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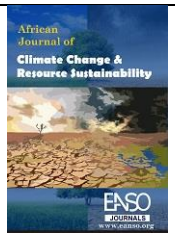

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Original Article

Urban Wetland Restoration and Its Impact on the Ecological and Socioeconomic Benefits. A Case Study of Nyandungu Eco-Tourism Park in Rwanda (2016-2024)

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Ecological Benefits, Ecosystem Services, Nyandungu, Socio-Economic Impact, Urban Wetland Restoration, Rwanda.

ABSTRACT

A wetland is a vital ecosystem characterised by its water-saturated conditions, either permanently or seasonally. It includes areas such as swamps, marshes, and bogs, which support diverse plant and animal life that has adapted to these unique conditions. This study examined "Urban Wetland Restoration and Its Impact on the Ecological and Socioeconomic Benefits: A Case Study of Nyandungu Eco-Tourism Park in Rwanda (2016-2024)." The study employed a mixed-methods approach to assess the ecological and socioeconomic impacts of Nyandungu Eco-Tourism Park's wetland restoration (2016–2024). Quantitative surveys captured visitor experiences, spending patterns, and environmental awareness, alongside local community perceptions of benefits, enabling analysis of social and economic outcomes. Semi-structured interviews with stakeholders (park managers, officials, experts, and community leaders) provided qualitative insights into management challenges, conservation strategies, and plans. Secondary data, academic literature, government reports, and environmental studies contextualised the findings, while remote sensing (2016 vs. 2024 orthophotos) quantified ecological changes. This triangulation of primary and secondary sources ensured a holistic evaluation of restoration impacts. The results demonstrated that the Nyandungu wetland restoration project successfully transformed a degraded area into a thriving ecosystem. Key statistics highlight this transformation: the reintroduction of 62 native plant species, the planting of 17,000 indigenous trees, and the establishment of habitats for over 100 bird species. Furthermore, the project created approximately 4,000 green jobs, with 50% of the local population perceiving improvements. Correlation analysis reveals strong positive relationships between restoration efforts and ecological ($r=0.87-0.95$), economic ($r=0.76-0.82$), and social dimensions ($r=0.72-0.79$), all with statistical significance ($p\leq0.05$). The findings offer critical insights into the multidimensional impacts of urban wetland restoration, demonstrating the potential of such interventions to simultaneously address community development objectives. By focusing on the Nyandungu Eco-Tourism Park, this study contributes to the growing body of knowledge on sustainable urban ecosystem management and provides valuable recommendations for future wetland restoration efforts in Rwanda and similar contexts.

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INTRODUCTION

Wetlands are crucial ecosystems found across the globe, covering an area estimated to be over 12.1 million km², which is larger than Canada. However, these vital habitats are disappearing at an alarming rate, with approximately 35% of natural wetlands lost since 1970, a rate three times faster than that of forests. Regionally, Asia accounts for the largest share of global wetland area at 31.8%, followed by North America at 27.1%, and Latin America and the Caribbean (Neotropics) at 15.8%. [1,21]. Europe and Asia have seen particularly significant declines, with reductions of around 60% in wetland extent. While natural wetlands are diminishing, human-made wetlands, such as rice paddies and reservoirs, have nearly doubled in area, now comprising 12% of all wetlands, but this increase has not compensated for the loss of natural systems. More than a billion people worldwide depend on wetlands for their livelihoods, yet their immense value, including acting as significant carbon stores and supporting 40% of all plant and animal species, remains widely underestimated. Approximately 6% of the Earth's terrestrial landscape is made up of wetlands. Approximately 4.7% (1.15 million km^2) of Africa's continental surface is made up of wetlands [2]. Wetlands are important for a variety of ecological processes and socioeconomic advantages for human people through different activities, including agriculture, tourism, and fishing [3,4]. Wetlands are essential to the maintenance of ecosystems on Earth, which control water supplies, modify regional temperatures, and provide food for people [5]. Wetlands support over 40% of the world's species, which means they contribute to the biodiversity of the planet [6]. In Africa, wetlands are widely utilised for water supplies and agriculture, supporting the livelihoods of millions of Africans [7,8]. These ecosystems have primarily been depleted for habitation and agriculture, overuse by local populations, and poorly thought-out development projects [9]. Africa's wetlands are experiencing immense pressure from human activities [10]. The wetland-to-grass conversions account for a total conversion area of over 27933 $km^{2,}$ contributing to about 24.3% of the total global wetland-to-grassland conversion area [1,21]. To increase rice production, dams and dikes were built on the upper Senegal River [1,21], which changed the aquatic regime, endangering the existence of certain plant species and promoting the expansion of others, thus changing the ecosystem's features of the river [10,25]. Another example of mismanagement of water resources on the wetland ecosystem happened in Cameroon, where inadequate plans for water use

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in northern Cameroon have decreased natural flooding in Waza National Park [11,14]. Furthermore, damming activities of the Tana and Athi rivers in Kenya have prevented migratory fish species from moving upstream, which has led to a decline in the numbers of two antelope species, the Korrigum Damaliscus lunatus korrigum and Buffon's Kob Kobus kob [11,23].

In Rwanda, wetlands rank among the most productive ecosystems in terms of fisheries, plant matter, and freshwater biodiversity support. About 16 % of the Rwandan surface area is covered by wetlands [3,4]. Throughout the dry season, they restore rivers and streams, absorb floodwaters, cushion agricultural fields and communities from heavy runoff, feed lakes and rivers, and trap and filter sediments and nutrients [13,24]. Wetlands are essential to human existence; therefore, acknowledging their significance serves as the foundation for their conservation [14]. Despite the crucial role played by Rwandan wetlands for survival, they are increasingly threatened by unsustainable utilisation [15]. The integrity of wetland ecosystems and their capacity to provide ecosystem services are increasingly under threat [16]. Rwanda's wetlands are under great pressure due to population growth, urbanisation, pollution, and degradation from numerous economic activities [16,22].

The Nyandungu Urban Wetland Eco-tourism Project (NUWEP) advanced the restoration of the Nyandungu degraded area, restored biodiversity by introducing native tree species, and restored terrestrial and aquatic habitats [17]. The Nyandungu wetland complex covers an area of 121.7 hectares that has been restored [18]. The restoration of Nyandungu wetland highlights the management techniques and green technologies that can be used in Rwanda's secondary cities, therefore demonstrating its scalability as a model for other wetlands and increasing its potential [19]. It is reported that the park was meant to improve the livelihoods of local communities by creating green jobs for local communities [20], restore biodiversity habitats, restore the wetland itself for sustainable use, and rehabilitate streams and ponds for flood alleviation of wetlands and the reed-bed for pollution abatement of wetlands[21]. The Nyandungu Wetland Eco-Park will not only provide social and economic benefits to the communities but also support innovative approaches to restore and conserve wetland ecosystems on about 134 ha, promote the sustainable management of natural resources, and support livelihood diversification to enhance incomes for local communities [22]. This newly constructed Wetland Eco-Park also responds to the Green Economy in the EDPRS II and is one of the aspirations of Vision 2050 of developing green cities [23]. Against this background, this study sought to assess the impact of urban wetland restoration on the ecological and socioeconomic benefits, using the Nyandungu Eco-tourism Park in Rwanda as a case study. Therefore, the specific objectives of this study are to: (1) assess the condition of the Nyandungu wetland before and after the restoration initiative. (2) To evaluate the ecological and socioeconomic benefits of the Nyandungu Eco-Tourism Park restoration, and (3) to assess the relationship between wetland restoration and socioeconomic benefits.

