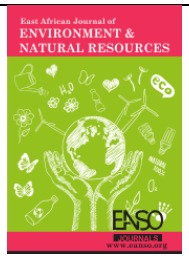


East African Journal of Environment and Natural Resources
eajenr.eanso.org
Volume 8, Issue 2, 2025
Print ISSN: 2707-4234 | Online ISSN: 2707-4242
Title DOI: https://doi.org/10.37284/2707-4242

EAST AFRICAN NATURE & SCIENCE ORGANIZATION

Original Article

Impacts of Non-Compliance with Environmental Mitigation Measures for Road Construction on Community Livelihood in Nyanza and Bugesera Districts, Rwanda

Gakunzi Santos[1], Dr. Pancras Ndokoye, PhD[2] & Regine Musengimana[3]*

[1] University of Lay Adventists of Kigali, P. O. Box 6392, Kigali, Rwanda.
[2] University of Technology and Arts of Byumba, P. O. Box 25, Byumba, Rwanda.
[3] Kibogora Polytechnic, P. O. Box 50, Nyamasheke, Rwanda.
[*] Correspondence Email: gakunzisantos123@gmail.com

Article DOI: https://doi.org/10.37284/eajenr.8.2.3445

Date Published: *06 August 2025*

Keywords: *Community Involvement, Environmental Degradation, Environmental Impact Assessment, Road Construction, Socio-Economic Impacts.*

ABSTRACT

The study sought to investigate the environmental impacts mitigation methods for road construction and community livelihood in Rwanda. Case of Nyanza and Bugesera. The study employed a mixed-method approach, collecting both quantitative and qualitative data by utilising a sample size of 249 respondents. Data collection techniques included questionnaires, interviews, and document analysis. The data were analysed through means, standard deviation and multiple linear regression analysis. Findings showed that environmental degradation was a notable outcome of the Kibugabuga-Shinga-Gasoro Road construction, with key concerns such as soil erosion (Mean = 3.85, SD = 0.78), vegetation destruction (Mean = 3.75, SD = 0.81), and water pollution exceeding World Health Organization thresholds. Multiple regression analysis revealed that 67.7% of the variance in environmental and socio-economic impacts could be explained by the combined effect of enforcement, mitigation, and monitoring measures. Among the predictors, monitoring contributed 39.8%, mitigation accounted for 26.5%, and enforcement contributed 24.2% to the observed impacts. These findings indicate that inadequate implementation of these three components was strongly associated with increased environmental degradation and socio-economic disturbances in the project areas. The study concludes that non-compliance with environmental impact mitigation measures significantly influenced environmental and socio-economic disruptions during the road construction project. The weak enforcement of environmental guidelines, poor implementation of mitigation measures, and inconsistent monitoring practices were the primary contributors to the observed negative impacts. To improve compliance and reduce negative outcomes, the study recommends that government agencies strengthen enforcement mechanisms through increased funding, staffing, and independent oversight. Project implementers should integrate mitigation plans into all stages of construction with clear timelines and accountability. Additionally, continuous environmental monitoring and transparent reporting should be institutionalised, and local communities should be actively involved in the oversight process to ensure sustainable and environmentally responsible road infrastructure development.

Article DOI: https://doi.org/10.37284/eajenr.8.2.3445

APA CITATION

Santos, G., Ndokoye, P. & Musengimana, R. (2025). Impacts of Non-Compliance with Environmental Mitigation Measures for Road Construction on Community Livelihood in Nyanza and Bugesera Districts, Rwanda. *East African Journal of Environment and Natural Resources*, *8*(2), 364-380. https://doi.org/10.37284/eajenr.8.2.3445.

CHICAGO CITATION

Santos, Gakunzi, Pancras Ndokoye and Regine Musengimana. 2025. "Impacts of Non-Compliance with Environmental Mitigation Measures for Road Construction on Community Livelihood in Nyanza and Bugesera Districts, Rwanda". *East African Journal of Environment and Natural Resources* 8 (2), 364-380. https://doi.org/10.37284/eajenr.8.2.3445

HARVARD CITATION

Santos, G., Ndokoye, P. & Musengimana, R. (2025) "Impacts of Non-Compliance with Environmental Mitigation Measures for Road Construction on Community Livelihood in Nyanza and Bugesera Districts, Rwanda", *East African Journal of Environment and Natural Resources*, 8 (2), pp. 364-380. doi: 10.37284/eajenr.8.2.3445.

IEEE CITATION

G. Santos, P. Ndokoye & R. Musengimana "Impacts of Non-Compliance with Environmental Mitigation Measures for Road Construction on Community Livelihood in Nyanza and Bugesera Districts, Rwanda", *EAJENR*, vol. 8, no. 2, pp. 364-380, Aug. 2025.

MLA CITATION

Santos, Gakunzi, Pancras Ndokoye & Regine Musengimana. "Impacts of Non-Compliance with Environmental Mitigation Measures for Road Construction on Community Livelihood in Nyanza and Bugesera Districts, Rwanda". *East African Journal of Environment and Natural Resources*, Vol. 8, no. 2, Aug 2025, pp. 364-380, doi:10.37284/eajenr.8.2.3445

INTRODUCTION

Road construction projects that disregard environmental mitigation measures are becoming more widely acknowledged as serious problems that have an impact on local residents and ecosystems (Awolorinke et al., 2023). In Rwanda, where economic growth depends on infrastructure development, adherence to Environmental Impact Assessments (EIAs) is crucial to guaranteeing sustainable practices. Given the serious environmental problems caused by disregarding EIA regulations, *Kibugabuga-Shinga-Gasoro* Road project serves as a case study emphasising the urgent necessity for efficient environmental governance. The livelihoods of communities and the integrity of natural resources are threatened by non-compliance, which can also result in serious ecological degradation, water pollution, and socioeconomic disturbances (Katju, 2018).

Despite the growing body of literature addressing environmental compliance in road construction, there remains a noticeable gap in research specific to Rwanda, particularly concerning localised factors influencing compliance behaviour. Studies in other contexts, such as Ali et al. (2021) and Olayinka et al. (2019), have identified issues like inadequate enforcement and financial constraints; however, these findings often lack contextual relevance to Rwanda's unique socio-economic and environmental landscape. Furthermore, regional studies such as Ndung'u et al. (2022) tend to generalise findings across East Africa without isolating the specific challenges and impacts faced within Rwanda. This lack of targeted research creates a knowledge gap that hampers effective policy-making and implementation strategies tailored to the country's needs.

