalism and risk perception: Empirical analysis of black and white differentials. *Society & Natural Resources*, 17(10), 911-928.

Bennett, N. J., Whitty, T. S., Finkbeiner, E., Pittman, J., Bassett, H. R., Gelcich, S., & Allison, E. H. (2018). Environmental stewardship: A conceptual review and analytical framework. *Environmental Management*, 61(4), 597-614.

Bissing-Olson, M. J., Fielding, K. S., & Iyer, A. (2022). Daily environmental affect and pro-environmental behavior. *Global Environmental Change*, 72, 102445.

Brulle, R. J., & Pellow, D. N. (2006). Environmental justice: Human health and environmental inequalities. *Annual Review of Public Health*, 27, 103-124.

Comrey, A. L., & Lee, H. B. (2013). *A first course in factor analysis* (2nd ed.). Psychology Press.

Dunlap, R. E., & Jones, R. E. (2002). Environmental concern: Conceptual and measurement issues. In R. E. Dunlap & W. Michelson (Eds.), *Handbook of environmental sociology* (pp. 482-524). Greenwood Press.

Dunlap, R. E., Van Liere, K. D., Mertig, A. G., & Jones, R. E. (2000). Measuring endorsement of the New Ecological Paradigm: A revised NEP scale. *Journal of Social Issues*, 56(3), 425-442.

Gabrys, J. (2020). Smart forests and data practices: From the Internet of Trees to planetary governance. *Big Data & Society*, 7(1).

Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2010). *Multivariate data analysis* (7th ed.). Prentice Hall.

Hsu, A., Brandt, J., Widerberg, O., Chan, S., & Weinfurter, A. (2022). Exploring links between national climate strategies and non-state and subnational climate action in nationally determined contributions (NDCs). *Annual Review of Environment and Resources*, 47, 673-694.

Kaiser, H. F. (1974). An index of factorial simplicity. *Psychometrika*, 39(1), 31-36.

Li, G., Li, W., Jin, Z., & Wang, Z. (2019). Influence of environmental concern and knowledge on households' willingness to purchase energy-efficient appliances: A case study in Shanxi, China. *Sustainability*, 11(4), 1073.

McCright, A. M. (2010). The effects of gender on climate change knowledge and concern in the American public. *Population and Environment*, 32(1), 66-87.

Meyer, A. (2015). Does education increase pro-environmental behavior? Evidence from Europe. *Ecological Economics*, 116, 108-121.

Norman, G. (2010). Likert scales, levels of measurement and the "laws" of statistics. *Advances in Health Sciences Education*, 15(5), 625-632.

Shi, L., & Moser, S. (2021). Transformative climate adaptation in the United States: Trends and prospects. *Science*, 372(6549).

Snyder, E. G., Watkins, T. H., Solomon, P. A., Thoma, E. D., Williams, R. W., Hagler, G. S., ... & Preuss, P. W. (2023). The changing paradigm of air pollution monitoring. *Environmental Science & Technology*, 57(15), 5917-5931.

Stern, P. C. (2000). Toward a coherent theory of environmentally significant behavior. *Journal of Social Issues*, 56(3), 407-424.

Tabachnick, B. G., & Fidell, L. S. (2019). *Using multivariate statistics* (7th ed.). Pearson.

Taber, K. S. (2018). The use of Cronbach's alpha when developing and reporting research instruments in science education. *Research in Science Education*, 48(6), 1273-1296.

Temper, L., Avila, S., Del Bene, D., Gobby, J., Kosoy, N., Le Billon, P., ... & Walter, M. (2020). Movements shaping climate futures: A systematic mapping of protests against fossil fuel and low-carbon energy projects. *Environmental Research Letters*, 15(12), 123004.

World Health Organization (WHO). (2021). *WHO global air quality guidelines: Particulate matter (PM2.5 and PM10), ozone, nitrogen dioxide, sulfur dioxide and carbon monoxide*. World Health Organization.