



Environmental Sustainability and Intergenerational Equity in Africa: Evidence from Nigeria on Local Conservation and Geospatial Governance

Happy Pere-ela Omodu, PhD

Department of Geography and Environmental Sustainability, Niger Delta University Wilberforce Island
Bayelsa State, Nigeria

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ABSTRACT

Africa's environmental pressures raise a direct question of intergenerational equity: whether current patterns of extraction, land conversion, pollution, and weak environmental monitoring are reducing the resource base available to future populations. This study examines that question through a framework that connects localized conservation practices with geospatial governance. A cross-sectional, mixed-source design combined structured survey evidence with secondary environmental and spatial information. Primary data comprised 842 valid responses from community members, industry practitioners, and local government and traditional leaders in environmentally affected Nigerian communities. Descriptive statistics assessed perceived degradation and projected resource deficits, while ordinary least squares regression tested the association of localized conservation and geospatial governance with intergenerational resource availability. Gas flaring recorded the highest current impact score (5.5 on a six-point scale), followed by carbon emissions (5.2), deforestation (4.8), and biodiversity loss (4.1). The regression model explained 68.4% of the variance in intergenerational resource availability ($R^2 = .684$, $F = 142.6$, $p < .001$). Localized conservation ($\beta = .412$, $t = 6.34$, $p < .001$) and geospatial governance ($\beta = .388$, $t = 5.82$, $p < .001$) were both positive predictors. The findings support an integrated approach in which community ecological knowledge supplies contextual intelligence while spatial technologies strengthen monitoring, accountability, and scale. Environmental policy that separates these capacities risks weakening long-term resource protection.

Keywords: environmental sustainability, geospatial governance, indigenous knowledge, intergenerational equity, localized conservation, natural capital, posterity

INTRODUCTION

Environmental sustainability in Africa is increasingly an intergenerational question rather than only a present-day management problem. Climate extremes, ecosystem degradation, pollution, and pressure on land and water systems affect current livelihoods, but they also alter the resource base available to future populations. The World Meteorological Organization (WMO, 2024) reports continuing climate-related pressure across Africa, while the Intergovernmental Panel on Climate Change (IPCC, 2022) identifies high exposure and adaptation constraints in many African settings. In extractive regions such as the Niger Delta, these pressures overlap with oil pollution, gas flaring, and other industrial impacts that affect local ecosystems and livelihoods (Henshaw, 2026; United Nations Environment Programme [UNEP], 2023). The result is a sustainability problem in which present economic activity can create ecological costs that persist beyond the generation that receives the immediate benefits.

Sustainable development requires present needs to be met without compromising the capacity of future generations to meet theirs (World Commission on Environment and Development [WCED], 1987). Intergenerational equity extends that principle by treating future people as legitimate beneficiaries of environmental governance even though they cannot participate in present political and market decisions. Fambasayi and Addaney (2021) connect this concern to the rights of children and future generations in African



climate governance, while Nkrumah (2024) places future citizens within contemporary climate-justice debates. The issue is therefore not only whether environmental harm is occurring, but also how present institutions distribute its consequences across time.

Recent scholarship points to two sets of responses that are especially relevant to that problem. The first is localized conservation, which draws on community rules, environmental knowledge, and locally grounded forms of stewardship. Studies of environmental management and community conservation in African contexts show that local actors often hold detailed knowledge of ecological change and resource use that can strengthen conservation practice (Aliyev et al., 2023; Enarebebe-Emberu et al., 2020; Kieti & Nthiga, 2023). The second is geospatial governance, through which remote sensing, spatial databases, predictive tools, and other forms of digital environmental monitoring can extend observation beyond the scale of a single community (Brookings Institution, 2024; United Nations Economic Commission for Africa [UNECA], 2024). These two bodies of work are rarely tested together in relation to intergenerational resource availability.

This study therefore examines the implications of contemporary environmental degradation for intergenerational resource availability and tests whether localized conservation practices and geospatial governance predict that outcome. The study proposes that the two mechanisms are complementary rather than competing. Local institutions provide context-specific ecological knowledge and legitimacy, while spatial technologies can improve measurement, monitoring, transparency, and coordination beyond the scale of a single community. The hypothesis is that localized conservation practices and geospatial governance are positively associated with intergenerational resource availability. By testing both predictors within one model, the study contributes evidence to debates on how culturally grounded environmental management can be connected to data-driven governance in environmentally vulnerable African settings.