This study seeks to fill these gaps by investigating the specific factors influencing non-compliance with EIA mitigation measures during the *Kibugabuga-Shinga-Gasoro* Road construction. By employing a mixed-methods approach that combines qualitative insights from stakeholders with quantitative data on environmental and socio-economic impacts, the research aims to provide an understanding of the relationship between environmental mitigation practices and community livelihoods. The findings contribute valuable insights for policymakers and practitioners, promoting enhanced compliance and sustainable infrastructure development in Rwanda. Ultimately, this research aspires to support the country's effort in achieving sustainable development goals and ensuring that infrastructure projects benefit both the environment and local communities.

Article DOI: https://doi.org/10.37284/eajenr.8.2.3445

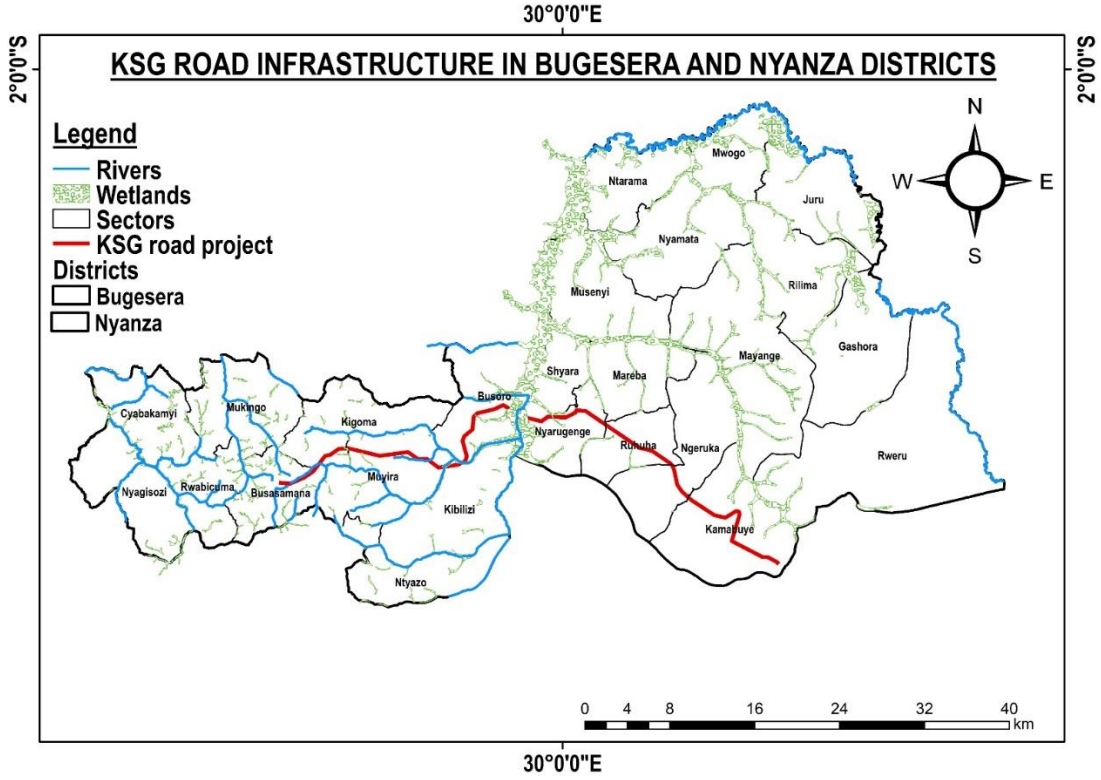
MATERIALS AND METHODS

Study Area Description

The *Kibugabuga-Shinga-Gasoro* Road Project, located in Rwanda's Nyanza and Bugesera districts, is a key infrastructure initiative aimed at enhancing regional transportation, promoting economic growth, and improving access to essential services for local communities (Munyaneza, 2024; Blowers, 2018). The project passes through a diverse landscape that includes agricultural lands, wetlands, and ecologically sensitive areas rich in biodiversity (Ali, 2021). These ecosystems are vital for the livelihoods of a growing population that heavily depends on agriculture and natural resources, highlighting the importance of environmental sustainability in the area (Jiang, 2019). Due to its strategic location near urban centres, the project area is also of significant development interest (Wang, 2021). However, the project has raised concerns about potential environmental degradation, particularly with regard to compliance with Environmental Impact Assessment (EIA) mitigation measures during construction (Munyaneza, 2024).

The study focuses on the geographical scope of the *Nyanza* district in the south and the *Bugesera* district in the east of Rwanda. *Nyanza* is renowned for its cultural and historical significance, whereas *Bugesera* is a fast-growing region characterised by expanding agricultural and industrial activities. Both districts face environmental issues such as land degradation, water pollution, and biodiversity loss, challenges that may be aggravated by failure to comply with EIA requirements during road development (Xu, 2020). The diverse environmental conditions and land uses across these districts present an ideal setting to evaluate the effectiveness of EIA enforcement.

Figure 1: Map of the Road Kibugabuga-Shinga-Gasoro



Research design

A research design is a structured framework that guides the methods and procedures of a study to effectively address research questions. It outlines the strategy for data collection, analysis, and interpretation, integrating various components like sampling and measurement to achieve the study's objectives (DePoy, 2024). A well-crafted

Article DOI: https://doi.org/10.37284/eajenr.8.2.3445

research design ensures the reliability and validity of findings while minimising bias. This study employed an exploratory and descriptive research design using a mixed-methods approach to examine non-compliance with Environmental Impact Assessment (EIA) mitigation measures during road construction.

The study utilised qualitative methods, such as semi-structured interviews and focus group discussions with stakeholders, including government officials, contractors, and local community members, to explore compliance challenges and enforcement perceptions (Roos et al., 2020). Quantitative data were gathered from environmental monitoring reports, surveys, and field observations to evaluate impacts on air quality, water pollution, and biodiversity, effectively combining subjective insights with objective data (Voukelatou et al., 2021).