MATERIALS AND METHODS

Site Description

Nyandungu Eco Park, located in Kigali, Rwanda, is a vibrant ecological sanctuary designed to promote urban green spaces and biodiversity conservation [8,21]. Spanning approximately 130 hectares, the park features a mix of restored wetlands, indigenous forests, and landscaped gardens [8,22]. It serves as a vital habitat for various flora and fauna, including numerous bird species and aquatic life [8,24]. Nyandungu Eco Park in Kigali, Rwanda, benefits from a tropical savanna climate characterised by moderate temperatures and distinct wet and dry seasons [8,24]. Kigali experiences average temperatures ranging from 15°C (59°F) to 27°C (81°F) throughout the year, with the wet season occurring from March to May and October to December, bringing heavy rainfall [8,24]. The dry season, spanning from June to September and January to February, sees less precipitation and more sunshine [1,25]. The topography of Nyandungu

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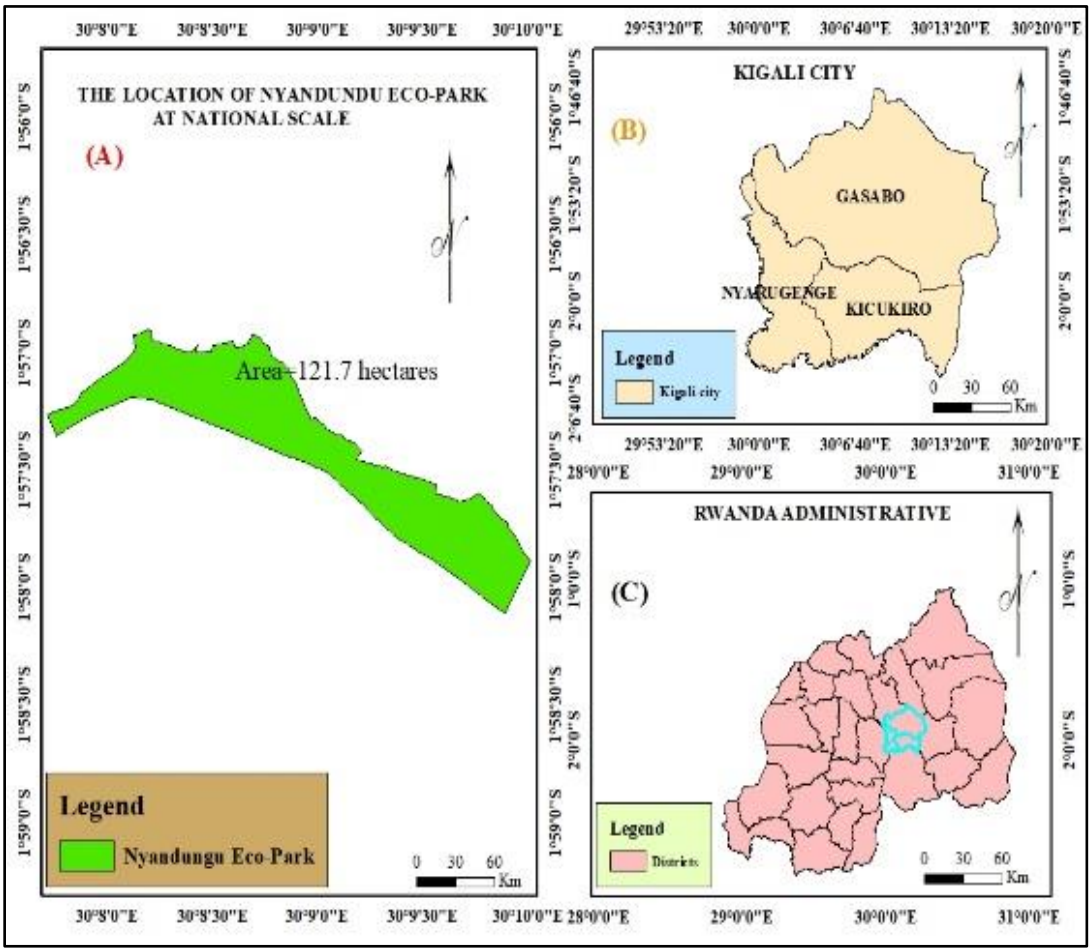
Eco Park is predominantly flat to gently undulating, situated within a valley that enhances its role in flood management and wetland restoration [25].

Figure 1: Map of the Study Area



Data and Approaches

This study employed both quantitative and qualitative mapping approaches to assess the Nyandungu wetland from 2016 to 2024. Quantitative data were collected through questionnaires to capture community perceptions, while remote sensing and orthophotos were used to map and analyse changes in the wetland over time. Observations, along with biological and acoustic assessments, provided insights into the current ecological status, focusing on flora and fauna. The research also examined biophysical indicators, such as invasive plant species and landscape conditions, while considering respondents' demographics, activities in and around the wetland, and their length of residence. The targeted population involved the community and local leaders within the surrounding villages that border the wetland. In this research, the local community surrounding Nyandungu Eco-Tourism Park participated in collecting data on the socioeconomic benefits of the park's restoration. The target population of this study comprises 206,144 households distributed across three different sectors: Nyarugunga, Kimironko, and Ndera. The data was based on the socio-economic activities, land use practices in wetlands, and community perceptions and local knowledge on biodiversity conservation in wetland ecosystems. By carefully choosing people who can offer knowledge and perspectives on socioeconomic aspects, four members of the key informants were included in the targeted population, and they were selected purposively from the park management staff, local government officials, tourism operators, and environmental experts.

For a population of 206,144, the Krejcie and Morgan table (from search results) provides a

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straightforward sample size of 384 respondents for a 5% margin of error and 95% confidence level. This aligns with the standard formula used in SurveyMonkey's calculator, which also yields ≈384 under the same parameters. Using the standard formula:

$$\boldsymbol{n} = \frac{\mathrm{N}^2 * \mathrm{e} * \mathrm{Z}^2}{(\mathrm{N}-1) * \mathrm{e}^2 + \mathrm{Z}^2 * \mathrm{p} * (1-\mathrm{p})}$$

Where:

- *N* = 206,144
- e = 0.05(5% margin of error)
- z = 1.96 (95% confidence level)
- p = 0.5 (neutral assumption)

Sample size ≈ 384 for a 5% margin of error and 95% confidence level.

Adjusting pp (expected proportion) or e (margin of error) modifies this value.

$$\mathbf{n} = \frac{3.8416 \cdot 0.25}{0.0025} = \frac{0.9604}{0.0025} = 384.16$$

Data Collection and Analysis

This study utilised both primary and secondary sources, emphasising remote sensing techniques to monitor ecological changes in the Nyandungu wetland from 2016 to 2024. Secondary data included orthophotos and satellite imagery used to map land cover changes and evaluate wetland restoration progress. Primary data were collected through field surveys, direct observations, and community questionnaires to capture socio-economic impacts and local perceptions. Together, these methods provided a comprehensive understanding of the environmental and social outcomes of urban wetland restoration. By combining numerical insights with community perspectives, the research aims to develop actionable strategies for enhancing the wetland's sustainability and conservation outcomes. Direct field observations and biodiversity surveys were essential in assessing the ecological and socioeconomic impacts of urban wetland restoration. Fieldwork involved documenting physical characteristics, restoration progress, and ecosystem changes through notes and photographs, while biodiversity surveys evaluated species diversity, distribution, and habitat quality. Socioeconomic data collection relied on structured questionnaires targeting visitors and residents to gauge experiences, spending patterns, and community perceptions. Semi-structured interviews with stakeholders offered deeper insights into management challenges, economic impacts, and conservation strategies.

