

**Ecosystem management in refugee-hosting communities: insights from Kyaka II Refugee Settlement,
Uganda.**

Reuben Twinomujuni, Kyambogo University (PhD Candidate) reubentwins@gmail.com

Hannah Muzee, Kyambogo University (Supervisor) hmuzee@kyu.ac.ug

Fredrick Kisekka-Ntale, Kyambogo University (Supervisor) fkisekka2018@gmail.com

Abstract

Refugee-hosting communities have long grappled with the tension between meeting basic human survival needs and protecting the environment. Uganda, home to over two million refugees and asylum seekers, is at the centre of this tension and therefore an important case study for understanding this challenge. Uganda, also rich in biodiversity, faces strong pressure to protect the environment, necessitating an appraisal of ecosystem management to clarify the relationship between environmental management and human survival needs. This understanding is necessary to inform policy and improve ecosystem management in refugee-hosting communities. Findings indicated that provisioning services- food, water, and firewood are easy to access; the challenge remains the quality, reliability, and long-term sustainability of these services. Regulating services, especially those related to water quality, waste management, forests, and wetlands, remain vulnerable as pressure on natural resources mounts. The study notes that cultural services support societal harmony, whereas refugee settlement can drive ecological degradation. However, this can also create opportunities to plan innovative approaches to ecosystem management. These innovative approaches could include using solar energy, working closely with local structures, and collaborating with international frameworks such as the SDGs and UNHCR guidelines.

Keywords: Ecosystem, Well-being, Indigenes, Kyaka II, Refugees

Introduction

Communities that host refugees have long grappled with challenges stemming from competition for resources, especially water, food, firewood, land, and housing, among others, between refugees and host communities that hinder effective ecosystem management (Ahimbisibwe, 2018; Ministry of Water and Environment, 2016; NEMA, 2019; UNHCR, 2005). Hosting refugees can contribute to ecological degradation and biodiversity decline, yet these ecosystems are necessary for human survival, societal harmony, and sustainable development (Wu et al., 2022).

The world relies on four primary interconnected ecosystems for its life support: the atmosphere (air), the hydrosphere (water), the geosphere (soil, rocks, and remnants), and the biosphere (living organisms) (Miller & Spoolman, 2012). Yet refugee settlement negatively affects all four ecosystems.

The growing human population has led to alarming depletion of natural resources, with habitats devastated, wildlife corridors obstructed, illegal resource extraction, and frequent wildfires (Kideghesho, 2021). These activities threaten the rich biodiversity of ecosystems that harbour a wide array of plant and animal species. These ecosystems are ecologically and economically significant and steeped in socio-cultural importance (Kideghesho et al., 2013). Uganda

Received: 06.09.2026

Accepted: 12.09.2026

Published on: 30.09.2026

is one of Africa's wealthiest countries in biodiversity, with 1,742 terrestrial vertebrate species, at least 3,662 plant species, and over half of Africa's bird population. Uganda is home to diverse ecosystems, including forests, wetlands, rangelands, lakes, and rivers, making it vital to global biodiversity conservation (NEMA, 2019).

Unfortunately, despite this glowing reputation for biodiversity, the country's forest cover is on the verge of extinction, having lost 3.1 million hectares over 25 years, averaging 122,000 hectares per year. Forests near refugee settlements face widespread pressure, as refugees cut down trees for various purposes (Ministry of Water and Environment, 2016). Refugees rely heavily on firewood and other forest materials for cooking and shelter. This reliance has degraded forests neighbouring refugee settlements. For instance, forests in Kyangwali, Rwamwanja, Oruchinga and Bidibidi have suffered from deforestation (NEMA, 2019). Similarly, refugee settlements have affected wetlands. For example, the Lake Albert basin experienced a 32% reduction in wetland area and lost over 903 km² of wetland between 1994 and 2015. This loss is attributed to population growth in the basin, including refugees who have encroached on wetlands for agriculture and settlement (NEMA, 2019). Moreover, in 2020, Uganda had 2.1 million hectares of natural forest, covering about 9% of its land area. By 2024, the country had lost 27,000 hectares of natural forest, resulting in 13 million tonnes of carbon dioxide emissions (Global Forest Watch, nd). From 2001 to 2024, 85% of tree cover loss occurred in areas where the main drivers of deforestation were present. As of 2000, 32% of Uganda's land cover was tree cover with over 30% canopy density (Global Forest Watch, nd). Refugees have consistently been recognised as key contributors to the degradation and deforestation of Uganda's forests (Ministry of Water and Environment, 2016). The nature of refugee settlements leads to the accumulation of waste materials. These include plastics, paper packaging, kitchen remains, plant residues, medical waste, ash, and faecal waste. To manage this, households use waste pits left wide open; some are burned, while others are scattered across open fields, including through open defecation, creating breeding sites for mosquitoes and flies. This poses public health risks, including waterborne diseases and other infections (NEMA, 2019).

NEMA (2019) reports that approximately 149.65 kg of waste is produced per person annually, resulting in a total of 188,069,494 tonnes of waste generated by refugees.

In Bukere, Kyaka II, the disposal site is near a water body in a valley, while Rhino and Omugo have no designated final disposal area. Landfilling and open dumping create numerous difficulties, mainly because wind disperses waste, leading to further littering.

Since the refugee population in the Kyaka II refugee settlement increased tenfold from 17,000 in 2017 (OPM, 2024) to 139,142 (UNHCR, 2026), the area has experienced land-use changes, leading to ecosystem decline, atmospheric changes, and altered rainfall patterns. These changes result from refugees' unsustainable utilisation of forests, wetlands, and the biodiversity and ecosystems they harbour.

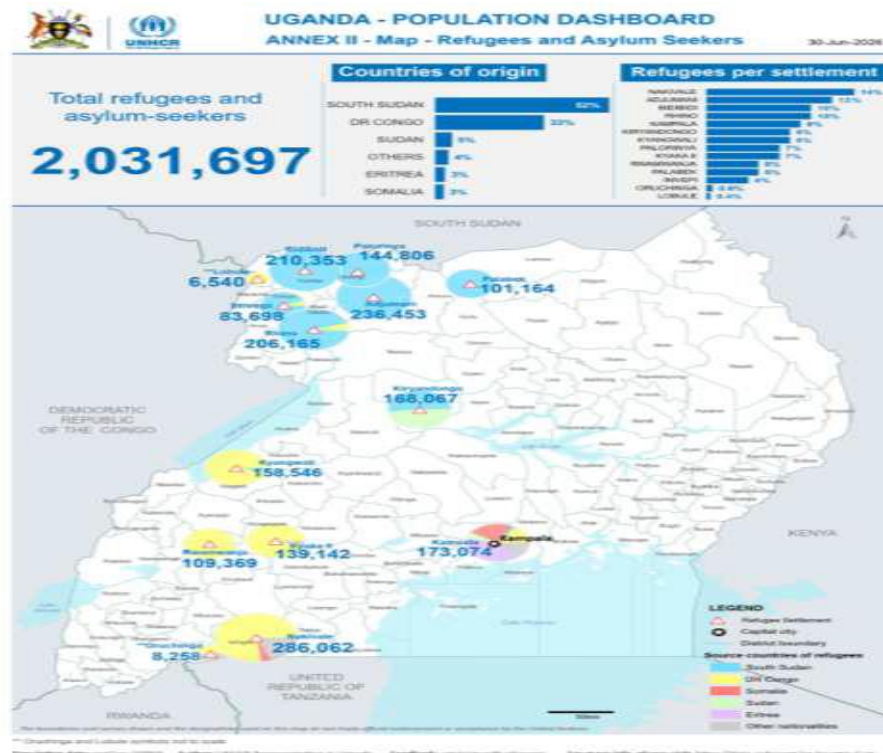
Established in 1983/84, Kyaka II refugee settlement was intended to host Rwandan refugees. When refugees returned, it was closed and reopened in 1995 to host Rwandan refugees. In 2005/6, it also hosted Congolese refugees. Until December 2017, Kyaka II had a population of around 27,000-30,00 refugees. Since then, refugees from Congo, Rwanda, and Burundi have been the settlement's primary residents (Danish Refugee Council, 2018). As at 30 June 2026, the Kyaka II refugee settlement has been home to 139,142 refugees (UNHCR, 2026).