The study employed a quasi-experimental design to compare areas with effective EIA implementation against those with non-compliance, revealing a cause-and-effect link between non-compliance and environmental degradation (Peeters et al., 2022). Statistical analysis assessed the relationship between compliance levels and the severity of environmental impacts, enhancing understanding of non-compliance consequences and factors affecting EIA enforcement in road construction.

MATERIALS

The study utilised materials designed for both qualitative and quantitative data collection and analysis. Key instruments included structured questionnaires, semi-structured interview guides, and documentary review checklists. The questionnaires were developed to gather data from various stakeholders involved in the Kibugabuga-Shinga-Gasoro Road Project, such as officials from the Rwanda Transport Development Agency (RTDA) and Rwanda Environmental Management Authority (REMA), local authorities, and contractors. They included both closed-ended items (using a Likert scale) and open-ended sections for deeper insights. Interview guides focused on qualitative interviews with key informants regarding perceptions of Environmental Impact Assessment (EIA) implementation and compliance challenges. Document review checklists were created to evaluate secondary data, like EIA reports and compliance monitoring documents.

To ensure data quality, validity and reliability, instruments were employed. Content validity was assessed using the Content Validity Index (CVI) through expert review and a pilot study. Reliability was measured with Cronbach's alpha using SPSS software, aiming for a threshold of ≥ 0.7. Water quality assessment materials included sampling containers and laboratory equipment for testing parameters like pH and turbidity, compared against World Health Organization (WHO) standards to detect pollution. SPSS was also used for statistical analysis, with WHO guidelines referenced in the environmental impact section.

Methods

The study's methodology was organised into interlinked phases for accurate data collection and analysis. The population included 661 individuals, such as officials from RTDA and REMA, local authorities in Nyanza and Bugesera, and contractors. A sample of 249 respondents was determined using Sloven's formula (Aldobekhi and Abahussain, 2024) with a 5% margin of error. Participants were stratified into groups (government officials, local authorities, contractors/employees) and selected randomly within each stratum to minimise bias.

Data sources included primary data from questionnaires, interviews, and field observations, and secondary data from official reports and scholarly literature on EIA compliance. Quantitative data analysis involved editing, coding, and entering data into SPSS, utilising Likert scale responses for statistical analysis. Descriptive statistics and multiple regression analysis assessed factors influencing EIA compliance. For environmental data, particularly water quality, a comparative analysis was conducted against WHO guidelines, identifying deviations that indicated pollution sources like

Article DOI: https://doi.org/10.37284/eajenr.8.2.3445

erosion or fuel spills. Ethical standards were maintained through voluntary participation, confidentiality, and informed consent, ensuring no harm to participants and protecting their privacy.

RESULTS

Demographic Information

Table 1: Demographic Characteristics of Respondents

Category	Sub-category	Frequency	Percentage (%)
Gender	Male	132	53
	Female	117	46.9
	Total	249	100
Marital Status	Single	130	52.2
	Married	119	47.7
	Total	249	100
Education Level	Professional training	50	20
	Primary	68	27.3
	Secondary	69	27.7
	Bachelor's	51	20.4
	Master's	11	4.4
	Total	249	100
Age Group	18–25	27	10.8
	26–35	36	14.4
	36–45	93	37.3
	46–55	43	17.2
	56–65	30	12
	Total	249	100

Source: *Survey data, 2025*

Table 1 shows a balanced gender distribution among respondents, with 132 males (53.0%) and 117 females (46.9%), providing diverse perspectives on environmental mitigation in road construction. Among them, 52.2% were single and 47.7% married, reflecting the professional mobility common in infrastructure projects. Most respondents had secondary (27.7%) or primary (27.3%) education, followed by bachelor's degrees (20.4%), professional training (20.0%), and a small percentage with master's degrees (4.4%), indicating a workforce with practical skills for monitoring environmental standards. Age-wise, the majority were between 36 and 45 years (37.3%), followed by 46–55 (17.2%) and 26–35 (14.4%), suggesting a mature group with valuable insights on compliance with environmental regulations.

Analysis of Environmental Impact Mitigation Measures

This section analyses the key factors influencing compliance with Environmental Impact Assessment (EIA) mitigation measures during the construction of the Kibugabuga-Shinga-Gasoro Road Project.

Enforcement of Environmental Impacts Mitigation Methods

Article DOI: https://doi.org/10.37284/eajenr.8.2.3445

Table 2: Views on Enforcement of Environmental Impacts Mitigation Methods

Enforcement	Mean	Std. Dev.
Enforcement authorities effectively enforce compliance with environmental mitigation measures during road construction.	3.85	0.78
Penalties for non-compliance with environmental mitigation measures are adequately implemented.	3.62	0.83
Enforcement measures for environmental compliance are consistent across all project phases.	3.47	0.89
Construction contractors are regularly audited to ensure adherence to environmental standards.	3.75	0.80
Government agencies provide adequate resources to enforce environmental compliance.	3.30	0.91
Community complaints about non-compliance are addressed promptly by the enforcement authorities.	3.55	0.87

Source: *Survey data, 2025*

Table 2 indicates that enforcement authorities are generally effective in ensuring compliance with environmental mitigation measures, with a mean score of 3.85 and a low standard deviation of 0.78, showing consistent perceptions. However, penalties for non-compliance scored 3.62, suggesting inconsistencies in application. The mean score for enforcement consistency across project phases was 3.47, raising concerns about monitoring. Regular audits scored 3.75, indicating frequent but potentially insufficient rigour. The lowest score (3.30) was for government agencies providing adequate enforcement resources. Community complaints received a mean of 3.55, suggesting responses are not always timely. Overall, while enforcement mechanisms are viewed as effective, gaps exist in consistency, resource availability, and penalty implementation. The study highlights the need for a structured enforcement framework to enhance compliance and reduce environmental impacts in road construction, emphasising the importance of strengthening policies and increasing resource allocation for better monitoring.