This comprehensive approach combined quantitative and qualitative data to effectively evaluate wetland restoration's ecological functionality and its social and economic benefits. Academic literature, government reports, and environmental studies related to wetland restoration and urban ecology. Published research articles, case studies, and previous assessments of similar projects provided a comparative framework and context for understanding the broader implications of wetland restoration. Government documents, such as environmental impact assessments, policy papers, and urban planning records, offer insights into regulatory and policy support for the restoration efforts. Reports from environmental organisations and NGOs involved in the project supplied valuable information on implementation strategies, community engagement, and measured outcomes. This secondary data complemented primary data by providing a deeper understanding of the long-term trends, challenges, and successes associated with urban wetland restoration initiatives. Social research was conducted through structured questionnaires, interviews, and focus group discussions, using digital survey tools and audio recorders to capture data on community perceptions. Participant observation and visitor logs were employed to gather information on park usage patterns. These diverse techniques and instruments ensured a comprehensive assessment of the socio-economic outcomes of the wetland restoration.

Excel is typically used for organizing, cleaning, and performing basic descriptive statistics on large datasets, while SPSS offers more advanced

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statistical analysis capabilities, such as regression, correlation, and multivariate analyses, which are essential for rigorously evaluating ecological indicators (like biodiversity, water quality) and socioeconomic outcomes (such as property values and recreational use). Using these tools, researchers can quantify changes in ecosystem services-such as flood mitigation, water purification, and biodiversity conservation measure the resulting social and economic benefits for urban communities, thereby providing evidence-based guidance for policymakers and stakeholders on the effectiveness of wetland restoration projects. To analyse the correlation and relationships between these variables, the following statistical metrics and methods can be used: Pearson Correlation Coefficient (r): This metric measures the strength and direction of the linear relationship between two continuous variables. It ranges from -1 to +1, where 1 indicates a perfect positive correlation, -1 indicates a perfect negative correlation, and 0 indicates no correlation. The equation of correlation analysis is as follows:

$$r = \frac{n(\sum xy) - (\sum x)(\sum y)}{\sqrt{\left[n\sum x^2 - (\sum x)^2\right]\left[n\sum y^2 - (\sum y)^2\right]}}$$

Where ***r*** is the Pearson correlation coefficient, ***n*** is the sample size, ***x*** is the independent variable, and ***y*** is the dependent variable. Regression analysis will depend on the complexity of the relationship and the number of independent variables; therefore, both Simple Linear Regression and Multiple Regression Analysis will be used. For the analysis involving one independent variable (e.g., restoration metric) predicting one dependent variable (e.g., income from tourism), the Simple Linear Regression will be applied. For multiple independent variables (e.g., various restoration metrics) to predict a single dependent variable (e.g., overall eco-socio-economic benefits), the Multiple Regression Analysis was implemented.

RESULTS

Condition of the Nyandungu Wetland Before and After the Restoration Initiative

Nyandungu Wetland Before Restoration

To present the results of the study on urbanisation indicator dynamics and its influence on drought vulnerability over the twenty-two-year period (2000–2022) and provide an interpretation of the findings.

Nyandungu was a degraded Wetland facing severe environmental pressures from urban expansion. Human activities like encroachment, sewage pollution, and habitat destruction led to biodiversity loss, downstream flooding, and reduced ecological functionality. The wetland's natural habitats were compromised, with native vegetation and wildlife declining due to unsustainable land use and infrastructure development. This degradation mirrored broader challenges in Kigali's wetlands, where rapid urbanisation disrupted hydrological systems and exacerbated pollution risks. The site's transformation into an eco-park began in 2016 as part of Rwanda's efforts to reverse these impacts through wetland restoration and sustainable urban planning.

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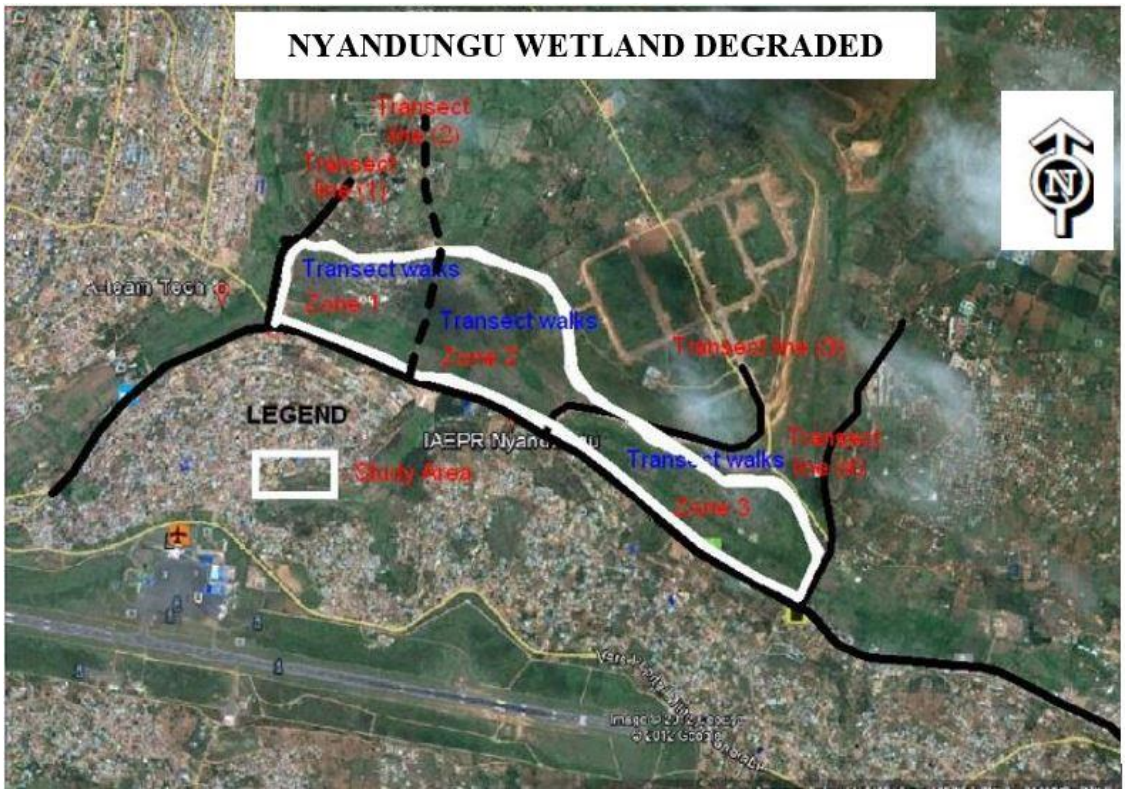
Figure 2: Nyandungu Wetland Degraded by Urban Expansion



Source: *USGS Earth Explorer, Pre-2016*

The Proposed Conceptual Plan for Nyandungu Wetland in 2012

Nyandungu Wetland Park, developed through par ticipatory research and SWOT analysis, emphasis es environmental protection, cultural integration, and socioeconomic sustainability. It envisions a regional ecotourism hub preserving the site's ecological integrity while offering recreational spaces, educational programs, and bi odiversity conservation through native species re storation. Key principles include accessibility (pe destrian/bicycle pathways), equity (inclusive facil ities), and coordination with urban planning to balance growth and green infrastructure. The plan integrates Community-

Based Stewardship Groups involving local stakeh olders to ensure long-term management and livelihood benefits, with features like medicinal gardens, catchment ponds, and educational centres to enhance ecological awareness. Sustainability relies on innovative pricing, green technologies, and partnerships to maintain biodiversity while addressing flooding and pollution.

