

ECOLOGICAL STUDY AND MAPPING OF BREEDING SITES OF THE GREY CROWNED CRANE (*BALEARICA REGULORUM*) IN MUBENDE, KASSANDA AND GOMBA DISTRICTS - UGANDA



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Table of contents

Contents-----	i
List of Acronyms and Abbreviations.....	iv
ACKNOWLEDGEMENTS-----	v
EXECUTIVE SUMMARY-----	vi
CHAPTER 1: INTRODUCTION-----	1
1.1 Background of the Study-----	1
1.3 Objectives of the Study-----	2
1.4 Rationale of the Study -----	3
1.5 Scope of the Study-----	3
1.6 Structure of the Study-----	3
CHAPTER 2: LITERATURE REVIEW-----	4
2.1 Introduction-----	4
2.2 Taxonomy and Distribution-----	4
2.4 Behavior and Feeding Ecology-----	5
2.5 Breeding Biology-----	5
2.6 Conservation Status and Threats-----	5
2.7 Global and Local Conservation Frameworks-----	6
2.8 Habitat and Range Expansion -----	6
2.9 Ecological Interactions and Role in Wetland Ecosystems-----	6
2.10 Behavior and Social Structure-----	7
2.11 Nesting Ecology and Hydrological Stability-----	7
2.12 Conservation Strategies and Community Involvement-----	7
2.13 Future Research Directions and Management-----	8
3.0 METHODOLOGY-----	9
3.1 Study Area Description-----	9
3.1.1. Geographical and Administrative Context-----	10
3.1.2. Hydrological and Ecological Features-----	10
3.1.3. Topography and Physical Characteristics-----	10
3.1.4. Vegetation and Land Cover-----	10
3.1.5. Climate-----	11
3.1.6. Population and Socio-Economic Context-----	11
3.2. Research Design-----	12
3.3 Data Collection Methods-----	12
3.3.1 Field Observations-----	13
3.3.2 Interviews and Focus Groups-----	13
3.3.3 Questionnaires-----	13
3.3.4 Ecological Surveys-----	13
3.4. Quantitative Data Analysis-----	13
3.5 Study Design-----	13
3.6 Sampling Strategy-----	13
3.6.1 Spatial sampling: selection of wetlands and observation units-----	13



3.6.2 Social sampling: households, interviews, and FGDs-----	14
3.7 Data Collection Methods-----	14
3.7.1 Field observations and crane counts-----	14
3.7.2 Household questionnaires-----	14
3.7.3 Ecological and habitat surveys-----	15
3.8 Data Analysis-----	15
3.8.1 Quantitative analysis-----	15
3.8.2 Qualitative analysis and integration-----	15
3.8.3 Qualitative Data Analysis-----	15
3.8.4 Spatial Data Analysis-----	16
3.9 Ethical Considerations-----	16
3.10. Limitations of the Study-----	16

Chapter 4: Results and Discussion----- 17

4.0. Introduction-----	17
4.1. Demographic Information-----	18
4.2. Grey Crowned Crane Sightings and Habitat Use-----	18
4.2.1. Ecological and Conservation Insights-----	22
4.3. GCC Behavior and Conservation Perceptions-----	24
4.4. Land use and land cover change-----	24
4.4.1 Land use land cover change – a comparison of 2015 to 2025-----	25
4.4.2. Expanded Mechanistic Pathways Affecting Crane Breeding Biology-----	29
4.4.2.1. Landscape Degradation in Relation to Grey Crowned Crane Conservation-----	31
4.4.2.2. Overall Implications for GCC Conservation-----	32
4.5. Courtship, Pairing, and the Need for Stability-----	33
4.5.1 Nest Placement and Vulnerability-----	34
4.5.2. Daily Foraging and Growing Interaction with Farmlands-----	35
4.6. Behavioral Shifts Driven by Human Disturbance-----	35
4.6.1. Community Perceptions: Cultural Affection and Livelihood Pressures-----	36
4.7. Gaps in Environmental Understanding and threats to the GCC-----	36
4.7.1. Opportunities for Community-Based Conservation-----	37
4.7.2. Human-Wildlife Interaction and Conservation Efforts-----	37
4.8. Predictions and future scenarios for conservation of the grey crested crane-----	38
4.8.1. Implications for the Grey Crowned Crane (GCC):-	40
4.9. Suggestions for Conservation of the Ecosystem and Grey Crowned Crane (GCC): Strategic Recommendations-----	40
4.10. Conclusion-----	43

Annexes----- 44

Annex 1 Tools and Instruments Used in the Study Methodology-----	44
Annex 2: Questionnaire: Community Engagement on Grey Crowned Crane Conservation-----	46
Annex 3: Study area map-----	50
Annex 4: Land use/cover classification-----	51
Annex 5: Prediction Map-----	52
Annex 6: Degradation map-----	53

References----- 54



List of figures

Figure 1: Demography of respondents-----	17
Figure 2: Categories pf respondents with regard to occupation-----	18
Figure 3: Interpretation of Grey Crowned Crane Activities by Time of Day-----	18
Figure 4: Places where the GCC were seen-----	20
Figure 5 A graph showing the comparison of land use land cover changes 2015-2025:---	26
Figure 6: Comparative degradation levels-----	26
Figure 7: Nests and where they are seen-----	34
Figure 8: Threats to the GCC-----	36
Figure 9: Prediction of land use land cover change by 2040-----	38

List of plates

Plate 1: GCC seen in a maize garden-----	21
Plate 2: The GCC seen flying from farm land-----	23
Plate 3: Area cleared for agriculture in Nabakazi buffer zone-----	24
Plate 4: Degraded area for Brick making -----	25
Plate 5; : GCC in a ready to harvest maize garden-----	27
Plate 6: GCC couples on the left, right is the rituals below the wedding ritual observed in Madudu-----	30
Plate 7: GCC seen parching in a farm in Kayebe sub county -----	35

List of maps

Map 1: Map of Nabakazi ecosystem catchment-----	9
Map 2: Comparative map of Land use and land cover change 2015-2025-----	26
Map 3: Map showing degradation-----	31
Map 4: Map predicting future of the ecosystem degradation-----	35

List of tables

Table 1: GCC breeding areas by village, parish and sub county in the study area -----	22
Table 2: Cause–Effect summary table-----	30
Table 3: Grey Crowned Crane (GCC) and Ecosystem Conservation Action Plan (2025–2030) -----	42



List of Acronyms and Abbreviations

CBD	Convention on Biological Diversity
EACOP	East African Crude Oil Pipeline
FGD	Focus Group Discussion
GCC	Grey Crowned Crane GCC
GIS	Geographic Information System
GPS	Global Positioning System
ICF	International Crane Foundation
IUCN	International Union for Conservation of Nature
JICA	Japan International Cooperation Agency
MWE	Ministry of Water and Environment
NBSAP	National Biodiversity Strategy and Action Plan
NEMA	National Environment Management Authority
NGO	Non-Governmental Organization
SDG	Sustainable Development Goal
UBOS	Uganda Bureau of Statistics
UWA	Uganda Wildlife Authority
UNEP	United Nations Environment Programme
UNEP-WCMC	United Nations Environment Programme – World Conservation Monitoring Centre
UWA	Uganda Wildlife Authority
WMZ	Wetland Management Zone
WMD	Wetlands Management Department
WWF	World Wide Fund for Nature
GO	Government Organization (<i>used contextually for agencies</i>)
HWC	Human–Wildlife Conflict
NT	Near Threatened (IUCN Red List Category)
FAO	Food and Agriculture Organization of the United Nations (<i>if later included in references or data</i>)
NGO	Non-Governmental Organization
SD	Standard Deviation (<i>used in data analysis contexts</i>)



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We also acknowledge the contributions of field teams, local communities, technical

experts, and stakeholders who participated in data collection, validation, and consultations. Their local knowledge in the Nabakazi wetland landscape, cooperation, and commitment were critical to the successful documentation of Grey Crowned Crane habitats, threats, conservation status and needed future conservation efforts .

This study provides an important evidence base for academic research, offering data and analysis that can support future scholarly work on avian ecology, wetland conservation, and biodiversity management. The findings are equally valuable for development planning and policy formulation, particularly for integrating conservation priorities into land-use planning, environmental assessments, and local government decision-making processes. Furthermore, the report serves as a practical tool for conservation action taking by civil society conservation groups, donors, communities, local governments, informing targeted interventions, awareness programs, and long-term strategies aimed at safeguarding the Grey Crowned Crane and its habitats.

It is our hope that this report will contribute meaningfully to continued research, informed planning, and effective conservation efforts at local, national, and international levels for the bird life.



EXECUTIVE SUMMARY

1. Background and Conservation

Significance

The Grey Crowned Crane (*Balearica regulorum*) Uganda's national bird is globally classified as Near threatened due to widespread habitat loss, wetland degradation and climate-driven ecological change. The Nabakazi wetland belt in Mubende, Kassanda and Gomba remains one of the last regionally significant breeding zones for the species. However, increasing anthropogenic pressure has shifted this landscape from intact wetland mosaics to fragmented agricultural blocks, reducing breeding success, foraging range and long term population viability.

This study was commissioned by the National Association of Professional Environmentalists (NAPE) with support from Partner Fur Klima Un Natur (PKN) to generate evidence based insights for scalable conservation investment, community led protection, and habitat restoration.

2. Purpose of the Study

To evaluate the landscape scale ecology, breeding patterns, habitat stability and land use dynamics influencing the survival of Grey Crowned Cranes and produce actionable recommendations for donors, government and civil society conservation groups such as NAPE for conservation and protection of the Grey crowned crested crane in Nabakazi and beyond.

Key questions addressed:

- Where do cranes breed, feed and roost within the Nabakazi system?
- How is land conversion affecting reproductive success and daily movement cycles?
- What are the community drivers of degradation, and what mitigation is possible?
- What investment priorities offer highest conservation return?

3. Methodology Overview

Data Collection Method	Purpose
Field ecological surveys	Nesting sites, feeding behaviour, flock structure
GIS–Land-Use Mapping	Habitat loss trends 2015–2025, fragmentation patterns
Household interviews (100)	Perceptions, crop-conflict data, ground reality
Key informant consultations	Local leadership, conservation actors, UWA insight
Behavioural observations	Morning/evening peak ecology, breeding triggers

4. Key Findings – Landscape and Species Condition

◆ Habitat Transformation (2015–2025)

Land Cover Type	2015 (km ²)	2025 (km ²)	Change
Farmland	394.56	962.33	+144% expansion
Grasslands	970.91	552.93	–43% decline
Woodlands	560.10	312.64	–44% loss
Built-Up Area	26.61	70.08	+163% increase
Wetlands (spatial)	94.37	94.86	Stable but functionally degraded
Forest Cover	↑ significant	Improved hydrology buffering only	



Interpretation: Wetlands remain in footprint but are losing ecological function. Grassland and wooded buffers critical for foraging and nest concealment are disappearing fastest.

□ Species Behavior and Movement Ecology

- Cranes show bimodal activity peaks — dawn and dusk.
- Highest morning behaviour: Feeding (38 obs), Flying (30 obs).
- Reproduction occurs selectively in low disturbance windows.
- Afternoon crane activity collapses near farms, grazing and brick sites.

Results indicate that Grey Crowned Crane breeding activity is strongly associated with shallow wetlands and tributaries characterized by emergent vegetation and adjacent open grasslands. Several villages and wetland sections were identified as confirmed or potential breeding areas based on repeated sightings of chicks and adult pairs. However, many of these sites are increasingly affected by seasonality, agricultural chemicals, sedimentation, grazing pressure, brick making, and settlement encroachment, which collectively reduce habitat suitability and breeding success. While the spatial extent of wetlands appears relatively stable, their ecological functionality is declining, posing significant risks to long-term crane

Photo & Table: Grey Crowned Crane (GCC) Breeding Areas Identified in the Study Area



Figure 1-Granes at Moma site in Madudu-January 2026.



District	Sub-county	Parish	Village / Area	Remarks
Mubende	Madudu	Kansambya	Moma–Kyamugavu	GCC seen perching on trees and gathering every afternoon; sometimes seen with chicks. Possible breeding area
			Kabweyakiza	Affected by seasonality, floods, and agricultural chemicals
			Kagunguli	Not frequent; chicks seldomly seen
			Luteete	Seasonal presence
			Kabulamuliro	Seasonally seen but not frequent; breeding possibly affected by human activity
		Lwensambya	Kijaguzo	Affected by encroachment
			Bukadde	Tributary of Nabakazi affected by sedimentation
			Nyegeza	Tributary heavily encroached by settlements and brick making
			Lulongo	Tributary affected by seasonality
			Bujuuko —	Agricultural disturbance evident
	1 Kalonga	Kalonga	Bwakago	Chicks previously seen; area now degraded, affecting visibility
			Part of Kirumbi	Affected by agricultural encroachment
	Kayebe	Kabyuma	Ssala	Encroached
		Kayebe	Kasambya	GCC often seen with chicks, especially in November
	Kitenga	Busooba	Busooba	Seldom sightings
		Bugonzi	Buswabwera	Threatened by agriculture
	Kigando	Bugonzi	Kalungi	Sedimentation and encroachment evident
		Bugonzi	Rwamaboga	Encroachment observed
		Kiyonga	Rwobushumi	Breeding area affected by grazing due to water scarcity
		Bubanda	Kattambogo	GCC seen with chicks, usually in November
	Kassanda	Bweyongedde	Lugaaga	Seldomly seen
			Bweyongedde	Former breeding area; reduced water levels
Gomba	Madu	Kiganda	Nsozinga	Reduced water levels due to settlement expansion
		Kyabagamba	Kyabagamba	Affected by reduced water levels and climate change (drought and wetland drying)

5. Threat Analysis and Risk Projection

Drivers of decline:

- Wetland drainage for rice and crop rotation
- Livestock overgrazing + vegetation loss
- Brickmaking, sand extraction, land burning
- Settlement expansion blocking movement corridors
- Human wildlife conflict such as egg theft, poisoning, crop retaliation

Without structured intervention, population status may shift from Near Threatened to Endangered within one ecological generation.

6. Funding Focused Recommendations

A. Habitat Protection and Restoration (Top Priority)

- Establish crane breeding sanctuaries along Nabakazi wetland.
- Restore papyrus and sedge buffers with tall grass to secure nest and crane chick survival.
- Rehabilitate degraded riparian zones via community contracting.
- Introduce tall sturdy trees such as Vachellia/acacia and other better roosting tree species dispersed around potential breeding sites and water sources as these make them safe from predators.



- Being the only type of cranes that roost in trees, planting native trees that provide shade and security in a mixed wetland –grassland habitat will best attract them.
- Protect wetland grassy edges with water and shrubs that provide nest cover, produce edible seeds and attract many insects.
- Napier Grass (*Pennisetum purpureum*): While primarily used as fodder for cattle, planting Napier grass around wetlands acts as a buffer zone, preventing human disturbance of nesting sites and attracting insects.
- Breeding sites map out, recovery and protection through intentioned stone marking and constant onsite monitoring.

B. Community Integrated Conservation Model

- Incentivize crane friendly agriculture (buffer zones, no burn, growing crops at buffer edges that sustain crane food (soya, millet, sorghum etc.) prioritizing migration routes, breeding sites, etc.
- Develop alternative income streams (eco tourism, craft, and beekeeping).
- Formal Community Conservation Agreements for wetland guardianship.
- Mass intentioned education for cattle keepers. Crested cranes often forage on farms among herds of cattle as cover against predators which are less likely to attack when the birds are surrounded by large livestock. More importantly, for easy foraging reasons, Cattle disturb the ground and vegetation, flushing out insects, worms, and small reptiles that the cranes eat. Cattle farms, particularly those with, or near, wetlands also provide a consistent source of food, including insects, larvae, and seeds and in the era of continued habitat loss, the cattle farms serve as their second near alike farms. It's therefore key for cattle farmers not to see them as grass pests but rather winged companions for their cattle as they also reduce the population of disease causing vectors such as ticks, flies on cattle farms.

C. Landscape Monitoring System - Donor Fund Ready Modules recommended

- Satellite linked GIS monitoring node (annual land use audit).
- Breeding site tagging coupled with long term population census.
- Predictive ecological risk modelling (early warning system).

7. Proposed Donor Budgetable Workstreams (3–5 years)

Workstream	Core Outputs
Habitat restoration and fencing	350–600 ha secured
Community stewardship fund	Conflict mitigation, livelihood shift
GIS based monitoring hub	Live habitat dashboard
Breeding site protection	Nest guard units and ranger support

Conclusion

The Nabakazi wetland remains one of the last viable breeding corridors for the Grey Crowned Crane yet the window for recovery is rapidly narrowing. This study provides the evidence base and implementation roadmap for donors, government and civil society to intervene at scale. Investments made

in the next 3–5 years will determine whether Uganda's national bird is conserved or lost completely from this landscape. The study concludes that without targeted wetland protection, land-use regulation, and community-based conservation interventions, the Nabakazi ecosystem may lose its capacity



to sustain viable Grey Crowned Crane breeding populations. The mapped breeding areas and associated threats provide a critical baseline for conserva-

tion planning, community centered action taking, district-level land management, and future monitoring initiatives.





CHAPTER 1: INTRODUCTION

1.1 Background of the Study

The Grey Crowned Crane (*Balearica regulorum*), often regarded as one of the most strikingly beautiful birds of the *Grus* family, is a symbol of both national pride and ecological importance in East Africa, particularly in Uganda, where it is the national bird (Birdlife International, 2023). With its elegant golden feathered crown, distinctive black plumage, and tall stature, Grey Crowned Cranes (GCCs) are not only an iconic species of wetland ecosystems but also an integral part of the rich biodiversity found in the region's diverse ecosystems (Kanyamibwa et al., 2021). This bird plays a vital role in the health of wetland habitats, serving as an indicator species that signals the overall well-being of these sensitive environments (International Crane Foundation (ICF), 2022; UNEP-WCMC, 2020).

Grey Crowned Cranes are primarily found in savannah wetlands and grasslands in parts of Uganda, Kenya, and Tanzania, where they thrive in shallow freshwater lakes, marshes, and seasonal floodplains (Birdlife International, 2023). These habitats provide the GCCs with abundant food sources, including insects, seeds, small fish, and aquatic vegetation, all of which are crucial for their breeding and survival (ICF, 2022). However, the stability of these ecosystems has been increasingly jeopardized by human-driven factors such as agricultural expansion, urbanization, and pollution (Kanyamibwa et al., 2021). Wetlands, which form the backbone of the Grey crowned crane's ecosystem, are being drained, degraded, and transformed for agricultural purposes, diminishing the available habitat for the GCC (UNEP-WCMC, 2020).

In Uganda, where the species is not only a national symbol but also a key figure in local culture, the Grey Crowned Crane's (*Balear-*

ica regulorum) population has been declining over the past few decades (BirdLife International, 2023). Much of this decline can be attributed to habitat destruction, climate change, human wildlife conflict, and poaching (Kaggwa et al., 2021). The ongoing loss of wetland ecosystems threatens not only the survival of the GCC but also the overall biodiversity of these ecosystems (Nature Uganda, 2022). Understanding the ecology, behavior, and breeding of the species is therefore essential for effective conservation strategies that aim to mitigate these threats and ensure long-term sustainability for the species (BirdLife International, 2023).

The IUCN Red List currently classifies the GCC as Near Threatened (NT), a status that reflects its threat in the face of increasing anthropogenic pressures (Citation). Despite this, there remains a notable lack of comprehensive research on the behavioral patterns, habitat requirements, and breeding ecology of the GCC (*Balearica regulorum*), especially in specific regions like Mubende District in Uganda, where populations of this GCC are still relatively high but face increasing threats from local agricultural practices and climate related shifts.

1.2 Statement of the Problem

The main challenge facing the GCC (*Balearica regulorum*) is the loss of critical wetland habitats that support both its feeding and breeding needs (BirdLife International, 2023). As wetland areas are drained or degraded for agricultural expansion or urban development, the quality and quantity of suitable habitats for these birds are severely reduced (Nature Uganda, 2022). Furthermore, the increasing frequency of climate change-induced droughts and flooding events is



creating unstable conditions for the GCCs' nesting and feeding grounds (Kaggwa et al., 2021). These environmental changes not only diminish the GCC access to food but also heighten the risk of nest destruction and chick mortality (BirdLife International, 2023).

