

EXPEDITION OVERVIEW

KABOMPO RIVER, ZAMBIA

2025



THE
WILDERNESS
PROJECT



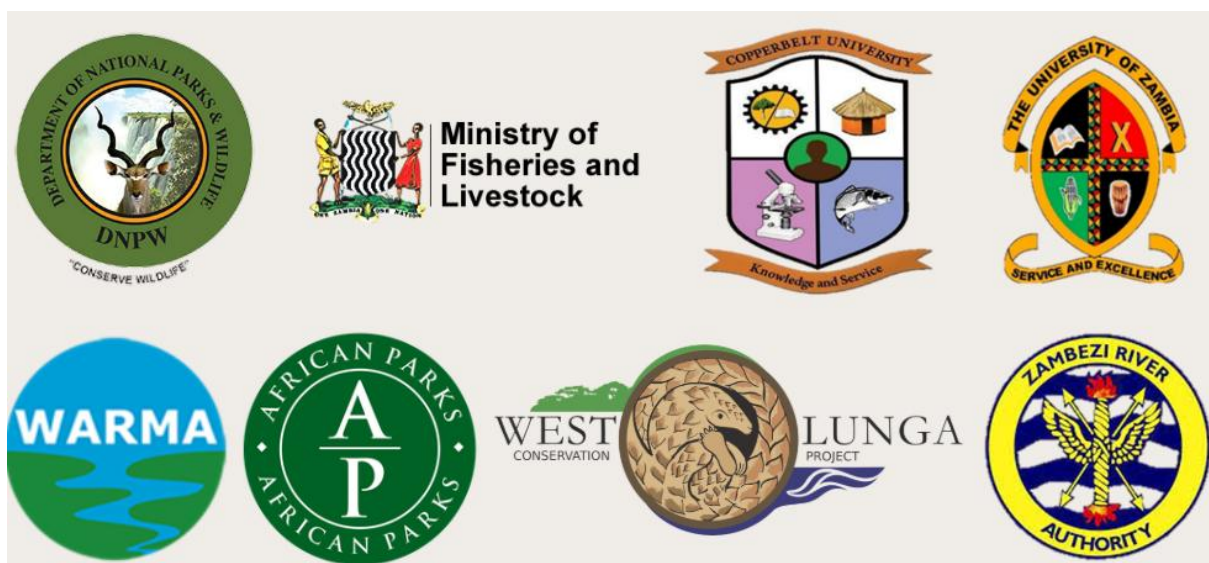
THE WILDERNESS PROJECT

About The Wilderness Project

By 2035, in partnership with local communities, governments, researchers and NGOs, The Wilderness Project aims to explore, study and better protect 1.2 million square kilometres of irreplaceable African wilderness. Central to this effort is the establishment of detailed hydrological and ecological baselines of the largely undocumented sources and watersheds of Africa's greatest river basins — the Zambezi, Congo, Nile, Chad, and Okavango.

Acknowledgements

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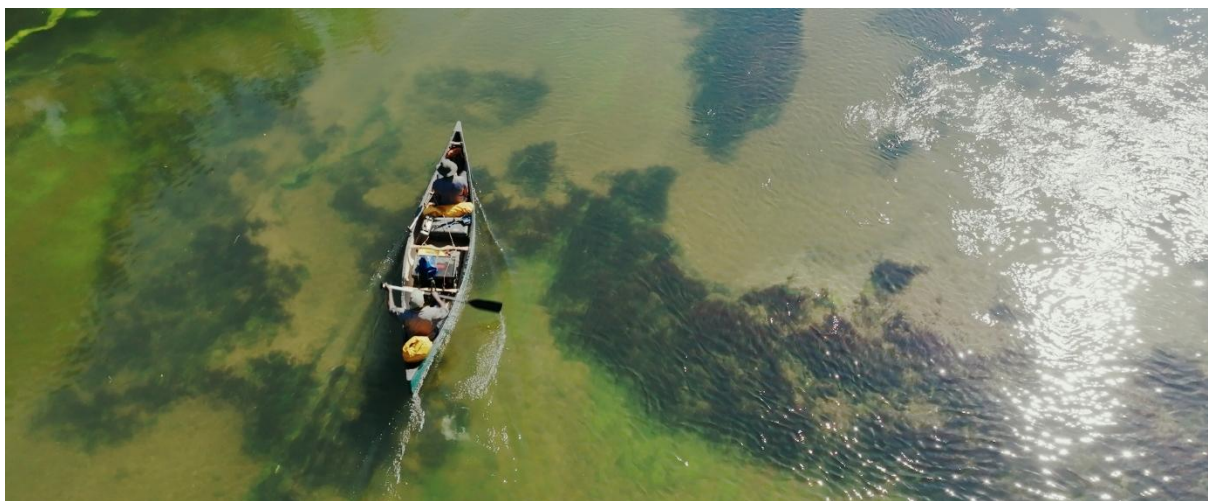
INTRODUCTION

The Kabompo River is one of the two largest headwater tributaries of the Upper Zambezi, alongside the Lungwebungu [1, 2]. This prominence makes the Kabompo a key source of water within Zambia's largest river basin. The Kabompo-Zambezi confluence is also located directly upstream of the Barotse Floodplain, which is Zambia's largest wetland supporting over 250 000 people [3]. As a result, the economy and livelihoods within the Zambezi Basin are intricately linked to the water quality, river flow, fisheries, and biodiversity of the Kabompo.

Along its course the river cuts through the scenic Kabompo Gorge, meanders across the Ntambu floodplains, and demarcates the eastern and southern boundaries of West Lunga National Park. Providing an important corridor of miombo woodland between the Kabompo and Kafue landscapes, the West Lunga National Parks helps safeguard regional ecologically connectivity; yet this parks remains undervalued, being among the least visited and regulated conservation features within Zambia.

The Kabompo River also flows through Zambia's intensifying mining frontier. Since the early 2000s, large-scale copper and nickel projects have transformed the demographic and economic profile of North-Western Province, driving population booms and rapid urbanisation in towns such as Solwezi and Kalumbila near the river's source [4]. This growth has quickly reshaped what was previously a sparsely populated area, with new settlements expanding along transport routes and rising pressure on land and services as communities adapt to the heightened demand created by mining operations and associated service industries.

Against this backdrop of rapid regional change, communities along the Kabompo, including the Lunda, Lozi, Luvale, Chokwe, and Nkoya peoples, continue to rely on the river for fishing, small-scale farming, and forest use. The sustained health of the Kabompo is therefore not just an environmental concern, but a fundamental necessity for the long-term security and well-being of the communities who rely on it.