LITERATURE REVIEW

Environmental sustainability links ecological integrity to the continuity of social and economic life. The classic formulation of sustainable development places future generations within present development choices by requiring that the needs of the present not be met through the erosion of future capacity (WCED, 1987). Intergenerational equity gives that principle a distributive meaning because environmental costs created today may be borne by people who had no role in the decisions that produced them. Fambasayi and Addaney (2021) locate this concern within African climate and child-rights debates, while the International Institute for Environment and Development (IIED, 2022) treats intergenerational equity as a practical question of how current development choices preserve or reduce future options. Nkrumah (2024) similarly frames future citizens as stakeholders in climate action. In this study, the posterity concept therefore refers to the obligation to maintain environmental conditions that allow future populations to sustain livelihoods and development opportunities.

The urgency of that obligation is visible in the interaction between environmental stress and socioeconomic vulnerability. WMO (2024) documents climate-related impacts across African economies and communities, while the Food and Agriculture Organization (FAO, 2023, 2024) links food-system pressures to environmental and economic conditions that affect agricultural productivity and household welfare. The African Development Bank (AfDB, 2024) also places climate resilience and natural-resource management within Africa's wider development challenge. Where pollution, land degradation, or ecosystem loss reduces the quality of productive resources, the effect can extend beyond immediate environmental damage to future employment, food security, health, and local income. UNEP (2023) adds that adaptation remains underfinanced relative to the scale of climate risk, which increases the likelihood that present environmental losses will remain unresolved.

Energy and extraction debates illustrate the same tension between present development needs and long-term environmental costs. The International Energy Agency (IEA, 2022) argues that Africa must expand access to modern energy while moving toward cleaner and more resilient systems. In the Niger Delta, public debate over gas flaring reflects the difficulty of reconciling production with the environmental and health costs borne by host communities (Fyneface, 2026; Henshaw, 2026). Renewable-energy investment may reduce some of these



pressures over time, but financing and infrastructure still need to reach the places where environmental risk is concentrated (International Renewable Energy Agency [IRENA], 2023). The intergenerational issue is therefore not a simple choice between development and conservation. It concerns the rules by which current benefits and delayed ecological costs are distributed.

Localized conservation offers one route for bringing long-term ecological knowledge into those rules. Indigenous and local knowledge systems are built through repeated observation of environmental change and practical interaction with specific ecosystems. Research on spatial and temporal environmental variation, community environmental management, and conservancy practice shows that local knowledge can identify ecological changes that broad administrative systems may miss (Aliyev et al., 2023; Enarebebe-Emberu et al., 2020; Kieti & Nthiga, 2023). The IPCC (2022) also recognizes the value of indigenous and local knowledge in climate adaptation. Such practices can include seasonal restrictions, customary access rules, community monitoring, and local indicators of environmental change. Their effectiveness, however, depends on institutional legitimacy, enforcement capacity, and the ability of local actors to withstand economic pressures that encourage overuse.

Ostrom's (1990) analysis of common-pool resources provides an institutional explanation for why community governance can succeed in some settings and fail in others. Her work challenges the assumption that centralized state control or privatization is always sufficient for resource protection. Durable common-resource institutions often depend on rules that fit local conditions, monitoring, sanctions, and arrangements that allow users to participate in rule making. More recent African evidence on community-based conservancies also shows that local participation can support conservation when communities retain a meaningful stake in environmental outcomes (Kieti & Nthiga, 2023). These perspectives help explain why localized conservation may contribute to future resource availability when knowledge is connected to authority and collective action rather than treated as information alone.

African communitarian thought adds a normative dimension to this institutional perspective. Chibvongodze (2016) argues that Ubuntu can extend moral relationships beyond human beings to the natural and spiritual environment. Environmental damage, from this perspective, is not only an economic externality but also a disruption of social continuity and relations with land and water. Ndlovu-Gatsheni (2020) similarly argues for African development approaches that take local knowledge systems seriously rather than treating external models as universally sufficient. This perspective aligns with the posterity concept because current people are understood as part of a continuing community whose obligations extend beyond immediate individual gain. It does not remove the need for modern environmental institutions, but it provides a culturally grounded account of why stewardship and continuity matter.

Geospatial governance addresses a different limitation of localized conservation: scale. Satellite imagery, geographic information systems, remote sensing, spatial databases, and predictive tools allow environmental change to be observed across areas that no single community can monitor. Brookings Institution (2024) identifies data and technological capacity as part of Africa's emerging development and governance agenda, while UNECA (2024) links green recovery to stronger systems for planning and environmental management. WMO (2024) also emphasizes the importance of climate information and monitoring for adaptation. Geospatial information can support accountability by linking environmental changes to identifiable locations and time periods. Its value nevertheless depends on data quality, institutional capacity, access, and the extent to which local observations are incorporated rather than displaced.