Human wildlife conflict is another critical problem, as local farmers working in the GCC habitats often view the birds as pests due to their tendency to raid crops, particularly maize, cassava, and rice (Kaggwa et al., 2021). In retaliation, farmers may resort to poisoning, shooting, or trapping, further compounding the species' declining numbers and targeting their eggs (BirdLife International, 2023). Additionally, the Grey Crowned Crane is targeted for its feathers in the illegal wildlife trade, adding yet another layer of threat to its survival (Nature Uganda, 2022).

While there are various ongoing conservation initiatives aimed at protecting wetland habitats and reducing human wildlife conflict, these efforts are often fragmented and lack systematic monitoring and data-driven strategies (Nature Uganda, 2022). A comprehensive understanding of the GCC's habitat preferences, behavioral ecology, and breeding success is crucial for devising effective conservation interventions (BirdLife International, 2023). Moreover, there is a need for more integrated conservation models that involve both government authorities and local communities in wetland management and protection (Kaggwa et al., 2021).

1.3 Objectives of the Study

This study aims to conduct an indepth analysis of the Grey Crowned Cranes in Uganda, focusing particularly on the Nabakazi wetland and river system, which is home to significant populations of this specie.

The primary objectives of this study are:

- i. To assess the habitat preferences of the GCC, including the specific types of wetland ecosystems that support its breeding and feeding activities, and how these habitats have changed over time due to human activities and climate change.
- ii. To investigate the behavioral patterns of GCC, with particular attention to their mating rituals, territorial behavior, and parental care, as well as how these behaviors may be influenced by environmental and human induced factors.
- iii. To analyze the breeding ecology of the GCC, including the timing and success rates of nesting, hatching, and chick survival, as well as the environmental variables (e.g., water levels, vegetation) that impact breeding outcomes.
- iv. To examine the impacts of human wildlife conflict, especially in areas where GCC and local farmers coexist, and to propose strategies to reduce negative interactions, such as crop raiding and poaching.
- v. To evaluate the effectiveness of existing conservation initiatives in Uganda, focusing on community based conservation models, wetland restoration projects, and government policies aimed at protecting the species and its habitat.
- vi. To propose recommendations for future research and conservation strategies, drawing on findings from this study to develop integrated approaches that involve local communities, government agencies, and NGOs in the sustainable management of wetland ecosystems.



1.4 Rationale of the Study

The Grey Crowned Crane plays a central role in both the ecology of East Africa's wetlands and the cultural heritage of Uganda, where it is celebrated as a national symbol. As such, its conservation is not just important for biodiversity, but also for the continued cultural and economic well-being of local communities who rely on the same wetland ecosystems for resources and income.

Despite its symbolic importance, the GCC faces severe threats from habitat loss, human wildlife conflict, and climate change. Understanding these threats and addressing them through a scientific study is crucial for policy development and for ensuring the GCC's survival. This research aims to provide actionable insights that can guide conservation efforts, as well as contribute to the sustainable management of East Africa's wetlands.

In particular, the study focuses on Mubende District because of its importance as a key habitat for the GCC. While the district has witnessed increasing human settlement and agricultural activity, there has been limited research on the current status of the Grey Crowned Crane population, their habitat use, and the local threats they face. This study intends to fill these gaps, providing a comprehensive picture of the species' needs and the challenges it faces, while recommending practical solutions for better protection.

1.5 Scope of the Study

This study will primarily focus on the Grey Crowned Crane populations in Mubende, Gomba and Kassanda Districts, Uganda, with comparative references to other GCC habitats in Uganda and East Africa. The scope will include an investigation of: The distribution and habitat use of Grey Crowned Cranes in the district.

The behavioral ecology of the GCC, including foraging behavior, courtship, and parental care.

The breeding ecology of GCC, including nesting sites, egg success rates, and juvenile survival.

The human wildlife conflict between local farmers and GCC, focusing on crop raiding and its impact on local attitudes toward conservation.

The evaluation of conservation strategies, including wetland protection, community engagement, and eco-tourism initiatives.

The study will employ both qualitative and quantitative research methods, including field observations, interviews with local farmers and conservationists, and analysis of secondary data from conservation reports, governmental agencies, and previous studies.

1.6 Structure of the Study

The study is organized into the following chapters:

Chapter 1: Introduction – Provides background information, problem statement, objectives, rationale, and scope of the study.

Chapter 2: Literature Review – Reviews previous research on the ecology, behavior, breeding, and conservation of the Grey Crowned Crane, identifying gaps in knowledge and areas requiring further exploration.

Chapter 3: Methodology – Describes the research design, data collection methods, and analytical techniques used to carry out the study.

Chapter 4: Results and Discussion – Presents and analyzes the findings



CHAPTER 2:

LITERATURE REVIEW

2.1 Introduction

The Grey Crowned Crane (GCC; *Balearica regulorum*) is a large, conspicuous wetland bird of sub-Saharan Africa that depends on mosaics of wetlands and adjacent open habitats for feeding and breeding (BirdLife International, 2023). In Uganda it is also culturally prominent as the national bird, appearing on the national emblem (Nature Uganda, 2022). Within the central Uganda wetland, farmland matrix including Mubende, Kassanda and Gomba districts (Nabakazi system). The GCC is increasingly exposed to rapid wetland conversion, human disturbance, and changing rainfall regimes, all of which can reduce habitat quality and breeding success (Kaggwa et al., 2021). This literature review therefore synthesizes ecological requirements, behaviour, breeding biology, conservation status and threats of the GCC, while explicitly relating these themes to the Nabakazi system setting where wetlands, smallholder agriculture, and settlement expansion intersect (BirdLife International, 2023).

2.2 Taxonomy and Distribution

The Grey Crowned Crane (*Balearica regulorum*) belongs to the family Gruidae and is closely related to the Black Crowned Crane (*Balearica pavonina*) (Urban et al., 1986). It is characterized by its distinctive crown of golden feathers, a long neck, and long legs. Regionally, the species occurs widely across East Africa, including Uganda, Kenya and Tanzania, occupying wetlands, seasonally flooded grasslands and savannas that provide nesting cover and diverse foraging resources (Urban et al., 1986; BirdLife International, 2020).

In Uganda, GCC distribution is strongly associated with wetland networks embedded in productive agricultural landscapes. This is

particularly relevant to Mubende, Kassanda and Gomba, where wetlands within the Nabakazi system function as local breeding/roosting sites and as feeding areas in surrounding farmlands and grasslands (Kabwoya et al., 2017). In such landscapes, persistence depends not only on wetland presence, but also on how surrounding land uses influence disturbance and food availability.

2.3 Ecological Requirements and Habitat

The GCC is wetland dependent, relying on wetlands for breeding, shelter and much of its foraging, while routinely using adjacent grasslands and cultivated fields for feeding (Hancock et al., 2003). The species prefers shallow freshwater wetlands, particularly those with abundant emergent vegetation such as papyrus and reeds, which provide both food and nesting sites. They are also found in grasslands and savannas adjacent to wetlands, where they can forage for seeds, insects, and small vertebrates (Hancock et al., 2003). Water availability and stability are repeatedly highlighted as key determinants of suitability, because stable water levels and sufficient vegetation cover reduce nest failure risk and support consistent food resources (Hancock et al., 2003). In Uganda, wetlands such as Kassanda and Myanzi offer favorable conditions for GCC populations, while more degraded areas, such as Bukuya, show reduced GCC presence due to human disturbance and agricultural encroachment (Sinsin et al., 2014). Additionally, wetland degradation primarily driven by agriculture, urbanization, and pollution, has led to the loss of critical GCC habitat, further complicating conservation efforts (Kareiva et al., 2017). This habitat loss, compounded by climate



change, which affects rainfall patterns and water availability, poses significant threats to the species (Kabwoya et al., 2017).

2.4 Behavior and Feeding Ecology

The GCC is an omnivorous bird, feeding on seeds and grains as well as insects, amphibians and other small vertebrates (Hancock et al., 2003; Jeschke and Strayer, 2008; Sibanda and Sinsin, 2016). The species' diet reflects the biodiversity of wetland ecosystems, where the abundance of aquatic plants and invertebrates supports foraging needs (Sinsin et al., 2014; Jeschke and Strayer, 2008). GCCs typically forage alone or in small groups, using shallow waters or grasslands near water sources (Hancock et al., 2003).

During breeding, GCC exhibit elaborate courtship and territorial behaviours, including dancing displays (jumping, bowing, wing flapping) and loud calls that help establish pair bonds and territory (Buchanan and Birkhead, 2005; Gratwick and Birkhead, 2007). Outside breeding periods, they become more gregarious, forming flocks that may exceed 50 individuals (Kabwoya et al., 2017; Sibanda and Sinsin, 2016). Such flocking is commonly observed in open areas near wetlands, precisely the habitat configuration typical of the Nabakazi system, where roosting sites in wetlands are linked to daily foraging movements into nearby grasslands and farms (Kabwoya et al., 2017; Sinsin et al., 2014).

2.5 Breeding Biology

Grey Crowned Cranes are monogamous and form strong pair bonds, with individuals typically breeding from about 2–3 years of age (Urban et al., 1986). Breeding timing is closely tied to rainfall because rainfall governs wetland inundation, vegetation growth, and prey availability (Urban et al., 1986; BirdLife International, 2020). In Uganda, breeding is reported mainly between February and May, broadly aligning with rainy season conditions (BirdLife International, 2020).

Nests are commonly constructed in shallow water or within wetland vegetation as raised platforms of reeds and grasses, which can reduce predation risk and buffer against moderate water-level changes (Hancock et al., 2003). Clutches are typically 2 to 4 eggs with incubation around 28 to 30 days, and chicks are precocial, moving with parents soon after hatching (Buchanan and Birkhead, 2005). Chick rearing depends on access to safe foraging sites rich in insects, seeds and aquatic prey, with fledging occurring after several months (Hancock et al., 2003). In Mubende, Kassanda and Gomba, breeding success is therefore expected to track (i) integrity of emergent vegetation for nest concealment and (ii) levels of disturbance from farming, grazing, burning, and wetland edge activities. Empirically, nests in dense vegetation and low disturbance areas show higher success, while proximity to settlements and farmlands increases disturbance and failure risk (Kabwoya et al., 2017; Nature Uganda, 2022).

2.6 Conservation Status and Threats

The GCC is listed as Near Threatened, with declines driven mainly by wetland loss and intensifying human pressures (IUCN, 2016; BirdLife International, 2020). In Mubende, Kassanda and Gomba, the most relevant threats include wetland drainage and degradation for cultivation/settlement (Hancock et al., 2003; BirdLife International, 2020), illegal capture and trade (Kabwoya et al., 2017; Nature Uganda, 2022), crop-related conflict that can lead to poisoning or trapping (Kareiva et al., 2017; Kabwoya et al., 2017), and climate-driven shifts in rainfall that reduce wetland suitability (Kabwoya et al., 2017; BirdLife International, 2020). Community-based initiatives in Mubende, alongside strengthened wetland regula-



tion and restoration, remain central to reducing habitat loss within the Nabakazi system (Sinsin et al., 2014; Nature Uganda, 2022).

2.7 Global and Local Conservation Frameworks

Efforts to conserve the GCC align with broader global biodiversity goals, notably those outlined in the Convention on Biological Diversity (CBD) and the United Nations Sustainable Development Goals (SDGs), particularly Goal 15: Life on Land, which emphasizes the protection, restoration, and sustainable use of terrestrial ecosystems.

In Uganda, these global commitments are reinforced through the National Biodiversity Strategy and Action Plan (NBSAP), which seeks to safeguard critical habitats for endangered species, including the GCC. Additionally, regional initiatives such as the East African Wetlands Conservation Program promote cross border collaboration among countries like Uganda, Kenya, and Tanzania to preserve shared wetland ecosystems essential for the species' survival (Sinsin et al., 2014).

2.8 Habitat and Range Expansion

Several studies have examined the spatial distribution and habitat preferences of the GCC across East Africa, providing valuable insights into its ecological requirements. Research by Sinsin et al. (2014) and Hancock et al. (2003) demonstrates a strong correlation between the species' range and the availability of wetland habitats. Their findings indicate that human induced alterations, including agricultural expansion, dam construction, and wetland drainage, are driving shifts in GCC distribution (Hancock et al., 2003; Sinsin et al., 2014). The species tends to prefer wetlands with low human disturbance, which offer optimal nesting and foraging opportunities (Kabwoya et al., 2017). Long-term monitoring in areas such as Mubende District and Western Uganda has revealed that habitat fragmentation and the loss of critical wetland areas have led to smaller, more isolated popu-

lations, heightening the risk of local extinction (Kabwoya et al., 2017).

In Kenya, Muiruri and Ogutu (2020) reported that GCC are particularly sensitive to habitat degradation, with some populations now restricted to protected wetlands that continue to face pressures from illegal grazing and cultivation (Muiruri and Ogutu, 2020). Consequently, the species' distribution range is projected to contract further unless immediate habitat restoration and conservation measures are implemented (Muiruri and Ogutu, 2020).

2.9 Ecological Interactions and Role in Wetland Ecosystems

The GCC contributes to wetland ecosystem functioning through foraging that affects nutrient cycling, vegetation dynamics, and seed movement (Jeschke and Strayer, 2008). By probing and moving through wetland vegetation, cranes can redistribute nutrients and influence plant community structure, supporting habitat heterogeneity (Jeschke and Strayer, 2008). Such processes are relevant to wetlands in the Nabakazi system because crane presence can be both an indicator and a contributor to wetland ecological integrity.

Declines in crane populations may therefore have broader ecosystem consequences. Reduced GCC numbers can weaken ecological roles linked to nutrient turnover and interactions with other wetland-dependent taxa, potentially lowering wetland resilience and biodiversity (Sibanda and Sinsin, 2016). In landscapes where wetlands are already under pressure—such as the wetland edges and valley systems of Mubende, Kassanda and Gomba—these cascading effects further justify targeted conservation of both cranes and their habitats (Jeschke and Strayer, 2008; Sibanda



and Sinsin, 2016).

2.10 Behavior and Social Structure

The Grey Crowned Crane demonstrates highly developed social behaviors, especially during the non-breeding season, when individuals tend to be more gregarious and form large communal flocks. According to Gratwick and Birkhead (2007), GCCs gather in communal roosts, where they engage in mutual preening, social calls, and coordinated foraging activities that strengthen group cohesion. These roosting sites, typically located in open grasslands near wetlands, are vital for the species' survival as they provide safety from predators and access to abundant food resources (Gratwick and Birkhead, 2007).

During the breeding season, the behavior of GCC changes significantly, with individuals particularly males becoming territorial and defending specific nesting areas. Males often perform visual and vocal displays to establish dominance and attract potential mates, behavior also observed in other GCC species (Gratwick and Birkhead, 2007). The mating displays of the GCC are particularly elaborate, involving dancing, head bobbing, bowing, jumping, and wing flapping, as documented by Buchanan and Birkhead (2005). These ritualized displays not only function to attract mates but also serve to reinforce pair bonds between long-term partners (Buchanan and Birkhead, 2005).

According to Buchanan and Birkhead (2005), these courtship behaviors are believed to act as signals of genetic fitness, health, and territorial strength, which are critical factors in mate selection and reproductive success. Collectively, the studies by Gratwick and Birkhead (2007) and Buchanan and Birkhead (2005) highlight the importance of social and reproductive behaviors in ensuring the stability and per-

sistence of GCC populations in their natural habitats.

2.11 Nesting Ecology and Hydrological Stability

Successful breeding depends heavily on stable wetland hydrology and dense vegetation that supports nest platforms in shallow water (Hancock et al., 2003). This nesting strategy can reduce predation risk and buffer against moderate water-level changes (Hancock et al., 2003). However, flooding can have mixed effects: moderate flooding may enhance vegetation availability for nesting, whereas extreme flooding can destroy nests and reduce egg and chick survival (Jeschke et al., 2009).

For the Nabakazi wetlands, which are sensitive to seasonal rainfall variability and localized drainage or channel modification, these findings emphasize that both drought and extreme rainfall events can reduce breeding success (Hancock et al., 2003; Jeschke et al., 2009). Managing hydrological stability through wetland protection, limiting drainage, and maintaining vegetated buffers therefore remains central to sustaining breeding opportunities in Mubende, Kassanda and Gomba.

2.12 Conservation Strategies and Community Involvement

Several conservation initiatives have been put in place to mitigate the threats facing GCCs. Community based conservation programs, such as those in Mubende and Kassanda, focus on empowering local communities to engage in sustainable land-use practices. These programs often involve eco-tourism initiatives, where locals serve as guides and protect wetland areas, benefiting both conservation and local livelihoods (Sinsin et al., 2014).

Moreover, the Uganda Wildlife Authority (UWA) and various NGOs have implemented wetland restoration projects in



regions heavily impacted by agricultural activities. By promoting sustainable farming techniques, including agroforestry and organic farming, they aim to reduce the pressure on wetland ecosystems while providing alternative income sources for local populations (Kabwoya et al., 2017).

In terms of policy, Uganda has made significant strides by incorporating the GCC into its National Biodiversity Strategy and recognizing the species in the National Wetland Policy. However, enforcement of these policies remains a challenge. The Wetland Management Zones (WMZ) in areas like Kassanda and Masindi require more comprehensive protection against illegal land use, including drainage and illegal settlement (Kabwoya et al., 2017).

2.13 Future Research Directions and Management

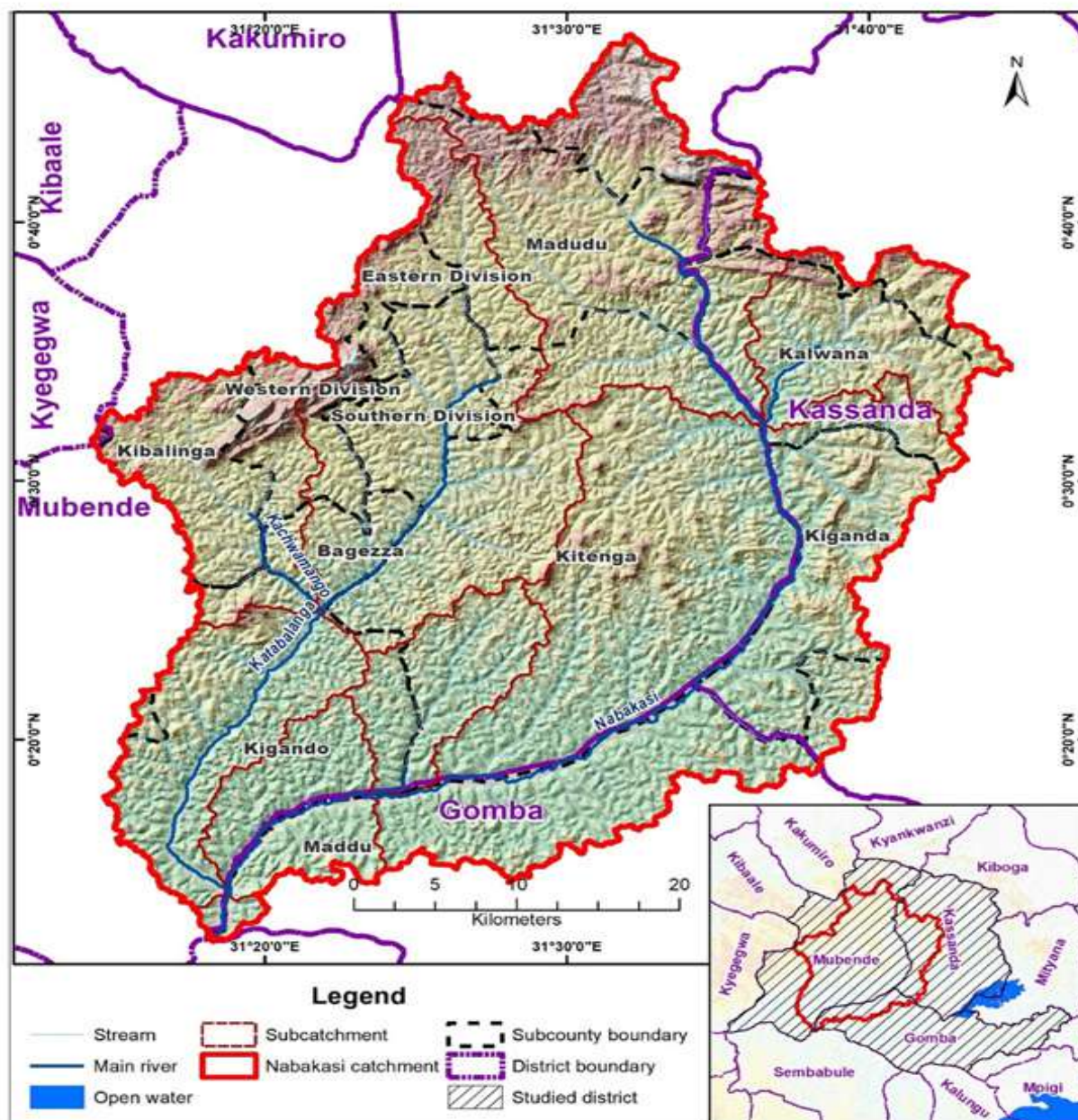
Despite ongoing efforts, important knowledge gaps remain regarding crane movement patterns, site fidelity to specific Nabakazi wetlands, breeding success across disturbance gradients, and long term population trends under combined land use and climate pressures (Jeschke et al., 2009). Future work could strengthen district level management by: (i) documenting seasonal wetland use and movement among wetlands within the Nabakazi system, (ii) quantifying breeding outcomes in relation to vegetation cover, water levels, and proximity to cultivation, and (iii) tracking changes in wetland condition alongside crane abundance to identify high-priority sites for protection or restoration (Hancock et al., 2003; Jeschke et al., 2009). Strengthening community involvement remains essential, particularly through approaches that reduce wetland-edge conversion and mitigate crop conflict while maintaining functional wetland habitat networks (Sinsin et al., 2014; Kabwoya et al., 2017).