The western part of Uganda hosts a reasonable number of refugees, mainly attributable to its proximity to the Democratic Republic of Congo, a country that has faced unending wars.

Kyegegwa District, which hosts the Kyaka II refugee settlement, neighbours other districts, including Kibaale, Mubende, Kiruhura, Kamwenge and Kyenjojo. These districts are also affected by the influx of refugees, mainly from the Democratic Republic of Congo. This underscores the difficulties of hosting and integrating refugees, given the effects of refugee settlement.

Figure 1

Map showing Kyaka II Refugee Settlement



Kyaka II is characterised by landscapes that include rolling hills, flatlands and valleys. It also includes significant ecological and physical features, including wetlands, forested areas, and rivers, which contribute to the region's environmental complexity and shape the livelihoods of both refugees and host communities.

Received: 06.09.2026

Accepted: 12.09.2026

Published on: 30.09.2026

For more than thirty years, the sub-counties of Nkanja, Ruyonza, and Kyegegwa have experienced persistent changes in land cover, resulting in the loss of valuable ecosystems. Furthermore, Ericksen et al. (2012), in their study of “ecosystem services in Kenya’s Ewaso Ng’iro catchment”, demonstrated that land-use decisions in dryland areas directly affect provisioning services, such as food, water, and firewood, and regulating services that influence climate, floods, disease, waste, and water quality.

Recent research has highlighted the undervaluation and growing vulnerability of ecosystem services in both drylands and forested landscapes under mounting human pressures (Bargue’s-Tobella et al., 2026; Lu et al., 2024; Pérez et al., 2026; Xirogiannis et al., 2026). Rapid population growth and dependence on natural resources intensify ecological pressure, particularly on forests and regulating services.

Given this growing ecosystem vulnerability driven by population growth and dependence on natural resources, the study emphasises the need to incorporate ecosystem management approaches into humanitarian governance (Laine, 2026; Oulu et al., 2023; Van Blerk et al., 2021).

While this scholarship, such as (Danish Refugee Council, 2018; Hassan et al., 2023; Ministry of Water and Environment, 2016; NEMA, 2019; Wu et al., 2022), documents the pressure on ecosystems resulting from refugee settlement, a gap remains in research on the lived experiences of indigenes. These indigenes rely on ecosystems to survive. They also make refugee settlement possible by feeding refugees. More research is needed to understand how ecosystems are managed in refugee-hosting communities and to place the lived experiences of refugee hosts in perspective.

Given this critical need, this study appraises ecosystem management in refugee-hosting communities, with a specific focus on the Kyaka II Refugee Settlement.

Ecosystem services theory underpinned this study. Propounded through the contributions of Paul and Anne Ehrlich (1981), Gretchen C. Daily (1997), and Robert Costanza et al (1997), it provides a rounded understanding of ecosystem dynamics by incorporating environmental science, policy formulation, conservation biology, and sociology, thereby providing ecological functions critical for human and biological survival.

The theory argues that ecosystems provide the ecological processes needed to sustain natural systems and strengthen conservation efforts. It explains the ecosystem services concept, facilitating better decision-making on environmental challenges. It encourages incorporating biodiversity conservation into ecosystem management, helps evaluate environmental trade-offs and advances initiatives in biodiversity conservation, ecosystem restoration and sustainable natural resource management.

Materials and Methods

This study used an explanatory sequential mixed-methods design with two phases. The first phase gathered quantitative data via a questionnaire, analysed the results, and used them to inform the second phase. In the second phase, the researchers gathered qualitative data through interviews and focus group discussions to explain the questionnaire responses in depth.

The study was conducted in twenty-four villages across the three sub-counties of Nkanja, Ruyonza and Kyegegwa. These sub-counties surround the Kyaka II Refugee Settlement. The settlement is under ecological strain, with deforestation, wetland encroachment and soil erosion driven by population growth and humanitarian demands.

The study targeted indigenes residing in Kyegegwa, Nkanja and Ruyonza sub-counties. These communities were selected because of their daily interactions with refugees and their mutual dependence on resources that are being degraded. As a result, indigenes' perspectives are crucial to a comprehensive understanding of the underlying forces shaping ecosystem management.

The study used linear extrapolation of the 2014 population census data from the Uganda Bureau of Statistics (UBOS) to estimate populations for the three sub-counties. Linear extrapolation based on assumptions. The first assumption was proportional growth, with the growth rates across these sub-counties aligned with the district-level population growth. Secondly, it was assumed that growth is consistent, with population growth remaining steady and linear from 2014 to 2024. After this process, the population totalled 151,462 distributed across the sub-counties. The distribution was 67,866 for Nkanja, 50,183 for Ruyonza and 333,413 for Kyegegwa. From that process, the study applied Yamane's formula, assuming a 5% margin of error, to determine the required sample size for future analysis.

$$n = \frac{N}{1 + Ne^2}$$

Where: n = sample size

N = population size (151462)

e = margin of error, where e = 0.05

Thus, $n = 151462/1 + (151462 \times (0.05)^2)$

n = 399 indigenous respondents

The study targeted 399 potential respondents and received 387 valid responses, yielding a 97.0% response rate. Therefore, 387 respondents participated in the study.

Twenty respondents were sampled from each of the twenty-four villages. This was intended to ensure equitable representation across the study area. The Chairpersons of Local Council I in each village assisted with the selection process. In Uganda, local councils (LCs) are established under the Local Governments Act (Cap. 243). These councils are grassroots structures that centralise political, administrative, and service-delivery functions, improving access to governance and public services at lower community levels. They also foster greater civic engagement and accountability.

In this data collection process, the chairpersons identified thirty participants from their respective villages. This was done under the guidance that each family should have only one respondent. Another guideline was to select respondents from across the entire village, not from the same neighbourhood. The selection process was based on age, ability to understand the questions, and time spent in the area. These ensured inclusivity and objectivity. The researchers selected twenty respondents from the provided thirty and invited them to meet the research team to complete the questionnaire.