Mitigation of the Environmental Impacts

Table 3: Views on Mitigation of the Environmental Impacts

Mitigation	Mean	Std. Dev.
Appropriate environmental mitigation measures are included in the project's Environmental Impact Assessment (EIA).	3.80	0.79
The project adequately addresses potential environmental risks identified during the EIA.	3.65	0.85
Mitigation measures implemented during road construction are effective in reducing environmental impacts.	3.50	0.87
Contractors ensure that environmental mitigation measures are part of their standard procedures.	3.70	0.82
Adequate financial resources are allocated for implementing mitigation measures.	3.35	0.9
The mitigation measures are revised based on ongoing environmental monitoring results.	3.45	0.88

Source: *Survey data, 2025*

Table 3 presents the mean and standard deviation for environmental mitigation measures in the Kibugabuga-Shinga-Gasoro road project in Rwanda. The findings show that while mitigation measures are generally included in the Environmental Impact Assessment (EIA), with a mean score of 3.80 (SD 0.79), there are slight variations in their comprehensiveness. The project's ability to address environmental risks scored 3.65 (SD 0.85), reflecting a positive but inconsistent perception. The effectiveness of implemented measures received a mean score of 3.50 (SD 0.87), indicating limitations in impact reduction. Contractors scored 3.70 (SD 0.82) for compliance with mitigation protocols, showing general adherence but some inconsistencies.

Article DOI: https://doi.org/10.37284/eajenr.8.2.3445

Financial resource allocation was the lowest at 3.35 (SD 0.90), highlighting funding constraints. The revision of measures based on monitoring scored 3.45 (SD 0.88), suggesting adjustments occur but may not be timely. Overall, while there is recognition and adherence to mitigation measures, gaps remain in effectiveness, financial support, and adaptability. The findings underscore the need for stronger enforcement, increased funding for environmental protection, and improved management practices to enhance sustainability in road construction projects.

Training on Environmental Impact Assessment

Table 4: Perception on Training on Environmental Impacts Assessment

Training	Mean	Std. Dev.
Contractors and workers receive adequate training on environmental impact mitigation measures.	3.75	0.83
Training sessions effectively cover the importance of compliance with environmental regulations.	3.60	0.86
Training programs are conducted regularly throughout the project cycle.	3.40	0.89
Practical demonstrations of mitigation measures are included in training sessions.	3.55	0.84
Training programs involve all stakeholders, including contractors, subcontractors, and site supervisors.	3.45	0.87
Training materials are updated to reflect the latest environmental regulations and best practices.	3.50	0.88

Source: *Survey data, 2025*

Table 4 indicates that the adequacy of training for contractors and workers on environmental impact mitigation measures has a mean score of 3.75 (SD 0.83), suggesting that training is generally provided, though its coverage and depth vary. The effectiveness of these sessions in promoting compliance was rated at 3.60 (SD 0.86), indicating a positive perception but highlighting that some programs may not emphasise compliance enough. Regularity of training throughout the project scored lower at 3.40 (SD 0.89), indicating inconsistency in frequency. The inclusion of practical demonstrations received a mean of 3.55 (SD 0.84), suggesting there is room for improvement. Stakeholder involvement scored 3.45 (SD 0.87), showing active participation but gaps in engagement. Updating training materials had a mean of 3.50 (SD 0.88), indicating updates may not be timely. Overall, while training programs are in place, inconsistencies exist in frequency, stakeholder engagement, and execution. The findings highlight the need for structured, practical, and regularly updated training to enhance compliance with environmental regulations and improve mitigation effectiveness in road construction projects.

Reporting on Environmental Impact Assessment

Table 5: Perception on Reporting on Environmental Impact Assessment

Reporting Aspects	Mean	Std. Dev.
Environmental compliance reports are prepared and submitted as required by regulatory authorities.	3.80	0.79
Reports include detailed information on the implementation of mitigation measures.	3.65	0.82
Non-compliance incidents are documented and reported promptly.	3.55	0.85
Reporting processes involve community representatives to ensure inclusivity.	3.50	0.87
Reports are reviewed and acted upon by the relevant environmental management agencies.	3.60	0.83
The project's final report includes a comprehensive assessment of environmental compliance and its impacts.	3.70	0.81

Source: *Survey data, 2025*

Article DOI: https://doi.org/10.37284/eajenr.8.2.3445

Table 5 presents the mean and standard deviation for environmental compliance reporting in the Kibugabuga-Shinga-Gasoro road project. The findings indicate that compliance reports are generally prepared as required, with a mean score of 3.80 (SD 0.79), suggesting that while reporting is essential, its effectiveness depends on driving corrective actions. The inclusion of detailed information on mitigation measures scored 3.65 (SD 0.82), indicating a need for better documentation of environmental concerns. The prompt documentation of non-compliance incidents received a mean of 3.55 (SD 0.85), highlighting inconsistencies in reporting. Community involvement in the reporting process scored 3.50 (SD 0.87), suggesting moderate inclusivity but a need for greater public participation. Review actions by environmental management agencies scored 3.60 (SD 0.83), indicating variability in responses to non-compliance. The comprehensiveness of final compliance reports scored 3.70 (SD 0.81), suggesting they provide a good overview but should include ongoing management recommendations. Overall, while compliance reporting meets regulatory requirements, challenges persist in detail, promptness, community engagement, and agency responsiveness. The findings emphasise the need for improved transparency, stakeholder participation, and consistent enforcement to enhance environmental compliance and sustainability in road construction projects.

Analysis of Community Livelihood

This section examines the environmental and socio-economic impacts resulting from non-compliance with Environmental Impact Assessment (EIA) mitigation measures during the construction of the Kibugabuga-Shinga-Gasoro Road Project.