3.0 METHODOLOGY

3.1 Study Area Description

Nabakazi Wetland Ecosystem is located within Mubende District in the Central Region of Uganda, at Latitude 0.5586° N and Longitude 31.3949° E. Mubende is one of Uganda's largest districts, covering an area of about 2,713 square kilometers.



Map 1: Map of Nabakazi ecosystem catchment

Nabakazi wetland makes a natural physical boundary between Kassanda and Mubende as observed at the Kampala–Fort Portal highway and also between Mubende and Gomba as observed at the Kyenda-Maddu-Gomba roads. District to the east, Kiboga and Mityana districts to the north, Sembabule and Kalungu to the south, and Kyegegwa and Kakumiro to the west.



3.1.1. Geographical and Administrative Context

The River Nabakazi ecosystem stretches for approximately 64 km, originating from Madudu Sub-county and traversing Kalonga, Kitenga, Kayebe, and Kigando Sub-counties before flowing into neighboring districts such as Kassanda and Gomba. The surveyed villages through which the river passes include Bwakago, Kibati, Kabweyakiza, Rutete, Kabulamuro, and Kalonga Parish. The ecosystem's hydrological network is interlinked with several catchments including Katonga, Nkuse, Muzizi, and Kafu, emphasizing the district's ecological interconnectedness and its role as a watershed for much of central Uganda.

3.1.2. Hydrological and Ecological Features.

The Nabakazi Wetland System plays a critical hydrological and ecological role within Mubende District. According to Wetlands Management Department (2019), the system serves as a major feeder to several seasonal streams and tributaries that drain into the Katonga River catchment, contributing significantly to the regional hydrological balance. The wetland's swampy floodplains facilitate groundwater recharge and maintain stream flow during dry seasons, ensuring continuous water supply for domestic, agricultural, and ecological use (NEMA, 2020). Additionally, the Nabakazi Wetland helps to regulate the local microclimate, store floodwaters, and support high biodiversity, providing critical habitat for species such as the GCC, fish, amphibians, and aquatic plants (Sinsin et al., 2014; NEMA, 2020).

However, recent studies and local observations indicate that the flow regime of the Nabakazi River has become increasingly unstable due to catchment degradation, wetland reclamation, deforestation, and siltation (Kabwoya et al., 2017; Wetlands

Management Department, 2019). These pressures have resulted in a shrinking river width, reduced water depth during dry seasons, and increased sediment loads during rainy months, all of which undermine the hydrological integrity and ecological stability of the wetland ecosystem (NEMA, 2020; Sinsin et al., 2014).

3.1.3. Topography and Physical Characteristics

The terrain along the Nabakazi River basin is generally undulating, with a mixture of moderate hills, wide valleys, and flat-bottomed plains. The river meanders through deeply incised valleys in the upper catchments (Madudu and Kalonga), while the lower reaches (Kitenga, Kayebe, and Kigando) are characterized by broad floodplains that support wetland agriculture and grazing.

In these low-lying sections, the river periodically overflows its banks during the rainy season, enriching surrounding soils but also increasing flood risk for settlements close to its banks. Soils in the area are predominantly ferrallitic loams and sandy clays, with high agricultural potential but prone to erosion when vegetation is removed.

3.1.4. Vegetation and Land Cover

Natural vegetation along the Nabakazi corridor includes papyrus swamps (*Cyperus papyrus*), *Miscanthus* grass, *Typha* species, *Vossia cuspidata*, and *Raphia* palm stands. These form dense wetland habitats that serve as breeding grounds for fish, amphibians, and water birds such as GCC and herons.

However, extensive parts of the riverbanks have been converted to farmland, especially for bananas, maize, beans, and coffee, resulting in significant degradation of riparian vegetation. In the upper catch-



ments of Madudu and Kalonga, most wetlands have been reclaimed for agriculture, while in Kitenga and Kigando, vegetation remains more intact but under pressure from grazing, expanding agriculture and brick-making.

3.1.5. Climate

Mubende and neighboring Gomba and Kassandra all experience a tropical climate characterized by bimodal rainfall, which supports two main agricultural seasons. The annual rainfall ranges from 560 mm to 1,272 mm, with the heaviest rains occurring from March to May and September to November. The dry seasons extend from June to July and December to February. The district's altitude (1,066–1,548 m above sea level) contributes to moderate temperatures averaging 17.2°C to 29°C, creating favorable conditions for agriculture, livestock, and forestry.

3.1.6. Population and Socio-Economic Context

According to the 2024 National Population and Housing Census (UBOS, 2024), Mubende District has a total population of approximately 522,015 people, of whom 48% are male and 52% are female. The district comprises about 132,046 households, with nearly 65% of the population engaged in agriculture as their primary source of livelihood (UBOS, 2024). The main ethnic groups in the district include Baganda (36.1%), Banyoro (14%), Banyankole (11.4%), Bakiga (10.7%), Banyarwanda (6.8%), among others (UBOS, 2024).

Agriculture and livestock rearing remain the dominant economic activities across the district; however, poverty, land scarcity, and increasing population pressure have led to the expansion of cultivation into wetland areas, resulting in widespread wetland degradation and loss of

ecosystem services (NEMA, 2020; UBOS, 2024).

Gomba District has an estimated population of 198,450 people (UBOS, 2024), comprising 49% males and 51% females. The district contains approximately 47,820 households, the majority of which depend on subsistence agriculture and livestock farming for their livelihoods (UBOS, 2024). The main ethnic groups in Gomba include Baganda (62%), Banyankole (13%), Bakiga (8%), Banyarwanda (6%), and smaller proportions of other groups such as the Banyoro and Basoga (UBOS, 2024).

The district's economy is primarily agrarian, with major crops including coffee, bananas, maize, beans, and sweet potatoes, alongside cattle rearing as a significant source of income (NEMA, 2020; UBOS, 2024). However, increasing land pressure, deforestation, and wetland encroachment—driven by population growth and poverty—have accelerated environmental degradation in the area (NEMA, 2020). As a result, Gomba's wetland ecosystems, which once supported diverse biodiversity such as the GCC, are increasingly threatened by conversion to agricultural land and unsustainable resource use (Sinsin et al., 2014; NEMA, 2020).

Kassandra District has a population of approximately 277,500 people, comprising 49% males and 51% females. The district consists of about 69,420 households, the majority of which depend on subsistence and small-scale commercial agriculture for their livelihoods (UBOS, 2024). The predominant ethnic groups in Kassandra include Baganda (54%), Banyankole (15%), Bakiga (10%), Banyarwanda (7%), and Banyoro (6%), along with smaller minority groups (UBOS, 2024). Kassandra's economy is largely agricultural, with major crops such as coffee, maize, beans, bananas, and cassava, alongside livestock rearing, particularly cattle, goats,



and poultry (NEMA, 2020). However, land degradation, deforestation, and wetland reclamation have intensified in recent years due to population growth, unsustainable farming practices, and informal gold mining, which have negatively affected soil fertility and water quality (Wetlands Management Department, 2019; NEMA, 2020). The district's wetland ecosystems, including sections that feed into the Katonga River system, are ecologically significant, providing habitat for species such as the GCC, but are now increasingly under threat from encroachment and siltation (Sinsin et al., 2014; Kabwoya et al., 2017; NEMA, 2020).

3.1.6.1. Settlements and Human Activities

The Nabakazi River traverses several densely populated and agriculturally active sub-counties, including:

Madudu Sub-county – The upper catchment, dominated by smallholder crop cultivation and mixed farming.

Kalonga Sub-county – Characterized by rolling hills and wetland farming, with several villages such as Bwakago, Kibati, and Kabweyakiza located close to the river.

Kitenga Sub-county – A key section of the river where the East African Crude Oil Pipeline (EACOP) crosses. This area is a hotspot for human settlement, livestock rearing, and brick-making.

Kayebe and Kigando Sub-counties

These downstream sections host expansive papyrus wetlands, open grazing areas, and scattered trading centers such as Kasule, Kanyogoga, and Nabingoola, which depend heavily on the river for domestic and agricultural water.

Economic activities along the river include crop cultivation, livestock watering, sand mining, brick-making, and charcoal burning, all of which exert increasing pressure on the ecosystem.

In summary, the Nabakazi River traverses a mosaic of landscapes — from highland agricultural zones in Madudu to low-lying papyrus wetlands in Kitenga and Kigando. It is both an ecological lifeline and an economic resource, underpinning local agriculture, livestock production, and domestic water use. However, increasing human pressure, land degradation, and poor resource management have severely impacted its health. The area presents a pressing need for integrated watershed management and ecosystem restoration interventions to ensure sustainable use and resilience of the Nabakazi ecosystem.

3.2. Research Design

This study adopted a mixed-methods research design, integrating both qualitative and quantitative approaches to gather comprehensive data on the GCC's ecology, behavior, breeding, and conservation. These approaches allowed for a more holistic understanding of the species, combining empirical data with deeper contextual insights from local communities and conservation practitioners.

The study was descriptive and analytical in nature. It describes and documents the behaviors, habitat use, and breeding patterns of the GCC while analyzing the environmental, human-related, and ecological factors influencing these behaviors. Data was collected through field observations, interviews, questionnaires, and secondary data analysis.

3.3 Data Collection Methods

Data were collected through a mixed-methods approach, which was reported to comprehensively capture the ecology, behavior, and conservation challenges of the Grey Crowned Crane (GCC), as documented in previous studies.



3.3.1 Field Observations

Systematic direct observations, behavioral sampling, and point counts was recorded: feeding habits, breeding behavior, territoriality, social interactions, and movement patterns.

3.3.2 Interviews and Focus Groups

Semi-structured interviews and FGDs with farmers, community leaders, and conservation experts was done to explore local knowledge, human-wildlife conflict, and attitudes toward conservation. Approximately 80 interviews and 3 FGDs were conducted.

3.3.3 Questionnaires

Structured questionnaires were administered to 100 households located in wetland-adjacent communities to assess the incidence of crop raiding, levels of knowledge of Grey Crowned Cranes (GCCs), prevailing conservation attitudes, and preferred mitigation strategies. In addition, socio-demographic data were collected to enable analysis of correlations between household characteristics and conservation perceptions.

3.3.4 Ecological Surveys

Habitat assessments included an evaluation of vegetation composition and indicators of human disturbance. Surveys were conducted across multiple wetland sites to assess habitat quality, levels of degradation, and seasonal variations.

3.4. Quantitative Data Analysis

The quantitative data that was collected through GPS tracking, field observations, and questionnaires was analyzed using statistical methods to identify trends, correlations, and patterns. The specific analyses included:

- Descriptive statistics: To summarize the basic features of the data (e.g., population size, distribution, habitat preferenc-

es, and conflict occurrences). Correlation analysis: To examine relationships between environmental factors (e.g., water quality, vegetation) and the behavior of GCCs (e.g., feeding habits, breeding success).

- Regression analysis: To understand how various factors (e.g., agricultural encroachment, water level fluctuations) influence the population dynamics of the GCC.

3.5 Study Design

This study adopted a mixed methods design integrating quantitative ecological field data with qualitative social data to generate a comprehensive understanding of Grey Crowned Crane (GCC) ecology, behaviour, breeding ecology, and conservation challenges within the Nabakazi wetland system in Mubende, Kassanda and Gomba. A convergent design was used, whereby ecological and social datasets were collected in parallel during the same field season(s) and then triangulated at analysis and interpretation stages to identify convergences and explain inconsistencies between observed crane patterns and community experiences (Hancock et al., 2003; Kabwoya et al., 2017; Newing et al., 2011; Sutherland, 2006). The study was descriptive, analytical and will document GCC habitat use and behaviour while testing relationships between crane presence/abundance/breeding activity and environmental conditions and human disturbance.

3.6 Sampling Strategy

3.6.1 Spatial sampling: selection of wetlands and observation units

Sampling was conducted across wetlands within the Nabakazi system in Mubende, Kassanda and Gomba. Wetlands were selected using a stratified purposive framework to ensure representation of the main



gradients expected to influence GCC ecology and conflict: (i) disturbance level (low, medium, high), (ii) wetland type/structure (permanent vs seasonal; papyrus dominated vs mixed vegetation), and (iii) surrounding land use (cropland dominated, grazing dominated, mixed mosaic) (Hancock et al., 2003; Sinsin et al., 2014).

A minimum of 9 wetlands were targeted (approximately 3 per district), with each wetland treated as a primary sampling unit. Within each wetland, 3–5 fixed observation points/line segments were established along accessible wetland edges and vantage points that allow consistent visibility of roosting, foraging and nesting areas. Points were at least 300–500 m apart to reduce double counting and ensure independent sampling. All sampling locations were recorded using GPS and mapped for repeatability.

3.6.2 Social sampling: households, interviews, and FGDs

For the household questionnaire survey, communities adjacent to each sampled wetland were identified in consultation with local leaders, and households were selected using systematic random sampling within a defined buffer of up to 2 km from the wetland edge, where interactions with Grey Crowned Cranes (GCCs) were most likely to occur. A total sample of 100 households was surveyed and allocated proportionally across wetlands and districts, based on the number and size of sampled wetlands, with an average of approximately 33 households per district.

For qualitative data collection, semi-structured interviews were conducted using purposive sampling to ensure representation of key stakeholder categories, including crop farmers, wetland users, local leaders, wildlife officers, and NGO/CSO practitioners. Approximately 80 interviews were completed across the three districts and

along a disturbance gradient to capture diverse perspectives. In addition, three focus group discussions were conducted, one per district, each comprising 8–12 participants. Where feasible, FGDs were organized by stakeholder group, such as farmers or local leaders, to encourage open discussion and minimize dominance effects.

3.7 Data Collection Methods

3.7.1 Field observations and crane counts.

Systematic field observations combined point counts to assess the presence and abundance of Grey Crowned Cranes (GCCs) with behavioral sampling to quantify activity budgets as well as social and breeding behaviors. At each fixed observation point, observers conducted standardized 30–45-minute scans, during which the number of individuals, age class where identifiable, group size, habitat use, and disturbance events were recorded. Disturbance events included human presence, livestock grazing, burning, and cultivation activities. Behavioral data were collected using instantaneous scan sampling at fixed intervals of 2–5 minutes and were complemented by focal observations when breeding behavior was detected.

To minimize double counting, observers documented flight direction, group movement, and distinguishing contextual cues such as location, time, and flock composition. Where feasible, simultaneous counts by two observers were conducted at larger wetlands to improve the reliability of abundance estimates.

3.7.2 Household questionnaires

Structured household questionnaires were administered to 100 households located within the defined wetland buffer zone to document the nature and extent of human–wildlife interactions, including the frequency and seasonality of crop raiding, crops affect-



ed, and mitigation measures in use. The survey also assessed community awareness of the GCC's protected status, attitudes toward wetland conservation, and preferred conflict-mitigation options. Socio-demographic information comprising age, gender, livelihood type, education level, landholding size, and proximity to the wetland was collected to support safeguards analysis of factors influencing conservation perceptions, vulnerability, and conflict reporting.

3.7.3 Ecological and habitat surveys

At each wetland, habitat assessments were conducted alongside crane counts to quantify environmental and disturbance correlates.

Vegetation characteristics were assessed using rapid assessment plots or transects to document dominant vegetation types, extent of emergent vegetation cover, and structural attributes relevant to crane nesting and roosting, consistent with methodologies described by Hancock and colleagues.

Indicators of human disturbance were recorded using a standardized scoring checklist capturing the intensity of key pressures such as cultivation encroachment, livestock grazing, evidence of burning, presence of drainage channels, and proximity of human settlements. This approach enabled the development of a comparable disturbance index across wetlands, as applied in established wetland and wildlife assessment frameworks.

3.8 Data Analysis

3.8.1 Quantitative analysis

Quantitative ecological and questionnaire data was analyzed to describe patterns and test hypothesized relationships between crane metrics and habitat/disturbance variables. Analyses included:

- Descriptive statistics summarizing GCC counts, group sizes, seasonal variation, habitat-use proportions, and conflict frequency.

3.8.2 Qualitative analysis and integration

Interview and focus group discussion notes and transcripts were thematically coded to identify recurring themes related to conflict drivers, seasonal patterns, and feasible mitigation options, following qualitative analysis approaches described by Newing and colleagues and Sutherland. The qualitative findings were then integrated with ecological results through triangulation, including comparison of wetlands reporting high levels of conflict with sites exhibiting higher crane use or degraded wetland edges. This triangulated analysis supported the development of locally grounded conservation recommendations for Mubende, Kassanda, and Gomba districts.

3.8.3 Qualitative Data Analysis

The qualitative data gathered from interviews and FGDs was analyzed using thematic analysis. Key steps in the analysis process include:

- Transcribing all interviews and FGDs verbatim.
- Coding responses to identify recurring themes and patterns related to human wildlife conflict, conservation awareness, and attitudes.
- Categorizing themes into broader topics (e.g., conservation strategies, community engagement, ecological threats).
- Comparing and contrasting responses across different demographic groups (e.g., farmers vs. conservationists, younger vs. older generations) to identify key factors influencing attitudes and behaviors.



3.8.4 Spatial Data Analysis

For GPS tracking data and habitat mapping, Geographic Information Systems (QGIS) software was used:

- Map movement patterns of the GCCs and identify core habitat areas.
- Overlay habitat changes (e.g., wetland degradation, encroachment) and assess their impact on GCC behavior and population dynamics.
- Create predictive models to estimate how changes in habitat quality or human activities might influence GCC populations in the future.

3.9 Ethical Considerations

The study adhered to the highest ethical standards to ensure the welfare of both the GCC and the local communities involved. Specific ethical considerations included:

- Informed consent: All participants in interviews, FGDs, and surveys were fully informed of the study's purpose and their right to anonymity and confidentiality. Consent was obtained verbally for oral interviews and in writing for more formal surveys.

- Wildlife welfare: GPS tracking devices were attached to the Crested GCCs in a noninvasive manner to minimize any risk or stress to the birds. Tracking only occurred on birds that have been safely captured and fitted with the necessary equipment.
- Cultural sensitivity: Interviews and community engagement were conducted in a culturally respectful manner, with attention to local beliefs, values, and customs.

3.10. Limitations of the Study

Potential limitations of the study included:

- Seasonal variations in GCC behavior and habitat use, was not fully captured since fieldwork was constrained to a specific season.
- Access to remote areas, which was impacted by logistical challenges such as poor road conditions or security concerns.
- Bias in self-reported data from interviews.



CHAPTER 4:

RESULTS AND DISCUSSION

4.0. Introduction

The results unravel the complex relationship between the GCC a species of immense ecological, cultural, and national importance and the changing landscapes of Mubende, Kassandra, and Gomba Districts. These districts therefore represent a landscape where wildlife survival and human livelihood pressures collide. Studying GCC breeding here offers an important window into the impacts of ongoing environmental change.”