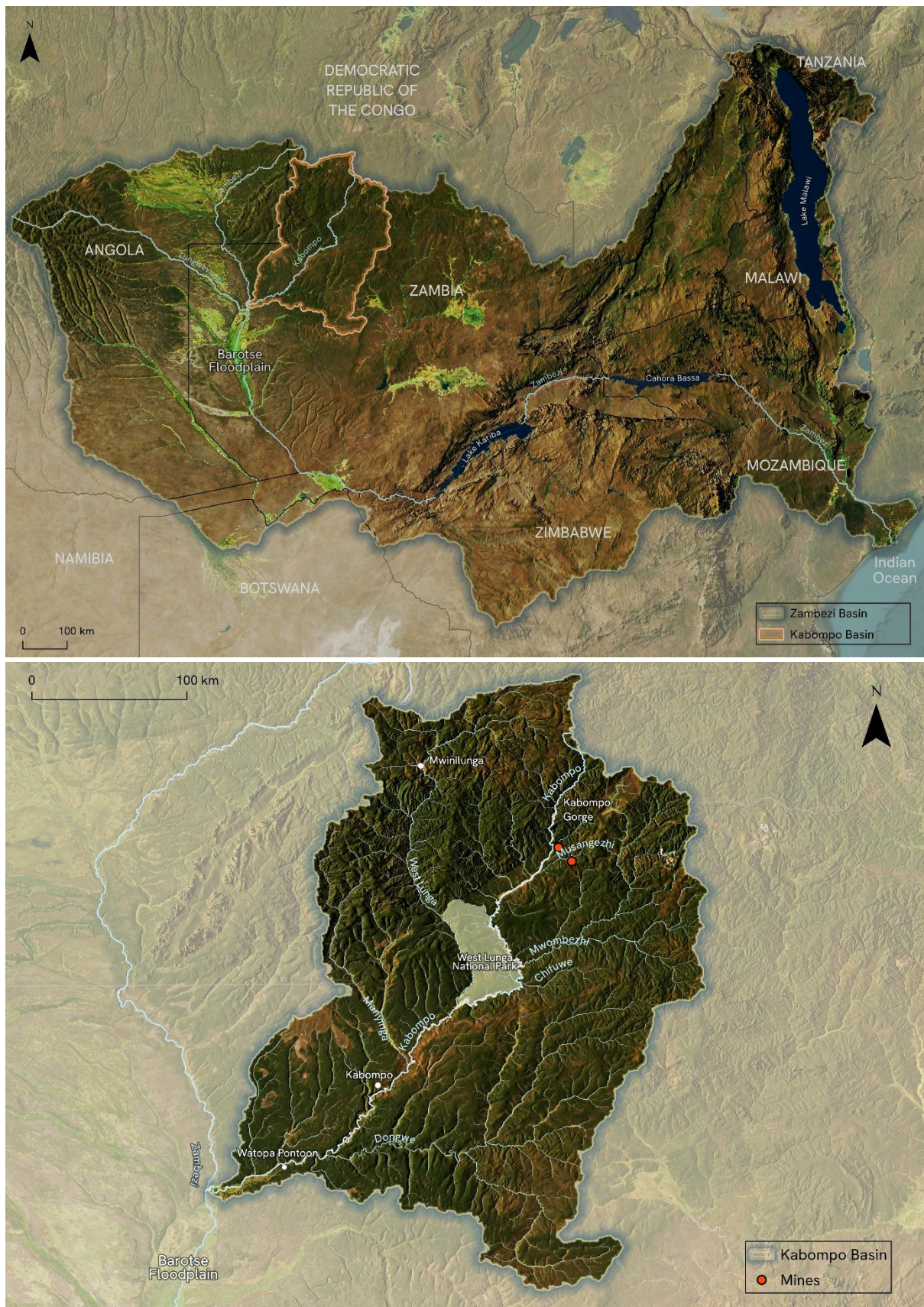


Figure 1. The Kabompo River is an important tributary of the Upper Zambezi, stretching over 730 km to form the backbone of the Kabompo Basin. It then joins the Zambezi just before the Barotse Floodplain.

EXPEDITION SUMMARY

Total distance travelled on the expedition: 730 km

The number of people in the expedition team: 14 people from 5 African countries

The number of days spent on the water: 25 days

The number of fixed survey sites established: 63 fixed research sites, 97 total sites

In June 2025, The Wilderness Project (TWP) undertook a research transect along the entire length of the Kabompo River. Starting at its source in marshlands near the Democratic Republic of Congo (DRC)-Zambian border, the team hiked the first 82 km before paddling the remaining 648 km to the river's confluence with the Zambezi.

The expedition team received support from rangers of the West Lunga National Park, as well as representatives of the Department of Fisheries (DoF). A total of 97 research sites were surveyed, with sampling at five tributary inflows (Musangezhi, Mwombezi, Chifuwe, West Lunga, Dongwe) and at the Zambezi. Several sites were sampled opportunistically, recording valuable data at points of interest such as mine tailings discharges and hot springs.

The transect collected baseline data on hydrology, water quality, biodiversity, and human activity. These findings provided key conservation insights, including ongoing threats to the river. Our intention is that the information generated through this research survey will be a valuable resource to river managers, conservation authorities, government agencies, and anyone invested in the future of the Kabompo River.



METHODS

Continuous Monitoring

Whilst paddling down the river, researchers continuously collected survey data and 360° imagery. Each boat included an observer and a recorder. Observers scanned the river and both banks — up to 100 m from the edge — identifying land use, infrastructure, biodiversity, and signs of disturbance. Recorders logged observations in real time using the Survey123 (ESRI) app on a smartphone, ensuring spatially referenced data across diverse indicators.



Fixed Survey Sites

Fixed survey sites were established at regular intervals to capture detailed information on water quality, biodiversity, and land use. These sites offer a strong foundation for long-term monitoring by communities, river authorities, and NGOs involved in river stewardship.

- Every 10 km: using drone imagery and water analysis, researchers revealed patterns not visible through observation alone.
- Every 50-75 km: eDNA sampling, macroinvertebrate surveys using the South African Scoring System (SASS), microplastics sampling, and further testing provided a foundation of river health and biodiversity.



Opportunistic Sites

To complement continuous observations, researchers conducted targeted sampling at selected sites along the transect. Leveraging local river conditions and insights from visual surveys, they deployed overnight bat recorders, set traps for freshwater fish and crustaceans, collected water samples, and measured river discharge. This approach enabled more detailed assessments of the river's hydrochemistry, hydrology, and biodiversity.