Data were collected using a previously published, globally applicable structured questionnaire designed to evaluate ecosystem management. It employed a five-point Likert scale, from 1 (Strongly Disagree) to 5 (Strongly Agree). The ecosystem measurement scale presented statements about ecosystem services, including regulating, provisioning, and cultural services. Respondents indicated whether they agreed or disagreed with these statements. After this process, the data were analysed, and the findings informed the qualitative phase.

Quantitative data were collected through focus group discussions, in-depth interviews, and key informant interviews; these are presented in Tables 1, 2, and 3.

Table 1*Focus Group Discussions*

Number	Village	Sub-County	Gender	Age Category	Participants
1	Katete	Nkanja	Women Only	18-35	06
2	Katete	Nkanja	Men Only	18-35	06
3	Karokarungi	Kyegegwa	Men Only	36-55	06
4	Karokarungi	Kyegegwa	Women Only	36-55	06
5	Ndama	Ruyonza	Women Only	55 and above	06
6	Ndama	Ruyonza	Men Only	55 and above	06

Source: Field data (2024)

As shown in table 1, each village held two sessions of the discussion for men and women, totalling 36 participants across the three villages. This approach was adopted to record gender- specific and community-specific insights.

Table 2*In-Depth Interviews*

No	Gender	Age	Status
1	Male	68	Married
2	Female	71	Widow
3	Male	46	Married
4	Female	33	Married
5	Male	75	Married
6	Female	48	Single
7	Female	36	Married
8	Male	48	Married
9	Male	56	Married
10	Male	30	Married
11	Female	41	Married
12	Female	54	Married
13	Male	32	Married
14	Male	71	Married
15	Male	45	Married
16	Female	32	Married
17	Female	45	Married
18	Male	46	Married

Source: Field data (2024)

As presented in Table 2, 18 participants took part in the in-depth interviews across the three villages. This approach explored community dynamics and provided a richer comprehension of the relationships and interactions within the community.

Table 3*Key Informant Interviews*

Number	Position	Institution
1	Assistant Settlement Commandant	Office Of the Prime Minister
2	Deputy Commandant-Security	Office Of the Prime Minister
3	Senior Environment Officer	Kyegegwa District
4	Assistant District Health Officer	Kyegegwa District
5	District Planner	Kyegegwa District Local Government

Received: 06.09.2026**Accepted: 12.09.2026****Published on: 30.09.2026**

6	District Production Officer	Kyegegwa District
7	District Probation Officer	Kyegegwa District
8	Programme Officer	Medical Teams International (MTI)
9	Project Manager	ADRA
10	Program Officer	Nsamizi
11	Program Officer	UNHCR
12	Chairperson LC 1	Katete village
13	Chairperson LC 1	Karokarungi village

Source: Field data (2024)

The researcher engaged participants in strategic positions spanning institutions, such as local leaders, district officials whose responsibilities were relevant to this study, and non-governmental organisations, including the UNHCR.

Results

During computation of the composite and Cronbach's alpha, some items showed low reliability. As part of the scale-refinement process, these were excluded to retain the most relevant items. This also effectively eliminated items that were unsuited to the context of Kyaka II.

After this refinement process, the scale was further tested using the measurement model. The model helped refine the scale, which had previously been examined using factor analysis, and the results showed that three dimensions were retained. The two dimensions of Access to Resources and Supporting Services rendered the model less reliable, with Cronbach's Alpha values below 0.700. For this reason, they were dropped, leaving only three dimensions: Regulating Services, Provisioning Services, and Cultural Services, as shown in Table 4.

Table 4

Factor Analysis of Ecosystem Services

Provisioning Services	Regulating Services	Cultural Services
.813		
.814		
.626		
.842		
.716		
.515		
.675		
.737		
.748		
.722		

.700

.726

.741

.849

.779

.870

.550

.807

.813

.896

.902

.885

.881

Source: Field data (2024)

As shown in Table 4, the information presented is a factor analysis of ecosystem services. Each dimension of ecosystem services includes multiple variables, along with their corresponding factor loadings, eigenvalues, and percentages of variance. For Provisioning Services, the factor loadings ranged from 0.515 to 0.842, indicating varying degrees of contribution to the provisioning services factor. The eigenvalue for this category is 15.538, accounting for 20.020% of the total variance. This indicates that provisioning services constitute a significant component of the ecosystem services being analysed.

Factor loadings for regulating services ranged from 0.550 to 0.870, indicating their importance within the ecosystem services. The eigenvalue for this category is 14.112, accounting for 15.921% of the total variance. This underscores the role that regulating services play in shaping overall ecosystem dynamics.

Cultural services showed high factor loadings, ranging from 0.807 to 0.902. With an eigenvalue of 10.642 and accounting for 11.67% of the total variance, this category clearly indicates that cultural services are well represented and an important element of the broader ecosystem services.

To assess effect sizes and predictive estimates for ecosystem services, and to evaluate the relative contributions of ecosystem services, the measures' contributions were tested again using F-squared values. This is presented in Table 5.

Table 5

F-squared values

	<i>f-Square</i>	R-Square	R-Square Adjusted
Cultural Services	.524	.738	.736

Provisioning Services	.798
Regulating Services	1.242

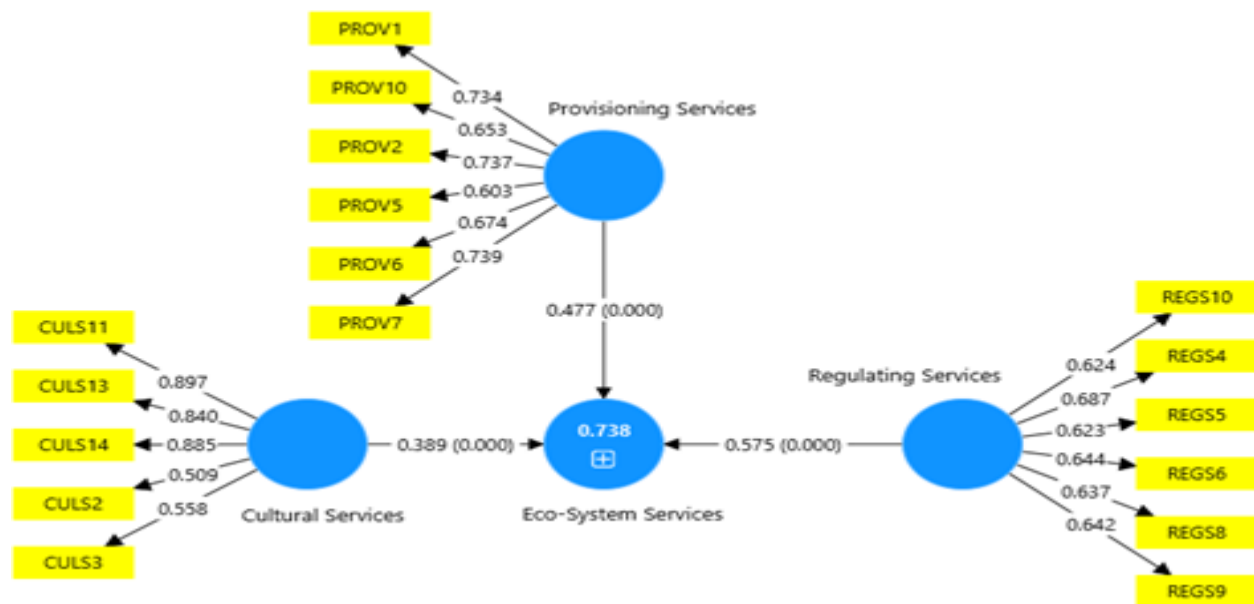
Source: Field data (2024)

As Table 5 shows, Regulating Services contributed the most ($F\text{-squared} = 1.242$), followed by Provisioning Services (such as food, water, timber, and firewood). The smallest contribution was from Cultural Services (which provided recreational, aesthetic, and spiritual benefits), with the lowest $F\text{-squared}$ value. Nevertheless, all three exceeded 0.02, indicating that they are vital for understanding ecosystem services.