4.1. Demographic Information

“In understanding ecological data, it is critically important to consider the composition of the communities living near GCC habitats. Demographics influence awareness, attitudes, and the likelihood of participating in conservation efforts.

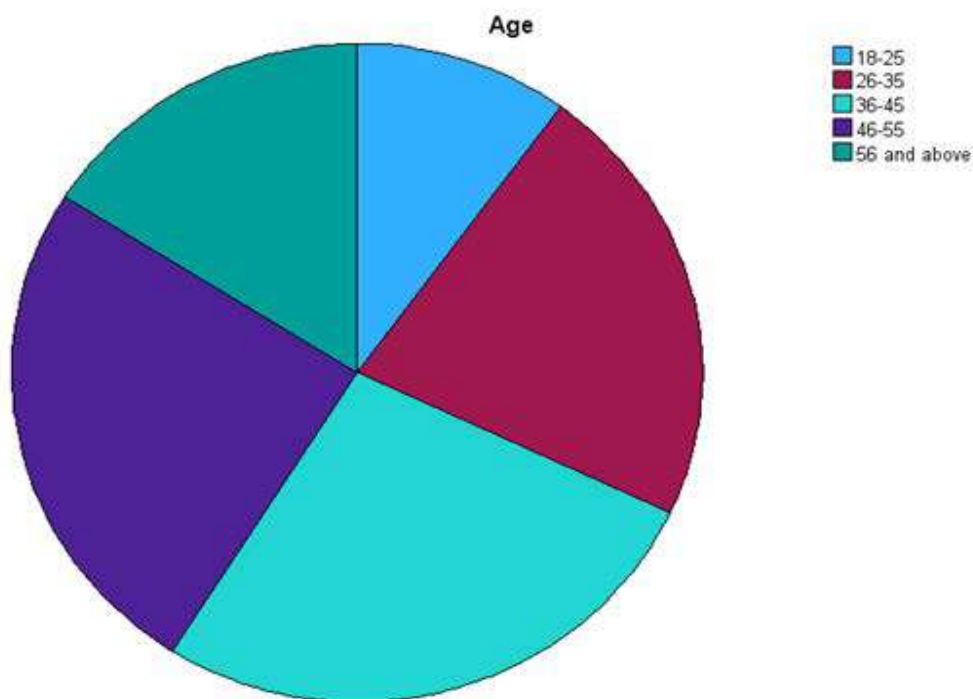


Figure 1: Demography of respondents

The respondents came from a broad mix of age groups, ranging from young adults to elders with decades of local ecological knowledge. Older respondents often provided historical perspectives—recalling periods when GCC numbers were significantly higher and wetland systems were intact. Younger respondents, on the other hand, often related their knowledge to present-day encounters, disruptions, and land use practices.

Gender distribution was fairly balanced, revealing that both men and women engage with wetlands and natural resources, either through fishing, farming, water collection, or grazing. Women in particular provided insights related to water resource use and vegetation changes, while men frequently discussed threats related to farming practices, hunting, or wetland encroachment.

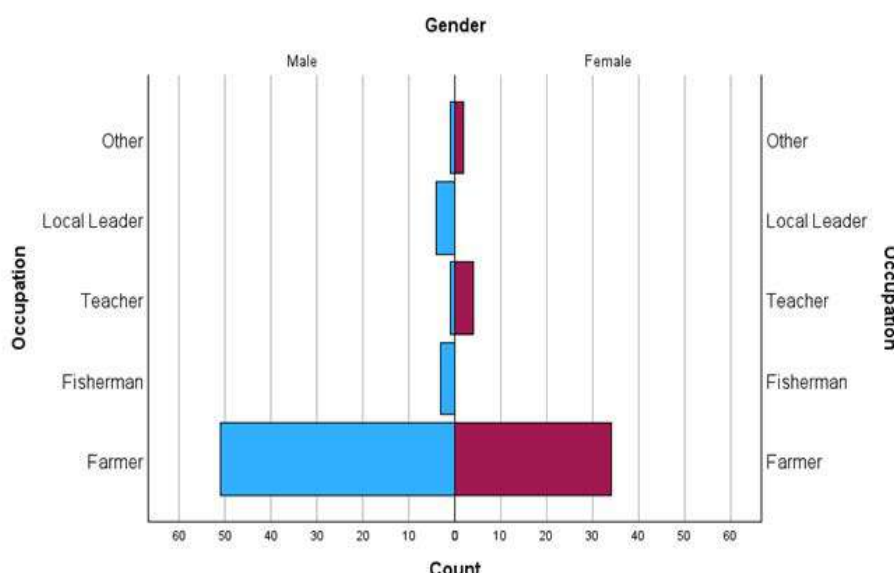


Figure 2: Categories of respondents with regard to occupation

Occupational data show that most respondents are smallholder farmers. This means their household survival is deeply tied to land and water resources the same ecosystems GCCs depend on. This socio-economic overlap has profound implications for conservation planning.”

4.2. Grey Crowned Crane Sightings and Habitat Use

The frequency with which respondents see GCCs varies widely and is closely tied to ecological conditions. Areas that retain extensive wetland vegetation, intact papyrus stands, sedge cover, and minimal human interference consistently record high frequencies of GCC sightings. In these ecologically intact zones, GCCs are often observed daily or weekly, engaging in behaviors ranging from foraging to social interactions. Observers report seeing GCCs in pairs, family groups, or small flocks, which signals that these habitats are sufficient to support the full spectrum of natural behaviors, including courtship, territorial displays, and chick-rearing activities.

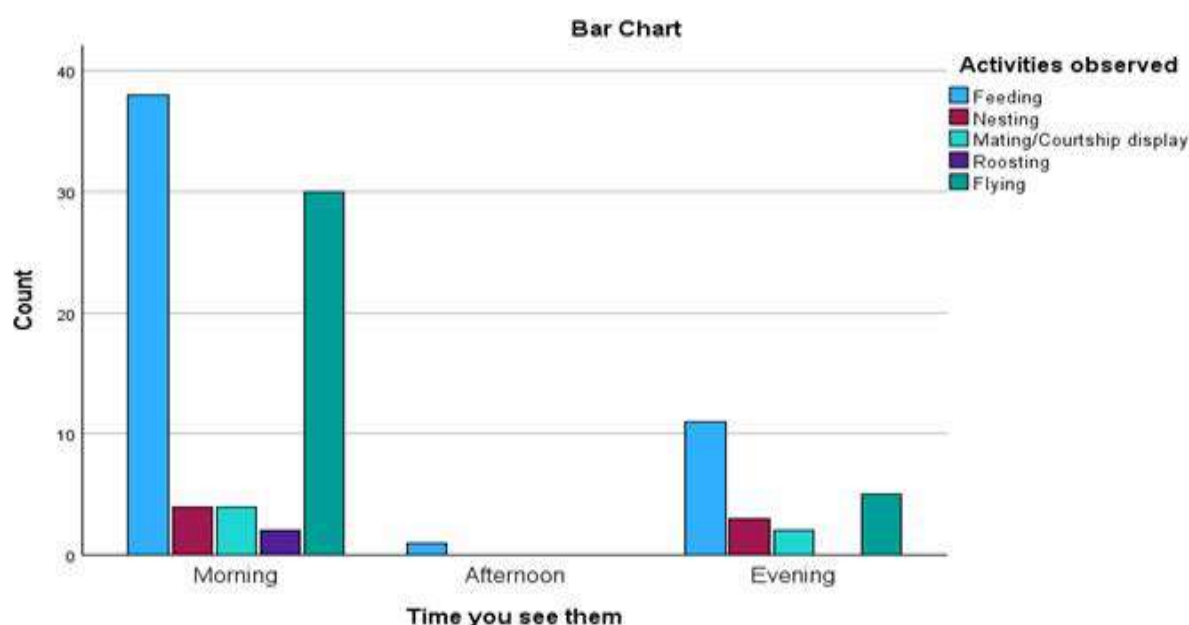


Figure 3: Interpretation of Grey Crowned Crane Activities by Time of Day



The bar chart presents the frequency of observed activities of GCCs during three daily periods: morning, afternoon, and evening. The activities include feeding, nesting, mating/courtship display, roosting, and flying.

The chart shows that morning is the peak period for most activities, particularly:

- **Feeding:** 38 observations clearly the most frequent activity. This indicates that GCCs prioritize foraging at dawn, likely taking advantage of cooler temperatures, higher insect and invertebrate activity, and safe visibility for detecting predators.
- **Flying:** 30 observations suggests that GCCs actively move between feeding, nesting, and roosting sites in the morning. Morning flights may also relate to territory patrols, social interaction, or commuting to optimal foraging patches.
- **Nesting and Mating/Courtship Displays:** Observed but at lower frequencies (nesting: 4, mating: 1). This indicates that while reproductive behaviors occur in the morning, they are less dominant than foraging and movement, suggesting that early hours are critical for energy acquisition.
- **Roosting:** Observed only 2 times in the morning, indicating that most GCCs have already left their roosting sites to engage in active behaviors.

Behavioral Interpretation: The dominance of feeding and flying in the morning aligns with the GCCs' need to replenish energy reserves after the night, establish territories, and prepare for courtship. Morning activity is therefore a key window for ecological observation of GCCs.

The chart shows dramatically reduced observations in the afternoon:

Feeding: Only 1 observation – a significant decline from the morning peak.

Other activities: Nesting, mating/courtship, roosting and flying are minimal to absent.

Behavioral Interpretation: This drop in activity could be due to several ecological and behavioral factors:

1. **Thermal avoidance:** Midday heat may limit visible GCC activity, as GCCs may seek shaded, cooler areas or remain in concealed spots within vegetation.
2. **Human disturbance:** Afternoon periods may coincide with increased human activity in wetlands (e.g., farming, grazing, brick-making), which can cause GCCs to reduce observable activity or move deeper into refuge zones.
3. **Behavioral flexibility:** GCCs may shift energy-intensive behaviors like feeding to cooler periods (morning/evening) to minimize stress and optimize efficiency.

This pattern reflects temporal compression of visible behaviors in response to environmental conditions.

Evening observations show a moderate resurgence in feeding and flying, though not as high as morning:

- **Feeding:** 11 observations – indicates GCCs resume foraging before nightfall, likely to meet energetic needs and prepare for overnight roosting.
- **Flying:** 5 observations – GCCs may return to roosting sites or move between remaining wetland patches.
- **Nesting:** 3 observations – suggests that some GCCs engage in nest maintenance or return to nest sites.
- **Mating/Courtship and Roosting:** Low frequencies, indicating reduced reproductive activity at this time.
- **Behavioral Interpretation:** Evening activity reflects a secondary foraging window, essential for energy balance, while low reproductive behaviors suggest that courtship and nesting are concentrated in safer, more productive times of day..



Places where the GCC were seen

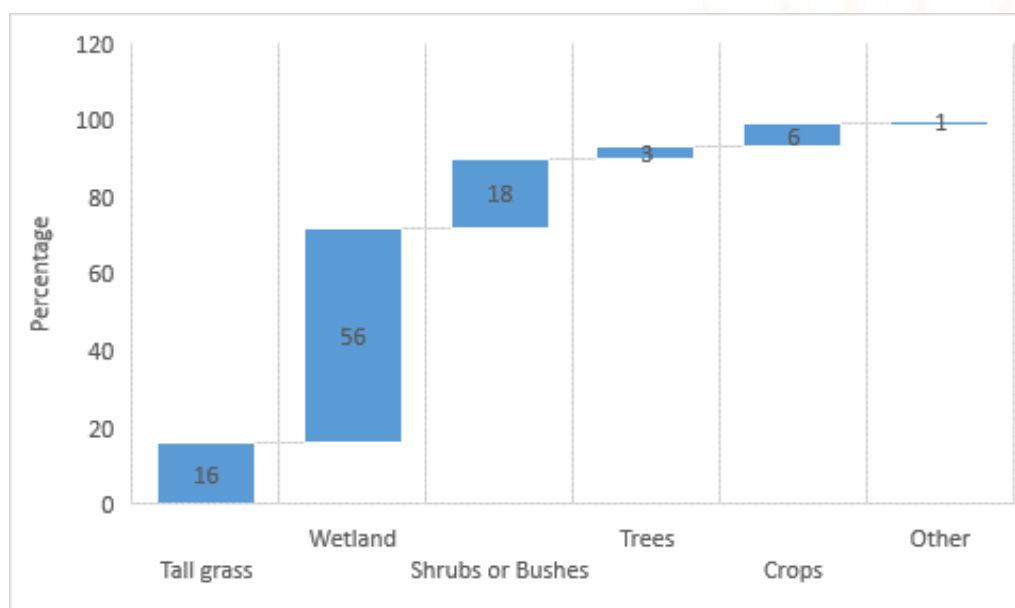


Figure 4: Places where the GCC were seen

According to the finding depicted by the bar graph above, vegetation types where they were most frequently observed are described as follows:

Wetland Vegetation: These areas are dominated by emergent aquatic plants such as papyrus (*Cyperus papyrus*), reeds (*Phragmites spp.*), sedges, and occasionally marsh grasses. The ground is often waterlogged, providing a soft substrate suitable for foraging.

Wetlands offer both feeding and nesting opportunities. GCCs forage on invertebrates, small amphibians, and seeds found in shallow water or mud. The dense vegetation also provides cover for nesting and protection from predators.

Grasslands / Open Savana: Predominantly open areas with short to medium-height grasses, interspersed with occasional shrubs or scattered trees. The soil is usually well-drained. These areas allow GCCs to forage efficiently on seeds, insects, and small vertebrates. The open visibility also reduces the risk of surprise

predator attacks while feeding or during courtship displays.

Agricultural or Cultivated Margins: Fields of crops such as rice, maize, and sugarcane bordering wetlands, often with patches of fallow land or uncultivated margins. Vegetation is generally low and patchy. GCCs are often seen here during the post-harvest season, feeding on leftover grains or insects. Such areas provide additional foraging habitat when natural wetlands are limited.

Riparian Vegetation: Dense shrubbery and small trees along riverbanks, swamps, and drainage channels, sometimes mixed with grasses and reeds. These strips serve as corridors for movement between wetlands, offer roosting sites, and provide some protection against human disturbance.

GCC are most abundant in areas with a mix of shallow wetlands, emergent vegetation, and adjacent open grasslands, often with minimal human disturbance. They prefer habitats that provide both foraging opportunities and safety for nesting and roosting.



Plate 1: GCC seen in a maize garden

The Grey Crowned Crane were also frequently found on cattle farms because the livestock-grazing environment provides an ideal habitat that mimics their natural wetlands while offering protection, easy foraging, and food security, especially as their natural habitats disappear. Their presence in the farms were attributed to;

- **Protection from Predators:** Crested cranes often flock within herds of cattle to use them as cover against predators, particularly because many of their natural predators (like dogs) are smaller and can be deterred by the presence of large livestock.
- **Easy Foraging:** Cattle grazing keeps grass short, which makes it easier for cranes to find insects, frogs, worms, and seeds. Similar to cattle egrets, these cranes follow cattle to catch insects that

are flushed out from the grass.

- **Habitat Loss Replacement:** Due to the degradation and drying up of wetlands in countries like Uganda, the cranes have been forced to move to farmland in search of food.
- **Food Availability:** The agricultural landscape, particularly during planting seasons, provides easy access to food, including maize, seeds, and millet, often leading them to feed on crops.

While they often coexist with cattle, these birds are sometimes considered pests by farmers because they can damage crops and risk being poisoned or killed or trapped by snare.



Photo & Table: Grey Crowned Crane (GCC) Breeding Areas Identified in the Study Area

District	Sub county	Parish	village	Remarks
Mubende	Madudu	Kansambya	Moma-Kyamugavu	GCC seen patching on trees and collect every afternoon. Sometimes seen with chicks. Possible breeding area
			Kabweyakiza	This area was affected by seasonality, floods and agricultural chemicals
			Kagunguli	Not frequent. Chicks seldomly seen
			Luteete	Seasonal
		Kabulamuliro	Kijaguzo	Seasonally seen but not frequent. Possibly breeding affected by human activity
			Lwensambya	Affected by encroachment
			Bukadde	A tributary of Nabakazi but affected by sedimentation
			Nyegeza	A tributary heavily encroached by settlements and brick making
			Lulongo	A tributary seasonality impact
			Bukuuko	Agricultural disturbance
	Kalonga	Kalonga	Bwakago	Chicks used to be seen but now degraded thus affecting visibility
			Part of Kirumbi	Affected by agricultural encroachment
	Kayebe	Kabyuma	Ssala	Encroached
		Kayebe	Kasambya	GCC often seen with chicks in the November season
			Busooba	Seldom
	Kitenga	Bugonzi	Buswabwera	Threatened by agriculture
			Kalungi	Sedimentation and encroachment evident
			Rwamaboga	Encroachment was observed
	Kigando	kiyonga	Rwobushumi	Breeding area affected by grazing due to water scarcity
			Kattambogo	GCC seen with chicks usually November
			Lugaaga	Seldomly seen
Kassanda	Kalwana	Bweyongedde	Bweyongedde	This area was a famous breeding area reduced water levels
		Kiganda	Nsozinga	Reduced water levels due to settlement expansion
Gomba	Madu	Kyabagamba	Kyabagamba	Affected by Reduced Water Levels & Climate Change: Drought and the drying of wetlands, exacerbated by climate change, directly impact nesting and reduce food sources.

4.2.1. Ecological and Conservation Insights

1. Peak Activity Periods: The chart clearly indicates morning as the most active period, followed by a smaller evening peak. This information is critical for field surveys, behavioral studies, and habitat monitoring, suggesting that early morning observation periods are most effective for data collection.

1. Energy Allocation: The high frequency of feeding and flying in the morning and evening demonstrates that energy acquisition and movement are prioritized, whereas reproductive behaviors are selectively timed to minimize interference and disturbance.



2. Impact of Disturbance: The near absence of visible activity in the afternoon may indicate behavioral avoidance of human presence or heat stress, highlighting the importance of minimizing anthropogenic disturbance during key feeding times.

3. Habitat Management: Understanding these daily activity peaks helps managers to:

- Schedule human activities away from peak GCC activity
- Identify critical feeding areas that require protection
- Design monitoring programs that coincide with morning and evening peaks for maximal observation efficiency

The bar chart demonstrates that GCCs exhibit a bimodal daily activity pattern: intense activity in the morning, minimal activity during the afternoon, and moderate activity in the evening. Feeding and movement dominate, reflecting the species' energy acquisition strategies and habitat use, while reproductive behaviors occur selectively in the morning when conditions are safer and optimal for display.

These patterns reflect both innate biological rhythms and adaptive responses to environmental pressures such as temperature, human activity, and habitat availability. From a conservation standpoint, this underscores the importance of timing field interventions and habitat protection measures to coincide with GCC activity peaks, ensuring that critical behaviors like feeding, courtship, and territorial defense are supported.

On the other hand, locations experiencing heavy anthropogenic pressure—such as wetland conversion, drainage channels, intensive grazing, and brick making—reported fewer GCC sightings. The decline in sighting frequency provides an important ecological signal: Grey crowned cranes often retreat from disturbed habitats, long before such changes are visible to the untrained eye.

Seasonality also plays a crucial role. Sightings peak during breeding and feeding seasons when wetlands hold sufficient water, vegetation is lush, and insect populations are abundant. During dry months, GCCs follow retreating water sources or move to alternative feeding grounds.”



Plate 2: The GCC seen flying from farm land



4.3. GCC Behavior and Conservation Perceptions

The analysis of GCC behavior and the accompanying community perceptions paints a vivid picture of an ecological system undergoing steady transformation, and a society increasingly grappling with the implications of that change. The Gray crowned cranes once a constant presence in the daily rhythm of many communities are now observed through a lens shaped both by nostalgia and concern. Their behavior, movements, and survival seem to mirror the shifting landscapes of wetlands, grasslands, and agricultural fields. Similarly, the attitudes of the communities that share these lands reveal a complex blend of admiration, frustration, responsibility, and ambivalence. Together, these findings narrate a story of coexistence under pressure, where both nature and society are navigating uncertain terrain.

4.4. Land use and land cover change

Respondents consistently noted that the frequency of crane sightings is not uniform across the district but highly dependent on

the integrity of the surrounding environment. In areas where wetlands remain largely undisturbed where grasslands still hold moisture during the dry months, where papyrus stands continue to provide cover, and where shallow pools support aquatic invertebrates the cranes appear with reassuring regularity. Residents of such zones commonly described daily or weekly encounters with pairs or family groups, suggesting that intact natural systems continue to offer the ecological security the cranes need to forage, rest, and interact normally.