RESEARCH SITES

Number of research sites: 97

Total number of water quality measurements: 87

Total number of aerial drone surveys: 79

Total number of wetland birds recorded: 1071 observations across 60 species

Total number of wildlife recorded: 234 observations across 11 species

Total number of fish collected: 888 specimens from 66 species (13 families)

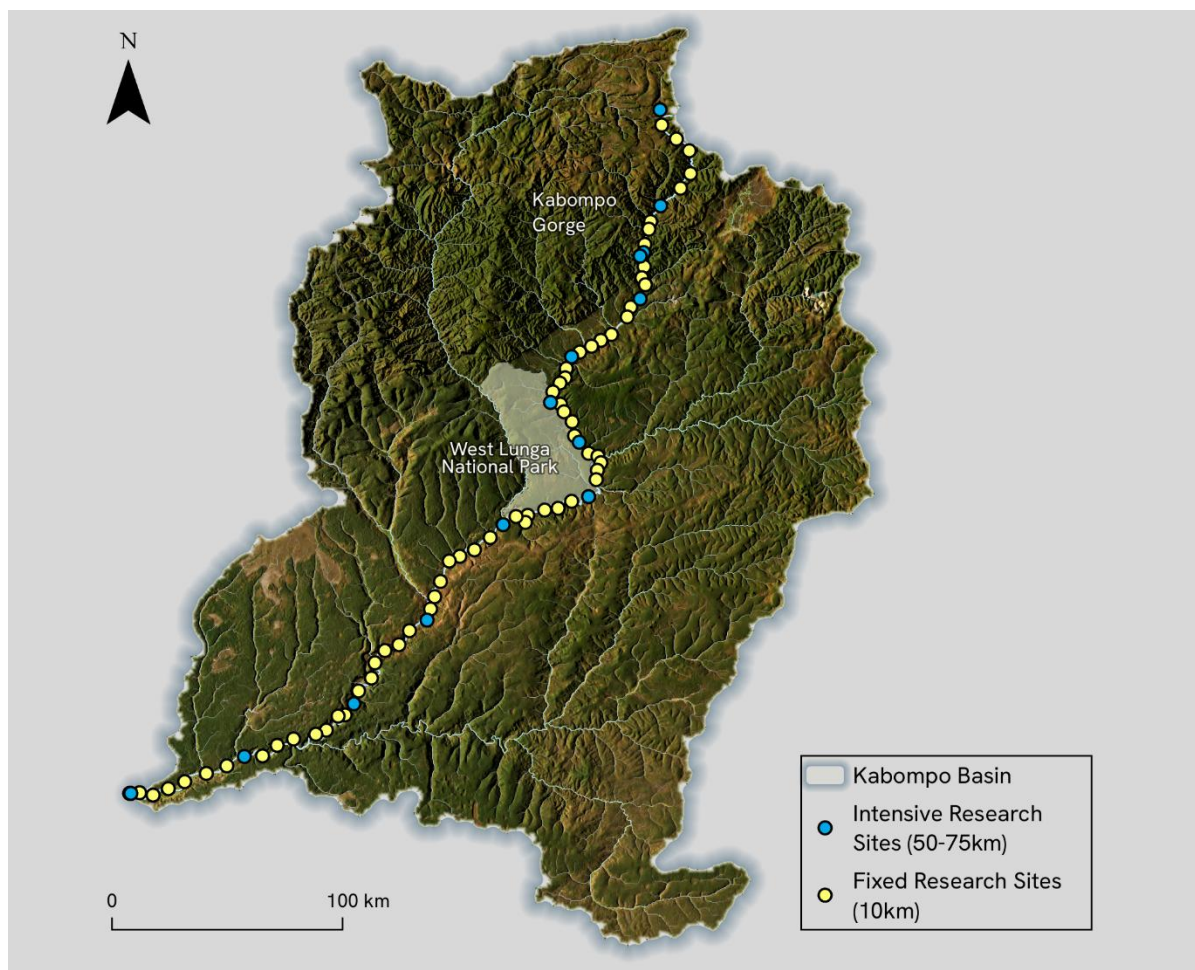


Figure 2. A total of 97 research sites were established along the transect.

HUMAN FOOTPRINT

The Kabompo River Basin occupies approximately 55% of Zambia's North-Western Province, a region home to more than 1.2 million people and the fastest growing population nationwide [5]. Positioned within Zambia's intensifying mining frontier, the basin is undergoing increased settlement and land-use change as copper and nickel developments near the headwaters draw investment into the area [4]. These shifts highlight the urgent need to monitor the Kabompo River over time.

Table 1. Human footprint on the Kabompo River, as compared to observations made on the 2023/2024 Zambezi River transects from source to sea.

	<i>Kabompo River</i>	<i>Zambezi mainstem</i>
<i>People / km</i>	2.5	6.1
<i>Fishers / km</i>	0.2	0.3
<i>Fishing gear / km</i>	1.7	0.8
<i>Vessels / km</i>	1.7	1.9
<i>Livestock / km</i>	0.5	3.3
<i>Riparian cropland (%)</i>	2.69	0.06

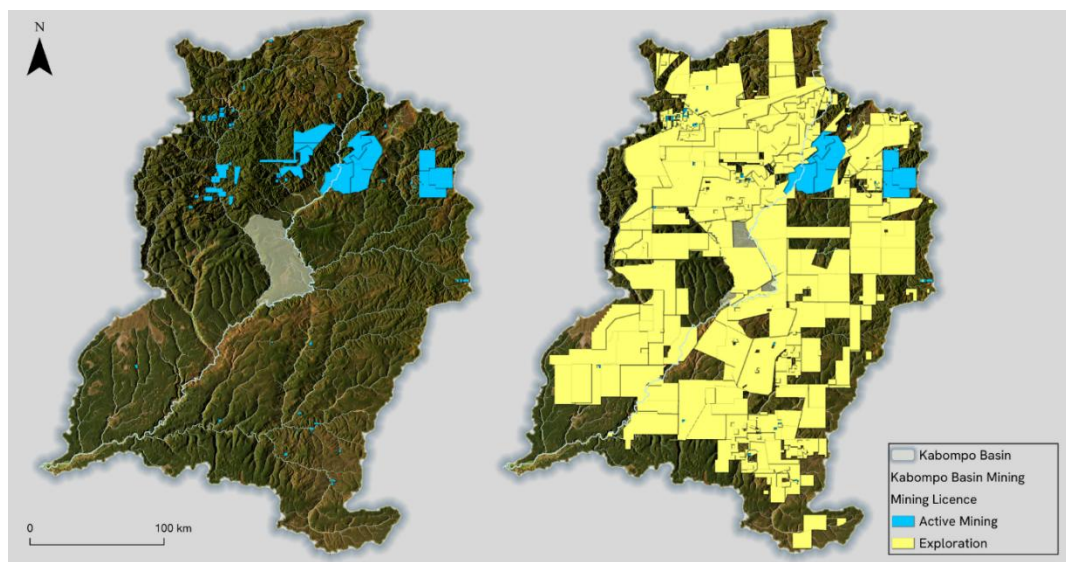


Figure 3. The Kabompo River flows through Zambia's intensifying mining frontier. Since the early 2000s, large-scale copper and nickel projects have transformed the demographic and economic profile of the Kabompo Basin, driving population growth and rapid urbanisation.