The measurement model below helped refine the Ecosystem scale, and the results show that the three dimensions were retained this time.

Figure 2

Measurement Model for Ecosystem Services



After testing the scale using the measurement model, it became clear that the Access to Resources and Supporting Services dimensions had to be dropped, as they reduced the model's reliability and yielded a Cronbach's alpha below 0.700. Regulating services made the greatest contribution to the global variable ($\beta = .575$, $p < .05$). The dimension had loadings ranging from 0.623 to 0.687. The contribution of the measures was further examined using f-square values, which should be at least 0.02. The results are presented in Table 6.

Table 6

Effect Size and Prediction Estimates for Eco-System Services

	<i>f-Square</i>	R-Square	R-Square Adjusted
Cultural Services	.524	.738	.736
Provisioning Services	.798		
Regulating Services	1.242		

The highest contribution was from the Regulating Services (f-square = 1.242), and the dimensions accounted for 73.8% of the global variance. The results in the measurement model were further indicated using the Bootstrapped estimates. To evaluate the significance and stability of the measurement model, a bootstrapping procedure was performed using Smart PLS. Bootstrapping provides estimates of standard errors, t-statistics, and p-values, allowing the statistical significance of the hypothesised relationships to be assessed (Hair et al., 2022).

Table 7.

Bootstrapped Measurement Model Estimates

	β	Std. Error	T statistics	p values
Cultural Services $\rightarrow$ Eco-System Services	.389	.032	12.051	.000
Provisioning Services $\rightarrow$ Eco-System Services	.477	.029	16.465	.000
Regulating Services $\rightarrow$ Eco-System Services	.575	.032	17.939	.000

The findings revealed that all dimensions of ecosystem services made positive and statistically significant contributions. Specifically, Cultural Services significantly influenced Eco-System Services, with a moderate effect size ($\beta = .389$, T value = 12.051, $p < .05$). Likewise, Provisioning Services exhibited a significant positive relationship with Eco-System Services ($\beta = .477$, T value = 16.465, $p < .05$). Among the three dimensions, Regulating Services demonstrated the strongest contribution to Eco-System Services ($\beta = .575$, T value = 17.939, $p < .05$). These findings validate the strength of the bootstrapped measurement model. They also provide empirical evidence of the contributions of provisioning, regulating and cultural services to the overall ecosystem services framework. Factor Analysis identified only three out of the five dimensions of ecosystem services – Regulating, provisioning and Cultural Services. The other two: Access to Resources and Supporting Services were excluded from further consideration because they presented low reliability with Cronbach's alpha below 0.700. This underscores the importance of methodological rigour when assessing the reliability of ecosystem services within the settlement.

Regulating Services emerged as the strongest predictor ($\beta = 0.575$, $p < 0.05$), followed by Provisioning Services ($\beta = 0.477$, $p < 0.05$) and Cultural Services ($\beta = 0.389$, $p < 0.05$).

These findings were robust, but they lacked the lived experiences of the host community members who benefit from or are affected by these ecosystem services. As a result, focus group discussions, in-depth interviews, and key informant interviews were conducted to understand the indigenes' lived experiences. This methodological approach yielded key themes.

Food shortages

The study revealed a challenge of food shortages, mainly due to prolonged drought and the presence of refugees. For instance, R48, through an in-depth interview in Ndama village, emphasised that “The food is not enough because the weather changed in a way that we haven't even commenced crop planting due to excess sunshine; we currently don't have food and water because without rain, there is no crop you may grow that yields.” Equally so, R7, in a focus group discussion in Katete, attributed food shortages to the presence of refugees.

The problems that have resulted from food shortages are these: there are many people who come around to get food. We produce a lot of food, but its consumers are too many. That's why we have food shortages. For instance, we have refugees neighbouring us. They get food for work from us.

On the contrary, some participants indicated that they don't face food shortages. Despite this acknowledgement, they also admitted that they sometimes experience food shortages due to population growth, drought, poor soil quality, and other overwhelming household needs. In this regard, R21 noted that "Food access in this area has continuously reduced as the population increased, and due to increased soil exhaustion and low harvests. All this has led to reduced food access [...]." This is a confirmation that the area experiences food shortages, although there are times when harvests are plentiful.

A large number of participants (62%) reported experiencing food shortages, while only 28% said they didn't. Remarkably, 90% of participants recognised that food is accessible, but this accessibility is inconsistent when other needs are considered. These findings show a relationship between environmental stability, social responsibilities and how they influence food security in Kyaka II.

Famine occurrences

The study found that Kyaka II experiences famine outbreaks, with participants identifying a range of other situations that confirm this. For instance, participant R24 said, "The food we produce would be enough, but because our soils are exhausted, we harvest little and later run short of food and experience famine." Similarly, participant R45 confirmed that Kyaka II experiences famine outbreaks mainly due to unpredictable weather patterns: "We are currently in times of drought, and this hinders the growth of our crops, hence leading to famine."

For participant R28, it is the big family that catalyses famine outbreaks: "[...] The third problem is the famine we experience. Food is not enough because we are looking after children whose mothers left them in our care."

Other participants, such as R26, attributed famine outbreaks to a lack of support: "What do they give us? We've seen nothing. We are hit by famine, suffer, and get no support. We need justice. Now that we are hit by famine, we should also receive rice, posho, and money [...]."

Famine outbreaks were further acknowledged by other participants, including R36, R37, and R40.

However, the follow-up interviews revealed that some participants don't experience famine outbreaks in Kyaka II. One such participant is R7, who confirmed that "[...] We rarely face famine because our land is not too exhausted to produce food."

Similarly, R21 appreciated the fertile soils of Kyaka, which support crop growth.

Compared to where I came from where we experienced famine almost all the time, Kyaka is different. We do not experience that bad famine. We get what to eat. While other places may be suffering with famine, here in Kyaka we rarely face it. Our soil is good in that food crops mature fast.

Water scarcity

Kyaka II faces water scarcity, forcing residents to resort to available water sources as revealed by R8: “We mainly use water from open wells. We don’t have any protected well. We use our own dug open wells and sometimes we get water from swamps.”

Water shortages in Kyaka are fuelled by a range of factors, such as infrastructure failures, and accessing dirty water had had its effects on the people as reported by R37.

[...] water is scarce because we had a borehole which also got spoilt meaning that we have to fetch water from the wells which at times get dry where we share with all kinds of animals too. We have heard of organisations connecting water in the neighbouring villages, but we haven’t gotten a chance to be connected.