In sharp contrast, other communities especially those living along wetlands that have been reclaimed for rice cultivation, converted to grazing plots, or slowly encroached upon by eucalyptus plantations reported only occasional or rare sightings. This pattern demonstrates a clear behavioral response: the cranes retreat from areas where traditional wetland functions are disrupted. Their disappearance is seldom abrupt; instead, it unfolds gradually, with sightings becoming less frequent as vegetation thins, human activity intensifies, and the sense of safety that cranes require is progressively eroded.



Plate 3: Area cleared for agriculture in Nabakazi buffer zone



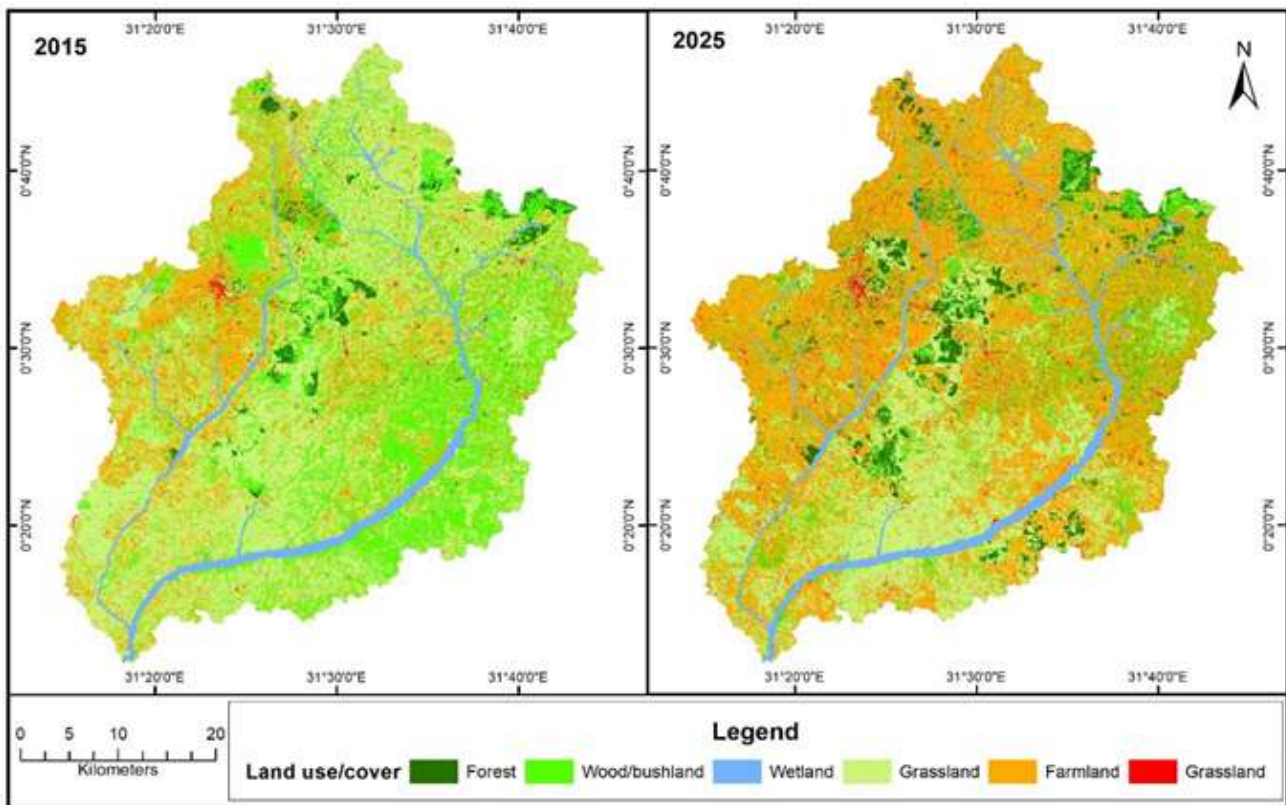
4.4.1 Land use land cover change – a comparison of 2015 to 2025

Understanding changes in land use and land cover is central to assessing the ecological future of wetland-dependent species such as the Grey Crowned Crane (GCC). The GCC relies on a delicate combination of wetlands for nesting, grasslands for foraging, and lightly modified farmlands for supplementary feeding. The land-use data (2015–2025) reveal a landscape that is transitioning rapidly under anthropogenic pressure. This transition, illustrated by sharp declines in natural habitats and expansion of agricultural and built-up areas, carries significant implications for the species' breeding ecology and long-term viability.

The comparative land-use graph (2015–2025) reveals transformations that are far from incremental they represent a fundamental reorganization of ecological space driven by human expansion, agricultural intensification, infrastructural development, and selective conservation gains. This report provides an exhaustive scientific analysis of these transitions, explaining how each land-cover category influences the crane's ecological niche, reproductive biology, and long-term population viability. The aim is to go beyond simple change detection and instead articulate mechanistic ecological pathways through which land-use change translates into species-level impacts.



Plate 4: Degraded area for Brick making



Map 2: Comparative map of Land use and land cover change 2015-2025

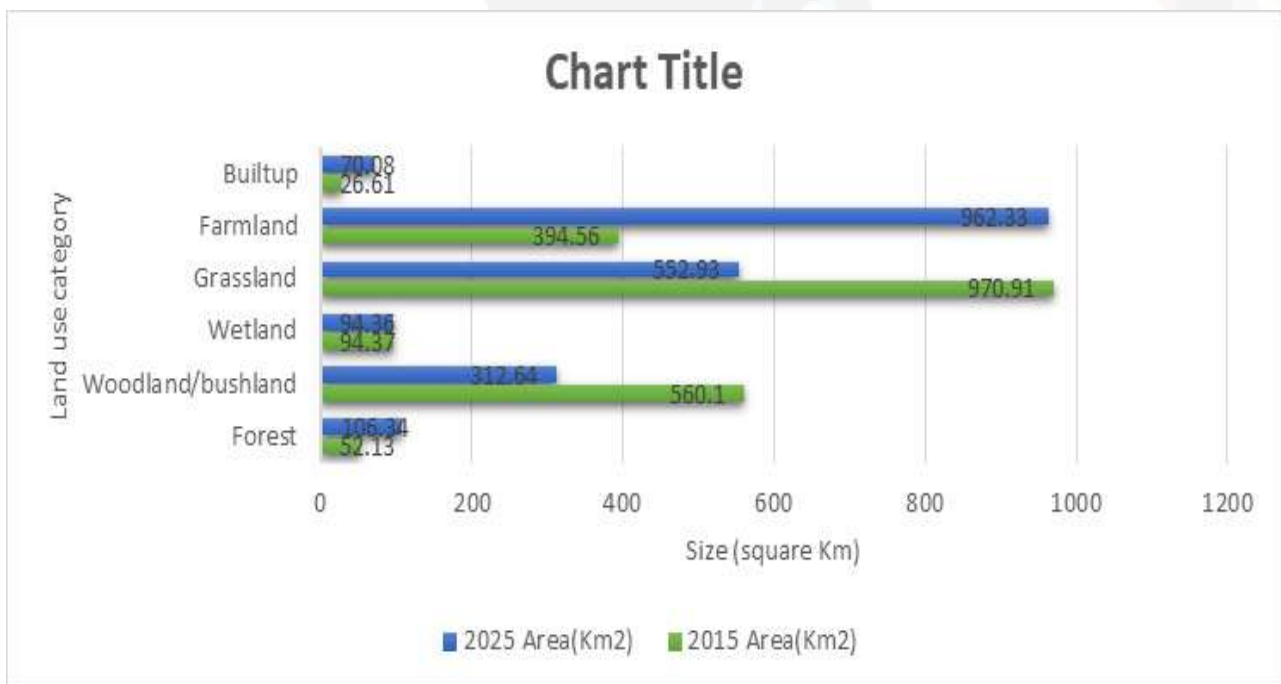


Figure 5 : A graph showing the comparison of land use land cover changes 2015-2025:



i. Farmland Expansion: Fundamental Restructuring of Crane Foraging Landscapes

The extremely sharp increase in farmland from 394.56 km² in 2015 to 962.33 km² in 2025—signals a major shift in the ecological functioning of the region. This trend is consistent with high population growth and intensified subsistence and commercial farming. Ecologically, farmland expansion represents the most disruptive form of land-cover change for cranes because it replaces heterogeneous natural habitats with simplified monocultures that lack the structural and trophic complexity required by wildlife.

Crucially, although Grey Crowned Cranes may exploit croplands opportunistically, particularly for feeding on soil invertebrates in freshly ploughed fields, this is a high-risk, low-stability feeding strategy. Such agricultural landscapes do not provide the long-term, predictable food resources required for adult body conditioning prior to the breeding season. Additionally, cranes become exposed to anthropogenic pressures such as farm machinery, chemical pesticides, human presence, and retaliatory crop-protection measures.



Plate 5 : GCC in a ready to harvest maize garden

On a landscape scale, the expansion of farmland fragments traditional crane movement pathways, effectively compartmentalizing the habitat into isolated patches. This reduces landscape permeability, increases energetic costs associated with moving between foraging and roosting sites, and disrupts the finely timed breeding cycles dependent on synchronized resource availability. Ultimately, farmland expansion constitutes a major ecological filter, displacing cranes from historically stable habitats and forcing them into more marginal, disturbed spaces.

ii. Grassland Decline: Severe Erosion of Core Ecological Functionality

Grasslands decline from 970.91 km² in 2015 to 552.93 km² in 2025, representing one of the most ecologically damaging transitions for the Grey Crowned Crane. Grasslands form the keystone habitat for the species' foraging ecology, offering insects, seeds, amphibians, tubers, and larvae. The openness of grasslands facilitates predator detection and provides the expansive space required for elaborate pair bonding and courtship displays



rituals central to crane reproductive success. The loss of grasslands results in the collapse of this ecological foundation. As grassland patches become smaller and more fragmented, cranes experience significant declines in feeding efficiency. The diminution of forage base has cascading physiological consequences: adults enter the breeding season with suboptimal body conditions, reducing their capacity for successful courtship, egg production, incubation, and chick provisioning.

Moreover, grasslands act as seasonal ecological buffers. During times of wetland flooding or droughts, cranes retreat into grasslands for alternative foraging. The loss of this buffering function increases the species' vulnerability to climate variability and extreme weather events, further threatening breeding success. Thus, grassland decline is not merely a reduction in land-cover category—it represents a direct erosion of the species' functional ecological niche.

iii. **Woodland/Bushland Loss: Degradation of Ecotones and Hydrological Buffers**

The reduction of woodland/bushland from 560.10 km² to 312.64 km² constitutes a significant ecological disruption. Woodlands play a critical role as **protective ecotones**—transitional interfaces between wetlands and upland areas. These zones function as hydrological buffers, regulating microclimates, stabilizing soils, and controlling surface runoff into wetlands.

For cranes, these woodlands provide essential protection during breeding seasons, as they limit human and livestock access to wetland edges. Their loss removes vital concealment for nests located along wetland margins, increasing exposure to predators such as snakes, mongooses, dogs, and even opportunistic raptors.

The removal of woody vegetation also disrupts hydrological cycles. Increased runoff accelerates siltation and erosion, degrading the structural vegetation necessary for cranes to build stable floating nests. Furthermore,

the deterioration of these ecotonal buffers increases the frequency of disturbance events, as wetland boundaries become more accessible to humans, livestock, charcoal burners, and resource collectors.

This habitat loss therefore has both direct biological consequences (increased predation, disturbance) and ecosystem-level consequences (wetland degradation), making it one of the most impactful changes identified in the graph.

iv. **Built-up Area Expansion: Intensification of Disturbance Regimes and Habitat Fragmentation**

The increase in built-up area from 26.61 km² to 70.08 km² reflects accelerated rural urbanization and infrastructural expansion. Built-up landscapes exert multi-layered ecological impacts on crane populations.

At the behavioral level, cranes exhibit extremely high sensitivity to disturbance, especially during nesting and early chick development. The proximity of settlements introduces continuous disturbance from humans, domestic dogs, vehicles, music, agricultural activity, and children. Even low-intensity disturbances have been shown to reduce nest attendance, increase chick mortality, or trigger complete nest abandonment.

On a spatial scale, built-up area expansion fragments habitat networks. Cranes rely on predictable pathways between roosting sites, nesting areas, and foraging grounds. When settlements obstruct these routes, cranes are forced to detour through riskier environments, increasing energetic expenditure during critical periods such as chick-rearing. Movement fragmentation can also isolate populations, reducing gene flow and increasing the risk of localized population collapse.

Built-up expansion therefore introduces pervasive, chronic disturbance and significantly increases the risk of breeding failure.



v. Forest Expansion: Hydrological Support but Low Direct Habitat Utility

Forest cover nearly doubles between 2015 and 2025. While forests are not primary crane habitats due to their structural density reducing visibility and access they provide indirect ecological benefits that can help sustain crane breeding environments.

Forests enhance hydrological function through increased infiltration, groundwater recharge, and stabilization of local rainfall patterns. These processes improve the stability of wetland water levels, which are essential for cranes to construct floating nests and maintain the shallow-water conditions needed for chick thermoregulation and predator evasion.

Additionally, forests reduce soil erosion and sediment loading into wetlands, maintaining water quality and vegetation structure. Although cranes do not utilize forests for feeding or nesting, these indirect services help preserve the functional integrity of wetland habitats.

However, poorly planned forest plantations near wetlands may create dense vegetative barriers that restrict crane movement or alter the open landscape structure required for foraging and display behaviors. Thus, forest expansion contributes positively only when spatially aligned with wetland conservation needs.

vi. Wetland Stability: Nominally Constant but Functionally Vulnerable.

Wetlands appear stable in area (94.37 - 94.86 km²), but this superficial stability can mask significant functional degradation. Wetlands form the epicenter of crane breeding ecology, providing nest-building substrates, chick refuge, thermoregulatory microhabitats, and predator-buffering vegetation.

Yet even slight increases in human, live-stock, or agricultural activity around wetland edges can reduce vegetation complexity, making nests more susceptible to detection by predators. Hydrological disruptions often

caused by upland agricultural expansion can cause flooding that submerges nests or drying that exposes eggs.

Additionally, wetlands situated within increasingly anthropogenic matrices suffer higher nutrient loading, contamination, and siltation, reducing the abundance of aquatic prey species vital for chicks.

Thus, despite stable area metrics, wetlands are becoming ecologically compromised, threatening crane breeding viability.

4.4.2. Expanded Mechanistic Pathways Affecting Crane Breeding Biology

From a systems ecology perspective, land-use change influences crane ecology through a series of interconnected pathways:

- 1. Nutritional Constraints:** Reduced grassland and bushland availability limits dietary diversity, causing cranes to enter breeding cycles with suboptimal body reserves. Poor body condition affects pair bonding, egg formation, and incubation stamina.
- 2. Disturbance-Induced Reproductive Failure:** Agricultural and settlement expansion increases direct disturbance at nesting sites. Disturbance disrupts incubation behavior, increases energetic stress, and leads to nest abandonment.
- 3. Predation Amplification:** Loss of buffer vegetation exposes nests to terrestrial predators. Reduced concealment increases visibility, especially for eggs and small chicks.
- 4. Movement Fragmentation:** Fragmentation of corridors increases energetic costs of daily movements and reduces parental efficiency in chick provisioning.
- 5. Hydrological Instability:** Altered runoff patterns degrade wetland nesting conditions, increasing flooding risk and reducing the stability of floating nests.

Each pathway reinforces the others, creating synergistic ecological stress on crane populations.



Table 2: Cause–Effect summary table

Land-Use Change	Primary Drivers	Expanded Ecological Effect on Grey Crowned Cranes
Grassland decline	Conversion to farmland; settlement pressure; livestock overuse	Loss of primary feeding grounds → reduction in dietary diversity and biomass availability → weakened adult body condition → diminished courtship quality, reduced clutch sizes, prolonged inter-nesting intervals, poor chick growth → long-term decline in recruitment
Woodland/bushland loss	Deforestation; charcoal production; agricultural expansion	Removal of protective ecotones → increased wetland boundary exposure → amplified predation on eggs/chicks; degraded hydrology; reduced nest concealment → higher nest failure rates and compromised breeding outcomes
Farmland expansion	Demographic growth; intensification of cultivation	Increased human disturbance; crop-raiding conflict; exposure to machinery and chemicals → nest destruction, chick mortality, behavioral stress → disruption of seasonal movement cycles and habitat fragmentation
Built-up area growth	Urbanization; roadside settlement expansion	Fragmentation of movement corridors; increased noise, domestic animals, and human presence → chronic disturbance at nesting sites → increased nest abandonment, impaired parental care, reduced fledgling survival
Wetland stability (area)	Legal protection; hydrological persistence	Functional deterioration due to edge pressure → thinning vegetation, altered hydroperiods → reduced nest stability and concealment → elevated flooding risk and heightened vulnerability to predators
Forest expansion	Reforestation/afforestation programs	Improved watershed hydrology and erosion control support wetland quality → indirect enhancement of breeding habitat → but minimal direct foraging utility and potential obstruction of open-land movement paths

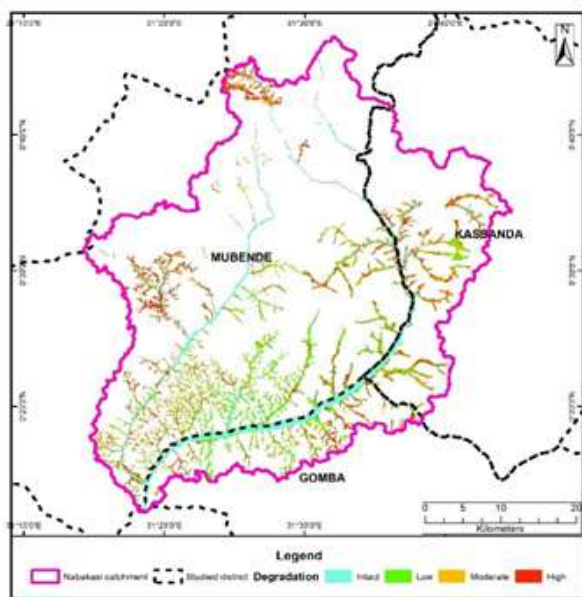
The expanded scientific analysis demonstrates that although wetlands and forests remain relatively stable or even increase in extent, the loss of grasslands and woodlands—combined with expansion of farmland and settlements—initiates a cascade of ecological pressures. These pressures undermine every stage of the Grey Crowned Crane’s breeding cycle,

from pre-breeding conditioning to nest success and juvenile survival.

The observed land-use transformations represent a systemic threat to the species, requiring targeted conservation interventions, protection of grassland–wetland mosaics, restoration of woodland buffers, and maintenance of ecological corridors.



4.4.2.1. Landscape Degradation in Relation to Grey Crowned Crane Conservation



Map 3: Map showing degradation

The spatial distribution of degradation levels across the assessed landscape 28% highly degraded, 15% moderately degraded, 31% low degradation, and only 26% intact presents a mixed but concerning ecological outlook for the conservation of the Grey Crowned Crane (GCC). As a species that is tightly dependent on a delicate mosaic of wetlands for breeding, grasslands for foraging, and cultivated landscapes for supplemental feeding, the degradation profile of the habitat has direct implications on its survival, reproductive success, and long-term population viability.

1. High Degradation Areas (28%) – Severe Habitat Stress and Breeding Decline

The fact that over a quarter (28%) of the landscape is classified as highly degraded signals intense anthropogenic and ecological pressures. In these areas, wetland drainage, vegetation loss, soil erosion, and agricultural encroachment are likely at their peak. For GCCs, which require intact, undisturbed wetlands for nesting, such degradation translates into:

- Loss of secure nesting grounds, increasing egg predation, flooding risk, and nest abandonment.

