



East African Journal of Environment and Natural Resources

eajenr.eanso.org

Volume 8, Issue 3, 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

Assessing the Impact of Inadequate Green Infrastructure on Socioeconomic Development in Kigali City: A Case Study of Gasabo District (2010-2024)

Shami David Hakizimana^{1*}

¹ University of Lay Adventists of Kigali, P. O. Box 6392, Kigali, Rwanda.

* Correspondence Email: shamidavidocst@gmail.com

Article DOI: <https://doi.org/10.37284/eajenr.8.3.3897>

Date Published: ABSTRACT

03 November 2025

Keywords:

*Flooding Risk,
Gasabo District,
Inadequate Green
Infrastructure,
Socioeconomic
Development and Urban
Sustainability.*

This study assessed the impact of inadequate green infrastructure on socio-economic development in Gasabo District, Kigali City. Gasabo, the largest district in Kigali, has experienced rapid urban expansion marked by significant population growth, infrastructure development, and environmental degradation. Primary data were collected through structured questionnaires and in-depth interviews with residents, administrative leaders, and key informants, while secondary data were sourced from government reports, academic publications, and relevant literature. A stratified random sampling technique was employed to ensure proportional representation across diverse urban and peri-urban settings, yielding a sample size of 400 households. Findings revealed severe green infrastructure deficiencies, particularly in high-density areas such as Kacyiru and Remera, where only 22% of residents have access to nearby recreational spaces. Wetland degradation exceeded 60% since 2015, reducing natural flood buffers and intensifying the urban heat island effect. Socio-economic analysis highlighted poverty and vulnerability in rural sectors and informal settlements, where 65% of low-income households lack basic services. Flooding emerged as a critical issue, disproportionately affecting vulnerable communities and causing fatalities and injuries in 2023. The study further established strong linkages between inadequate green infrastructure and adverse socio-economic outcomes. Health problems, including respiratory diseases and poor mental well-being, were more prevalent in areas with limited green spaces. Economically, reduced property values and weakened municipal revenues were observed, while socially, diminished community cohesion was reported by 70% of respondents. The findings underscore the urgent need for sustainable urban planning, improved investment in green infrastructure, and targeted interventions to balance Gasabo's economic growth with environmental sustainability.

APA CITATION

Hakizimana, S. D. (2025). Assessing the Impact of Inadequate Green Infrastructure on Socioeconomic Development in Kigali City: A Case Study of Gasabo District (2010-2024). *East African Journal of Environment and Natural Resources*, 8(3), 313-321. <https://doi.org/10.37284/eajenr.8.3.3897>.

CHICAGO CITATION

Hakizimana, Shami David. 2025. "Assessing the Impact of Inadequate Green Infrastructure on Socioeconomic Development in Kigali City: A Case Study of Gasabo District (2010-2024)". *East African Journal of Environment and Natural Resources* 8 (3), 313-321. <https://doi.org/10.37284/eajenr.8.3.3897>

HARVARD CITATION

Hakizimana, S. D. (2025) "Assessing the Impact of Inadequate Green Infrastructure on Socioeconomic Development in Kigali City: A Case Study of Gasabo District (2010-2024)", *East African Journal of Environment and Natural Resources*, 8 (3), pp. 313-321. doi: 10.37284/eajenr.8.3.3897.

IEEE CITATION

S. D., Hakizimana "Assessing the Impact of Inadequate Green Infrastructure on Socioeconomic Development in Kigali City: A Case Study of Gasabo District (2010-2024)", *EAJENR*, vol. 8, no. 3, pp. 313-321, Nov. 2025.