We sometimes get malaria due to dirty water [...]

Furthermore, participants described water as dirty, contaminated with worms, and often shared with livestock, posing health risks. According to R9, “This is because we drink the same water that cows drink. Eventually, people get worms from this water. For us, water is a very big challenge.”

Open defecation was identified as a major source of contamination, along with practices such as washing clothes in wells and improper disposal of animal waste. “We also have a problem of animal grazers who defecate openly anywhere in the bushes. This leads to water contamination and diseases when we drink this water”, said R8.

Despite the widespread contamination, some participants reported having access to relatively clean water through practices such as fencing off wells, separating water sources for animals and humans, and reducing congestion at shared wells, as reported by R8

We, as natives, try to dig open wells, put a simple fence around them, and have fairly clean water. Secondly, in the past, the whole village would have one well, but today you find that only 3-4 households are sharing a well. So there’s no congestion, and the owners try to keep them clean [...]. Thirdly, some people now have separate wells for the animals so that the wells for domestic use are not contaminated with animal waste.

Others mentioned clean water sourced from wetlands or purification pots distributed by organisations, which helped ensure safer drinking water, as reported by R35, “The water is good, and it got better when we received the pots from some organisation where we used our national IDs to acquire; each pot carries around 10 litres, and they help us make the water clean and safe for drinking.”

These findings show that 54% of participants find it difficult to access water. 24% reported having easy access to water. This presents 78% of participants reporting varying experiences with water access, highlighting the difficulty in accessing water, which threatens their livelihoods, physical health, social stability and general well-being.

Firewood shortages

The study found that the Kyaka II community faces significant firewood shortages, constraining daily cooking, as reported by R26.

We don't have anything to cook with. [...]. When we uproot cassava, we dry the stems, which we later use as cooking firewood. So we lack firewood.

The scarcity of firewood has reached annoying levels, with people getting imprisoned, their pieces of land taken from them, as reported by R32: "My biggest problem, which annoys me here, is the lack of firewood. If someone finds you in their forest looking for firewood, they send you to prison and usually demand a piece of your land."

Indeed, firewood scarcity is at a crisis level, as some participants reported failing to cook because of firewood, as reported by R43: "We even at times fail to have food ready due to firewood, and we would appreciate any efforts on how we would have our food ready."

This scarcity was attributed to a number of problems, including the high population and refugees, as reported by R42: "The increased number causes scarcity of a lot of other things, i.e. firewood, because the more people, the less the land per person, and so it becomes challenging for some people to plant trees where they will get firewood." R26 added: "Refugees are the leading cutters of our trees. Every day, they pass by carrying firewood; they would rather go with fresh wood than return home with nothing."

Despite this firewood scarcity crisis, some participants reported that they access firewood. One such participant is R34, who reported that

For firewood, we have farms that are owned by people from home; you seek permission and then go ahead to fetch firewood. For instance, when people like Arthur, our chairman, have cut down trees in their farms, that's when we access trees.

Climate change

Climate change has become a critical issue in Kyaka II; for example, a representative from the Planning Office stressed the importance of adopting climate-smart agriculture to mitigate climate risks: "For example, we need to plant drought-resistant crops. You need to plant agroforestry. You need to continue supporting micro-scale irrigation schemes."

Culture and the environment

The study confirmed that cultural practices and values depend on the environment. R11 stated, "Yes, in this community, we have certain species of trees that are used for cultural practices. Some cultural practitioners pray from those trees and put some items underneath them." R33 added: "We have traditional healers and fortune tellers [who] worship stones and trees in the assumption that they receive blessings."

Several other participants, such as R35, R38, R36, and R39, agreed that there are traditionalists and fortune tellers in the community who worship trees and stones for blessings and medicine.

Relatedly, according to interviewee R39, the community has traditional healers who hunt and kill wild animals for their parts. “For the traditional healers, [...] I hear that traditionalists sometimes [...] they go hunting for some wild animals where you find them with tails of some animals.”

However, R49 reported that “we don’t have traditionalists here for the time I have been here, though I have a feeling there could be some, but it’s not as intensive as it is in Buganda.”

Access to green spaces

The study revealed that communal spaces provide venues for relaxation, conversation, and social bonding, as reported by R41.

For places of hanging out, such things can never miss in people’s day to day lives even when they aren’t as rich but when you get a visitor or when evening time reaches, one can leave his home and head to the town centre and have a drink [...] you buy for yourself or even some times for a friend because when men meet, [they] converse which is like a norm.

Discussion

The findings show that provisioning services – food, water and firewood – are a lifeline and necessary for the survival of humanity in refugee-hosting communities, especially in Kyaka II, the focus area for this study. However, Uganda’s refugee policy focuses on integration and the shared use of resources (Ahimbisibwe, 2018; OPM & UNHCR, 2023). This has largely enabled access to resources, but even that accessibility is jeopardised by unsustainable practices. For example, refugees consume nearly two million tonnes of firewood annually. This has facilitated deforestation and the decline in ecosystem services (NEMA, 2019).

As a result, Uganda’s forest cover fell sharply from 24% to 9% between 1990 and 2015, amounting to a loss of 3.1 million hectares over 25 years. On average, the country loses about 122,000 hectares of forest each year (Ministry of Water and Environment, 2016).

Additionally, parts of the woodlands in the Adjumani and Moyo districts are under pressure from the influx of refugees from South Sudan, who engage in illegal logging for firewood and building poles. This has become a major contributor to the degradation and deforestation of Uganda’s forests. Refugee settlements in Kyangwali, Bidibidi, Rwamwanja, and Oruchinga, along with their surrounding areas, suffer from deforestation due to refugees’ reliance on fuelwood and construction poles, and illegal logging in nearby forests (NEMA, 2019).

Furthermore, the Lake Albert drainage basin has experienced the most significant loss of wetlands, with a staggering 32% reduction and over 903 km² lost between 1994 and 2015. This loss is attributed to the growing population in the basin, including refugees who have encroached on wetlands for agriculture and settlement (NEMA, 2019).

Deforestation is harmful to habitats, biodiversity, and other ecological processes (Garai, 2024; Negret et al., 2021; Ngeve et al., 2026; Perrin et al., 2025). Deforestation also adversely affects the ecological endurance of the host communities (Arthington, 2025; Ban et al., 2025; Dyck et al., 2008; Tonkin et al., 2026).

Degrading wetlands is a ticking time bomb, given their role in regulating water and supporting biodiversity. Unfortunately, a lack of effective monitoring and enforcement has facilitated ongoing wetland degradation (Ministry of Water and Environment, 2019).

In addition, refugee settlements produce large amounts of waste and experience poor waste management, creating a conducive environment for disease. Some of these diseases are respiratory and vector-borne. This is exemplified by the 188 million tonnes of waste produced annually by refugee settlements. Much of this is mismanaged, resulting in pollution and related health risks (NEMA, 2019). Poor practices, such as open dumping and inadequate landfill management, are responsible for environmental harm and ill health (Shackelford et al., 2026).