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Figure 3: The Proposed Conceptual Plan for Nyandungu Wetland Park 2012

Source: *Nyandungu Eco-Park, 2025*

Nyandungu Wetland After Restoration

The Nyandungu Urban Wetland Restoration and Recreation Eco-Tourism Park transformed a degraded wetland in Kigali into a thriving ecosystem and recreational hub through a six-year initiative (2016–2021). The project restored 121.7 hectares of marsh and forest, reintroducing native tree species and rehabilitating streams to mitigate flooding and pollution. Key achievements include planting 17,000 indigenous trees, creating 4,000 green jobs for local communities, and establishing biodiversity hotspots with over 62 plant species and 100 bird species. The Park now features 10 km of walkways, an information centre, and recreational facilities, serving as both an educational resource and a model for sustainable urban wetland management. Urban challenges by demonstrating how wetland conservation can enhance climate resilience and economic opportunities. By rehabilitating degraded habitats and installing pollution abatement systems, Nyandungu reduces flood risks and improves water quality. This success has drawn international recognition, with visitors including dignitaries like IMF Managing Director Kristalina Georgieva and Gabon's Environment Minister. The park's integration of ecotourism and biodiversity conservation exemplifies Rwanda's green economy strategy, offering lessons for replicating such initiatives in other urban wetlands. Challenges such as encroachment and pollution persist, but the project's focus on community engagement and sustainable livelihoods underscores its long-term viability.

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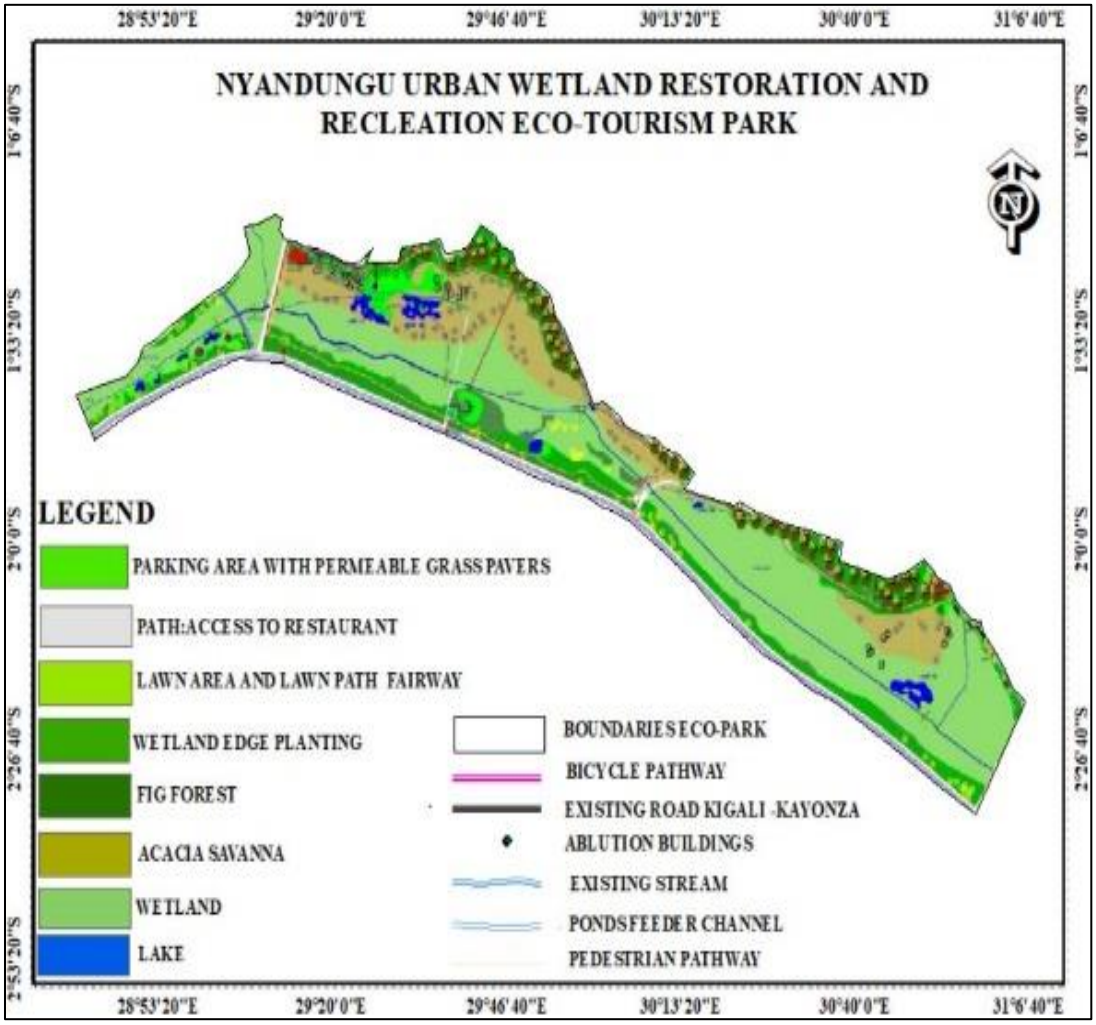
Figure 4: Nyandungu Urban Wetland and Restoration, and Recreation Eco-tourism Park (2024)



Source: *Primary data, 2025*

Nyandungu Eco-Park exemplifies how wetland restoration enhances socioeconomic benefits through job creation, livelihood diversification, and ecotourism revenue generation. The project created 4,000 green jobs for local youth and women in conservation, park management, and visitor services while integrating traditional practices like communal work to foster community ownership. By restoring biodiversity (55 Indigenous tree species, 100+ bird species) and rehabilitating habitats, the park attracts tourists, supporting a restaurant, an artisan shop, and educational facilities that boost local economies. Flood mitigation and pollution abatement functions improve urban resilience, indirectly enhancing the quality of life and property values. These outcomes demonstrate how wetland restoration can align ecological recovery with equitable socioeconomic development, particularly in urban settings like Kigali.

The Ecological and Socioeconomic Benefits Provided by the Nyandungu Wetland

Socio-demographic Characteristics of Respondents

The demographic data reveals that 54.95% of respondents aged 18–25 and 25% aged 26–35 dominate the engagement with Nyandungu Eco-Tourism Park, highlighting its strong appeal to younger populations. This aligns with the park's role in creating 4,000 green jobs and fostering ecotourism, which particularly benefits youth and women, as outlined in Rwanda's National Strategy for Transformation. The lower representation of older age groups (4.95% for 46–55 and 2.89% for 56+) suggests potential gaps in outreach or accessibility for these

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demographics. The park's success in restoring biodiversity, mitigating floods, and providing recreational spaces has significantly enhanced socioeconomic benefits, such as improved livelihoods, health outcomes, and community well-being. However, targeted efforts to include older populations and diversify employment opportunities could further amplify its impact, ensuring equitable benefits across all age groups while reinforcing the park's role as a model for urban wetland restoration.