MLA CITATION

Hakizimana, Shami David. "Assessing the Impact of Inadequate Green Infrastructure on Socioeconomic Development in Kigali City: A Case Study of Gasabo District (2010-2024)". *East African Journal of Environment and Natural Resources*, Vol. 8, no. 3, Nov 2025, pp. 313-321, doi:10.37284/eajenr.8.3.3897

INTRODUCTION

Globally, since the 21st century, the rapid expansion and growth of urban areas represent a critical facet of global change, significantly impacting the physical landscapes of cities (Watson, 2009). Urbanisation represents a profound and often severe transformation of land, significantly diminishing the ecosystem's ability to provide essential services and support biodiversity (Cumming *et al.*, 2014). By 2030, it is estimated that 5 billion people will inhabit cities, with urban land cover expected to increase by 200% between 2000 and 2030 (Seto, 2009). The substantial loss of urban green infrastructure during this process poses a direct threat to the physical and psychological well-being of urban residents (Wang *et al.*, 2014). The anticipated combination of climate change and urbanisation until 2050 presents new challenges for land-use planning, especially in mitigating urban vulnerability to hazards resulting from projected increases in the frequency and intensity of climate extremes (Kılış, 2022). Understanding how people perceive and interact with urban green infrastructure is pivotal in bridging the knowledge gap between the impacts of urbanisation and the overall quality of urban life (Andersson *et al.*, 2014).

Africa, in particular, is currently undergoing a profound phase of demographic and economic growth (Canning *et al.*, 2015). Projections indicate that the current population of 1.1 billion is expected to double by 2050, with the majority of this growth concentrated in urban areas (Angel *et al.*, 2011). This rapid and unprecedented urbanisation is occurring without adequate pre-planning, and investments are struggling to keep pace with the escalating demand for essential services (Titz *et al.*, 2019). Notably, African cities are expanding into regions with delicate and crucial ecosystems, including forests, low-elevation coastal zones, and mega-deltas; this expansion is altering the natural landscape, resulting in adverse ecological impacts such as deforestation, habitat fragmentation, and soil erosion (Tzoulas *et al.*, 2007). The continent is experiencing a warming trend 1.5 times faster than the global average, making urban areas highly susceptible to the impacts of climate change, including droughts, increased precipitation, rising sea levels, more frequent and severe cyclones and storms, and extreme temperatures (Cilliers, 2019). To achieve inclusive growth, poverty reduction, and improved living standards while enhancing urban resilience and sustainability, there must be a concerted effort to integrate support for and regeneration of urban ecosystems into the fabric of

urban infrastructure development (Gulati *et al.*, 2020).

Sub-Saharan Africa (SSA) stands out as one of the most rapidly urbanising regions globally, with the projected proportion of African urban dwellers expected to surge from 11.3% in 2010 to 20.2% by 2050 (Thorn *et al.*, 2021). However, this urbanisation is entwined with formidable challenges, including widespread poverty and the uncontrolled expansion of informal settlements, characterised by high population densities and structures made from affordable materials like corrugated iron sheets, often lacking essential elements such as formal employment, secure land rights, reliable food sources, and numerous basic services (Wijesinghe *et al.*, 2021). Similarly, the escalating urbanisation levels in Eastern Africa represent an undeniable trend that demands attention from both scientists and urban planners (Ayeni *et al.*, 2023). Robust research indicates a growing consensus among researchers that the systematic incorporation of Green Infrastructure concepts into urban planning is a vital strategy for addressing significant present and future challenges (Li *et al.*, 2022). To enhance the efficacy of urban green infrastructure, experts strongly advocate for expanding its conceptualisation to include governance and rights-based perspectives (Titz *et al.*, 2019).

In Rwanda, the socioeconomic and demographic shifts, encompassing factors like population growth, industrialisation, land utilisation, and infrastructure development, have significantly shaped the trajectory of urban expansion, especially in Kigali, the country's capital city (Nduwayezu, 2016). In the same lookout, a comprehensive understanding of the factors steering Kigali City's growth is imperative to pave the way for a sustainable future (Mwenje, 2019). Presently, the development of green infrastructure stands out as a critical concern among the key factors, signifying its pivotal role in shaping the city's sustainable development trajectory (Ngome *et al.*, 2024). This research aims

to investigate the presence, awareness, and socio-economic effects of green infrastructure availability in Kigali City, providing insights into its role in fostering sustainable urban development.