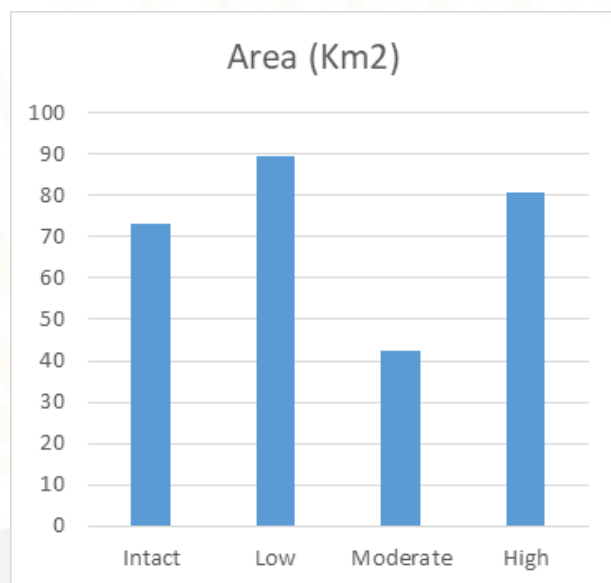


Figure 7: Comparative degradation levels

- Reduced food availability, particularly invertebrates and plant materials that are abundant in healthy wetlands.
- Fragmentation of movement corridors, forcing cranes to travel longer distances between feeding and roosting sites, thus increasing energy expenditure and exposure to threats.
- High degradation zones therefore represent ecological sinks, where the probability of successful breeding is significantly diminished. If left unmitigated, these areas may become completely unsuitable for GCC occupancy.

2. Moderately Degraded Areas (15%) – Transitional Zones of Ecological Instability

The 15% classified as moderately degraded is equally important as it likely represents zones currently under pressure but still capable of recovery. For GCCs, these are transitional landscapes where:

- Wetland structure is partially functional but hydrological balance is unstable.
- Foraging grounds remain available through declining in productivity.



- Human activities such as grazing, cultivation, and settlement expansion are gradually reducing habitat quality. Moderately degraded areas often serve as temporary foraging zones for cranes displaced from highly degraded locations. However, the progressive shift toward more intense exploitation means these habitats are on a trajectory toward high degradation if no remedial action is taken. Strategic restoration in these areas could significantly buffer the intact and low-degradation habitats.

3. Low Degradation Areas (31%) – Key Foraging Grounds Under Emerging Pressure

The largest portion of the landscape (31%) is categorized as experiencing low degradation, indicating areas where ecological function is still largely maintained but showing early signs of disturbance. These areas often constitute:

- Grasslands and mixed agro-ecosystems where cranes forage for insects, grains, tubers, and small vertebrates.
- Seasonally flooded plots that provide temporary feeding opportunities. Semi-natural buffers surrounding core wetlands.
- For GCC conservation, low-degradation habitats serve as critical feeding zones, especially outside the breeding season. However, the presence of emerging degradation trends suggests potential long-term risks:
 - Expansion of agriculture could reduce food availability.
 - Intensification of grazing could compact soils and destroy ground vegetation.
 - Increasing disturbance could push cranes into conflict with farmers as they search for food elsewhere. These ecosystems therefore require proactive management to prevent slippage into moderate or high degradation status.

4. Intact Areas (26%) – The Remaining Strongholds for GCC Productivity

Only 26% of the landscape remains intact, meaning that less than one-third of the environment still provides the structural and functional integrity necessary for optimal GCC breeding, roosting, and foraging. These intact areas typically encompass:

- Unaltered wetlands, which are the core breeding habitats for cranes.
- Healthy grassland mosaics, supporting rich biodiversity and stable food chains.
- Low-disturbance zones, enabling secure nesting, pair bonding, and chick rearing.

However, the proportion of intact habitat is insufficient for sustaining a growing GCC population, especially given the species' large home-range requirements and sensitivity to disturbance. The limited extent of intact areas also increases vulnerability to localized threats such as:

- Wetland drainage for agriculture
 - Burning and grazing pressure
 - Infrastructure development
 - Encroachment by human settlements
- Thus, intact zones function as refugia for the species, and their protection is of the highest priority.

4.4.2.2. Overall Implications for GCC Conservation

The landscape degradation profile depicts an ecological system under significant stress, with more than 40% (28% + 15%) in moderate to high degradation categories. When combined with only 26% intact habitat, this pattern signifies:

- Increasing habitat fragmentation, disrupting movement and dispersal pathways.
- Reduced breeding success, due to fewer secure wetland refuges.
- Heightened human–wildlife conflict, as cranes forage more in agricultural lands.
- Lower ecological resilience, making the entire system more sensitive to climate variability and land-use change.



4.5. Courtship, Pairing, and the Need for Stability

Despite the challenges, cranes sighted around Nabakazi wetland still display their iconic courtship rituals. Respondents described moments of witnessing the birds bowing, jumping, flapping wings, and engaging in synchronized calls activities that signify strong pair bonds and readiness to reproduce. These dis-

plays were most often seen near relatively undisturbed wetland pockets, suggesting that cranes rely on environmental cues and require a level of stability before initiating reproductive behavior. The presence of such rituals in remaining natural habitats underscores the cranes' resilience, but also highlights how deeply their reproductive success is tied to ecosystem integrity.



Plate 6: GCC couples on the left, right is the rituals below the wedding ritual observed in Madudu



4.5.1 Nest Placement and Vulnerability

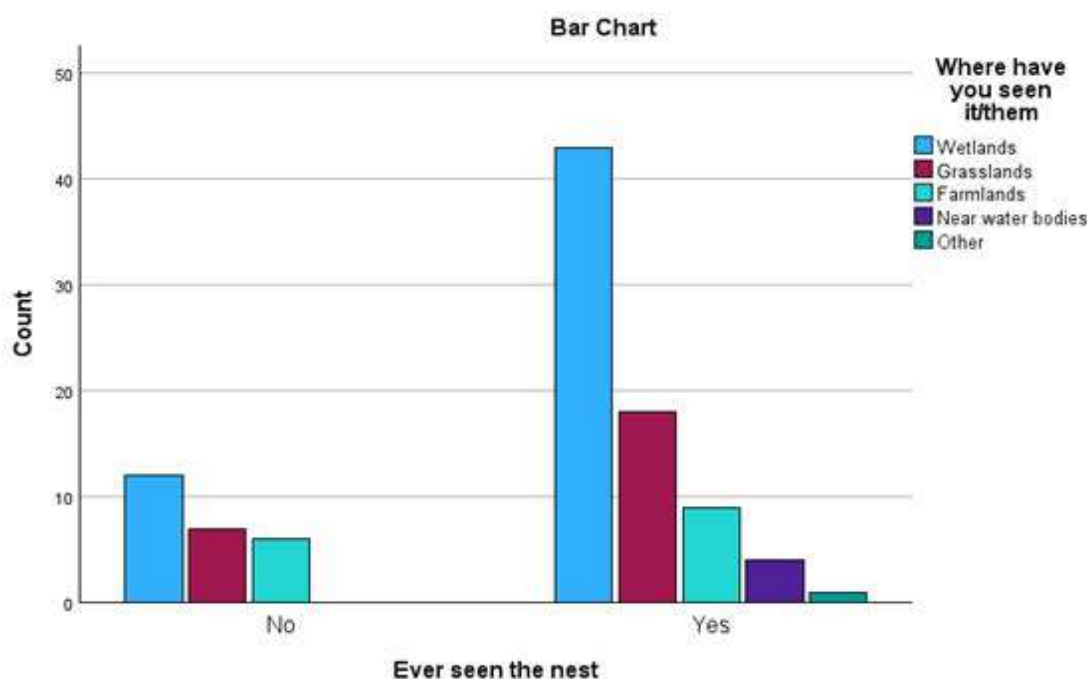


Figure 7: Nests and where they are seen

The bar chart compares two groups of respondents those who have ever seen a Grey Crowned Crane nest (“Yes”) and those who have not (“No”) and shows the types of habitats where each group typically observes cranes.

Wetlands dominate sightings among those who have seen nests. The tallest bar in the entire graph is the wetlands category under “Yes”, indicating that respondents who have seen nests most frequently encounter cranes in wetlands. This suggests a strong link between nest visibility and wetland locations.

Grasslands and farmlands also show higher counts among the “Yes” group. The “Yes” category also shows notable counts in Grasslands and Farmlands. This indicates that respondents who have observed nests tend to see cranes across several habitat types, but wetlands remain the primary location.

Respondents who have not seen crane nests report fewer sightings overall across all environments. Their bars are shorter in every habitat category, showing less frequent crane encounters in general. Habitat distribution differs notably between the two

groups

For the “Yes” group, wetlands clearly stand out as the major habitat.

For the “No” group, sightings are more spread out but consistently lower, with no habitat showing a very dominant count.

Minor categories (“Near water bodies” and “Other”) remain low for both groups. Both “Yes” and “No” respondents report very few sightings in areas near water bodies and “Other” locations

This indicates that these habitats contribute minimally to crane sightings regardless of nest-observing experience.

In Summary therefore;

- i. People who see nests overwhelmingly see cranes in wetlands.
 - ii. People who do not see nests have fewer crane sightings overall.
 - iii. Grasslands and farmlands are secondary habitats but more relevant to the “Yes” group.
 - iv. Sightings near water bodies or “other” places are minimal for everyone.
- Nesting behavior further reinforces this dependency. Cranes prefer secluded



wetland sites with thick vegetation places where cattails, grasses, and papyrus provide not only nesting materials but also camouflage against predators and humans. Respondents who live near these pockets noted that when wetlands are disturbed either by fire, vegetation harvesting, livestock movements, or the creation of brickmaking pits the cranes either abandon nesting sites or attempt to nest in less optimal locations. Such areas often expose eggs and chicks to high levels of

disturbance, leading to increased nest abandonment, predation, and in some cases, accidental destruction.

This shift in nesting behavior is one of the clearest indicators of ecological stress. Cranes are highly selective nesters, and when they begin to resort to suboptimal sites such as fields near human paths, boundaries of grazing paddocks, or partially drained wetlands it signals that the availability of suitable habitat has declined to a critical level.



Plate 7: GCC seen parching in a farm in Kayebe sub county

4.5.2. Daily Foraging and Growing Interaction with Farmlands

Foraging behavior reveals the cranes' adaptability but also exposes their vulnerability. In traditional wetland environments, they feed on a variety of invertebrates, seeds, amphibians, and plant shoots. However, as wetlands shrink or dry prematurely, cranes increasingly move into croplands, especially areas with germinating cereals, sweet potatoes, groundnuts, and beans. Respondents' descriptions suggest that these movements are rarely destructive—in most cases, cranes feed on insects and leftover grains rather than freshly planted crops.

Nonetheless, the mere presence of cranes in cultivated fields sometimes raises suspicions among farmers who are already coping with limited yields and unpredictable weather pat-

terns. This creates an emerging tension: although cranes do not typically inflict major crop damage, some households perceive them as potential threats to livelihood security. This perception, if not addressed through awareness and education, risks eroding the cultural and symbolic goodwill historically associated with the species.

4.6. Behavioral Shifts Driven by Human Disturbance

Human activity plays a significant role in shaping crane behavior. Respondents noted that cranes in highly disturbed areas tend to be flightier, more cautious, and less likely to remain in a single location for long. Regular disturbances such as children playing near nesting sites, people harvesting reeds, herders moving livestock, or the noise generated by brick kilns push cranes



into a pattern of frequent displacement. As they move more widely in search of safety and resources, they become more exposed to hazards such as predation, entanglement in agricultural activities, or collision with vehicles along major roads.

In some instances, respondents described cranes gathering in larger-than-normal groups, possibly because they are being pushed into fewer remaining safe spaces. This congregation offers temporary protection but also indicates a compression of habitat that can intensify competition for limited food resources.

4.6.1. Community Perceptions: Cultural Affection and Livelihood Pressures

Despite these ecological pressures, community perceptions reveal a deep cultural appreciation for Grey Crowned Cranes. Many respondents described the birds with a sense of pride identifying them as symbols of beauty, peace, dignity, and national identity. Elders recounted stories of how cranes were traditionally protected, with taboos discouraging harm or harassment. In several communities, the presence of cranes was associated with good fortune or rain, and their absence felt like a sign of environmental imbalance.

It was noted from discussions with the communities that the crested crane is revered as a royal messenger and a symbol of wealth, stability, and longevity. Seeing one is considered a sign of good luck and a blessed journey.

Additionally, that the crane's striking appearance and elaborate dancing rituals are believed by some to bring rain and fertility to the land.

Fidelity and Loyalty: Cranes are monogamous and form lifelong pair bonds, making them a powerful symbol of faithfulness, enduring love, and strong marital fidelity in many African cultures. Some members said that the when a woman fries eggs for her

husband, the man will be loyal and will only have her as a wife.

However, alongside this cultural reverence lies a pragmatic acknowledgment of livelihood realities. Households struggling with limited land, declining soil fertility, or irregular rainfall often view wetlands as opportunities for survival spaces where crops can be grown even in drought years, or where materials such as papyrus and clay can be harvested for income. This creates a difficult paradox: people value cranes and their wetlands, yet economic necessity drives them into the very ecosystems the cranes need to survive.

4.7. Gaps in Environmental Understanding and threats to the GCC

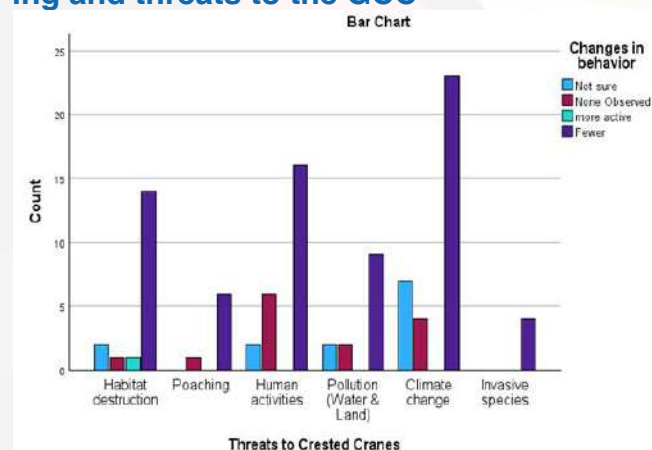


Figure 9: Threats to the GCC

The findings also reveal knowledge gaps that influence community interactions with both wetlands and cranes. While many respondents understood that wetlands are important, few could articulate the specific ecological functions they perform such as stabilizing local climates, supporting groundwater recharge, filtering pollutants, or providing breeding and feeding habitats for cranes. This limited ecological understanding contributes to activities that seem harmless at first such as seasonal burning or selective vegetation clearing but cumulatively degrade wetland health and reduce crane habitat quality.



4.7.1. Opportunities for Community-Based Conservation.

Despite these challenges, the findings offer clear avenues for strengthening conservation. Communities possess rich local knowledge about crane behavior, including information on breeding seasons, preferred nesting sites, and long-term changes in habitat use. This knowledge, if harnessed through participatory monitoring or community wetland committees, could significantly enhance conservation efforts.

Furthermore, the strong cultural attachment to cranes provides a favorable foundation for awareness campaigns, school-based education, and the development of local by-laws. Such initiatives could be complemented by livelihood support programs that offer alternatives to wetland conversion such as beekeeping, fish ponds, sustainable craft production, eco-tourism, or regulated harvesting of wetland plants.

The detailed analysis of crane behavior and community conservation perceptions reveals a story of coexistence under increasing tension. The cranes' behavior expressed through their nesting patterns, feeding habits, courtship displays, and shifting territories reflects an environment undergoing profound transformation. Meanwhile, the perceptions of the communities show both a desire to conserve this iconic species and an acute struggle to meet daily socioeconomic needs.

The path forward lies in bridging these two realities: safeguarding crane habitat while simultaneously supporting community well-being. Conservation strategies must therefore be integrated, community-led, culturally sensitive, and economically realistic. Only through such harmonized approaches can the district hope to secure a future where cranes continue to dance, nest, and thrive alongside the people who have admired them for generations.

4.7.2. Human-Wildlife Interaction and Conservation Efforts.

The behavioral frequencies illustrated in the graph provide important insight into human–wildlife interactions in landscapes shared by people and Grey Crowned Cranes. The dominance of foraging behavior indicates that most crane–human encounters occur in actively used human environments such as crop fields, grazing lands, open grasslands, and wetland edges. This shows that cranes commonly utilize areas associated with daily livelihood activities, making their presence routine, visible, and generally non-conflictual. Rather than avoiding people entirely, cranes appear to exploit accessible feeding grounds within agricultural mosaics, reflecting a degree of coexistence.

The relatively high frequency of flight and movement behaviors further suggests that cranes are highly mobile across human-dominated landscapes, regularly moving between habitat patches. This mobility reinforces their visibility and normalizes their presence within local communities, often fostering tolerance and awareness. At the same time, such frequent movement may signal habitat fragmentation, where cranes are compelled to travel longer distances between increasingly isolated feeding and resting areas—an underlying conservation concern that may not be immediately apparent to local observers.

In contrast, the low occurrence of sensitive behaviors such as mating, courtship, and territoriality highlights the spatial separation between areas of human activity and critical breeding habitats. These behaviors typically occur in less disturbed environments, such as wetland interiors and seasonally flooded grasslands, which are rarely accessed by people. Their scarcity in the observations suggests that breeding sites remain largely unseen and potentially



vulnerable, as communities primarily associate cranes with farmland rather than wetlands. This disconnect creates a conservation challenge: while cranes are visible and familiar during foraging, the habitats essential for reproduction may be degrading unnoticed due to drainage, cultivation, encroachment, or other pressures.

This behavioral divide has direct implications for conservation responses. Community actions tend to focus on crop-related interactions rather than protection of wet-

lands that support breeding and chick rearing. The data therefore underscore the need for conservation strategies that bridge this gap by raising awareness of the cranes' full ecological requirements. Overall, the graph reflects a pattern of frequent, peaceful coexistence in shared landscapes, while simultaneously revealing hidden vulnerabilities linked to unseen breeding habitats. Effective conservation must integrate community engagement, wetland protection, and habitat connectivity to ensure the long-term survival of Grey Crowned Cranes.

4.8. Predictions and future scenarios for conservation of the grey crested crane

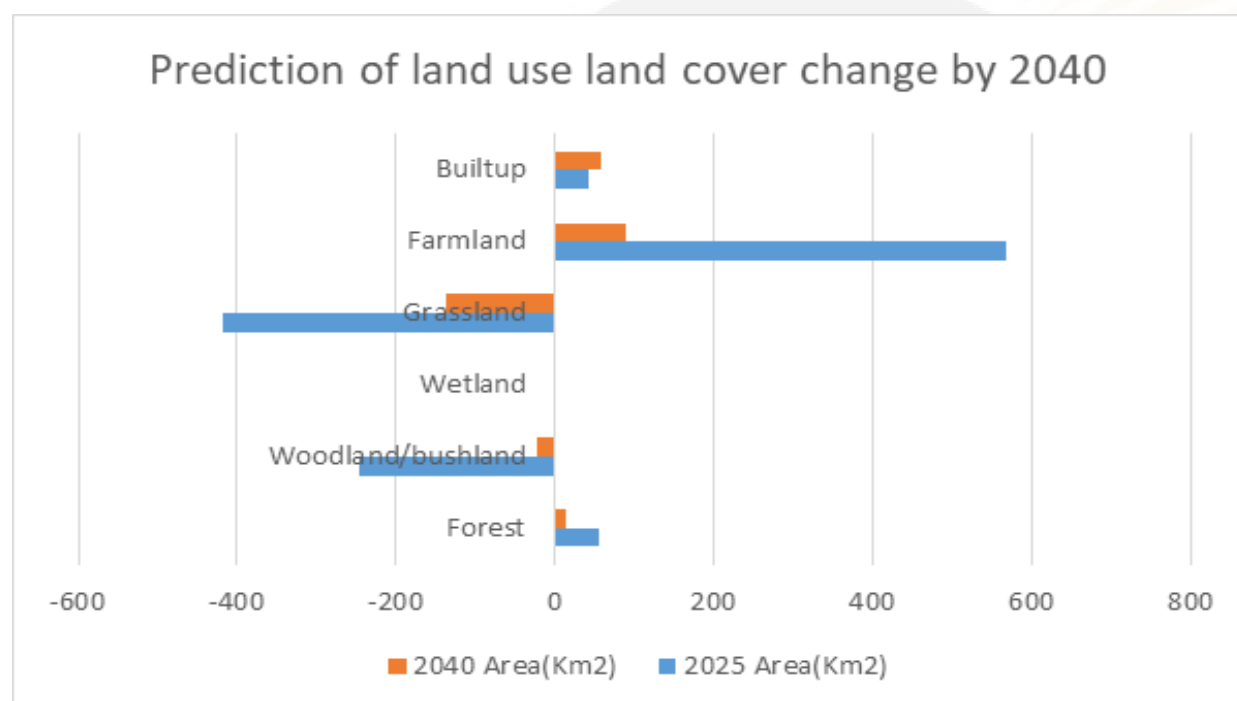


Figure 9: Prediction of land use land cover change by 2040

The bar chart presents a comparative analysis of land cover changes across six key habitat types between 2025 and projections for 2040. The habitats include Built-up areas, Farmland, Grassland, Wetlands, Woodland/Bushland, and Forest. Each category is quantified in terms of area (Km²), highlighting potential shifts in habitat availability and, by extension, the implications for the Grey Crowned Crane (GCC), a species highly sensitive to habitat structure and quality.