Table 1: Age distribution

Age Group	Respondents	Percentage
18–25	211	54.95
26–35	96	25
36–45	47	12.24
46–55	19	4.95
Over 55	11	2.89
Total	**384**	**100**

Source: *Primary data, 2025*

The occupation distribution of respondents highlights the significant socioeconomic impact of the Nyandungu Eco-Tourism Park, with 46.61% engaged in tourism/conservation, underscoring its role in creating green jobs and fostering ecotourism. This aligns with the park's restoration efforts, which have generated 4,000 jobs, particularly benefiting women and youth, and contributed to Rwanda's sustainable development goals. The 20.05% in education reflects the park's value as an educational hub, offering insights into wetland conservation and ecosystem services, while the 14.32% in the private sector indicates its broader economic influence, likely through businesses catering to tourists. The 7.81% in government suggests administrative and regulatory roles, essential for the park's management and scalability. However, the 5.47% unemployment and minimal representation from agriculture (2.34%) and students (2.34%) reveal gaps in inclusivity, suggesting the need for targeted initiatives to engage these groups. The research demonstrates how urban wetland restoration, as exemplified by Nyandungu, not only enhances environmental health but also drives economic growth, community well-being, and educational opportunities, reinforcing its role as a model for sustainable urban development.

Table 2: Occupation Distribution

Sector Occupation	**Respondents**	**%**
Tourism/Conservation	179	46.61
Education	77	20.05
Private Sector	55	14.32
Government	30	7.81
Unemployed	21	5.47
Agriculture	9	2.34
Student	9	2.34
Other	4	1.04
Total	**384**	**100**

Source: *Primary data, 2025*

Moreover, the results of the research highlight the park's significant impact on residents (67.97%), who benefit directly from enhanced access to green spaces, improved environmental health, and economic opportunities such as jobs in tourism and conservation. Visitors (29.43%) reflect the park's role as a recreational and educational hub, attracting ecotourism and fostering awareness of wetland restoration's benefits. The small percentage of business owners (2.60%)

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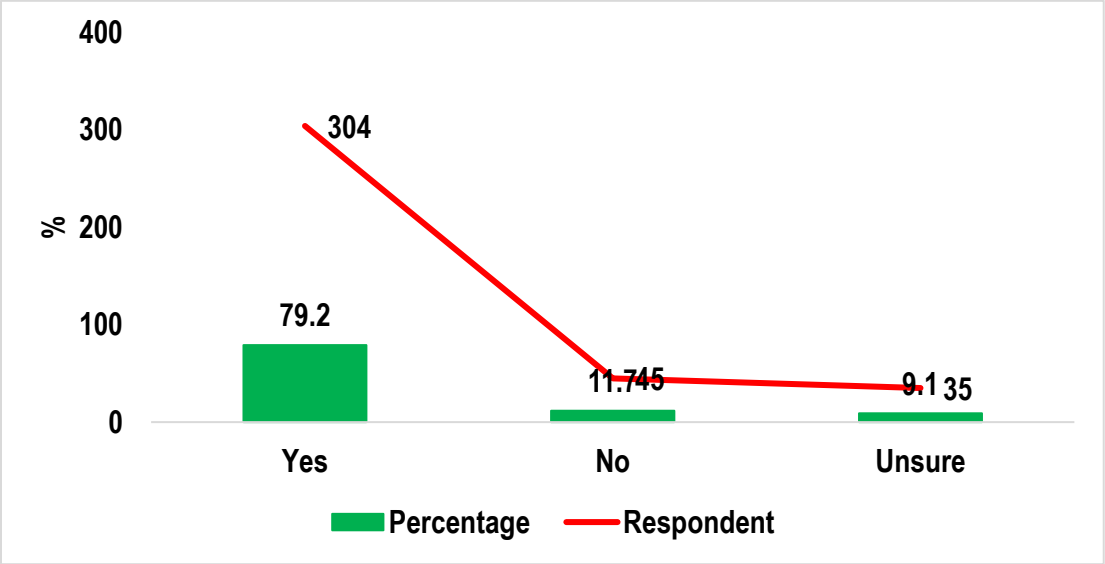
underscores the park's potential to expand its economic influence through partnerships and services linked to its operations. The proximity data underscores Nyandungu's success in integrating urban wetland restoration into local livelihoods and community well-being, aligning with Rwanda's goals of sustainable development and climate resilience.

Impact of Nyandungu Eco-Park on Local Tourism Revenue

The research highlights Nyandungu Eco-Park's significant contribution to local economic growth through tourism. The 79.2% "Yes" responses align with the park's role in attracting 6,000 monthly visitors, boosting businesses like hotels, restaurants, and souvenir shops. The 11.7% "No" and 9.1% "Unsure" responses may indicate areas with limited direct benefits or a lack of awareness about the park's economic impact. Overall, the park exemplifies how urban wetland restoration can drive sustainable tourism, create jobs, and enhance local livelihoods, reinforcing its role as a model for eco-tourism and community development in Rwanda.

Figure 5: Impact of Nyandungu Eco-Park on Local Tourism Revenue



Source: *Primary data, 2025*

The Nyandungu Eco-park's Impact on Primary Income Sources

The Nyandungu Eco-Park's Impact on Primary Income Sources. The majority of respondents (287/384) reported that the park improved their primary income source, with 74.7% answering "Improved," 21.9% "No change," and 3.4% "Declined. The research reflects Nyandungu Eco-Park's significant role in enhancing local livelihoods through green jobs, tourism, and ecosystem services. The 74.7% improvement aligns with the park's creation of 4,000 jobs, particularly benefiting women and youth, and its contribution to sustainable income generation. The 21.9% "No change" responses may indicate indirect or limited engagement with the park's economic opportunities, while the 3.4% "Declined" could suggest challenges such as displacement or competition. Overall, the park exemplifies how urban wetland restoration can drive socioeconomic development, fostering economic resilience and community well-being in Rwanda.

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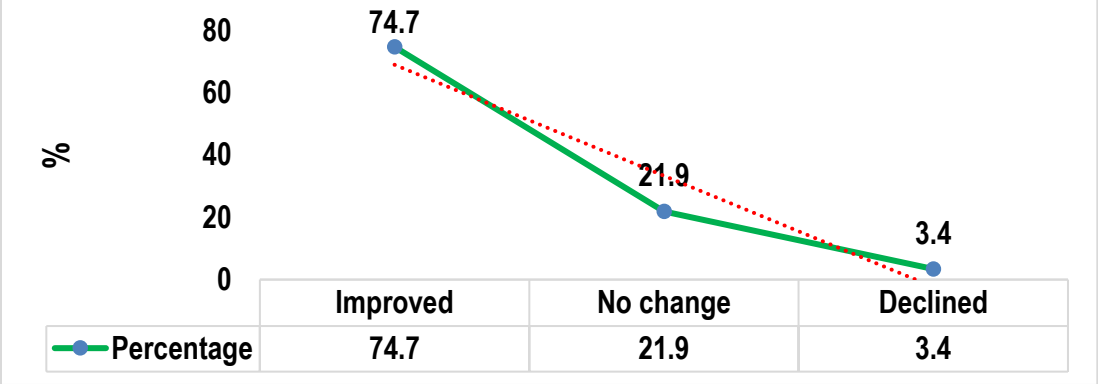
Figure 6: The Nyandungu Eco-park's Impact on Primary Income Sources