METHODOLOGY

Description of the Study Area

Gasabo District, one of the three districts that make up Kigali City, is the largest both in terms of land area and population. Covering approximately 429 square kilometres, it is located in the central part of Rwanda, bordering Rulindo District to the north, Kicukiro District to the south, and Nyarugenge District to the west. The district is subdivided into 15 sectors, 73 cells, and 501 villages, with key urban centres such as Kimironko, Remera, Kacyiru, and Gisozi hosting major commercial, administrative, and residential areas. Gasabo serves as a critical economic hub within Kigali due to its diverse business environment, government institutions, and expanding infrastructure projects.

The district has experienced rapid population growth, with the latest National Institute of Statistics of Rwanda (NISR) 2022 report estimating its population at approximately 530,907 people. This urban expansion has led to a surge in housing developments, commercial activities, and infrastructure projects. However, this rapid urbanisation has put immense pressure on green infrastructure, leading to significant environmental concerns such as deforestation, wetland encroachment, and inadequate drainage systems. For instance, over 30% of wetlands in Kigali have been degraded due to construction activities, reducing their ability to regulate floods and maintain biodiversity (Rwanda Environment Management Authority, 2021).

Gasabo's climate is characterised by a moderate tropical climate with an annual rainfall ranging between 900mm and 1,300mm, distributed across two rainy seasons (March-May and September-December). However, poor land use planning and deforestation have contributed to environmental

risks such as seasonal flooding and increased soil erosion. The Nyabugogo and Rugende wetlands, which are crucial for flood control, have suffered from encroachment, leading to recurrent flooding in low-lying areas such as Kimironko and Gisozi. Moreover, the loss of tree cover has led to rising temperatures, with Kigali experiencing an average temperature increase of 1.4°C over the past 30 years (World Bank, 2022).

Despite the presence of some conservation initiatives, including the Nyandungu Urban Wetland Eco-Park, the overall green infrastructure in Gasabo is still inadequate to support sustainable urban development. The district faces a challenge in balancing economic development with environmental sustainability, as new commercial and residential projects continue to expand at the expense of natural ecosystems. The Rwanda Housing Authority (RHA, 2023) reported that over 65% of Gasabo's land area is now urbanised, with green spaces shrinking at an alarming rate. This has

negatively affected air quality, water retention, and overall public health, particularly in heavily populated areas where air pollution from vehicle emissions and industrial activities is rising.

Infrastructure development in Gasabo has been impressive, with major road networks such as the KN5 and KN8 highways improving connectivity. However, the drainage and sewage systems have not kept pace with the rapid growth, exacerbating the problem of urban flooding. The absence of sufficient green spaces in commercial zones such as Kacyiru and Remera has also contributed to the urban heat island effect, making these areas significantly warmer than surrounding rural locations. Sustainable urban planning policies and improved investment in green infrastructure are essential to mitigate these challenges. Without proper intervention, the continued degradation of natural ecosystems in Gasabo could threaten the district's long-term socioeconomic development and climate resilience.

Figure 1: Location and Administrative Divisions of Kigali City



Sources of Data

Primary Data

Primary data referred to information collected firsthand by the researcher specifically for the current study. In this research, primary data were gathered through the administration of structured questionnaires to residents of Kigali City. These questionnaires were designed to elicit responses related to participants' demographics, awareness of green infrastructure, and perceptions of its socio-economic impacts. Additionally, qualitative data were obtained through in-depth interviews with selected participants, allowing for a deeper exploration of their perspectives and experiences regarding green infrastructure in the urban context.

Secondary Data

Secondary data comprised existing information that had been collected by other researchers or organisations. In this research, secondary data sources have included academic publications, government reports, and relevant literature on green infrastructure and urban development in Kigali City and similar contexts. These sources have provided valuable insights into the historical, social, economic, and environmental factors influencing the presence and impacts of green infrastructure in the study area. Additionally, secondary data facilitated the contextualization of findings and comparison with existing research findings, enriching the analysis and interpretation of primary data.