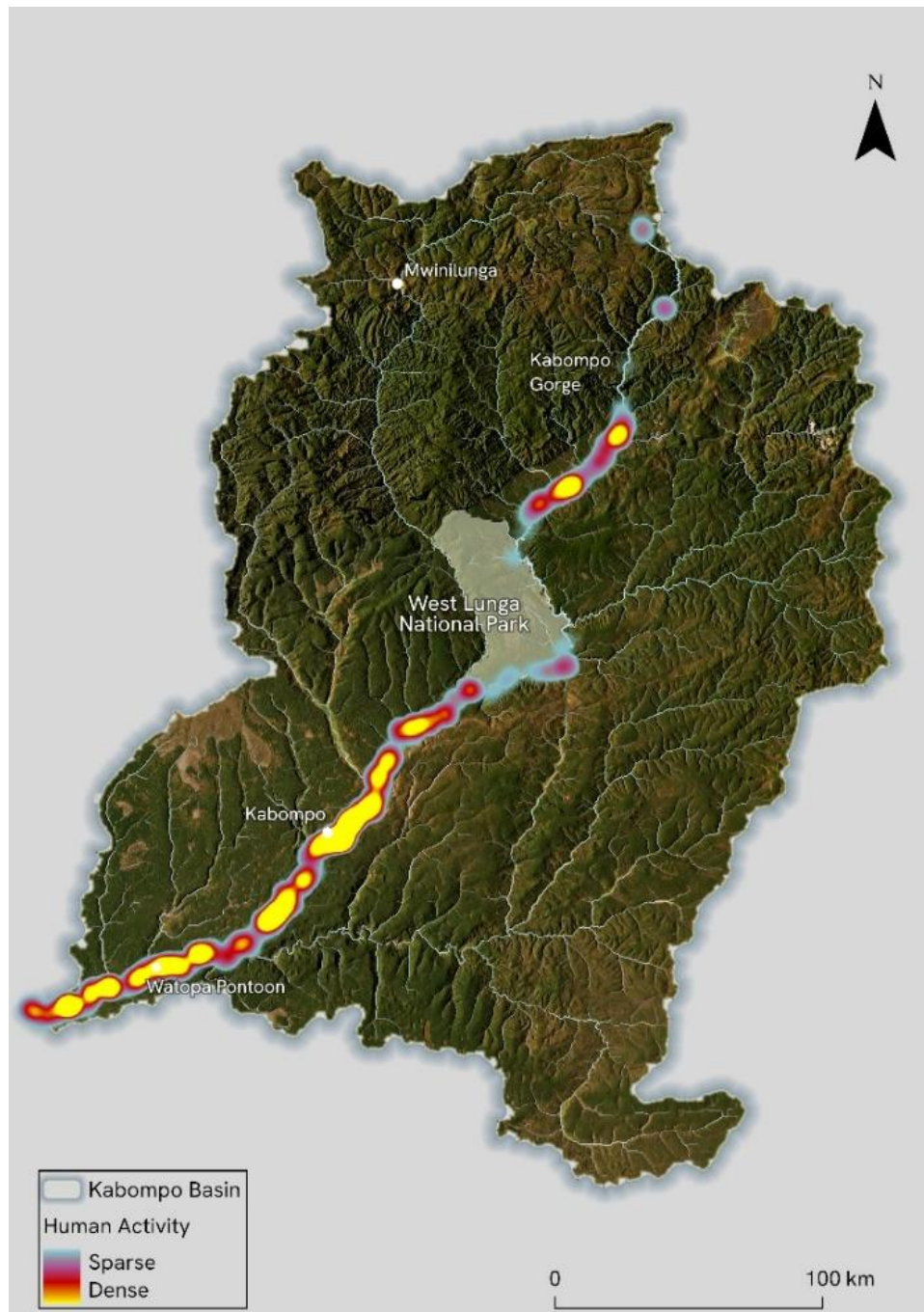


Figure 4. Distribution of people observed along the transect. The population of the Kabompo District has increased by over 90% in the last 22 years [6], indicating growing pressures within the Kabompo Basin.

Although the Kabompo is more sparsely populated compared with the Kafue or the Zambezi mainstem, settlement expansion has accelerated over the past three decades, with a 143% rise in settlement land-use between 1992–2020 (Figure 6; [Appendix A](#)). Unlike the Kafue or Zambezi, the Kabompo is a small river, making it particularly sensitive to development, contamination, or deforestation. While built-up areas remain small and dispersed, satellite mapping shows that buildings are typically concentrated along the river corridor.

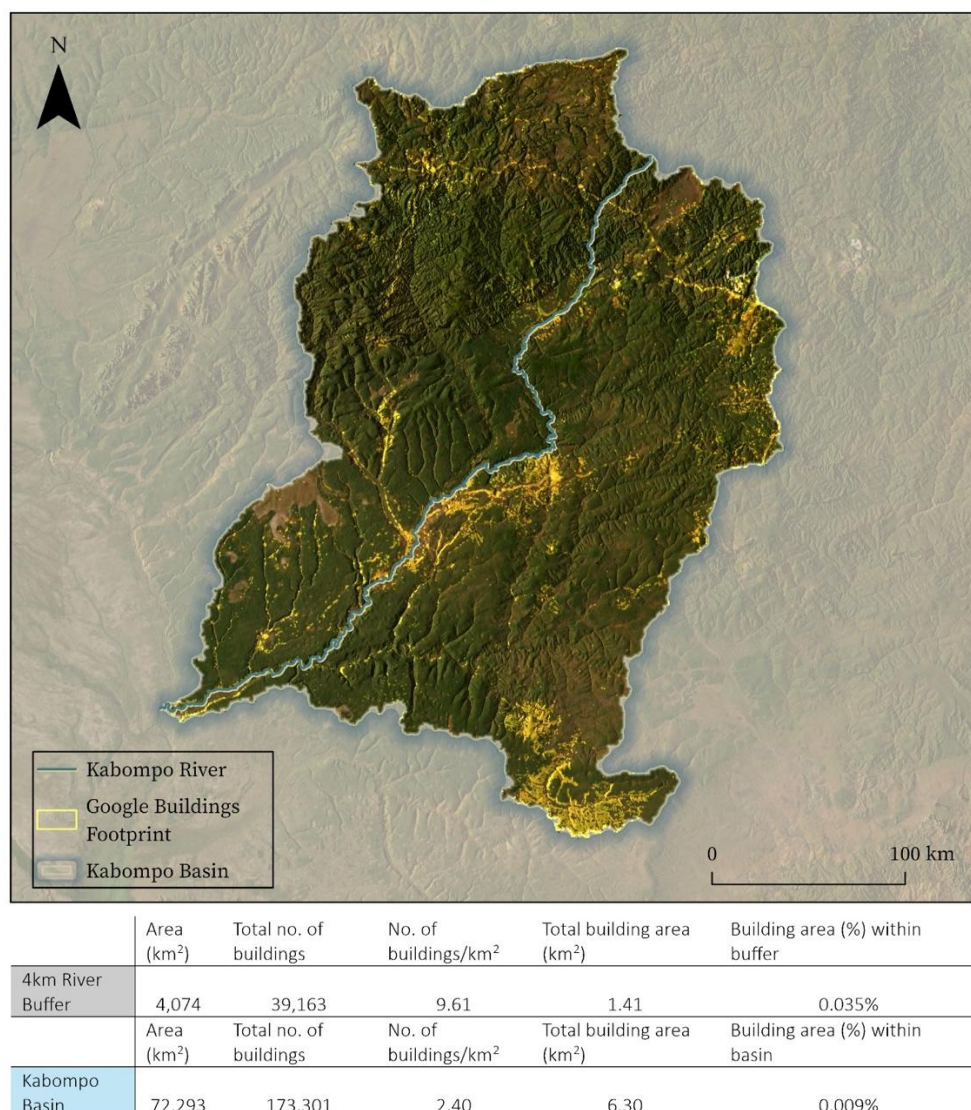


Figure 5. While built-up areas remain small and dispersed, satellite mapping (using the Google Open Buildings dataset; see [Appendix A](#)) shows that buildings are typically concentrated along the river corridor, within a 4 km buffer zone from the riverbank.