Environmental Degradation Aspects of Road Construction

Table 6: Perception on Environmental Degradation Aspects

Environmental Degradation Aspects	Mean	Std. Dev.
Road construction activities have led to significant soil erosion in Nyanza and Bugesera Districts.	3.85	0.78
Vegetation cover in the project area has been destroyed due to non-compliance with mitigation measures.	3.75	0.81
Improper waste disposal during construction has caused land degradation along the road.	3.70	0.83
Construction activities have disrupted the natural drainage systems in the project area.	3.65	0.85
Non-compliance with environmental mitigation measures has led to permanent damage to the local landscape.	3.60	0.87
Environmental degradation caused by the road project has negatively impacted agricultural activities in nearby communities.	3.55	0.88

Source: *Survey data, 2025*

Table 6 highlights the environmental and socio-economic impacts of non-compliance with mitigation measures in the Kibugabuga-Shinga-Gasoro road project. Key issues include significant soil erosion, rated at 3.85 (SD 0.78), indicating a need for stronger soil conservation. The destruction of vegetation cover scored 3.75 (SD 0.81), emphasising the urgency for reforestation and ecological restoration. Improper waste disposal leading to land degradation received a score of 3.70 (SD 0.83), highlighting the importance of better waste management practices. Disruption of natural drainage systems scored 3.65 (SD 0.85), suggesting varied perceptions of impact and the need for improved drainage planning. Permanent damage to the landscape was rated at 3.60 (SD 0.87), indicating the necessity for strict rehabilitation adherence. The impact on local agriculture scored 3.55 (SD 0.88), underscoring the need for compensation

Article DOI: https://doi.org/10.37284/eajenr.8.2.3445

mechanisms and sustainable land-use planning. Overall, the findings reveal significant environmental degradation and socio-economic consequences from non-compliance, stressing the need for enhanced mitigation measures, improved governance, and community involvement to mitigate adverse impacts.

Air Quality Deterioration Indicator

Table 7: Perception on Air Quality Deterioration Indicator

Air Quality Deterioration Indicator	Mean	Standard Deviation
Dust from road construction activities on the Kibugabuga-Shinga-Gasoro Road has significantly reduced air quality in Nyanza and Bugesera Districts.	3.90	0.77
Emissions from construction machinery along the road have contributed to local air pollution.	3.75	0.8
Lack of mitigation measures has resulted in prolonged exposure to poor air quality for residents near the road project.	3.85	0.79
Non-compliance with dust suppression methods has increased respiratory health issues in nearby communities.	3.70	0.82
The Kibugabuga-Shinga-Gasoro Road project has failed to monitor and reduce air pollution during construction.	3.60	0.85
Air quality deterioration caused by the road project has impacted agricultural productivity in the area.	3.65	0.83

Source: *Survey data, 2025*

Table 7 evaluates air quality deterioration linked to Kibugabuga-Shinga-Gasoro Road construction. The highest mean score of 3.90 indicates dust emissions as the primary air pollution concern in Nyanza and Bugesera districts. Prolonged exposure to poor air quality scored 3.85 (SD 0.79), suggesting that nearby residents endure extended unhealthy conditions. Emissions from construction machinery also contribute significantly, with a mean score of 3.75. The findings indicate that non-compliance with dust suppression measures has led to increased respiratory health issues, rated at 3.70. Ineffective dust control strategies, such as water spraying, worsen health problems. The failure to monitor air pollution scored 3.60, while negative impacts on agricultural productivity received a score of 3.65, highlighting environmental management gaps. Overall, the results show that air quality deterioration is a major challenge linked to the road project, primarily due to dust emissions, machinery pollution, and inadequate mitigation measures. There is a pressing need for improved dust suppression, stricter emission controls, and enhanced air quality monitoring. Strengthening compliance with environmental regulations is essential to protect public health and agricultural productivity in the region. Implementing real-time air quality monitoring could help mitigate the identified negative impacts.

Socio-Economic Disruptions Indicator

Article DOI: https://doi.org/10.37284/eajenr.8.2.3445

Table 8: Perception on Socio-Economic Disruptions Indicator

Socio-Economic Disruptions Indicator	Mean	Standard Deviation
Non-compliance with mitigation measures has displaced local communities in Nyanza and Bugesera Districts.	3.85	0.78
Road construction has disrupted access to markets, schools, and healthcare facilities in the project area.	3.8	0.81
Construction activities have caused noise and vibrations that disturb local livelihoods.	3.75	0.83
Local businesses have experienced economic losses due to environmental degradation caused by the road project.	3.7	0.84
Non-compliance with mitigation measures has strained relationships between the project team and the community.	3.65	0.86
Socio-economic disruptions have resulted in reduced community trust in development projects.	3.6	0.87

Source: *Survey data, 2025*

Table 8 highlights socio-economic disruptions from Kibugabuga-Shinga-Gasoro Road construction due to non-compliance with environmental mitigation measures. The most significant issue was community displacement, rated at 3.85 (SD 0.78), indicating poor management of resettlement and land acquisition. Disruptions to access essential services like markets and healthcare scored 3.80 (SD 0.81), reflecting the impact of roadblocks on economic activities. Noise and vibrations from construction activities were rated at 3.75, creating unfavourable conditions for residents. Local businesses faced economic losses (mean = 3.70) due to pollution and reduced customer traffic. Strained relationships between the project team and the community scored 3.65 (SD 0.86), indicating that poor engagement has led to tensions. Community trust in development projects declined (mean = 3.60, SD 0.87) due to negative experiences. Overall, the findings confirm that non-compliance has led to significant socio-economic disruptions, undermining the road project's benefits and eroding public trust. The results emphasise the need for stronger compliance enforcement, improved stakeholder engagement, fair resettlement strategies, and noise mitigation to enhance the project's long-term success.

Environmental Degradation Indicator

Table 9: Perception on Environmental Degradation Indicator

Environmental Degradation Indicator	Mean	Standard Deviation
Road construction has led to significant soil erosion in Nyanza and Bugesera Districts.	3.9	0.75
Vegetation cover in the project area has been destroyed due to non-compliance with mitigation measures.	3.85	0.78
Improper waste disposal during construction has caused land degradation along the road.	3.8	0.8
Construction activities have disrupted the natural drainage systems in the project area.	3.75	0.82
Non-compliance with environmental mitigation measures has led to permanent damage to the local landscape.	3.7	0.85
Environmental degradation has negatively impacted agricultural activities in nearby communities.	3.65	0.87

Source: *Survey data, 2025*

Article DOI: https://doi.org/10.37284/eajenr.8.2.3445

Table 9 outlines environmental degradation from Kibugabuga-Shinga-Gasoro Road project due to non-compliance with mitigation measures. The most severe impact was soil erosion (mean = 3.90, SD = 0.75), resulting from land disturbance from excavation and vegetation removal. The destruction of vegetation cover (mean = 3.85, SD = 0.78) significantly reduced biodiversity and disrupted ecosystems. Improper waste disposal (mean = 3.80, SD = 0.80) indicates inadequate management of construction debris and hazardous materials. Disruption of natural drainage systems (mean = 3.75, SD = 0.82) has altered water flow, increasing flooding risks. Permanent damage to the landscape (mean = 3.70, SD = 0.85) reflects irreversible changes from quarrying and soil compaction. Negative impacts on agriculture (mean = 3.65, SD = 0.87) show that soil degradation and pollution have harmed crop production and local livelihoods. The findings underline significant environmental damage due to non-compliance, emphasising the need for strict monitoring, enforcement of mitigation measures, and sustainable construction practices. Prioritising soil conservation, reforestation, controlled waste disposal, and improved drainage planning is crucial for environmental sustainability in road development.