Data Collection Techniques

Sampling Frame and Population of the Study

The sampling frame for this study consisted of representative households residing in Kigali City, Rwanda. According to the most recent Rwanda Fifth Population and Housing Census (R5PHC) conducted by the National Institute of Statistics of Rwanda (NISR) in 2022, the total number of households in Kigali City is estimated to be 488,868. These households encompass a diverse range of socio-economic backgrounds, residential areas, and demographic characteristics, which made them a suitable target population for investigating the presence, awareness, and socio-economic effects of green infrastructure within the urban context of Kigali City.

Sample Size Determination

Initially, the sample size determination was conducted using Taro Yamane's formula (Umar, 2017), which is expressed as follows:

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

Here, "n" represents the estimated sample size, "e" is the error margin (set at 0.05) at a 95% confidence level, and "N" stands for the total population size. Substituting the values, the calculated sample size is approximately 400 households. The detailed sample size breakdown is represented in Table 1 below.

Table 1: Sample Size Breakdown

(District	Sector	Number of households	Sample household estimate using $n_i = n \frac{N_i}{N}$)
Gasabo	BUMBOGO	30,892	25
	GATSATA	14,197	12
	GIKOMERO	4,792	4
	GISOZI	22,899	19
	JABANA	16,621	14
	JALI	10,832	9
	KACYIRU	8,918	7
	KIMIHURURA	5,352	4
	KIMIRONKO	17,612	14

(District	Sector	Number of households	Sample household estimate using $n_i = n \frac{N_i}{N}$
	KINYINYA	36,610	30
	NDERA	28,286	23
	NDUBA	17,795	15
	REMERA	12,347	10
	RUSORORO	16,650	14
	RUTUNGA	5,617	4
TOTAL		249420	204

Sampling Techniques

To effectively assess the impact of inadequate green infrastructure on socioeconomic development in Gasabo District, a stratified random sampling technique is highly appropriate. Gasabo is a diverse district with a mix of urban, peri-urban, and rural areas, each experiencing different levels of infrastructure development and socioeconomic outcomes. By stratifying the population based on geographical zones or neighbourhood types (e.g., high-density urban zones vs. low-density suburban areas), the researcher ensures that all significant sub-groups are proportionally represented. This enhances the generalizability of the findings across the district. In addition, purposive sampling can be employed to select key informants who have in-depth knowledge or are directly affected by green infrastructure challenges. These may include local government officials, urban planners, environmental experts, and long-term residents. These participants can provide detailed insights on policy implementation, historical changes in infrastructure, and observed socioeconomic impacts such as public health, employment, and quality of life. This technique helps capture nuanced, experience-based information that might not emerge from broader survey data. Finally, for the quantitative component of the research, systematic random sampling can be used to select household respondents within selected strata. For example, every 10th household on a street could be chosen after a random starting point, ensuring a fair and unbiased sample of residents. This technique is both

time-efficient and simple to implement, especially in densely populated areas. Combined, these sampling methods provided a comprehensive and balanced perspective on how green infrastructure or the lack thereof, has influenced socioeconomic development in Gasabo District over the study period.

Data Collection Techniques

Desk Review

A desk review was extensively utilised in this study. This involved systematically reviewing existing documents, such as academic publications, government reports, and relevant literature on green infrastructure and urban development in Kigali City. Documentary review provided valuable contextual information and background insights into the presence, awareness, and socio-economic effects of green infrastructure in the study area.

Questionnaires

The questionnaire was administered in two ways to accommodate varying respondent preferences and schedules. Firstly, in the method administered by the researcher, participants engaged directly with the researcher, who verbally presented the questionnaire items and meticulously recorded their responses on the questionnaire document. This approach facilitated real-time clarification of any queries and maintained consistent data collection procedures across all participants. Conversely, in the self-administered method, respondents were provided with the questionnaire to complete at their

convenience. Respondents were instructed to carefully read the questions and independently record their responses. This approach afforded participants flexibility, potentially resulting in more thoughtful responses and reducing respondent burden.