The relationship between local knowledge and geospatial systems is therefore potentially complementary. Local conservation can supply contextual information about ecological processes, land use, customary boundaries, and livelihood dependence, while geospatial systems can extend and document those observations across larger areas. The Global Center on Adaptation (GCA, 2022) stresses the need for locally informed adaptation that can also attract and guide wider investment, and WMO (2024) places climate information at the centre of risk management. When local observations can be connected to mapped evidence, environmental claims become easier to compare, communicate, and incorporate into planning. This creates a practical route through which community knowledge can inform institutions operating beyond the immediate locality.

The study integrates these arguments through sustainable development theory and African communitarian environmental thought. Sustainable development provides the intergenerational criterion: resource use should not erode the environmental capacity needed by future populations (WCED, 1987). Communitarian thought provides a relational account of stewardship grounded in social and ecological obligations (Chibvongodze, 2016). Geospatial governance adds the monitoring capacity needed to apply these principles across contemporary extractive and climate-stressed environments. Figure 1 presents the resulting framework. Localized conservation practices and geospatial governance effectiveness are treated as separate but related predictors of intergenerational resource availability, while environmental degradation forms the context in which those relationships are tested.

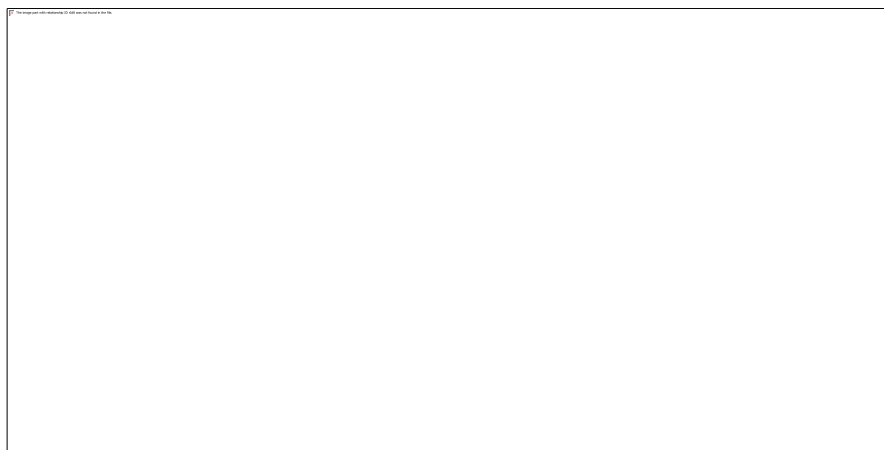


Figure 1. Integrated local conservation and geospatial governance framework.

METHODOLOGY

The study used a cross-sectional, mixed-source design that combined primary survey data with secondary environmental and spatial information. The design was chosen to connect perceptions and governance practices at community level with broader indicators of environmental pressure. Primary fieldwork focused on Nigerian locations affected by oil and gas activity, logging, coastal erosion, or related forms of environmental stress. Three geopolitical zones were purposively selected to capture contrasting extractive and ecological settings. Within these zones, communities were stratified according to proximity to active extraction sites or areas experiencing visible environmental degradation. Respondents were then selected from community members, industry practitioners, and local government and traditional leadership categories.

Structured digital questionnaires were administered between January and March 2026. The instrument measured perceived ecological decline, the presence and enforcement of localized conservation practices, the use of spatial or digital monitoring tools in governance, and expectations about future resource availability. A total of 842 valid responses were retained for analysis. The respondent pool comprised 412 community members, 218 industry practitioners, and 212 local government and traditional leaders. Secondary environmental information was drawn from established institutional sources and used to provide context for indicators related to forest loss, emissions, food systems, and resource pressure.

The dependent variable was Intergenerational Resource Availability, operationalized in the original study as a composite measure linking future livelihood viability to environmental resource conditions. The Localized Conservation Metric captured the reported presence and effectiveness of community-based ecological rules and practices. Geospatial Governance Effectiveness measured the use of spatial data, monitoring technologies, and related information systems in environmental decision making. Environmental degradation was summarized through four indicators: deforestation, carbon emissions, gas flaring, and biodiversity loss. Current impact was rated on a six-point scale from 1, minimal, to 6, critical. The study also reported projected ten-year resource deficits associated with each indicator.