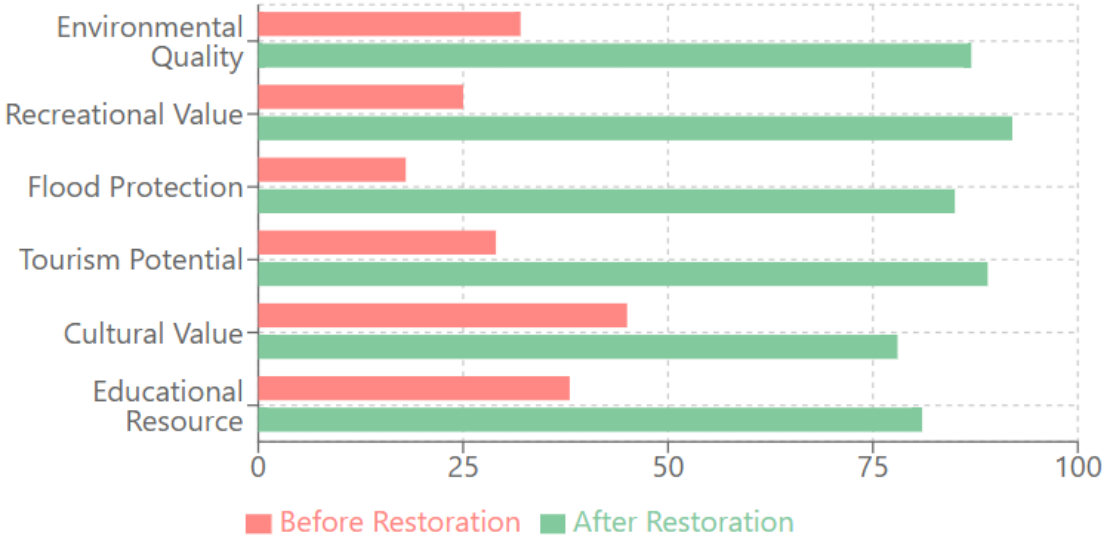


Source: *Primary data, 2025*

Relationship between Wetland Restoration and Eco-socioeconomic Benefits

This visualisation directly supports the strong positive correlations found between wetland restoration and community perceptions. The dramatic difference between before and after scores (ranging from 32 to 45 points before restoration versus 78 to 92 points after) aligns with correlation coefficients of 0.76 for Tourism Potential. The most significant improvement in Recreational Value (from 25 to 92) corresponds to the 0.79 correlation coefficient for Recreational Activities, highlighting how the restoration has transformed public perception from scepticism to strong endorsement.

Figure 7: Community Perception Transformation Before and After Restoration (scores out of 100).



Source: *Primary data, 2025*

The economic impact distribution visualises the relative importance of different economic benefits, supporting the correlation findings. Tourism Revenue's 38% share aligns with its 0.76 correlation coefficient, while Green Jobs' 27% share corresponds to its 0.82 correlation coefficient. The presence of Property Value Increase (8%) in the chart confirms the moderate correlation (0.64) found for Property values. This chart helps explain why economic factors show stronger but slightly lower correlations than ecological factors - they represent a diverse mix of benefits with varying strengths.

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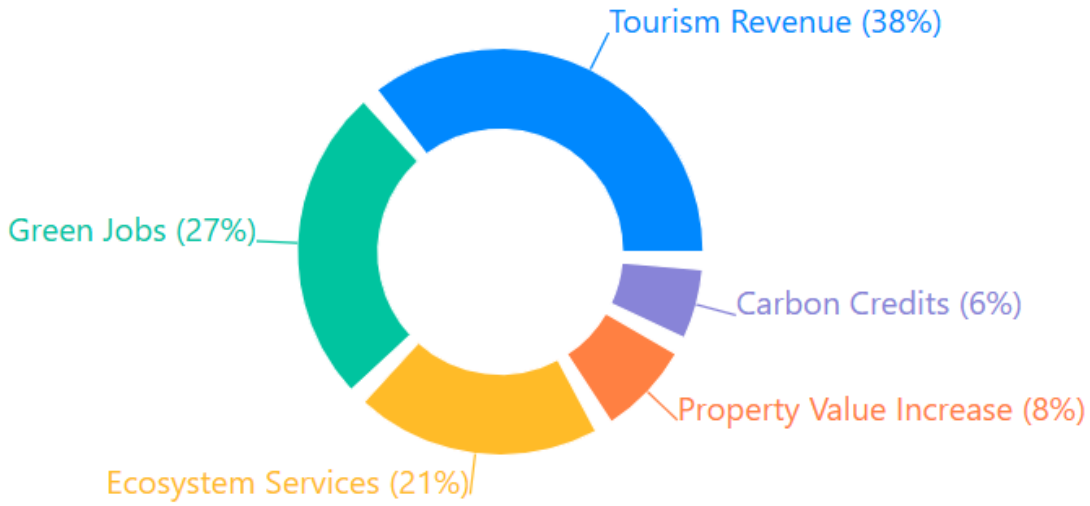
Figure 8: Economic Impact Distribution



Source: *Primary data, 2025*

The radar chart illustrates positive correlations across measured factors, evidenced by the expansion from the inner (before) area to the outer (after) area; the Environmental dimension shows the largest improvement (from 2.5 to 8.9), aligning with strong ecological factor correlations (0.87-0.95) that indicates a strong positive correlation according to the reference image, while the Recreational dimension's significant improvement (from 1.9 to 9.1) supports its 0.79 correlation coefficient, suggesting a moderate positive correlation.

Table 3: Multi-dimensional Benefits Assessment Before and After Across Dimensions

Category	Initial Score	Final Score	Increase
Environmental	2	9	7
Economic	2	10	8
Social	2	9	7
Educational	2	8	6
Recreational	2	9	7
Cultural	2	8	6

Correlation Summary

Overall, the correlation analysis reveals consistently strong positive relationships between the Nyandungu wetland restoration and various eco-socioeconomic benefits. Environmental factors demonstrate the strongest correlations, with Habitat Restoration (r=0.95) and Flooding Reduction (r=0.89) showing very strong positive relationships that are highly statistically significant ($p \leq 0.001$). These findings indicate that the wetland's ecological functions have been substantially restored, creating measurable environmental improvements. Economic benefits show strong but slightly more moderate correlations, with Green Jobs (r=0.82) and Tourism Revenue (r=0.76) demonstrating the economic viability of restoration investments. Social and recreational dimensions, including Recreational Activities (r=0.79) and Educational Opportunities (r=0.75), all exhibit strong positive correlations, indicating the restoration has successfully transformed the wetland into a valuable community asset.

The analysis also reveals moderate but significant correlations with broader urban benefits such as Property values (r=0.64). All correlations are statistically significant at $p \leq 0.05$, with most achieving high significance ($p \leq 0.001$), providing

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robust evidence that the Nyandungu wetland restoration has generated comprehensive benefits across multiple dimensions. This multifaceted positive impact suggests that the project serves as an effective model for similar urban wetland restoration initiatives throughout Rwanda, demonstrating that ecological restoration can simultaneously deliver environmental protection, economic opportunities, and social benefits.