FINDINGS

Summary of Major Findings

To Evaluate the Extent of Inadequate Green Infrastructure in the Gasabo District

Our assessment revealed severe deficiencies in green infrastructure throughout Gasabo District. High-density urban areas like Kacyiru and Remera showed particularly limited access to green spaces, with only 22% of residents living within walking distance of parks or recreational areas. The district has experienced alarming wetland degradation, with 60% loss since 2015, significantly reducing natural flood buffers. Urban planning shortcomings were evident, as current zoning laws require only 10% green coverage in developments - far below what's needed to mitigate the 2.3°C urban heat island effect measured in recent years. These infrastructure gaps have created visible environmental stress across the district.

To Analyse the Socioeconomic Status of the Community in Gasabo District

The socioeconomic analysis uncovered stark disparities across Gasabo District. Poverty emerged as the most pressing concern, scoring 17.69 on our assessment scale, particularly in rural sectors and informal settlements. While commerce and public administration have fostered a growing middle class in some areas, 65% of low-income households lack access to basic services. Flooding disproportionately affected vulnerable communities, with our mapping identifying five high-risk zones impacting over 200 households. The human toll was significant, with flood-related incidents causing 9 deaths and 5 injuries in 2023 alone. These findings highlight the urgent need for

targeted interventions in the district's most disadvantaged areas.

To Explore the Relationship between Inadequate Green Infrastructure and Socioeconomic Development

Our investigation revealed profound connections between green infrastructure deficits and socioeconomic challenges. Health impacts were particularly striking - respiratory disease rates were 40% higher in neighbourhoods with minimal green space, and 65% of residents reported negative mental health effects from the lack of recreational areas. Economically, the absence of green infrastructure depressed property values by up to 30% compared to greener neighbourhoods, reducing municipal tax revenues. Socially, 70% of respondents reported weakened community ties due to insufficient shared public spaces. Environmental degradation from inadequate green infrastructure, including increased flooding and soil erosion, created additional economic burdens through damage to homes, businesses, and agricultural land.

CONCLUSION

This study set out to investigate the impact of inadequate green infrastructure on socioeconomic development in Gasabo District, the largest and most rapidly urbanising district of Kigali City. By employing both primary and secondary data collection methods, including structured questionnaires, in-depth interviews, and documentary reviews, the research captured a comprehensive picture of how urban expansion, environmental change, and social well-being intersect in this dynamic urban context. Stratified and purposive sampling ensured that the voices of diverse residents, from high-density urban neighbourhoods to peri-urban zones, were represented, providing both breadth and depth to the analysis. The findings revealed that green infrastructure in Gasabo is severely underdeveloped and has been progressively degraded due to rapid urbanisation, poor land use planning, and

inadequate enforcement of zoning regulations. Wetland loss, insufficient green spaces, and weak drainage systems have intensified environmental challenges, such as flooding, heat island effects, and declining air quality. These environmental stresses have not only undermined ecological resilience but have also directly compromised the quality of life for residents, particularly those in low-income and high-risk zones. From a socioeconomic perspective, inadequate green infrastructure has deepened inequalities within the district. Vulnerable communities, especially those in informal settlements, face disproportionate risks from flooding and lack of access to basic services, while health challenges, including higher rates of respiratory illnesses and mental health issues, are strongly linked to the scarcity of green spaces. Furthermore, the absence of adequate green infrastructure has negatively impacted economic stability by reducing property values, straining municipal resources, and limiting opportunities for social cohesion and recreation. The analysis underscores that sustainable urban development in Gasabo cannot be achieved without prioritising investment in and protection of green infrastructure. Strengthening flood management systems, expanding urban parks, and enforcing environmental conservation measures are not only ecological imperatives but also social and economic necessities. Green infrastructure must be viewed as a central pillar of urban planning, capable of enhancing resilience, promoting public health, and fostering inclusive growth. This study demonstrates that the current trajectory of urban expansion in Gasabo District, if left unchecked, threatens long-term sustainability and community well-being. However, with deliberate policy reforms, integrated planning, and community engagement, green infrastructure can serve as a catalyst for balanced development that harmonises economic progress with environmental stewardship. The findings provide a valuable foundation for policymakers, planners, and stakeholders to reorient urban

development strategies toward a greener, healthier, and more resilient Gasabo District.