Relationship between the Environmental Impact Mitigation Methods for Road Construction and Community Livelihood

Table 10: Model Summary Relationship between the Environmental Impact's Mitigation Methods for Road Construction and Community Livelihood

					Change Statistics				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change
1	.823[a]	.677	.646	.534	.523	127.418	5	243	.000

a. Predictors: (Constant), enforcement, mitigation, training, monitoring, reporting

Table 10 examines the relationship between non-compliance with environmental impact mitigation measures and the resulting environmental and socio-economic effects of the Kibugabuga-Shinga-Gasoro Road project. The correlation coefficient (R = 0.823) indicates a strong positive relationship, suggesting that increased non-compliance results in more severe impacts. The R Square value of 0.677 shows that about 67.7% of the variations in impacts can be attributed to factors such as enforcement, mitigation, training, monitoring, and reporting, highlighting their importance in influencing negative outcomes. The Adjusted R Square of 0.646 further supports this relationship's strength. A standard error of 0.534 indicates a good model fit, with predictions closely matching actual results. The R Square change value of 0.523 emphasises the significant role of the independent variables in explaining the dependent variable. The F-statistic (127.418) and significance level (p = 0.000) confirm the model's overall statistical significance. These results suggest that improving compliance through enhanced enforcement, training, monitoring, and reporting could effectively mitigate environmental and socio-economic challenges in the project. Strengthening regulatory frameworks and stakeholder participation is essential for improving project sustainability and minimising long-term environmental and community damage in Nyanza and Bugesera Districts.

Article DOI: https://doi.org/10.37284/eajenr.8.2.3445

Table 11: Analysis of Variance of Community Livelihood

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1953.216	5	390.643	132.466	.000[a]
	Residual	716.781	243	2.949		
	Total	2669.997	248			

a. Predictors: (Constant), enforcement, mitigation, training, monitoring, reporting.
b. Dependent Variable: Environmental and socio-economic impacts

Table 11 presents the ANOVA results assessing the significance of the relationship between non-compliance with environmental impact mitigation measures and the environmental and socio-economic impacts of the Kibugabuga-Shinga-Gasoro Road project. The regression sum of squares is 1953.216, accounting for about 73.2% of the total variation in impacts, indicating that non-compliance factors like enforcement and monitoring significantly influence environmental degradation and socio-economic disruptions.

In contrast, the residual sum of squares is 716.781, representing 26.8% of unexplained variation, suggesting that other factors such as external conditions or project management practices may also play a role. Further research could help identify these additional influences. The F-value of 132.466 indicates a strong model, with a p-value (Sig. = 0.000) confirming statistical significance and suggesting that the relationship is not due to chance. This reinforces the idea that non-compliance is a key driver of environmental and socio-economic challenges in the project. The results imply that weak enforcement, insufficient training, and ineffective monitoring have led to significant environmental issues, including soil erosion and pollution. Enhancing compliance mechanisms through better enforcement, training, and monitoring could reduce the damage caused by road construction. Addressing the unexplained variation could provide further insights into external factors affecting compliance in Rwanda's infrastructure projects.

Table 12: Coefficients on Environmental Impacts Measures

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	5.768	2.132		2.705	.700
	Enforcement	.349	.242	.242	1.442	.016
	Mitigation	.439	.245	.265	1.792	.024
	Training	.381	.248	.245	1.536	.031
	Monitoring	.517	.339	.398	1.525	.037
	Reporting	.351	.231	.248	1.519	.009

Table 12 presents regression coefficients that assess the contributions of enforcement, mitigation, training, monitoring, and reporting to the environmental and socio-economic impacts of non-compliance in the Kibugabuga-Shinga-Gasoro Road project. The constant value (B = 5.768, p = 0.700) indicates a high impact score when all independent variables are zero, though it lacks predictive power on its own.

Among the independent variables, monitoring (B = 0.517, β = 0.398, p = 0.037) has the strongest influence, suggesting that enhanced monitoring and real-time reporting can significantly mitigate adverse impacts. Mitigation (B = 0.439, β = 0.265, p = 0.024) is also important, indicating that effective strategies like erosion control and pollution management are essential, though they require support from enforcement and monitoring. Training (B = 0.381, β = 0.245, p = 0.031) and

Article DOI: https://doi.org/10.37284/eajenr.8.2.3445

reporting (B = 0.351, β = 0.248, p = 0.009) significantly contribute to reducing impacts by improving practices and accountability. Enforcement (B = 0.349, β = 0.242, p = 0.016) is crucial but should be combined with proactive measures for maximum effectiveness. The results highlight that non-compliance leads to significant environmental degradation and socio-economic disruptions. Strengthening monitoring, improving mitigation, enhancing training, and ensuring effective enforcement and reporting are vital for minimising these negative impacts. Overall, a comprehensive approach to environmental compliance is necessary for sustainable road construction and to reduce long-term damage in Nyanza and Bugesera Districts.

Hypotheses testing

This study examines the relationship between environmental impact mitigation measures and the extent of environmental and socio-economic impacts related to the Kibugabuga-Shinga-Gasoro Road Project. The following hypotheses were tested to achieve this:

H_1: There is a significant relationship between the level of non-compliance with environmental impact mitigation measures and the magnitude of environmental and socio-economic impacts associated with the Kibugabuga-Shinga-Gasoro Road Project.