Development within the Kabompo Basin will influence the catchment in important ways. Some impacts are direct, such as fishing pressure, water abstraction, or localised discharges. Others occur indirectly, when activities on land change the condition of the catchment itself. For example, deforestation and clearing vegetation for crops, settlements, or access roads reduces ground cover and exposes soils, which can alter runoff patterns and increase the movement of sediment into the river. Because much of this activity is located close to the river and its tributaries, changes on land are closely linked to conditions in the channel. Over time, these processes can degrade water quality, bank stability, and aquatic habitats. Monitoring across the basin is therefore necessary to document how the river responds to increasing human footprint and to guide future land and water management decisions.

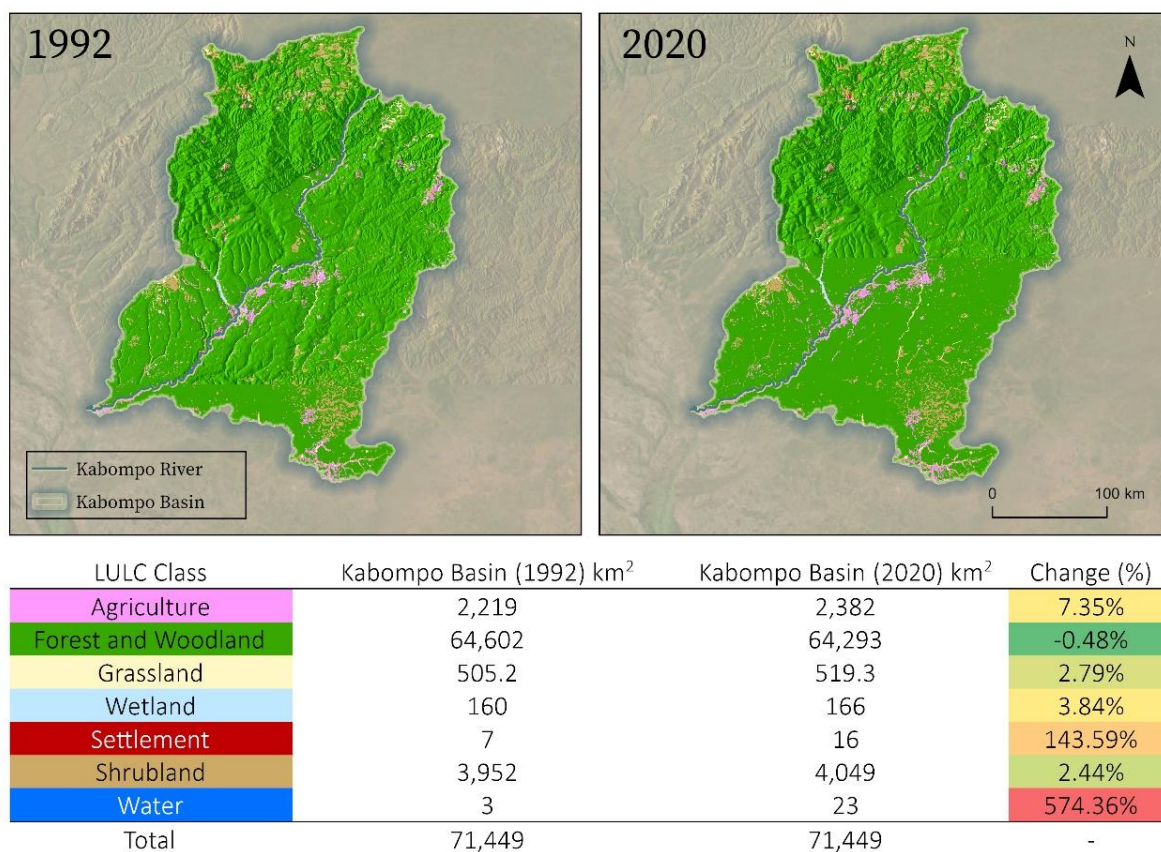


Figure 6. The land-use land change analysis of the Kabompo Basin from 1992 to 2020. The forest and woodlands of the basin are by far the predominant land-cover, however, settlement areas have more than doubled over the past three decades, a trend that is in line with patterns of population growth and urbanisation across the country.



Figure 7. Kabompo River bridge near the settlement of Ntambu.

RIVER FLOW

The Kabompo is one of the Upper Zambezi's most important Zambian tributaries, contributing nearly a quarter of the flow entering the Barotse Floodplain during the late wet season [2]. This important role, combined with its high ecological value and sensitivity to human impact, is why the Kabompo catchment is identified as a priority Water Resource Protection Area for Zambia [7, 8]. The river is critical to sustaining the Zambezi's seasonal flood pulse, which supports fisheries, agriculture, and wildlife habitats downstream.

The flow of the Kabompo is highly seasonal, with peak discharge occurring between February and April, towards the end of the rainy season. This is followed by a steady decline in flow throughout the dry season. The average flow of the river is approximately $273 \text{ m}^3/\text{s}$, though this can half in drought years, highlighting its sensitivity to rainfall [1].

To measure flow during the expedition, the team used an Acoustic Doppler Current Profiler (ADCP). Thirteen sites were surveyed, including nine along the Kabompo mainstem, three at major tributaries (the Chifuwe, West Lunga, Dongwe), and lastly at the Kabompo–Zambezi confluence. Depth measurements were taken opportunistically using a handheld sonar depth finder, with a maximum recorded depth of 12.4 m.



Figure 8. An Acoustic Doppler Current Profiler (ADCP) was used to measure flow, water depth, and channel width at thirteen sites along the transect.

Discharge increased along the river, from just over $5 \text{ m}^3/\text{s}$ in the upper reaches to $105 \text{ m}^3/\text{s}$ before the confluence with the Zambezi. At this point, the Zambezi carried $396 \text{ m}^3/\text{s}$, meaning the Kabompo contributed approximately 20% of total flow entering the Barotse Floodplain. Our findings are consistent with measurements from 2023 [2], underscoring the

important role of the Kabompo River as one of the Zambezi's most significant headwater tributaries.