Descriptive statistics were used to summarize respondent composition and environmental degradation scores. Ordinary least squares regression tested the joint relationship between localized conservation, geospatial governance, and intergenerational resource availability. The estimated model was $IRA = \beta_0 + \beta_1 LC + \beta_2 GG + \varepsilon$, where IRA denotes Intergenerational Resource Availability, LC denotes the Localized Conservation Metric, GG denotes Geospatial Governance Effectiveness, and ε is the error term. The variables were standardized before coefficient comparison. The original analysis also checked multicollinearity and heteroscedasticity as model diagnostics. Statistical decisions were based on the reported p values, with the regression model evaluated through R^2 , the F statistic, standardized coefficients, and t statistics.

RESULTS

All 842 valid responses were included in the quantitative analysis. Community members formed the largest respondent group, accounting for 48.9% of the sample. Industry practitioners represented 25.9%, while local government and traditional leaders represented 25.2% (Table 1).

Table 1 Profile of Study Respondents

Respondent category	Frequency	Percentage
Community members	412	48.9
Industry practitioners	218	25.9
Local government and traditional leaders	212	25.2

Note. Percentages are calculated from 842 valid responses.

The environmental indicators showed consistently high perceived pressure (Table 2). Gas flaring recorded the highest current impact score at 5.5 on the six-point scale and was classified as critical. Carbon emissions followed at 5.2, also within the critical range. Deforestation recorded 4.8 and was classified as high, while biodiversity loss recorded 4.1 and was classified as moderate. The study's ten-year projections associated gas flaring with the largest resource deficit, a 31.0% reduction in agricultural yield. Deforestation was associated with a 22.4% reduction in land viability, carbon emissions with an 18.1% decline in the air-quality index, and biodiversity loss with a 12.5% reduction in species retention. Figure 2 compares the current impact scores.

Table 2 Environmental Degradation Indicators and Projected Intergenerational Impacts

Indicator	Current impact score	Severity	Projected ten-year implication
Deforestation	4.8	High	22.4% reduction in land viability
Carbon emissions	5.2	Critical	18.1% decline in air-quality index
Gas flaring	5.5	Critical	31.0% reduction in agricultural yield
Biodiversity loss	4.1	Moderate	12.5% reduction in species retention

Note. Current impact scores use a six-point scale from 1 (minimal) to 6 (critical). Projected implications are the estimates reported in the original study for the ten-year period to 2036.

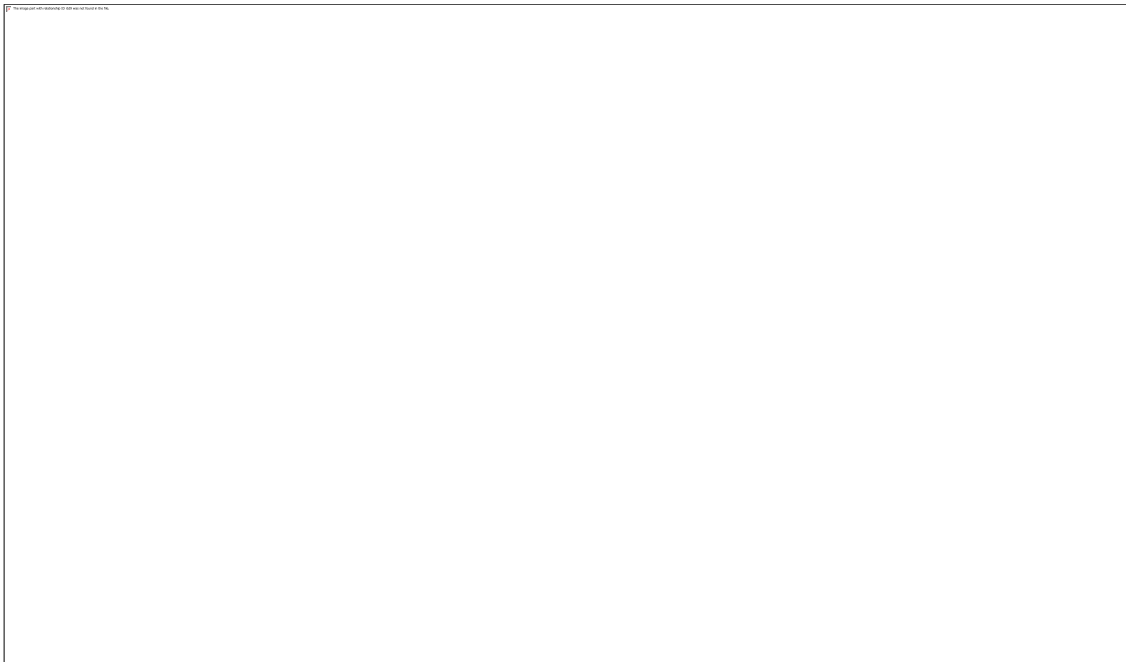


Figure 2. Current impact scores for the four environmental degradation indicators.