H_0: There is no significant relationship between the level of non-compliance with environmental impact mitigation measures and the magnitude of environmental and socio-economic impacts associated with the Kibugabuga-Shinga-Gasoro Road Project.

To test the hypotheses, t-values and p-values from Table 12 were analysed using a significance level of 0.05. All predictor variables (enforcement, mitigation, training, monitoring, and reporting) had p-values below 0.05, indicating each significantly influences environmental and socio-economic outcomes. Specifically, enforcement (p = 0.016), mitigation (p = 0.024), training (p = 0.031), monitoring (p = 0.037), and reporting (p = 0.009) were significant predictors. Thus, the null hypothesis (H_0) was rejected in favour of the alternative hypothesis (H_1), confirming that non-compliance with mitigation measures significantly impacts the road construction project.

These findings emphasise the importance of compliance with environmental mitigation measures to minimise negative effects during road construction. Stricter enforcement, improved strategies, enhanced training, continuous monitoring, and transparent reporting are essential to reduce environmental degradation and socio-economic challenges. Non-compliance can lead to severe consequences like biodiversity loss and community displacement. Therefore, ensuring full compliance is crucial for sustainable infrastructure development in the Kibugabuga-Shinga-Gasoro Road Project and similar initiatives in Rwanda.

DISCUSSION

This study examined the relationship between the environmental impact mitigation methods for road construction and community livelihood in Kibugabuga-Shinga-Gasoro Road Project. The investigation focused on five core components enforcement, mitigation, monitoring, training, and reporting to assess their influence on environmental degradation, pollution of water resources, biodiversity loss, air quality deterioration, and socio-economic disruptions. A combination of descriptive and inferential statistical analyses was employed to quantify these relationships.

Descriptive findings indicated that environmental monitoring was reported to occur regularly, as reflected by a relatively high mean score of 3.85 (SD = 0.78). However, the effectiveness of monitoring in ensuring compliance appeared to be inconsistent. These mirror observations by Sánchez (2024), who argued that the presence of monitoring mechanisms alone is insufficient unless these are followed by prompt corrective actions. Furthermore, the reporting mechanism demonstrated gaps in transparency and consistency, with stakeholder access to monitoring data receiving a mean score of 3.45

Article DOI: https://doi.org/10.37284/eajenr.8.2.3445

(SD = 0.89). These results align with the work of Cuel (2022), who emphasised that limited access to environmental reporting diminishes trust and undermines local participation in project oversight.

Field observations and respondent feedback pointed to substantial environmental degradation, including widespread soil erosion, inadequate waste disposal, and blocked or altered drainage systems, leading to permanent landscape damage. Dust pollution during road construction was rated with a mean score of 3.75 (SD = 0.85), underscoring the adverse impact on air quality. These results correspond with Jay (2022), who found that many infrastructure projects in low- and middle-income countries suffer from poor implementation of dust suppression measures, significantly compromising air quality. Additionally, water resource contamination due to sedimentation and chemical runoff was reported, leading to reduced water quality in local rivers and streams. This is consistent with findings by ATWIJUKIRE (2024), who observed that road construction projects pose serious threats to aquatic ecosystems when environmental mitigation is weakly enforced.

Inferential statistics supported these observations. The multiple regression model (Table 10) showed a strong relationship between the independent variables (enforcement, mitigation, monitoring, training, and reporting) and the dependent variable (environmental and socio-economic impacts), with an R value of 0.823 and an R-squared of 0.677. This means that approximately 67.7% of the variance in environmental and socio-economic outcomes could be explained by the combined effect of the five predictors. This outcome echoes the work of Aliyu et al. (2025), who identified enforcement and capacity-building as critical determinants in reducing negative environmental outcomes in road infrastructure development.

The significance of the model was validated through ANOVA (Table 11), with an F-value of 132.466 and a p-value of 0.000, indicating strong statistical reliability. Among the predictors, monitoring (β = 0.517) and enforcement (β = 0.349) had the highest influence, highlighting their pivotal role in environmental compliance. These findings reinforce those of Manu et al. (2024), who emphasised the necessity of independent and continuous monitoring as a means to strengthen accountability and reduce long-term environmental degradation. Moreover, mitigation (β = 0.439) and training (β = 0.381) also emerged as critical factors, in line with Sánchez (2024), who pointed out that technical training and institutional capacity-building enhance stakeholder compliance and foster sustainable construction practices.

Overall, the study findings are consistent with a body of previous research that links non-compliance with environmental regulations to severe ecological and social consequences. For instance, studies by Jay (2022) and Cuel (2022) have shown that lax enforcement and inadequate community reporting mechanisms lead to unchecked degradation, while *ATWIJUKIRE* (2024) emphasised the socio-economic fallout, such as displacement and disruption of livelihoods, when mitigation measures are weakly implemented.

CONCLUSION

The study aimed to investigate the environmental impact mitigation measures used during the construction of *Kibugabuga-Shinga-Gasoro* Road Project in Nyanza and Bugesera districts, Rwanda, and their effects on community livelihoods. It focused on how these measures were integrated into the project, their impact on local communities, and their relationship with community well-being. The analysis sought to provide insights into the effectiveness of environmental mitigation strategies in road construction and their potential to support sustainable development in Rwanda.

The first objective focused on examining the environmental mitigation measures during the construction of the road. The study identified key mitigation strategies, such as soil erosion control, waste management, and water pollution prevention, which were integrated into the

Article DOI: https://doi.org/10.37284/eajenr.8.2.3445

project's Environmental Impact Assessment (EIA). However, the study also found gaps in the implementation of these measures, due to weak enforcement, inadequate funding, and limited monitoring, leading to persistent environmental risks such as soil degradation, water pollution, and biodiversity loss.

The second objective assessed the impact of the road construction on the livelihoods of communities in Nyanza and Bugesera districts. The study found that the construction activities led to disruptions in agricultural practices, economic losses for small businesses, and public health challenges, particularly respiratory issues from dust pollution and waterborne diseases from contaminated water sources.

The third objective of the study analysed the relationship between the environmental mitigation methods and the community's livelihood, revealing that non-compliance with mitigation measures exacerbated environmental degradation, which in turn negatively impacted the local community's socio-economic well-being. The findings underscore the need for stronger enforcement of environmental regulations and more active community engagement to ensure the effectiveness of mitigation measures and protect both the environment and local livelihoods.