Given this hydrological importance to the Zambezi system, understanding the contributions of the Kabompo River's major tributaries is also crucial for monitoring flow regimes. The West Lunga, in particular, is the Kabompo's most influential tributary, more than doubling the flow at their confluence. Because this junction effectively shapes the volume of water the Kabompo delivers downstream, establishing a long-term monitoring station here would provide valuable insight into how upstream conditions affect the volume and timing of water delivered to the wider Zambezi system.

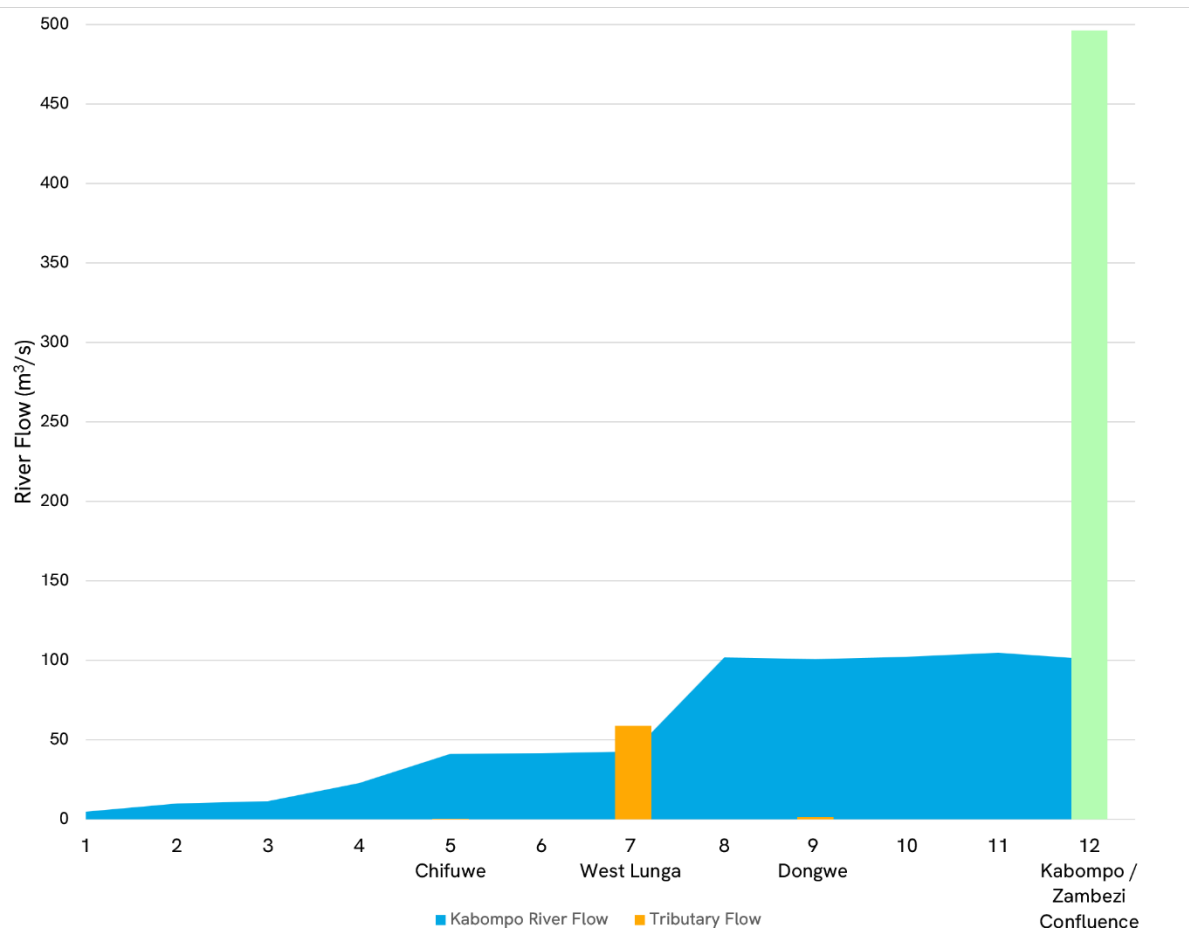


Figure 9. Discharge increased along the river, from just over 5 m³/s in the upper reaches to 105 m³/s before the confluence with the Zambezi. At this final confluence, the Zambezi carried 396 m³/s, meaning the Kabompo contributed around 20% of total flow entering the Barotse Floodplain.