Farmland represents the largest area both currently (2025) and in future projections (2040). The chart indicates a marked reduction in farmland from approximately 570 Km² in 2025 to roughly 100 Km² by 2040. This dramatic contraction signals a potential risk for GCC populations that utilize cultivated landscapes for foraging, particularly during post-harvest periods. Such a decrease in farmland could force GCCs to rely more heavily on remaining natural habitats, possibly increasing competition and exposing them to human–wildlife conflicts.

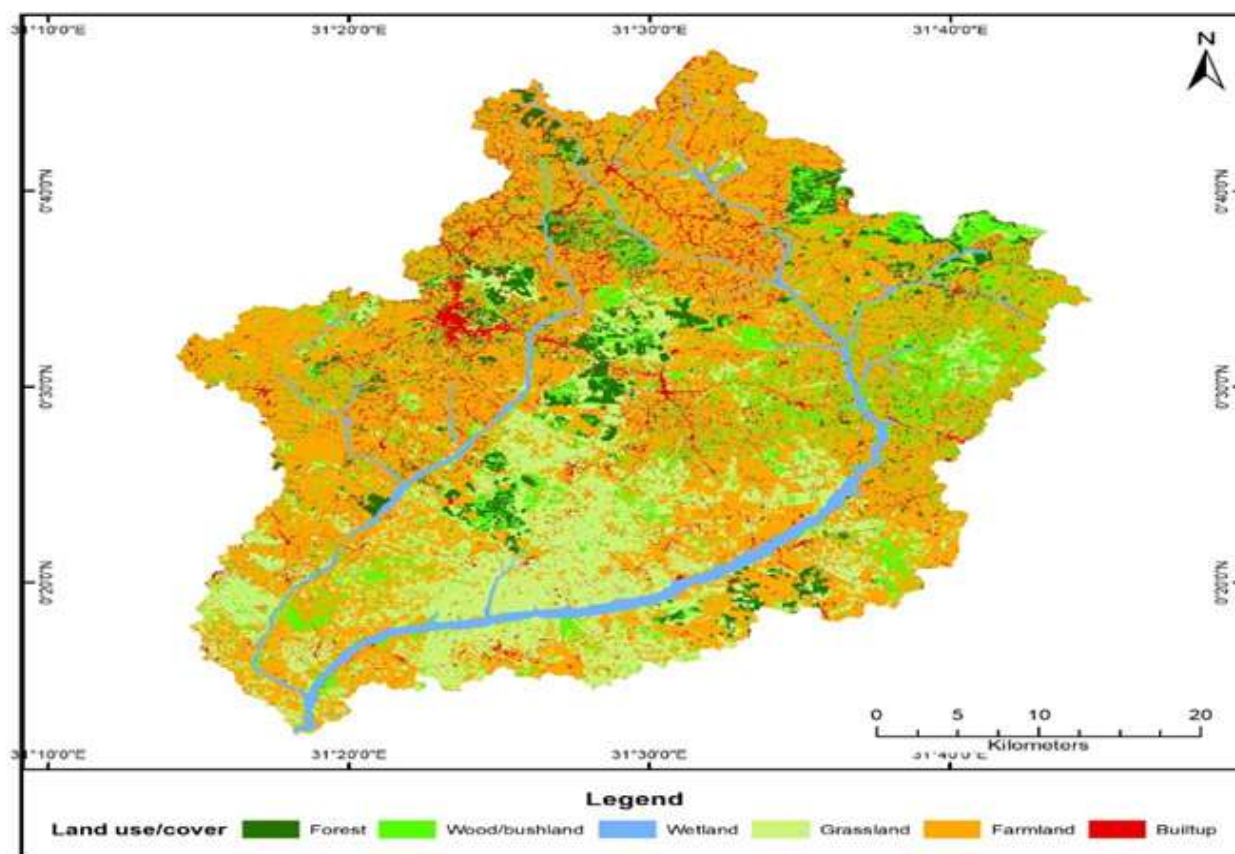


Grasslands are projected to experience the most severe decline, shifting from around -410 Km² (indicating a net loss relative to some base-line or current extent) in 2025 to approximately -200 Km² in 2040. Grasslands are critical for GCC foraging, nesting, and brood-rearing activities. A continued reduction threatens not only the quantity of available habitat but also its spatial connectivity, potentially fragmenting GCC populations and restricting access to key resources. This trend underscores the urgent need for grassland conservation and restoration strategies.

Wetlands, a quintessential habitat for GCC due to their role in providing foraging grounds, breeding sites, and refuge from predators, appear to maintain a stable area in the projections. While the chart shows minimal numerical change, even small reductions or degradation in wetland quality could have disproportionately high impacts on GCC survival, as these areas are highly sensitive to hydrological alterations, pollution, and encroachment.

Woodland/Bushland and **Forest** habitats show minor fluctuations. Woodland/Bushland exhibits a slight decrease in projected area, while forested areas increase marginally from about 40 Km² to a slightly higher value. Although these habitats are not the primary foraging grounds for GCC, they serve as complementary refuges and dispersal corridors. Maintenance of these habitats is vital to sustain ecological connectivity and buffer the species against intensive agricultural and urban expansion.

Built-up areas show a slight projected increase from 2025 to 2040, reflecting ongoing urbanization. Although the absolute area is small, the expansion of human settlements can have significant localized impacts on GCC populations, including habitat fragmentation, increased human disturbance, and heightened exposure to poaching or collisions with infrastructure.



Map 4: Map predicting future of the ecosystem degradation



4.8.1. Implications for the Grey Crowned Crane (GCC):

The projected landscape changes suggest that GCCs will face a progressively constrained habitat mosaic by 2040, with critical reductions in farmland and grasslands. These shifts could lead to increased population pressures in remaining suitable areas, greater overlap with human activities, and heightened vulnerability to ecological and anthropogenic stressors. Conservation planning should prioritize the protection and restoration of grasslands and wetlands, implement habitat corridors to facilitate movement, and integrate GCC considerations into agricultural and urban planning. Additionally, promoting community-based conservation initiatives could mitigate human–crane conflicts, ensuring sustainable coexistence.

In conclusion, the comparative analysis highlights the urgent need for proactive habitat management. The observed trends underscore that GCC persistence will increasingly depend on targeted conservation interventions, particularly in grassland and wetland ecosystems, to counterbalance the pressures of land-use change projected over the next two decades.

4.9. Suggestions for Conservation of the Ecosystem and Grey Crowned Crane (GCC): Strategic Recommendations

The Grey Crowned Crane (GCC) is not only an iconic flagship species but also a sensitive ecological indicator, reflecting the overall health of wetland, grassland, and farmland ecosystems. Its continued survival is intimately linked to the integrity and functionality of these habitats. Recent trends in land-use change, including wetland encroachment, conversion of grasslands to agriculture, and unsustainable farming practices, pose significant threats to GCC populations. Conserving this species, therefore, requires a strategic, multi-stakeholder, and adaptive conservation approach that aligns ecological preservation with sustainable

development and community livelihoods. By protecting the GCC and its habitats, ecosystem services such as water regulation, soil fertility maintenance, and climate moderation are safeguarded, which in turn supports local agriculture, fisheries, and other natural-resource-dependent activities.

1. Protection and Restoration of Wetlands and Grasslands.

Wetlands and grasslands serve as critical foraging, roosting, and breeding habitats for GCC. Effective conservation requires both protective measures and ecological restoration. Protection should include legal demarcation of key habitats, the establishment of buffer zones, and enforcement against encroachment or degradation. Restoration efforts must prioritize rehabilitation of degraded wetlands and grasslands, including replanting indigenous vegetation, controlling invasive species, and restoring hydrological regimes. Engagement of local communities in these restoration initiatives is crucial, as participatory approaches encourage stewardship and compliance. Realistic implementation strategies include community-based wetland monitoring, payment-for-ecosystem-services schemes, and integrating local ecological knowledge to ensure habitat improvements are sustainable and context-specific.

2. Promotion of Sustainable Agricultural Practices.

Given that farmlands constitute significant portions of GCC habitat, wildlife-friendly agriculture is essential. Practices such as reduced pesticide use, maintenance of natural buffer zones around wetlands, rotational cropping, and integration of agroforestry systems can substantially reduce negative impacts on the cranes.



Additionally, incorporating agro ecological principles—such as organic soil enrichment, intercropping, and conservation tillage—can enhance habitat quality while maintaining farm productivity. Implementable actions include training programs for farmers, establishment of demonstration plots, and provision of incentives (e.g., access to microcredit or market premiums for wildlife-friendly produce), ensuring that conservation objectives are aligned with farmers' economic interests.

3. Habitat Connectivity and Corridor Development

Habitat fragmentation is a critical threat, limiting GCC movement between feeding, breeding, and roosting sites. To address this, ecological corridors should be established to link wetlands, grasslands, and woodlands. These corridors not only facilitate crane mobility but also support broader biodiversity, mitigate the impacts of climate change, and enhance ecosystem resilience. Implementation should involve mapping priority linkages, land-use negotiations with local communities, and integrating corridors into regional development and land-use planning frameworks. Corridors can be further strengthened through community-led stewardship agreements and incentives for private landowners who maintain or restore natural vegetation.

4. Community Engagement and Awareness

Sustainable conservation is contingent on active local participation. Awareness campaigns should focus on the ecological and economic importance of GCC and wetlands, emphasizing potential benefits such as eco-tourism, sustainable fisheries, and cultural heritage. Participatory programs can include community-managed conservation areas, citizen science initiatives, and educational outreach in schools. Incentive-based approaches, such as revenue-sharing from

tourism or conservation-linked livelihoods, can reduce human-wildlife conflicts and foster a sense of ownership among local communities, making conservation more effective and enduring.

5. Policy Enforcement and Institutional Collaboration

Strong governance and institutional synergy are fundamental to effective conservation. Existing environmental policies, land-use regulations, and protected area frameworks must be consistently enforced. This requires coordinated action between district authorities, national regulatory bodies (such as NEMA), sectoral ministries (Water, Agriculture, Environment), and non-governmental organizations. Implementable strategies include joint monitoring committees, inter-agency agreements for enforcement, and integration of conservation objectives into local development planning. Ensuring adequate financial and technical resources for enforcement agencies is critical to achieve tangible outcomes.

6. Monitoring, Research, and Adaptive Management

Conservation success relies on evidence-based interventions. Continuous monitoring of GCC populations, habitat conditions, and threats is essential for informed decision-making. Research priorities should include behavioral ecology, population trends, habitat utilization, and responses to anthropogenic pressures. Adaptive management—where conservation strategies are revised based on monitoring outcomes—ensures interventions remain effective under changing environmental and socio-economic conditions. Practical measures include establishing permanent monitoring plots, community reporting systems, and collaboration with academic institutions to leverage expertise and resources.



Table 3: Grey Crowned Crane (GCC) and Ecosystem Conservation Action Plan (2025–2030)

Conservation Action	Key Activities / Interventions	Start Date	End Date	Responsible Parties	Notes / Implementation Strategy
Wetland Protection	Demarcate key wetlands, fence critical areas, enforce legal protection, community stewardship programs	Jan 2025	Dec 2030	Mubende District Local Gov't, NEMA, Ministry of Water and Environment, CSOs	Phased demarcation starting with high-priority wetlands; community-led monitoring integrated
Grassland Restoration	Plant indigenous grass species, control invasive plants, soil rehabilitation, habitat improvement	Feb 2025	Dec 2030	NAPE, Local NGOs/CSOs, Mubende District Local Gov't, Community Groups	Focus on degraded areas first; combine with wetland restoration for maximum habitat connectivity
Wildlife-friendly Agriculture	Promote buffer zones, rotational cropping, agroforestry, reduced pesticide use, farmer training	Mar 2025	Dec 2030	Ministry of Agriculture, Mubende District Local Gov't, Farmer Associations, NGOs	Establish demonstration farms and incentive schemes for participating farmers
Habitat Corridors	Identify priority corridors, negotiate land-use agreements with landowners, plant native vegetation, integrate corridors into local planning	Apr 2025	Dec 2030	Mubende District Local Gov't, Ministry of Water and Environment, NAPE, NGOs	Corridors to connect wetlands, grasslands, and woodlands; phased implementation based on land availability
Community Engagement	Awareness campaigns, eco-tourism promotion, participatory conservation programs, school outreach	Jan 2025	Dec 2030	NGOs (NAPE), Mubende District Local Gov't, CBOs	Incorporate local ecological knowledge; incentivize communities through eco-tourism revenue-sharing
Policy Enforcement	Enforce environmental laws, anti-encroachment regulations, strengthen compliance monitoring	Jan 2025	Dec 2030	NEMA, Mubende District Local Gov't, Ministry of Water and Environment	Regular audits and patrols; cross-sectoral enforcement committees
Monitoring and Research	Population surveys, habitat quality assessments, threat analysis, research on behavioral ecology	Jan 2025	Dec 2030	NAPE, Universities, Research Institutions, Mubende District Local Gov't	Use standard protocols; integrate citizen science and student research projects
Adaptive Management	Review monitoring data annually, adjust interventions, update management plans, policy recommendations	Jan 2025	Dec 2030	Mubende District Local Gov't, NEMA, Ministry of Water and Environment, NGOs	Annual adaptive management workshops; lessons learned integrated into subsequent planning cycles



Implementation Notes:

- 1. Phased approach:** Priority actions (wetlands, high-risk grasslands, and wild-life-friendly farms) should begin immediately, while corridors and large-scale community programs are rolled out in parallel.
- 2. Integration:** All interventions should align with local land-use plans, district development strategies, and national environmental policies.
- 3. Capacity Building:** Training of local officials, farmers, and community monitors is crucial for sustainable conservation.
- 4. Funding and Incentives:** Secure multi-source funding (government, NGOs, international donors) and incentivize community

participation through revenue-sharing, conservation credits, or alternative livelihoods.

- 5. Monitoring and Evaluation:** Establish a centralized reporting system to track progress, detect challenges early, and guide adaptive management.

This integrated framework provides a realistic, actionable roadmap for conserving the GCC and associated ecosystems while balancing socio-economic development. By combining habitat protection, sustainable land management, community engagement, and strong institutional coordination, long-term resilience of the GCC and the ecosystem can be achieved.

4.10. Conclusion

The findings of this study underscore a landscape undergoing significant ecological stress, with direct and far-reaching implications for the conservation of the Grey Crowned Crane (GCC). The degradation profile characterized by 28% highly degraded, 15% moderately degraded, 31% low degradation, and only 26% intact habitat reveals a shrinking mosaic of functional wetlands and grasslands that are essential for the species' breeding, foraging, and seasonal movements. As degradation intensifies, it fragments habitats, reduces food availability, heightens disturbance, and erodes the ecological integrity required to sustain viable crane populations.

The study demonstrates that GCC presence and behavior are tightly linked to habitat quality: intact and low-degradation areas support regular sightings and successful reproduction, while moderately and highly degraded zones are increasingly avoided or used only opportunistically, often driving cranes into agricultural lands where conflict becomes more pronounced. The interplay between human pressure, declining wetland health, and ecological fragmentation thus emerges as a central driver of conservation risk. Despite these challenges, the landscape retains notable opportunities for recovery. The proportion of moderately and low-degraded areas indicates that much of the ecosystem remains restorable, and community willingness to engage in conservation initiatives provides a foundation for collaborative management. Targeted restoration of wetlands, strategic protection of intact areas, and improved land-use governance can reverse current trends and re-establish ecological continuity across the crane range.

In conclusion, the study affirms that safeguarding the Grey Crowned Crane requires a landscape-level conservation strategy anchored in habitat restoration, strengthened environmental management, and active community participation. If pursued with urgency and coordinated commitment, these interventions hold promise not only for stabilizing the GCC population but also for restoring the broader ecological functions on which both wildlife and local livelihoods depend.



Annexes

Annex 1 Tools and Instruments Used in the Study Methodology

Tool / Instrument	Category	Specific Use in the Study	Data Generated / Purpose
<i>Field observation checklists</i>	Ecological / Primary data	Systematic recording of Grey Crowned Crane (GCC) presence, behavior, flock size, feeding activity, courtship, nesting behavior, and movement patterns	Qualitative and quantitative ecological data on crane behavior and habitat use
<i>Direct visual observation (point counts & transects)</i>	Ecological survey tool	Counting cranes at fixed observation points and along wetland transects during morning and evening activity peaks	Population estimates, spatial distribution, and activity patterns
<i>GPS handheld devices</i>	Spatial / Mapping	Recording coordinates of crane sightings, breeding sites, roosting areas, and key wetland features	Spatial location data for mapping breeding and habitat-use sites
<i>GIS software (e.g. ArcGIS / QGIS)</i>	Spatial analysis	Mapping breeding sites, land use/land cover change (2015–2025), wetland degradation, and future scenarios	Land use maps, degradation maps, habitat fragmentation analysis
<i>Satellite imagery (historical and recent)</i>	Remote sensing	Analysis of land use and land cover change over time in the Nabakazi wetland system	Quantitative evidence of habitat change and degradation trends
<i>Structured household questionnaires</i>	Socio-economic	Administered to 100 households near wetlands to assess crop raiding, perceptions of GCC, conservation awareness, and mitigation preferences	Quantitative socio-economic and perception data
<i>Semi-structured interview guides</i>	Qualitative / Social	Interviews with farmers, community leaders, conservation practitioners, and local authorities	In-depth qualitative insights on human–wildlife conflict, threats, and conservation practices



<i>Focus Group Discussion (FGD) guides</i>	Participatory	Conducting FGDs with selected community groups to validate findings and capture shared local knowledge	Community-level perspectives and consensus on threats and solutions
<i>Ecological habitat assessment forms</i>	Ecological survey	Recording vegetation type, water depth, disturbance signs, grazing pressure, brick-making, and farming activities	Habitat condition and suitability data for breeding and foraging
<i>Camera / smartphone photography</i>	Visual documentation	Capturing images of cranes, nests, habitats, degradation activities, and land-use practices	Photographic evidence to support observations and reporting
<i>Secondary data review checklist</i>	Desk review	Reviewing reports, census data, conservation records, and policy documents	Contextual and comparative data to support analysis
<i>Statistical analysis tools (e.g. Excel/SPSS)</i>	Data analysis	Analyzing questionnaire responses, frequencies, trends, and descriptive statistics	Quantitative summaries, graphs, and tables
<i>Qualitative content analysis framework</i>	Data integration	Thematic analysis of interviews and FGDs and integration with ecological findings	Interpretation of social drivers, perceptions, and conservation opportunities



Annex 2:

Questionnaire: Community Engagement on Grey Crowned Crane Conservation

Introduction:

We are conducting a study on the Grey Crowned Crane (*Balearica regulorum*) in Mubende District. Your input will help us understand the local presence of these cranes, their behavior, and the impacts of human activities on their habitats. The information gathered will be used to create effective conservation strategies for these birds.

All responses will remain confidential.