Table 4: Correlation Summary

Factor	Correlation (r)	Direction	Significance	Interpretation
Habitat Restoration	0.95	Positive	***(p=0.001)	Very strong
Flooding Reduction	0.89	Positive	***(p=0.001)	Very strong
Biodiversity	0.87	Positive	***(p=0.001)	Very strong
Green Jobs	0.82	Positive	***(p=0.001)	Very strong
Recreational Activities	0.79	Positive	***(p=0.001)	Strong
Ecosystem Awareness	0.78	Positive	***(p=0.001)	Strong
Tourism Revenue	0.76	Positive	***(p=0.001)	Strong
Educational Opportunities	0.75	Positive	***(p=0.001)	Strong
Property Values	0.64	Positive	**(p=0.002)	Slightly strong

*Significance levels: *** $p \leq 0.001$, ** $p \leq 0.01$, * $p \leq 0.05$, ns: not significant*

DISCUSSION

This study examined three key objectives: The first objective was to assess the condition of the Nyandungu wetland before and after restoration. Before restoration efforts began in 2016, the Nyandungu wetland was severely degraded due to urbanisation pressures, improper waste disposal, and unsustainable human activities. These factors have compromised the wetland's ecological functions and service provision capabilities. The restoration initiative successfully transformed this degraded landscape by removing stress factors and implementing ecological rehabilitation measures. Post-restoration assessment reveals a functioning ecosystem now capable of providing essential services such as flood regulation, water purification, and habitat support for biodiversity [1,26].

Second, to identify the eco-socio-economic benefits resulting from the restoration; The restoration has generated substantial eco-socio-economic benefits including reduced flooding incidents, improved maintenance of restored habitats (55 Indigenous tree species, 100+ bird species), amplified ecosystem services awareness, creation of green jobs 4,000 green jobs for local youth and women in conservation, park management, and visitor services, and establishment of a model for replication in other Rwandan urban wetlands. The wetland has become a hub for recreational tourism and sustainable revenue generation. The results show that 50% perceived improvement aligns with the project's tangible outcomes, such as reintroducing 62 native plant species and 100+ bird species, alongside planting 17,000 Indigenous trees [26-27]. The last objective is to analyse the correlation between restoration efforts and observed benefits [27-28]. Correlation analysis demonstrates strong positive relationships between restoration efforts and these benefits, with particularly strong correlations for ecological factors (r=0.87-0.95) and significant correlations for economic factors (r=0.76-0.82) and social dimensions (r=0.72-0.79) [29]. All correlations were statistically significant ($p \leq 0.05$), providing robust evidence that Nyandungu wetland restoration delivers comprehensive benefits across environmental, economic, and social dimensions, offering a compelling model for urban wetland management throughout Rwanda [30-31].

CONCLUSION

The status of the Nyandungu wetland was assessed through remotely sensed observations complemented by an assessment of biological indicators known to inhabit heavily disturbed

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wetland ecosystems in Rwanda. Further documented the effectiveness of qualitative respondent sampling to study human impacts on the changes in the integrity of the wetland. Based on the scope of the study, the assessed socio-demographic profile of the respondents included the gender, length of residence around the study area, and the activities mostly undertaken around the study area. The restoration of the Nyandungu Urban Wetland into an eco-tourism park in Rwanda has demonstrated important socioeconomic benefits, serving as a model for sustainable urban development. The project, which spanned six years and covered 121.7 hectares, successfully restored biodiversity by introducing native tree species and aquatic habitats while also mitigating flooding and pollution through the rehabilitation of streams and ponds.

This transformation not only enhanced the local ecosystem but also created approximately 4,000 green jobs, significantly improving the livelihoods of surrounding communities by providing employment opportunities and supporting local businesses. The Park has become a recreational and educational hub, featuring amenities such as nature-viewing areas, picnic spots, and an information centre, which attract tourists and researchers alike, thereby boosting the local economy. The integration of the park into the City of Kigali Master Plan underscores its role in promoting environmental conservation while delivering tangible economic and social benefits, including increased property values and enhanced community well-being. The Nyandungu project exemplifies how urban wetland restoration can harmonise ecological preservation with socioeconomic development, offering a scalable blueprint for similar initiatives in other regions. Future studies on urban wetland restoration at Nyandungu Eco-Tourism Park should explore long-term ecological monitoring to assess biodiversity trends and ecosystem health beyond 2024. Researchers are encouraged to investigate the socioeconomic impacts on local communities, including job creation, public health, and tourism development. Comparative studies with other restored urban wetlands in Rwanda or East Africa could offer valuable insights into best practices and policy frameworks, and integrating community participation and indigenous knowledge in restoration efforts can enhance sustainability and local engagement.

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Declarations of Conflict of Interest

The authors declare that they have no conflict of interest.

Author's Approval.

We ensure that all the authors mentioned in the manuscript have agreed to authorship, read and approved the manuscript, and given consent for submission and subsequent publication of the manuscript.

Ethical Approval.

While collecting our data, all applicable guidelines and principles for the care of species were followed under the ethical standards, and informed consent was obtained from all individual participants involved in the study by assuring their anonymity and informing talked about the purpose of conducting the research.

REFERENCES

[1] Adnan, M. S. G., Talchabhadel, R., Nakagawa, H., & Hall, J. W. (2020). The potential of Tidal River Management for flood alleviation in South Western Bangladesh. Science of the Total Environment, 731.https://doi.org/10.1016/j.scitotenv.2019.05.048.

[2] Alikhani, S., Nummi, P., & Ojala, A. (2021). Urban wetlands: A review on ecological and

Article DOI : https://doi.org/10.37284/ajccrs.4.1.3269

cultural values. Water, 13(22), 3301.https://www.mdpi.com/2073-4441/13/22/3301

[3] Barbier, E. B., Koch, E. W., Silliman, B. R., Hacker, S. D., Kennedy, C., Hughes, A. R., ... & York, P. H. (2011). The value of estuarine and coastal ecosystem services. Ecological Monographs, 81(2), 169-193.https://doi.org/10.1890/10-1510.1.

[4] Bunch, M. J., Morrison, K. E., Parkes, M. W., & Venema, H. D. (2011). Promoting health and well-being by managing for social-ecological resilience: the potential of integrating eco-health and water resources management approaches. Ecology and Society, 16(1). https: //www.ecologyandsociety.org/vol16/iss1/art8.

[5] Cai, Y. B., Zhang, H., Pan, W. B., Chen, Y. H., & Wang, X. R. (2013). Land use pattern, socio-economic development, and assessment of their impacts on ecosystem service value: study on natural wetlands distribution area (NWDA) in Fuzhou city, south-eastern China. Environmental monitoring and assessment, 185, 5111- 5123.https://doi.org/10.1007/s10661-012-2929-x.

[6] De Dieu Uwisengeyimana, J., Teke, A., & Ibrikci, T. (2016). Current Overview of Renewable Energy Resources in Rwanda. *Journal of Energy and Natural Resources*, *5*(6), 92– 97. https://doi.org/10.11648/j.jenr.20160506.13

[7] Finlayson Maxwell; Nick Davidson. (2018). Extent, regional distribution, and changes in the area of different classes of wetland. Institute for Land, Water, and Society, Charles Sturt University, Elizabeth Mitchell Drive. Corresponding author: Email: arenaria.interpres@gmail.com. This Supplementary. *Marine and Freshwater Research*, *69*, 1525–1533.https://doi.org/10.1071/MF17377.