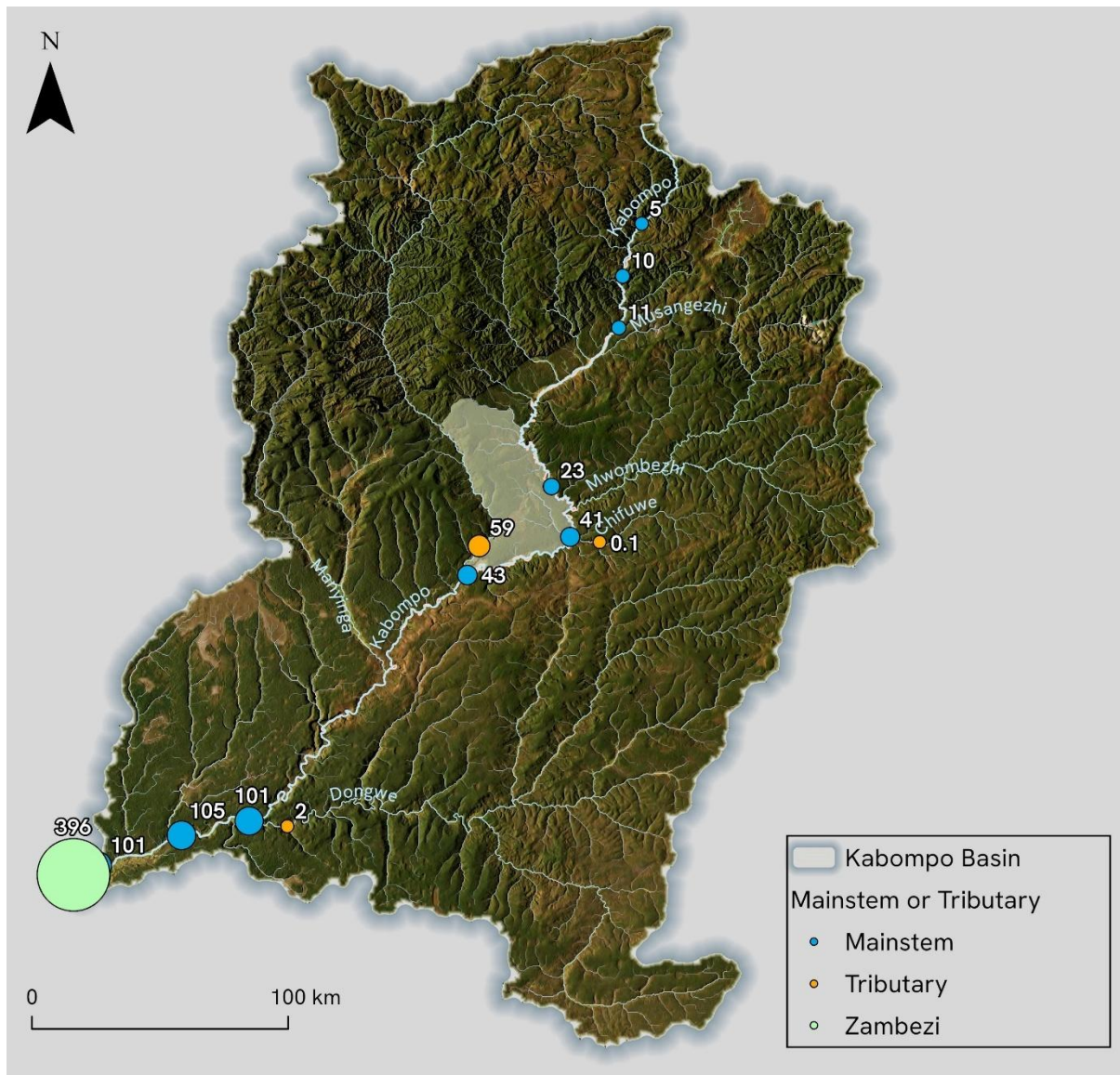


Figure 10. The location of each discharge measurement performed on the Kabompo River and its tributaries, with points sized relative to the flow measured at each location.

WATER QUALITY

Water quality is a key measure of river health. Poor water quality can impact aquatic biodiversity and fisheries, render water unsuitable for agriculture, reduce the quality of drinking water for local communities, and degrade riverine habitats. While some variation in water chemistry is natural, mining, agricultural runoff, and untreated effluent can shift conditions beyond background levels. Establishing a clear baseline is therefore essential for long-term river management.

Unlike other Upper Zambezi tributaries, the Kabompo has little wetland buffering capacity (see [Appendix A](#)), making the river more vulnerable to land-use pressures. Water quality measurements taken in 2023 show the Kabompo exhibits the highest conductivity and total dissolved solids (TDS) of any Upper Zambezi tributary, over 15 times higher than the Zambezi mainstem above its confluence with the Kabompo, which is a pattern that may be linked to copper and nickel mining in the Kabompo basin [2]. The more detailed hydrochemical assessment undertaken during this expedition confirms that the Kabompo is naturally mineral-rich, while also demonstrating that mining activity is measurably altering river chemistry.

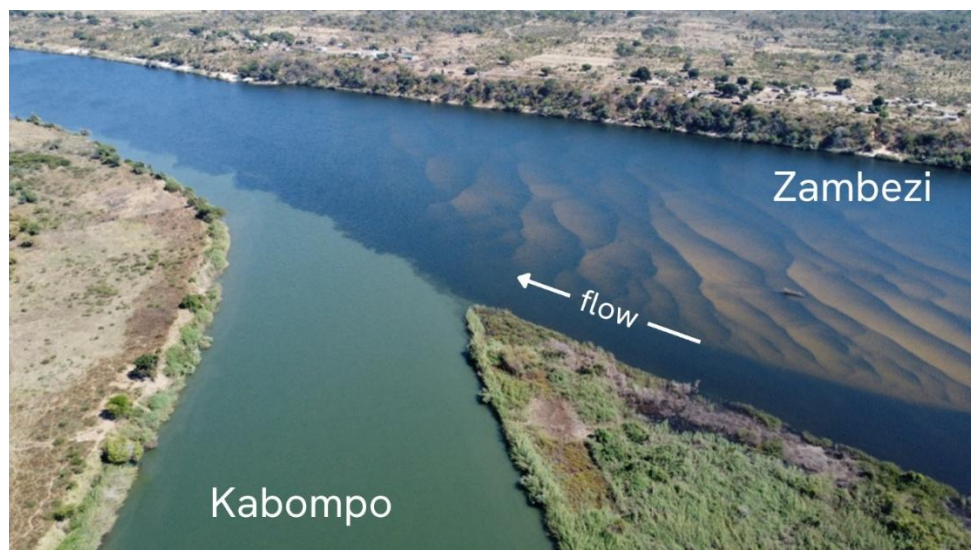


Figure 11. Confluence of the Kabompo and Zambezi rivers. The distinct colour contrast at the mixing zone is consistent with measurements showing elevated conductivity and total dissolved solids in the Kabompo.

Water quality was measured at 87 sites along the river using an AquaTroll sonde, with laboratory analyses undertaken on water and sediment samples collected at representative locations. Together, these datasets show that mining is measurably altering the chemistry of the Kabompo, but that this impact is more concealed than standard water-quality indicators suggest. This is because the river's underlying carbonate geology neutralises mining-related acidity, in a buffering effect that results in Neutral Mine Drainage (NMD). As a result, mining signatures are not obvious in this kind of system, and the

presence of NMD needs to be explored through nuanced changes in physical and chemical parameters along the river, most notably the heavy metals and sulphate levels.

The clearest of these changes occurs at two points along the transect. Downstream of the Chisola mine tailings dam discharge (site 18; Figure 12), turbidity, conductivity and total dissolved solids increase sharply and remain elevated for a considerable distance downstream (Figure 13). A similar shift occurs at the Musangezhi tributary (site 24), which drains an active copper mining area, confirming that mining inputs enter the Kabompo from more than one source.



Figure 12. The Chisola mine tailings dam discharges directly into the Kabompo River, where bright green algae lined the banks.