This relationship between refugee settlements and environmental stability is complex, as refugee settlements are often associated with deforestation, biodiversity loss, resource depletion and environmental conflicts (Dutta, 2024; Kideghesho et al., 2013; Rubangangeyo & Apecu, (2026). In addition, refugee settlements can be an economic burden; for example, between 2016 and 2017, Uganda lost nearly US\$280 million in natural resources due to refugee resettlement, with firewood and water accounting for over half of the losses (NEMA, 2019).

While this correlation between refugee settlement and ecological strain stems from population growth and poor planning, it also drives the search for innovative solutions, as exemplified by solar energy in Zaatari and reforestation in Dadaab. These examples can inform ecosystem management initiatives in Kyaka II. There's a looming global crisis driven by biodiversity loss. This crisis is exemplified by human-induced ecological strain, including climate change, habitat loss and unsustainable resource extraction, which are accelerating the extinction of critical species (Habibullah et al., 2022; Rogers, 2025). In this regard, Mooney et al. (2009) estimate that over the past 50 years more than 60% of ecosystem services have been degraded. As a result, rivers have been altered, oceans have been depleted, and coral reefs have collapsed. Given this, Pimm (2009) warns of an irreversible tipping point at which extinct species are irretrievable, even if the conditions that led to their extinction improve.

From an ecological epidemiology perspective, there's sufficient evidence linking ecosystem degradation to disease transmission. Water contamination, poor sanitation, and sharing resources with animals create conditions conducive to the transmission of diseases such as diarrhoea, malaria, and other parasitic infections (Bwanbale, 2026; Pinto Jimenez et al., 2023; WHO, 2025; Wolf et al., 2023). Experiences from Kyaka II point to cases of worms, typhoid and malaria due to dirty water shared with animals. This aligns with Levins and Lopez (1999) concept of the "ecological production of disease." This concept highlights how the interaction between human activities and environmental conditions shapes epidemiological outcomes.

Kyaka II's experiences of water scarcity and contamination highlight gendered ecological burdens and ecological epidemiology. Scholars such as Adom et al. (2025), Hidrobo et al. (2026), and UNECE (2026) show how ecological crises affect women and marginalised groups, given their roles in managing household water needs, despite their exclusion and vulnerability at water sources. Regulating services, including climate regulation, waste management, and water purification, remain vulnerable despite their importance to ecosystem management. According to OPM

Received: 06.09.2026

Accepted: 12.09.2026

Published on: 30.09.2026

(2024), the population of Kyaka II was 17,000 in 2017, but this has increased nearly tenfold to 139,142 (UNHCR, 2026). This population spike has exacerbated changes in land use, thereby disrupting rainfall patterns and the attendant atmospheric instability (Colomer et al., 2026; Zebensui et al., 2018)

In addition to challenges such as climate change, waste mismanagement, and water quality and its related health problems, other issues, such as nutritional deficiencies, plague Kyaka II. The community is grappling with disturbing statistics, with stunting among refugee children at 45.5%, compared with 8% among the children of the local population. This points to food insecurity and underscores gaps in dietary diversity. This calls for interventions, such as training in modern farming methods, with a focus on the nutritional needs of the communities. This means that food interventions should focus on both quality and quantity (Guli et al., 2023; Khuri et al., 2022).

The study highlights the importance of cultural services to ecosystem functioning within the broader framework of environmental studies, linking environmental conditions to the intrinsic values of cultural practices. Participants reported cultural practices such as hunting wild fauna for cultural purposes and using non-destructive herbal medicine. They also reported contemporary religious practice and tourism potential arising from the presence of caves and cultural sites. Scholarship, such as Gladkikha et al. (2019) and Pearson et al. (2021) , noted a shift by refugee-hosting communities towards these resources and a subsequent reduction in reliance on cultural sites.

This tourism potential attests to the influence of cultural services on overall ecosystem management frameworks. Cultural services alleviate psychological stress common in refugee-hosting communities; they nurture a sense of belonging and cement community ties. This perspective is corroborated by Gladkikha et al. (2019). This interconnectedness among culture, the environment, and socio-economic factors points to the lack of a comprehensive strategy that integrates cultural heritage into environmental sustainability and community development initiatives.

Refugee settlements, such as Kyaka II, face deforestation, soil degradation, wetland encroachment and degradation, and poor waste management, undermining ecosystem management and harming well-being in these communities (Bose, 2024; Dutta, 2023; Ruesink & Gronau, 2025). For the Kyaka II refugee settlement, which spans 81.5 square kilometres, ecosystem management practices are essential for social stability and livelihood security (Salemi, 2021; Van Blerk et al., 2021). These findings reveal a strong link between refugee settlements and ecosystem mismanagement. This study focused on indigenous perspectives, not on the refugee point of view. While the latter is important, given that host communities sustain refugee settlements, it is also important to include refugee voices to avoid marginalising them, as their perspectives can inform policy formulation. This study therefore recommends that future studies employ a comparative approach that incorporates refugee narratives.

Furthermore, this study recommends a longitudinal study to assess how ecosystem management interventions evolve and their impacts on ecological sustainability and community cohesion over time.

Acknowledgments

The PhD candidate met the financial obligations for this study, while the Research Grants and Publications Committee of Kyambogo University partially funded the fieldwork. This financial support is acknowledged and appreciated for its contribution to this study.

Funding Source

Funding for this study was largely provided by the PhD candidate, who is self-funding. A contribution specifically for data collection was made by the Research Grants and Publications Committee of Kyambogo University.

Author Contributions

This paper forms part of the doctoral study. The supervisors, Dr Fredrick Kisekka-Ntale and Dr Hannah Muzee, played a critical role in the conceptualisation and design of this study. Reuben Twinomujuni is a PhD candidate. He conducted the data collection, analysed the data, and interpreted the results. Throughout the research, the supervisors provided guidance and oversight. Twinomujuni drafted the manuscript and the accompanying figures, while the supervisors improved the manuscript through a back-and-forth feedback process, contributing to the revisions. They approved the final manuscript for submission. All three authors prepared the manuscript through to the final stage of endorsement before submission.

Data Availability Statement

The datasets generated for this study are available on request from the corresponding authors.

Conflicts/Competing Interests

There were no conflicts of interest from anyone during the entire process.

Compliance with Ethical Standards

Before data collection, the researcher obtained approval from the Research Ethics Committee. Before collecting data from indigenes living in Kyegegwa District, permission to conduct the study within the district was sought and secured. Measures such as having respondents sign informed consent forms, obtaining participants' agreement before interviews, and ensuring their anonymity were observed.

Statement on AI Usage

AI, mainly Copilot was used minimally, especially to address grammatical errors and sharpen the tone.