[8] Gonzalez, F. R., Raval, S., Taplin, R., Timms, W., & Hitch, M. (2019). Evaluation of the Impact of Potential Extreme Rainfall Events on Mining in Peru. *Natural Resources Research*, *28*(2), 393–408. https://doi.org/10.1007/s11053-018-9396-1

[9] Hobbs, R. J., & Harris, J. A. (2001). Restoration ecology: Repairing the earth's ecosystems in the new millennium. *Restoration Ecology*, *9*(2), 239–246.https://onlinelibrary.wiley.com/doi/abs/10.1046/j.1526-100x.2001.009002239.x.

[10] Jia, L., Deng, Y., Hou, M., Li, Y., Ding, Z., & Yao, S. (2022). Pathways from the payment for ecosystem services program to ecological and socio-economic outcomes. Ecological Indicators, 144, 109534.https://www.google.com/search?q=https://www.sciencedirect.com/science/article/pii/S1470160X2200742X.

[11] Knox, A. K., Dahlgren, R. A., Tate, K. W., & Atwill, E. R. (2008). Efficacy of natural wetlands to retain nutrients, sediment, and microbial pollutants. Journal of Environmental Quality, 37(5), 1837-1846.https://pubmed.ncbi.nlm.nih.gov/18689745.

[12] Liu, L., Wang, H. J., & Yue, Q. (2020). China's coastal wetlands: Ecological challenges, restoration, and management suggestions. Regional Studies in Marine Science, 37, 101- 337.https://chatgpt.com/c/68495c00- 16d0- 8006- 8609- d94ae52f029c#:~:text=https%3A//doi.org/10.1016/j.rsma.2020.101337%3AcontentReference%5Boaicite%3A5%5D%7Bindex%3D5%7D

[13] Mamajonova, N., Oydin, M., Usmonali, T., Olimjon, A., Madina, A., & Marg'uba, M. (2024). The role of green spaces in urban planning is to enhance sustainability and quality of life. Holders of Reason, 2(1), 346-358.https://jshe.researchculturesociety.org/wp-content/uploads/JSHE202406001-min.pdf

[14] Nancy McCarthy, CÈline Dutilly-DianÈ, and B. D. (2002). Cooperation, collective action, and natural resources management in Burkina Faso: CGIAR Systemwide Program on Collective Action and Property Rights

Article DOI : https://doi.org/10.37284/ajccrs.4.1.3269

Secretariat, International Food Policy Research Institute. *International Livestock Research Institute, 27*. (https:/www.cgiar.org).

[15] Ndayisaba, F., Nahayo, L., Guo, H., Bao, A., Kayiranga, A., Karamage, F., & Nyesheja, E. M. (2017). Mapping and monitoring the Akagera Wetland in Rwanda. Sustainability, 9(2), 174.https://www.mdpi.com/2071-1050/9/2/174

[16] Pattison-Williams, J. K., Pomeroy, J. W., Badiou, P., & Gabor, S. (2018). Wetlands, flood control, and ecosystem services in the Smith Creek Drainage Basin: A case study in Saskatchewan, Canada. Ecological economic s, 147,36- 47. https://doi.org/10.1016/j.ecolec on.2017.12.026

[17] PRITCHARD, D. (2023). Convention on Wetlands. *Berkshire Encyclopedia of Sustainability 3/10*, 98–100. https://doi.org/10.2307/jj.9561408.32

[18] Qi, Y., Lian, X., Wang, H., Zhang, J., & Yang, R. (2020). Dynamic mechanism between human activities and ecosystem services: A case study of Qinghai Lake watershed, China. Ecological Indicators, 117, 106528.https://dx.doi.org/10.1016/j.ecolind. 2020.106528

[19] Rugege, D. (2004). Environmental Impact Assessment of the proposed establishment of free zones in the Nyandungu Valley and adjacent areas in the City of Kigali. Kigali, Rwanda.https://www.rema.gov.rw

[20] Shahid, M. J., Arslan, M., Ali, S., Siddique, M., & Afzal, M. (2018). Floating wetlands: a sustainable tool for wastewater treatment. Clean–Soil, Air, Water, 46(10), 1800120.https://doi.org/10.1002/clen.201800 120.

[21] Swim, J. K., Stern, P. C., Doherty, T. J., Clayton, S., Reser, J. P., Weber, E. U., & Howard, G. S. (2011). Psychology's contributions to understanding and addressing global climate change. American psychologis t, 66(4), 241.https://doi.org/10.1037/a002322 0.

[22] Tsinda, A., & Ilunga, L. (2006). Facteurs physiques du ruissellement à Kigali (Rwanda) . Geo-Eco-Trop, 2004, 28, 1 2: Pp.53-60. https://www.geoecotrop.be/uploads/publi cations/pub_302_02.pdf

[23] Turyahabwe, N., Tumusiime, D. M., Kakuru, W., & Barasa, B. (2013). Wetland Use/Cover Changes and Local Perceptions in Uganda. *Sustainable Agriculture Research*, *2*(4), 95. https://doi.org/10.5539/sar.v2n4p95

[24] Talbot, C. J., Bennett, E. M., Cassell, K., Hanes, D. M., Minor, E. C., Paerl, H., & Xenopoulos, M. A. (2018). The impact of flooding on aquatic ecosystem services. Biogeochemistry, 141, 439-461.https://doi.org/10.1007/s10533-018-0449-7.

[25] Urakawa, H., & Bernhard, A. E. (2017). Wetland management using microbial indicators. Ecological Engineering, 108, 456-476.https://www.sciencedirect.com/science/a rticle/abs/pii/S092585741730438X.

[26] Villa, J. A., & Bernal, B. (2018). Carbon sequestration in wetlands, from science to practice: An overview of the biogeochemical process, measurement methods, and policy framework. Ecological Engineering, 114, 115- 128.https://www.sciencedirect.com/scie nce/article/pii/S0925857417303658.

[27] Vörösmarty, C. J., Osuna, V. R., Cak, A. D., Bhaduri, A., Bunn, S. E., Corsi, F., ... & Uhlenbrook, S. (2018). Ecosystem-based water security and the Sustainable Development Goals (SDGs). Ecohydrology & Hydrobiology, 18(4), 317- 333.https://www.s ciencedirect.com/science/article/abs/pii/S164 2359318300636.

[28] UNEP. (2021). Ecosystem restoration for people, nature, and climate. In *Ecosystem restoration for people, nature, and climate*. https://doi.org/10.4060/cb4927en

Article DOI : https://doi.org/10.37284/ajccrs.4.1.3269

[29] Zhao, Q., Bai, J., Huang, L., Gu, B., Lu, Q., & Gao, Z. (2016). A review of methodologies and success indicators for coastal wetland restoration. Ecological indicators, 60, 442-452.https://doi.org/10.1016/j.ecolind.2015.07.003.

[30] Žigrai, F. (2010). Landscape ecology in theory and practice (selected theoretical and meta- scientific aspects). *Ekologia Bratislava*, *29*(3), 229– 246. https://doi.org/10.4149/ekol_2010_03_229.

[31] Zedler, J. B., & Kercher, S. (2005). Wetland resources: Status, trends, ecosystem services, and restorability. *Annual Review of Environment and Resources*, *30*, 39– 74. https://doi.org/10.1146/annurev.energy.30.050504.144248