The regression model was statistically significant, $F = 142.6$, $p < .001$, and explained 68.4% of the variance in Intergenerational Resource Availability, $R^2 = .684$. Localized conservation had a positive standardized coefficient, $\beta = .412$, $t = 6.34$, $p < .001$. Geospatial governance also had a positive coefficient, $\beta = .388$, $t = 5.82$, $p < .001$. Both predictors were therefore positively associated with the dependent variable in the fitted model (Table 3).

Table 3 OLS Regression Predicting Intergenerational Resource Availability

Predictor	Standardized β	t	p
Localized conservation	.412	6.34	< .001
Geospatial governance	.388	5.82	< .001

Note. Dependent variable: Intergenerational Resource Availability. Model statistics: $R^2 = .684$, $F = 142.6$, $p < .001$, $N = 842$.

DISCUSSION

Gas flaring produced the highest impact score, while carbon emissions and deforestation also ranked near the upper end of the six-point scale. This pattern is consistent with evidence that environmental pressure in Africa often arises from overlapping climate, extraction, and resource-management problems rather than from a single hazard (AfDB, 2024; WMO, 2024). In the Niger Delta, continuing concern over gas flaring reflects the direct connection between extractive activity, community exposure, and long-term environmental quality (Henshaw, 2026). UNEP (2022, 2023) likewise links environmental deterioration and adaptation deficits to wider economic and social risks. The study's results therefore point to a cumulative problem in which present environmental pressures can narrow the resource options available to future populations.

The agricultural implications deserve particular attention because environmental stress interacts with existing food-system vulnerability. FAO (2023, 2024) identifies continuing pressure on food security and agricultural systems across Africa, while the International Labour Organization (ILO, 2023) shows that employment prospects remain closely connected to wider economic and structural conditions. In communities where land, fisheries, forests, or other natural resources support household income, ecological decline can affect both present earnings and future livelihood opportunities. Health consequences add another layer of exposure, as the



World Health Organization (WHO, 2023) links climate-related environmental conditions to health risks in the African region. The projected deficits reported in this study should be interpreted as study estimates rather than observed future outcomes, but their direction is consistent with the wider evidence that environmental degradation can weaken the productive base on which later generations depend.

Localized conservation was the stronger of the two predictors in the regression model. The positive coefficient indicates that stronger reported local conservation practices were associated with better intergenerational resource availability after geospatial governance was included in the same model. This result is consistent with evidence that locally grounded environmental knowledge can improve the recognition and management of spatially specific ecological change (Aliyev et al., 2023; Enarebebe-Emberu et al., 2020). Community-based conservancy research also shows that local participation can align livelihoods with conservation objectives when communities have a direct stake in resource protection (Kieti & Nthiga, 2023). The African Union Commission (AUC, 2021) similarly recognizes community participation and local knowledge within continental climate strategy. The finding therefore supports an institutional role for local actors without implying that community governance is sufficient on its own.

The result also gives empirical relevance to the communitarian dimension of the study. Chibvongodze (2016) treats Ubuntu as a relationship that can include the natural environment rather than only interpersonal obligation. Applied to environmental governance, that view shifts attention from ownership alone to continuity, responsibility, and shared dependence. Ndlovu-Gatsheni (2020) adds a decolonial argument for development approaches that take African knowledge systems seriously. A seasonal fishing restriction or community rule protecting a local ecosystem may appear small when measured against national policy, yet it can embody a long-term stewardship logic that formal institutions struggle to reproduce. The statistical association reported here cannot establish that communitarian values caused higher resource availability, but it is compatible with the proposition that locally legitimate conservation institutions can support environmental continuity when they remain active and enforceable.