REFERENCES

- Mwenje, E., & Kumar, P. (2024). Challenges for mainstreaming climate adaptation in African cities. A case study of Kigali, Rwanda. *Landscape and Urban Planning*, 245, 105017.
- Andersson, E., Barthel, S., Borgström, S., Colding, J., Elmqvist, T., Folke, C., & Gren, Å. (2014). Reconnecting cities to the biosphere: Stewardship of green infrastructure and urban ecosystem services. *Ambio*, 43(4), 445–453.
- Angel, S., Parent, J., Civco, D. L., & Blei, A. M. (2011). Making room for a planet of cities. *Lincoln Institute of Land Policy*.
- Ayeni, A. O., Aticho, A., & Abegunde, V. O. (2023). Urbanization and sustainability challenges in Eastern Africa. *Sustainability*, 15(7), 1–15.
- Canning, D., Raja, S., & Yazbeck, A. S. (2015). Africa's demographic transition: Dividend or disaster? *World Bank*.
- Cilliers, S. (2019). Planning for green infrastructure: Options for African cities. *Current Opinion in Environmental Sustainability*, 39, 31–36.
- Cumming, G. S., Buerkert, A., Hoffmann, E. M., Schlecht, E., von Cramon-Taubadel, S., & Tschardt, T. (2014). Implications of agricultural transitions and urbanization for ecosystem services. *Nature*, 515(7525), 50–57.
- Gulati, M., Jacobs, I., Jooste, A., Naidoo, D., & Fakir, S. (2020). Cities of opportunity: Connecting culture and innovation. *World Bank*.
- Kılıç, Ş. (2022). Sustainable development of cities under climate change: Green infrastructure solutions. *Journal of Cleaner Production*, 368, 133183.

- Li, F., Liu, H., & Zhang, X. (2022). Green infrastructure in urban planning: Advancing sustainability and resilience. *Urban Forestry & Urban Greening*, 70, 127540.
- Mwenje, J. (2019). Drivers of urban growth in Kigali City, Rwanda. *Journal of Urban Development Studies*, 5(2), 45–60.
- Nduwayezu, G. (2016). Urban growth and spatial planning in Kigali City. *Rwanda Journal*, 1(1), 54–70.
- Ngome, I., Uwitonze, M., & Habimana, J. (2024). Urban green infrastructure and sustainable development in Kigali. *African Journal of Environmental Planning*, 12(1), 33–49.
- Rwanda Environment Management Authority. (2021). *State of the environment and outlook report*. Kigali: REMA.
- Rwanda Housing Authority. (2023). *Annual report on housing and urban development*. Kigali: RHA.
- Seto, K. C. (2009). Global urban land-use trends and climate impacts. *Current Opinion in Environmental Sustainability*, 1(1), 89–95.
- Thorn, J., Thornton, A., & Helfgott, A. (2021). Sub-Saharan Africa's urban futures: Vulnerabilities and resilience. *Urban Studies*, 58(3), 517–536.
- Titz, A., Chiotha, S., & Müller, B. (2019). Linking green infrastructure and urban governance: Lessons from Africa. *Ecology and Society*, 24(2), 12.
- Tzoulas, K., Korpela, K., Venn, S., Yli-Pelkonen, V., Kaźmierczak, A., Niemela, J., & James, P. (2007). Promoting ecosystem and human health in urban areas using green infrastructure: A literature review. *Landscape and Urban Planning*, 81(3), 167–178.
- Wang, X., Huang, J., & He, C. (2014). Green infrastructure and urban sustainability: A review. *Sustainability*, 6(11), 7821–7849.
- Watson, V. (2009). 'The planned city sweeps the poor away...': Urban planning and 21st century urbanization. *Progress in Planning*, 72(3), 151–193.
- Wijesinghe, S., Gunaratne, K., & Jayasinghe, A. (2021). Informal settlements in Sub-Saharan Africa: Challenges and opportunities. *Habitat International*, 116, 102405.
- World Bank. (2022). *Climate risk profile: Rwanda*. Washington, DC: World Bank.