References

- Adom, R. K., Afuye, G. A., Kalumba, A. M., & Simatele, M. D. (2025). Integrating the Perspectives of Youth, Women, and Marginalised Communities in Addressing Global Environmental Management Challenges. *Environmental Management*, 75(12), 3261-3282. <https://doi.org/10.1007/s00267-025-02254-7>
- Ahimbisibwe, F. (2018). Uganda and the Refugee Problem : Challenges and Opportunities Frank Ahimbisibwe. In.
- Arthington, A. H. H. (2025). Safeguarding freshwater biodiversity and resilient social-ecological systems in uncertain futures [Perspective]. *Frontiers in Environmental Science*, Volume 13 - 2025. <https://doi.org/10.3389/fenvs.2025.1617363>

- Ban, X., Guo, W., & Fu, Y. (2025). Impact of Environmental Factors on Aquatic Ecosystem. *Water*, 17(10), 1453. <https://www.mdpi.com/2073-4441/17/10/1453>
- Bargue's-Tobella, A., Knutsson, P., Bostedt, G. r., Ho"nnell, A., Lindvall, K., Mpairwe, D., Mureithi, S., Nyberg, G., Nyberg, Y., Ong'ao Ng'asike, P., Schumann, B., Turinawe, A., Va"gen, T.-G., Winowiecki, A. L., Wredle, E., & O"born, I. (2026). Social–ecological transformations towards sustainability in drylands: A conceptual framework with examples from the Karamoja cluster in East Africa *Ambio*. <https://doi.org/10.1007/s13280-026-02389-9>
- Bose, P. (2024). Nexus dynamics: the impact of environmental vulnerabilities and climate change on refugee camps. *Oxford Open Climate Change*, 4(1). <https://doi.org/10.1093/oxfclm/kgae001>
- Bwanbale, G. D. (2026). The Impact of Livestock and Agriculture on Diarrheal Disease in Rural Communities. *Research Output Journal of Biological and Applied Science* ();, 6(1), 36-40. <https://doi.org/10.59298/ROJBAS/2026/613640>
- Colomer, M. À., Tobajas, J., Nadal, J., Pérez-García, J. M., Oliva-Vidal, P., & Margalida, A. (2026). Hunters' perception of the ecosystem services provided by the vertebrate scavenger guild, , 22:1, 2626761, DOI: . *Ecosystems and People*, 22, 2626761. <https://doi.org/10.1080/26395916.2026.2626761>
- Danish Refugee Council. (2018). *Rapid Conflict Assessment*, .
- Dutta, H. (2023). The Environmental Aspects of Refugee Crises: Insights from South Asia, Middle East, and Sub-Saharan Africa. *Journal of International Migration and Integration*, 24(2), 913-938. <https://doi.org/10.1007/s12134-022-00986-7>
- Dutta, H. (2024). Insights into different facets of the refugee crises–environment nexus. *Journal of Social and Economic Development*, 26(3), 1120-1143.
- Dyck, H. V., Stewart, A. J. A., New, T. R., & Lewis, O. T. (2008). Insect Conservation Biology. *Journal of Insect Conservation*. . <https://doi.org/10.1007/s10841-008-9167-0>
- Ericksen, P., Leeuw, d. J., Said, M., Silvestri, S., & Zaibet, L. (2012). Mapping ecosystem services in the Ewaso Ng'iro catchment. *International Journal of Environmental Research and Public Health*, 8(1-2), 122-134. <https://doi.org/10.1080/21513732.2011.651487>
- Garai, K. (2024). The Effects of Habitat Fragmentation on Insect Populations. *Agrospheres*, 25-27. <http://agrospheresmagazine.vitalbiotech.org/>
- Gladkikha, M. T., Goulda, K. R., & Coleman, J. K. (2019). Cultural ecosystem services and the well-being of refugee communities. In U. o. Vermont (Ed.).

- Global Forest Watch. (nd). *Primary Forest Loss in Uganda*.
https://www.globalforestwatch.org/dashboards/country/UGA/?utm_source=copilot.com
- Guli, A. E., Barakagira, A., & Zombeire, R. (2023). Humanitarian Food Assistance and Nutrition Outcomes among Refugees - A Historical Perspective *Journal of Scientific Research and Reports*, 29(1), 26-37.
<https://doi.org/10.9734/JSRR/2023/v29i11723>
- Habibullah, M. S., Din, B. H., Tan, S.-H., & Zahid, H. (2022). Impact of climate change on biodiversity loss: global evidence. *Environmental Science and Pollution Research*, 29(1), 1073-1086. <https://doi.org/10.1007/s11356-021-15702-8>
- Hassan, M. M., Duveneck, M., & Southworth, J. (2023). The role of the refugee crises in driving forest cover change and fragmentation in Teknaf, Bangladesh. *Ecological Informatics*, 74, 101966.
<https://doi.org/https://doi.org/10.1016/j.ecoinf.2022.101966>
- Hidrobo, M., Mueller, V., Roy, S., Bryan, E., Nesbitt-Ahmed, Z., & Läderach, P. (2026). Leveraging social protection to strengthen Women's and Girls' Climate-Resilience in agrifood systems. *Food Policy*, 140, 103066.
<https://doi.org/https://doi.org/10.1016/j.foodpol.2026.103066>
- Khuri, J., Wang Y, Holden K, Mbogori T, Fly A, Mueller S, Kandiah J, & M., Z. (2022). Dietary Intake and Nutritional Status among Refugees in Host Countries: A Systematic Review. *American Society for Nutrition*, 14(6), 1846–1865. <https://doi.org/10.1093/cdn/nzac060.041>.
- Kideghesho, J. (2021). Introductory Chapter: Managing Wildlife in a Changing World - Trends, Drivers and the Way Forward. In J. R. Kideghesho (Ed.), *Managing Wildlife in a Changing World*. IntechOpen.
<https://doi.org/10.5772/intechopen.98851>
- Kideghesho, R. J., Alfian, R. A., Kuruthumu, M. A., & Selemani, S. I. (2013). Emerging issues and challenges in conservation of biodiversity in the rangelands of Tanzania. *Nature Conservation*.
<https://doi.org/10.3897/natureconservation.6.5407>
- Laine, P. J. (2026). Bridging the Implementation Gap: Refugee Governance and Institutional Coordination in Uganda's Borderlands. *Journal on Migration and Human Security*, 14(1), 78–94.
<https://doi.org/10.1177/23315024251409778>
- Levins, R., & Lopez, C. (1999). Toward an ecosocial view of health. *International Journal of Health Services*, 29(2), 261-293.
- Lu, N., Yu, D., Zhang, L., Lu, Y., & Fu, B. (2024). Dryland Ecosystem Services and Human Wellbeing in a Changing Environment and Society. In B. Fu & M. Stafford-Smith (Eds.), *Dryland Social-Ecological Systems in Changing Environments* (pp. 109-137). Springer Nature Singapore. https://doi.org/10.1007/978-981-99-9375-8_4
- Miller, T., & Spoolman, S. (2012). *Living in the Environment* (17th ed.). Yolanda Cossio.
- Ministry of Water and Environment. (2016). *State of Uganda's Forestry Report 2016*.