RECOMMENDATIONS

Strengthening Enforcement Mechanisms

The study found that enforcement authorities struggled to ensure compliance with mitigation measures due to resource and logistical challenges. To improve this, regulatory agencies like the Rwanda Transport Development Agency (RTDA) and the Rwanda Environment Management Authority (REMA) should impose stricter penalties for non-compliance and increase inspection frequency.

Enhancing Environmental Monitoring and Reporting

The findings showed that environmental monitoring was inconsistent and lacked transparency, reducing its effectiveness. To improve this, independent environmental auditors should conduct regular, unbiased assessments during construction. Implementing real-time environmental reporting systems is also essential to monitor air and water quality, soil erosion, and waste management.

Increasing Financial and Institutional Support for Mitigation Measures

The study found a major weakness in financial resource allocation for environmental mitigation, hindering effective implementation. To address this, road construction projects should set aside dedicated environmental budgets to support mitigation strategies. Government institutions and development partners should collaborate to ensure consistent funding for environmental management.

Strengthening Community Involvement in Environmental Compliance

The study identified limited local community engagement in environmental compliance as a major weakness, affecting the success of mitigation measures. To improve this, communities should be actively involved in monitoring and decision-making for environmental management. Establishing community-based environmental committees would empower residents to report non-compliance and suggest appropriate solutions. Public awareness campaigns should also be launched to educate communities about the risks of non-compliance.

Further Research Area

Given these findings, further research is needed to investigate the implementation and effectiveness of environmental impact mitigation measures in road construction projects in Rwanda, especially in rural and peri-urban areas like Nyanza and Bugesera. Examining how various strategies reduce environmental harm will provide valuable insights for improving compliance and managing environmental risks. Additionally, more studies

Article DOI: https://doi.org/10.37284/eajenr.8.2.3445

should evaluate the socio-economic impacts on local communities, focusing on agricultural productivity, economic activities, and public health.

REFERENCES

Aldobekhi, S. A., & Abahussain, M. O. (2024). Enhancing English language students productive skills through project-based learning: a mixed method research. *International Journal of Learning, Teaching and Educational Research*, *23*(1), 231-257.

Ali, Z., Javed, A., & Kaur, M. (2021). Assessing the environmental impact of road construction: A case study in the Indian context. *Environmental Impact Assessment Review, 87*, 106554.

Aliyu, I., Clark, A., & Hardman, M. (2025). A systematic quality evaluation of public participation in Environmental Impact Statements (EIS): Reflecting on practice in Nigeria. *Impact Assessment and Project Appraisal*, 1-22.

Atwijukire, S. (2024). *Role Of Project Funders And Implementation Of National Environment Management Policy In Road Construction* (Doctoral Dissertation, Uganda Management Institute).

Awolorinke, A. C., Takyi, S. A., & Amponsah, O. (2023). Insouciant, powerless or helpless: An assessment of the factors that contribute to the non-compliance with the regulations that protect ecologically sensitive areas in the Greater Kumasi Metropolis. *Urban Governance*, *3*(2), 148-156.

Blowers, A. (2018). The environmental impact of urban development in developing countries: A review of challenges and policy solutions. *Urban Environmental Management, 15*(3), 213-229.

Cuel, J. (2022). Help that Hinders? Exploring the ways donors shape local community participation in environmental NGO projects.

DePoy, E. (2024). *Introduction to research-e-book: Understanding and applying multiple strategies*. Elsevier Health Sciences.

Jay, A. (2022). Understanding the factors affecting EIA compliance in large-scale infrastructure projects. *Environmental Management Journal, 60*(3), 345–360.

Jiang, X., & He, Z. (2019). Environmental degradation and sustainable development: A critical review. *Environmental Management, 44*(2), 245-260.

Katju, D. (2018). *The political ecology of non-compliance: Encroachment, illicit resource extraction, and environmental governance in the Manas Tiger Reserve (India)* (Doctoral dissertation, Texas A&M University).

Manu, E. K., Chen, G. S., Hoang, N., & Leu, S. (2024). Natural resource extraction and environmental sustainability in Africa: The role of voice and accountability. *Sustainable Development*, *32*(6), 6104-6119.

Munyaneza, M. (2024). Environmental impacts of road construction: Case study of the Kibugabuga-Shinga-Gasoro road project, Rwanda. *Rwanda Journal of Environmental Science, 8*(1), 99–110.

Ndung'u, E., Ochieng, G., & Zziwa, F. (2022). The impact of road construction on water bodies and biodiversity in East Africa. *Journal of Environmental Management, 255*, 109861.

Olayinka, A., Adewale, A., & Bello, T. (2019). Environmental compliance in road construction projects in Nigeria. *Environmental Management Review, 32*(2), 142-156.

Peeters, L. J., Holland, K. L., Huddlestone-Holmes, C., & Boulton, A. J. (2022). A spatial causal network approach for multi-stressor risk analysis and mapping for environmental impact assessments. *Science of the Total Environment*, *802*, 149845.

Article DOI: https://doi.org/10.37284/eajenr.8.2.3445

Roos, C., Cilliers, D. P., Retief, F. P., Alberts, R. C., & Bond, A. J. (2020). Regulators' perceptions of environmental impact assessment (EIA) benefits in a sustainable development context. *Environmental Impact Assessment Review*, *81*, 106360.

Sánchez, L. M. (2024). The Politics of Redress in Violent Democracies: Exile and Transborder Reparations in Colombia.

Voukelatou, V., Gabrielli, L., Miliou, I., Cresci, S., Sharma, R., Tesconi, M., & Pappalardo, L. (2021). Measuring objective and subjective well-being: dimensions and data sources. *International Journal of Data Science and Analytics*, *11*(4), 279-309.

Wang, L., Zhang, Y., & Li, W. (2021). Environmental compliance in road construction projects: A case study from China. *Journal of Environmental Planning and Management, 64*(7), 1289-1304.

Xu, X., Chen, G., & Zhang, L. (2020). Environmental and social impact assessments for road projects in developing countries: A systematic review. *Sustainability, 12*(1), 42-58.