Geospatial governance was also positively associated with intergenerational resource availability. This result matters because local knowledge, though valuable, has limits of coverage and verification. Environmental damage linked to extraction, deforestation, coastal change, or flooding may occur across large areas and involve actors beyond the immediate community. Spatial technologies can extend observation across those scales, create repeatable records, and provide evidence that can be compared over time. Brookings Institution (2024), GCA (2022), UNECA (2024), and WMO (2024) all place stronger information systems, data use, or monitoring within wider African resilience and development efforts. In the present study, the positive coefficient for geospatial governance suggests that respondents perceived stronger future resource conditions where environmental management was supported by spatially organized information.

Taken together, the two coefficients support an integrated rather than substitutional model of environmental governance. Local conservation contributes context, ecological memory, social legitimacy, and knowledge of how resources are used. Geospatial governance contributes scale, documentation, and a basis for coordination across administrative boundaries. Either system can be weakened when it operates alone. A technically sophisticated monitoring platform may identify environmental decline without producing action if local actors do not trust it or if the data fail to reflect lived ecological conditions. Conversely, a community may recognize erosion, forest loss, or declining fish stocks without having the evidentiary reach needed to influence regulators. The combined model is consistent with regional calls for stronger links between local adaptation, formal institutions, and measurable environmental governance (GCA, 2022; UNFCCC, 2023).

The findings also refine the application of sustainable development theory. WCED's (1987) intergenerational principle is often expressed at a high level of abstraction, but the present results identify two institutional mechanisms through which that principle can be made operational. Localized conservation addresses how communities govern resources in daily practice, while geospatial governance addresses how environmental change can be measured and communicated over time. Fambasayi and Addaney (2021) and Nkrumah (2024) both place future generations within contemporary African climate and justice debates. The present findings



add an institutional dimension to that argument by showing that future resource availability is positively associated with both local conservation and spatially informed governance.

Policy design should therefore avoid treating digital environmental governance as a replacement for local institutions. Public agencies can strengthen monitoring by linking satellite data, GIS-based records, and other spatial information with community reporting and local ecological knowledge. Such integration can improve the identification of environmental damage and help direct remediation, conservation finance, and enforcement. Continental and national policy frameworks already emphasize climate action, green investment, and environmental accountability (African Union [AU], 2022; AUC, 2021; IRENA, 2023). Economic instruments can also play a role where they are supported by credible monitoring. The World Bank (2023) shows that carbon-pricing systems are increasingly used to place an explicit cost on emissions. In extractive communities, however, such instruments are more likely to support intergenerational equity when affected populations have a meaningful role in identifying and documenting environmental costs.

Several limitations qualify these findings. The survey design is cross-sectional, so the regression estimates indicate association rather than temporal causation. The constructs rely partly on respondent assessments, which may reflect differences in experience, institutional position, and exposure to environmental problems. The ten-year deficit estimates are projections rather than observed future outcomes and should be interpreted within that constraint. The primary respondents were drawn from Nigeria, even though the conceptual argument addresses wider African sustainability debates. Future research could test the model longitudinally, combine household and institutional surveys with independently measured satellite indicators, and compare extractive regions across multiple African countries. Such designs would clarify whether the relationships reported here persist across governance systems and over time.

CONCLUSION

Environmental sustainability becomes an intergenerational governance problem when current economic activity reduces the land, water, ecosystem services, and livelihood options available to future populations. This study examined that problem by bringing localized conservation and geospatial governance into a single empirical model. The results showed high perceived pressure from gas flaring, carbon emissions, deforestation, and biodiversity loss, with gas flaring receiving the highest current impact score. The regression model accounted for 68.4% of the variation in Intergenerational Resource Availability, while both localized conservation and geospatial governance were positive predictors.

The findings support an approach to environmental governance that combines rather than separates local ecological institutions and spatial technologies. Community-based rules and knowledge can provide detailed understanding of ecosystem use, local legitimacy, and continuity of stewardship. Geospatial systems can extend those observations through monitoring, documentation, and comparison across space and time. The value of the model lies in this complementarity. Technology without local institutional grounding may produce data that do not translate into action, while local knowledge without wider monitoring capacity may struggle to influence decisions beyond the community.

For policy and research, the central implication is that intergenerational equity should be treated as an operational criterion for environmental management rather than only a moral aspiration. Environmental agencies, local governments, traditional institutions, and extractive-sector regulators can strengthen long-term resource protection by linking community monitoring to credible spatial evidence and by using that evidence to guide enforcement, remediation, and investment. Future work should test the model with longitudinal environmental observations and cross-country data. Protecting posterity requires decisions that preserve ecological capacity before degradation becomes an inheritance.

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