Received: 06.09.2026

Accepted: 12.09.2026

Published on: 30.09.2026

- Ministry of Water and Environment. (2019). *Water and Environment Sector Response Plan for Refugees and Host Communities in Uganda*.
- Mooney, H., Larigauderie, A., Cesario, M., Elmquist, T., Ove, H.-G., Lavorel, S., Mace, G. M., Palmer, M., Scholes, R., & Tetsukazu, Y. (2009). Biodiversity, climate change, and ecosystem services. *Current Opinion in Environmental Sustainability*, 1, 46–54. <https://doi.org/10.1016/j.cosust.2009.07.006>
- Negret, J. P., Maron, M., Fuller, A. R., Possingham, P. H., Watson, E. M. J., & Simmonds, S. J. (2021). Deforestation and bird habitat loss in Colombia. *Biological Conservation*, 257, 109044.
- NEMA. (2019). *National State of the Environment Report 2018-2019*.
- Ngeve, M. N., Rufo, K. E., & Zbinden, Z. D. (2026). Management Pathways for Fragmented Populations: From Habitat Restoration to Genetic Intervention. *Diversity*, 18(2), 73. <https://www.mdpi.com/1424-2818/18/2/73>
- OPM. (2024). *Refugee Settlement - Kyaka II Settlement*. Retrieved 22/4/2024 from <http://urrms.opm.go.ug/settlement.html>
- OPM, & UNHCR. (2023). *Uganda Country Refugee Response Plan Detailed planning 2024-2025*.
- Oulu, M., Darko, D., Osaliya, R., Aziz, F., & Wekesa, D. (2023). Governing the nexus: Water-energy-food nexus governance strategies in Ghana and Uganda. *Environmental Development*, 48, 100933. <https://doi.org/https://doi.org/10.1016/j.envdev.2023.100933>
- Pearson, J., Jackson, G., & McNamara, E. K. (2021). Climate-driven losses to knowledge systems and cultural heritage: A literature review exploring the impacts on Indigenous and local cultures. *Sage Journals*, 10(2), 343-366. <https://doi.org/10.1177/20530196211005482>
- Pérez, P. A., Quiroz, W., & Echeveste, P. (2026). Coupled pollution and water scarcity heighten ecological degradation and social vulnerability in global dryland rivers. *Environmental Research*, 293, 123708. <https://doi.org/https://doi.org/10.1016/j.envres.2026.123708>
- Perrin, A., Rein, F., Christe, P., & Pellet, J. (2025). Habitat fragmentation impact on insect diversity: opposing forces at patch and landscape levels. *Landscape Ecology*, 40(6), 113. <https://doi.org/10.1007/s10980-025-02133-w>
- Pimm, S. L. (2009). Climate disruption and biodiversity. *Current biology*, 19(14), R595-R601.
- Pinto Jimenez, C. E., Keestra, S., Tandon, P., Cumming, O., Pickering, A. J., Moodley, A., & Chandler, C. I. R. (2023). Biosecurity and water, sanitation, and hygiene (WASH) interventions in animal agricultural settings for reducing infection burden, antibiotic use, and antibiotic resistance: a One Health systematic review. *The Lancet Planetary Health*, 7(5), e418-e434. [https://doi.org/10.1016/S2542-5196\(23\)00049-9](https://doi.org/10.1016/S2542-5196(23)00049-9)
- Rogers, A. (2025). Predicting biodiversity loss in terrestrial vertebrates: A global analysis of Red List Index trends and key drivers (2002–2021). *Biological Conservation*, 309, 111316. <https://doi.org/https://doi.org/10.1016/j.biocon.2025.111316>

- Rubangangeyo, M. O., & Apecu, S. L. ((2026). Contested Landscapes: Environmental Resource Tensions Between Refugees and Host Communities in Ayilo I & II, Adjumani District, Uganda. *International Journal of Advanced Research*, 9(1), 126-140. <https://doi.org/10.37284/ijar.9.1.4688>
- Ruesink, B., & Gronau, S. (2025). Forest resource management, refugee integration, and food security in rural Zambia: balancing sustainability and equity. *Food Security*, 17, 1273–1299. <https://doi.org/10.1007/s12571-025-01547-3>
- Salemi, C. (2021). Refugee camps and deforestation in Sub-Saharan Africa. *Journal of Development Economics*, 152, 102682. <https://doi.org/https://doi.org/10.1016/j.jdeveco.2021.102682>
- Shackelford, B. B., Berendes, D., Handzel, T., Schweitzer, R., Murphy, J., Chigwechokha, P., Chauma, A., & Holm, R. H. (2026). Possibilities and Limitations for Conducting Wastewater and Environmental Surveillance in Refugee Camps Worldwide. *Am J Public Health*, e1-e5. <https://doi.org/10.2105/ajph.2026.308433>
- Tonkin, J. D., Siqueira, T., Merder, J., Datry, T., Poff, N. L., Talbot-Jones, J., & Olden, J. D. (2026). Extreme events and river biodiversity under climate change. *Nature Reviews Biodiversity*, 2(3), 150-169. <https://doi.org/10.1038/s44358-026-00131-7>
- UNECE. (2026). *Guidelines for Integrating Human Rights and Gender Equality into Sustainable Resource Management and Governance: Leveraging UNFC and UNRMS*.
- UNHCR. (2005). *UNHCR Environmental Guidelines*. Geneva
- UNHCR. (2026, June 30, 2026). *Uganda Comprehensive Refugee Statistics*. <https://data.unhcr.org/en/country/uga>
- Van Blerk, L., Cutler, M., Hewitson, L., Hunter, J., Bamutaze, Y. K., & Martha, I. (2021). *Displaced Communities, Environmental Change and Sustainable Livelihoods in Uganda*.
- WHO. (2025). *WHO publishes 54 pathogen background documents to support safe water and sanitation systems*. <https://www.who.int/news/item/21-06-2025-who-publishes-54-pathogen-background-documents-to-support-safe-water-and-sanitation-systems?>
- Wolf, J., Johnston, R. B., Ambelu, A., Arnold, B. F., Bain, R., Brauer, M., Brown, J., Caruso, B. A., Clasen, T., Colford, J. M., Jr., Mills, J. E., Evans, B., Freeman, M. C., Gordon, B., Kang, G., Lanata, C. F., Medlicott, K. O., Prüss-Ustün, A., Troeger, C., . . . Cumming, O. (2023). Burden of disease attributable to unsafe drinking water, sanitation, and hygiene in domestic settings: a global analysis for selected adverse health outcomes. *The Lancet*, 401(10393), 2060-2071. [https://doi.org/10.1016/S0140-6736\(23\)00458-0](https://doi.org/10.1016/S0140-6736(23)00458-0)
- Wu, S., Chen, Y., Hao, C., Liu, K., Zhang, W., & Zhang, L. (2022). Promoting Biodiversity Conservation Requires a Better Understanding of the Relationships Between Ecosystem Services and Multiple Biodiversity Dimensions. *Frontiers in Ecology and Evolution*, 10(891627). <https://doi.org/10.3389/fevo.2022.891627>
- Xirogiannis, M., Charalampos, K., & Konstantinos, M. (2026). Beyond Shelter: Displacement at the Threshold of Ecological Change. *Journal "Sustainable Development, Culture, Traditions*, 7a. <https://doi.org/10.26341/issn.2241-4010-2026-7a-2-L02200>

Received: 06.09.2026

Accepted: 12.09.2026

Published on: 30.09.2026

Zebensui, M. R., José Antonio Sánchez, Z., Marcos Moleón, P., Fernando Hiraldo, C., Andrés Giménez, C., Elisa Oteros, R., Joan Real, O., & Nuria, S. (2018). *Ecosystem services and scavengers: ecological and socio-cultural assessment* Universidad Miguel Hernández de Elche]. <https://produccioncientifica.ugr.es/documentos/603e19d3441e30047634744a>