Section 1: Demographic Information

1. Name:.....(Optional)

2. Age:

☐ 18-25

☐ 26-35

☐ 36-45

☐ 46-55

☐ 56 and above

3. Gender:

☐ Male

☐ Female

☐ Other

4. Occupation:

☐ Farmer

☐ Fisherman

☐ Teacher

☐ Local leader

☐ Other (Please specify): _____

5. Which sub-county do you live in?

☐ Madudu

☐ Kalong

☐ Kitenga

☐ Kayebe

☐ Kigando

☐ Other (Please specify): _____

Section 2: Crane Sightings and Habitat Use

6. Have you ever seen a Grey Crowned Crane in your area?

☐ Yes

☐ No

7. If yes, how often do you see Grey Crowned Crane s in your area?

☐ Daily

☐ Weekly

☐ Monthly

☐ Rarely



8. Where do you usually see Grey Crowned Crane s? *(write down the specific spots – (name, village, in which parish and in which sub county because the aim is to know these breeding spots and know what can be done to either maintain them, conserve them or restore them and where they are degraded, clearly know the potential drivers).*

(Please select all that apply)

- ☐ Wetlands
- ☐ Grasslands
- ☐ Farmlands
- ☐ Near water bodies (lakes, rivers, etc.)
- ☐ Other (Please specify): _____

9. At what time of day do you usually see the Grey Crowned Crane s?

- ☐ Morning
- ☐ Afternoon
- ☐ Evening
- ☐ Night

10. What type of vegetation is commonly associated with the places where you see the cranes?

- ☐ Tall grass
- ☐ Wetland vegetation
- ☐ Shrubs or bushes
- ☐ Trees
- ☐ Crops (maize, cassava, etc.)
- ☐ Other (Please specify): _____

Section 3: Crane Behavior and Conservation Perceptions

11. What activities have you observed Grey Crowned Crane s doing in your area?
(Check all that apply)

- ☐ Feeding
- ☐ Nesting
- ☐ Mating/Courtship displays
- ☐ Roosting
- ☐ Flying
- ☐ Other (Please specify): _____

12. Have you ever observed a Grey Crowned Crane nest?

- ☐ Yes
- ☐ No
- ☐ Not sure

i) If yes, where did you observe the nest?

(Please describe the location, e.g., near a wetland, in tall grass, etc.)



13. What is your understanding of the importance of Grey Crowned Crane s in the local environment?

- ☐ They help in pest control
- ☐ They are important for biodiversity
- ☐ They are culturally significant
- ☐ They are important for wetland health
- ☐ Other (Please specify): _____
- ☐ I don't know

14. Do you think the number of Grey Crowned Crane s in your area is:

- ☐ Increasing
- ☐ Decreasing
- ☐ Staying the same
- ☐ Not sure

15. What do you think are the main threats to Grey Crowned Crane s in your area?
(Check all that apply)

- ☐ Habitat destruction (wetland reclamation, farming)
- ☐ Poaching/Illegal hunting
- ☐ Disturbance from human activities (farming, fishing)
- ☐ Pollution (water, land)
- ☐ Climate change
- ☐ Invasive plant species
- ☐ Other (Please specify): _____

16. Have you noticed any changes in crane behavior or population over the past years?

- ☐ Yes, they are fewer
- ☐ Yes, they are more active
- ☐ No, no changes observed
- ☐ Not sure

Section 4: Human-Wildlife Interaction and Conservation Efforts

17. Do you or your community members interact with Grey Crowned Crane s in any way?

- ☐ Yes, by protecting their habitat
- ☐ Yes, by feeding them
- ☐ Yes, by observing them
- ☐ No, no interaction
- ☐ Other (Please specify): _____

18. Are you aware of any conservation efforts aimed at protecting Grey Crowned Crane s in your area?

- ☐ Yes
- ☐ No
- ☐ i) If yes, what types of conservation efforts are you aware of?
 - ☐ Protected wetland areas
 - ☐ Education and awareness programs
 - ☐ Local community conservation initiatives
 - ☐ Restricting hunting or egg collection
 - ☐ Others (Please specify): _____



19. Do you think conservation efforts for the Grey Crowned Crane are important?

- ☐ Yes, very important
- ☐ Yes, somewhat important
- ☐ No, not important
- ☐ Not sure

20. What actions would you be willing to take to help conserve Grey Crowned Crane s in your area?

- ☐ Participate in local conservation programs
- ☐ Educate others about the importance of Grey Crowned Crane s
- ☐ Report illegal activities like poaching or habitat destruction
- ☐ Protect wetlands and avoid disturbing crane nests
- ☐ Other (Please specify): _____

Section 5: Suggestions for Conservation

21. What do you think could be done to protect the Grey Crowned Crane in your area?
(very key question that can present actionable interventions and strategies that can be presented to potential donors for future conservation.)

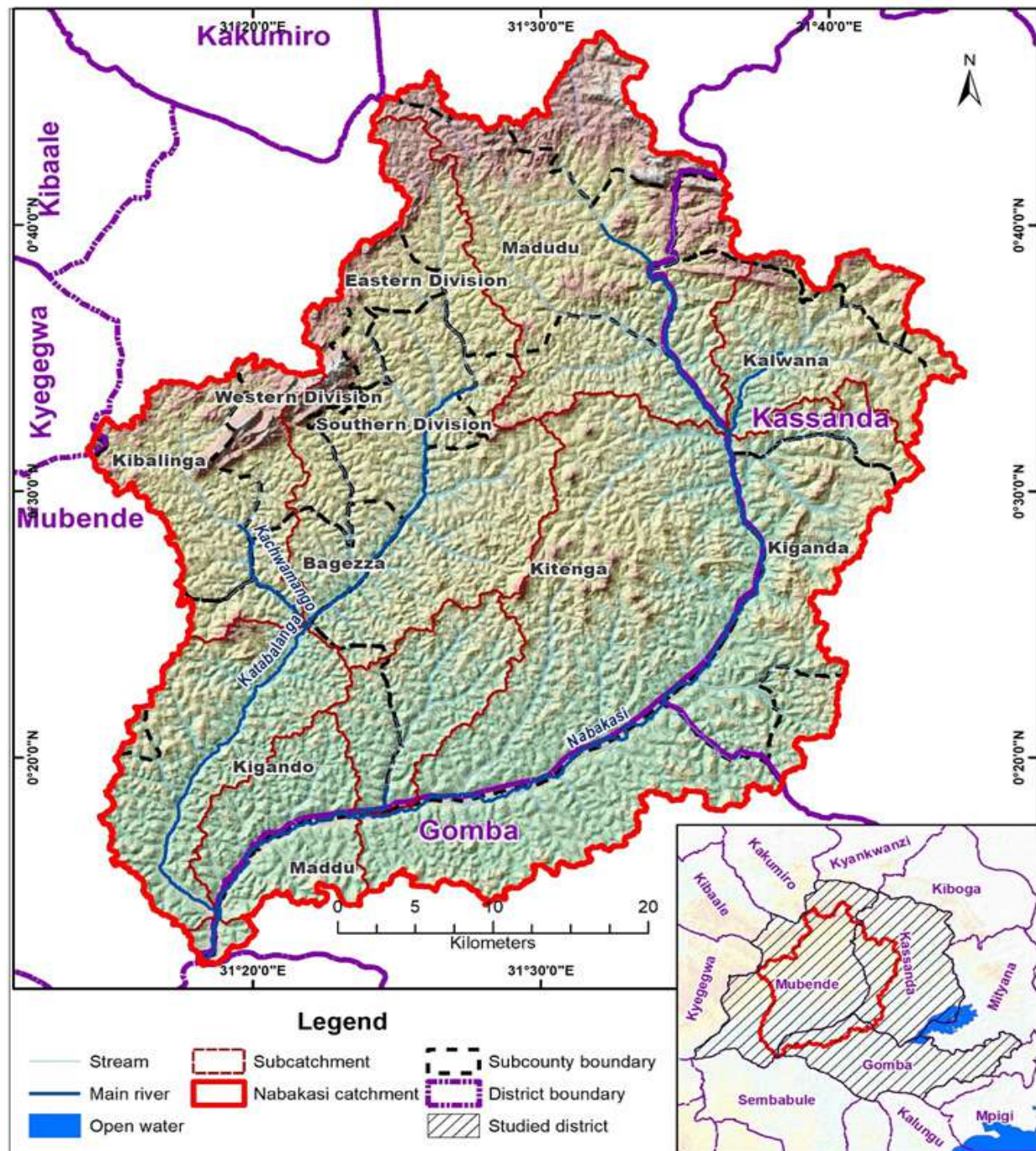
22. How can the community be involved in the conservation of Grey Crowned Crane s?

Thank you for your participation!

Your responses are invaluable in understanding the local ecology of the Grey Crowned Crane and in developing strategies for their conservation.

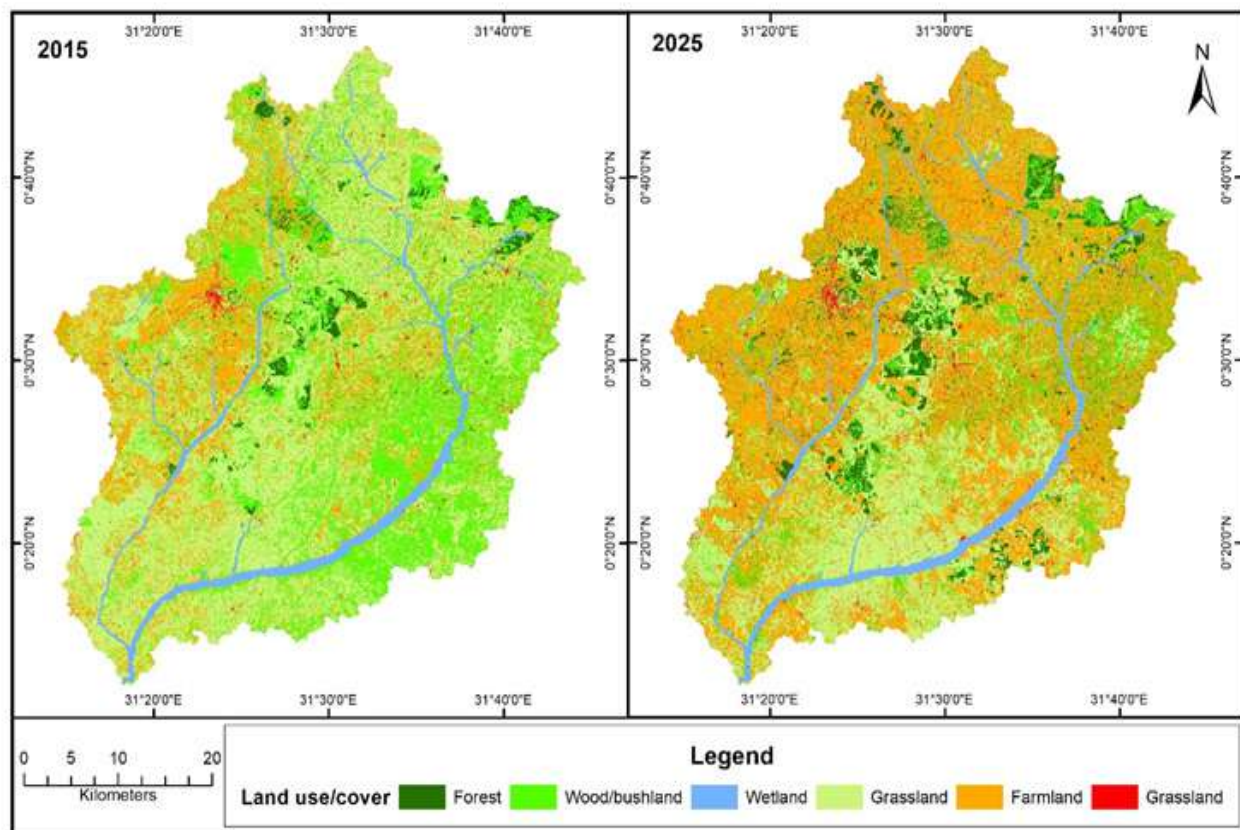


Annex 3: Study area map





Annex 4: Land use/cover classification

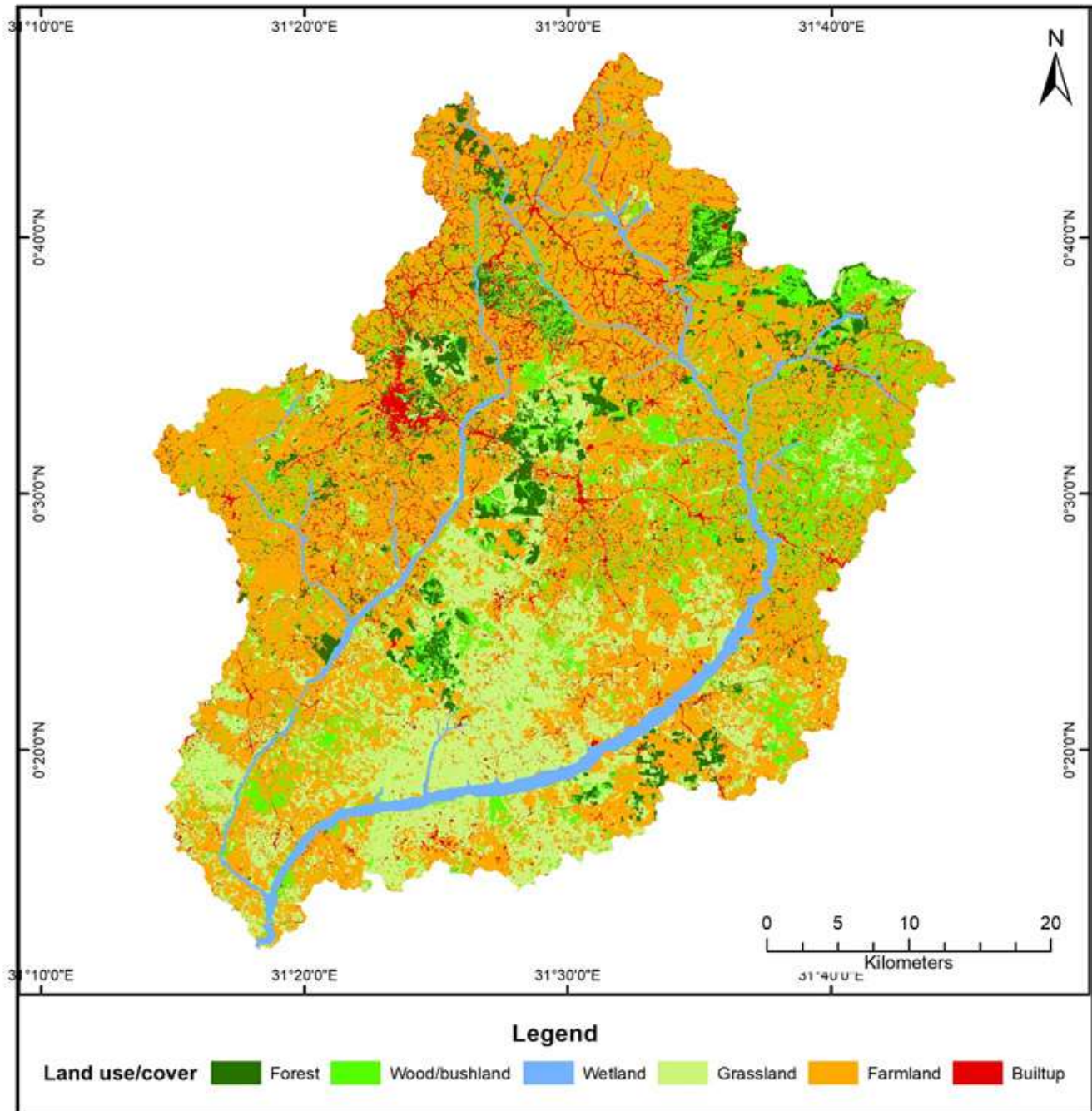


Classification statistics

Land use/cover	2015		2025		2040		2015 to 2025		2025 to 2040	
	Area(Km ²)	Area(%)	Area(Km ²)	Area(%)	Area(Km ²)	Area(%)	Area(Km ²)	Area(%)	Area(Km ²)	Area(%)
Forest	52.13	2.48	106.34	5.07	119.31	5.69	54.20	2.58	12.97	0.62
Woodland/bushland	560.10	26.69	312.64	14.90	289.10	13.78	-247.46	-11.79	-23.54	-1.12
Wetland	94.37	4.50	94.36	4.50	94.32	4.49	-0.01	0.00	-0.04	0.00
Grassland	970.91	46.26	552.93	26.35	417.03	19.87	-417.98	-19.92	-135.90	-6.48
Farmland	394.56	18.80	962.33	45.85	1050.94	50.08	567.77	27.05	88.61	4.22
Builtup	26.61	1.27	70.08	3.34	127.98	6.10	43.47	2.07	57.90	2.76
Total	2098.68	100	2098.68	100	2098.68	100	0.00	0.00	0.00	0.00

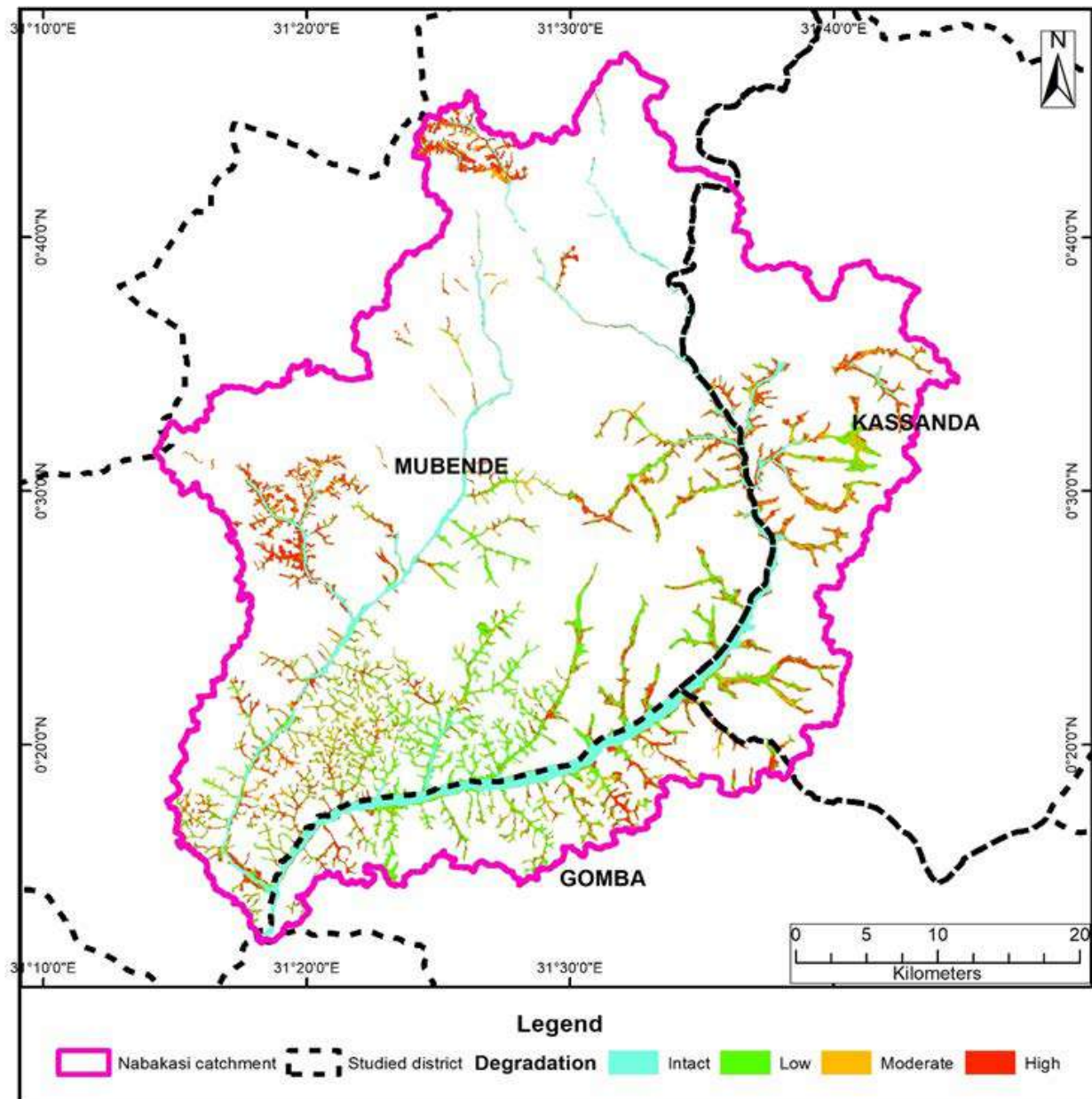


Annex 5: Prediction Map





Annex 6: Degradation map



Degradation statistics

Degradation	Area (Km2)	Area(%)
Intact	73.16	25.61
Low	89.71	31.40
Moderate	42.24	14.78
High	80.60	28.21
Total	285.71	100



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