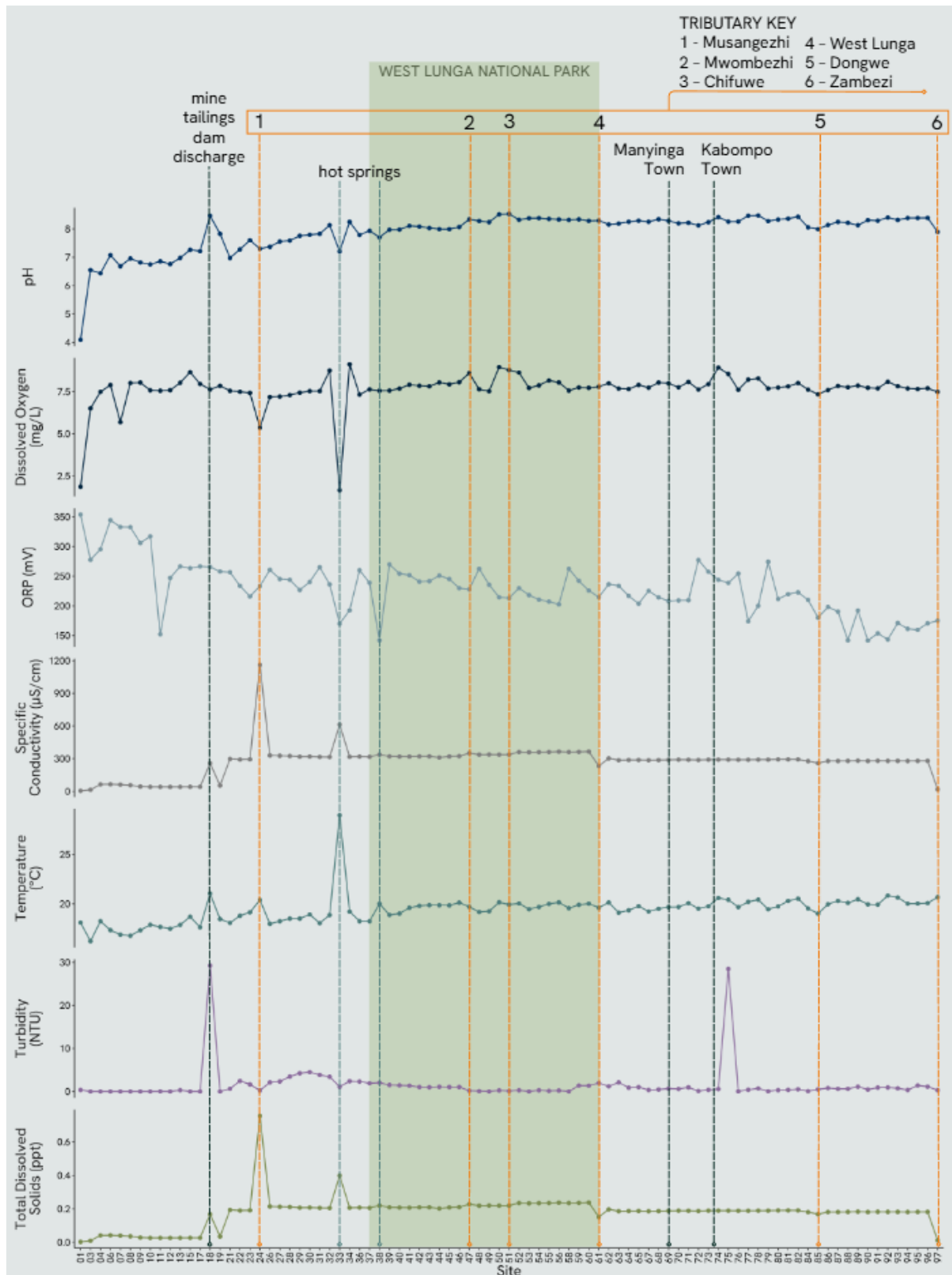


Figure 13. A clear shift in water quality was detected at site 18, where the Chisola mine tailings dam discharges directly into the Kabompo. Similar anomalies in water quality were also measured at the Musangezhi tributary at site 24, which receives upstream mine effluent, suggesting multiple mining-related inputs within the basin.

A more diagnostic signal comes from the percentage difference between sulphate and chloride (Figure 14). The concentration of chloride in the river only changes with dilution rather than with rock weathering or mineral reactions, so it serves as a stable natural baseline against which other ions can be compared. Therefore, the percentage difference between chloride and sulphate measures how far sulphate exceeds expected levels, with any excess suggesting a mining source. Figure 14 shows how this difference rises from a natural baseline of around 40% along the upper mainstem to 74% at the mine tailings discharge and 96% at the Musangezhi confluence, remaining elevated for the remainder of the river. Every other water source on the transect, including the hot spring and the West Lunga, Dongwe, and Zambezi confluences, returns to that same baseline, confirming that the Kabompo's elevated sulphate is specific to the mainstem rather than a regional background level. At the Musangezhi tributary, sulphate shows the strongest signal, but pH remains neutral and several priority metals (copper, chromium, arsenic, cadmium, mercury and lead) fall below detection limits, confirming that this sulphate signal is detecting mining contamination that pH and metal readings alone would have missed entirely.

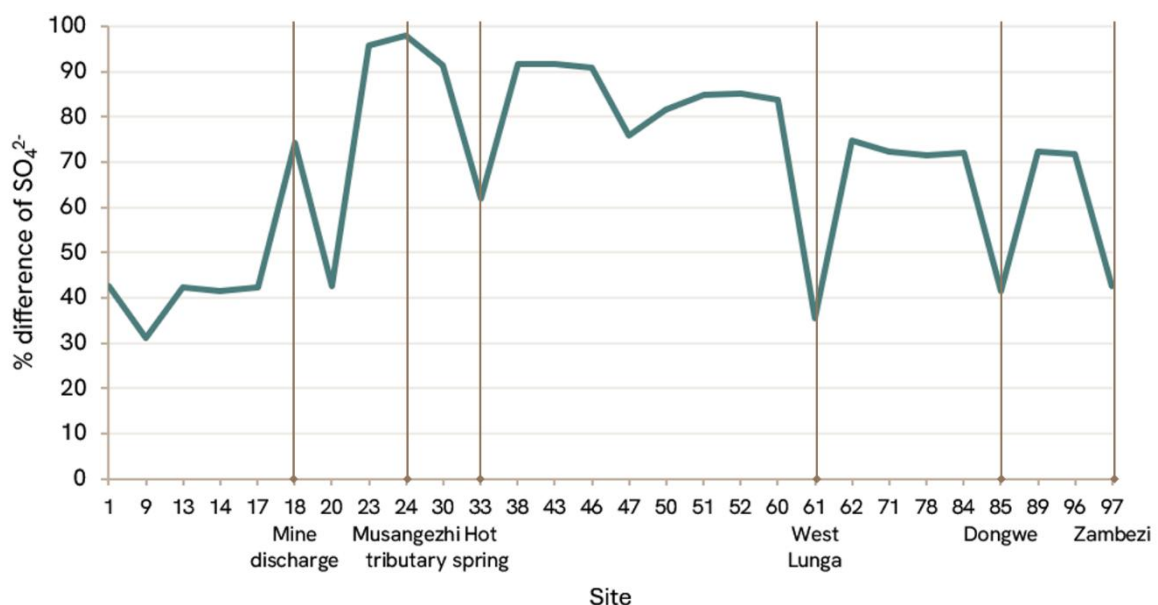


Figure 14. Percentage difference between sulphate and chloride along the Kabompo River. Higher values indicate sulphate levels exceeding what natural dilution would predict, a signature of mining-related contamination. Elevated values downstream of the mine discharge and Musangezhi tributary contrast with the lower, natural baseline seen at unaffected tributaries and the hot spring.

Sediment sampling adds a further line of evidence, with geoaccumulation indices highlighting where certain heavy metals are enriched along the Kabompo River [9]. Several metals are enriched relative to global crustal averages [10], and enrichment relative to an upstream reference site is highest immediately upstream of the Chisola discharge (Figure 15). Because riverbank sediments can be reworked by erosion, this points to localised enrichment rather than confirmed long-term contamination. In the water column, dissolved metals remain within World Health Organization (WHO) drinking water guidelines

throughout, but uranium (U), strontium (Sr), molybdenum (Mo), and barium (Ba) all increase measurably downstream (Figure 16), tracking the same sulphate rise already described, a pattern guidelines cannot fully assess, since none yet exist for several of these elements, including cobalt and strontium. Given the potential adverse health effects associated with these elements, the results reported here underscore the need for ongoing monitoring and the development of more comprehensive drinking water standards for the region.

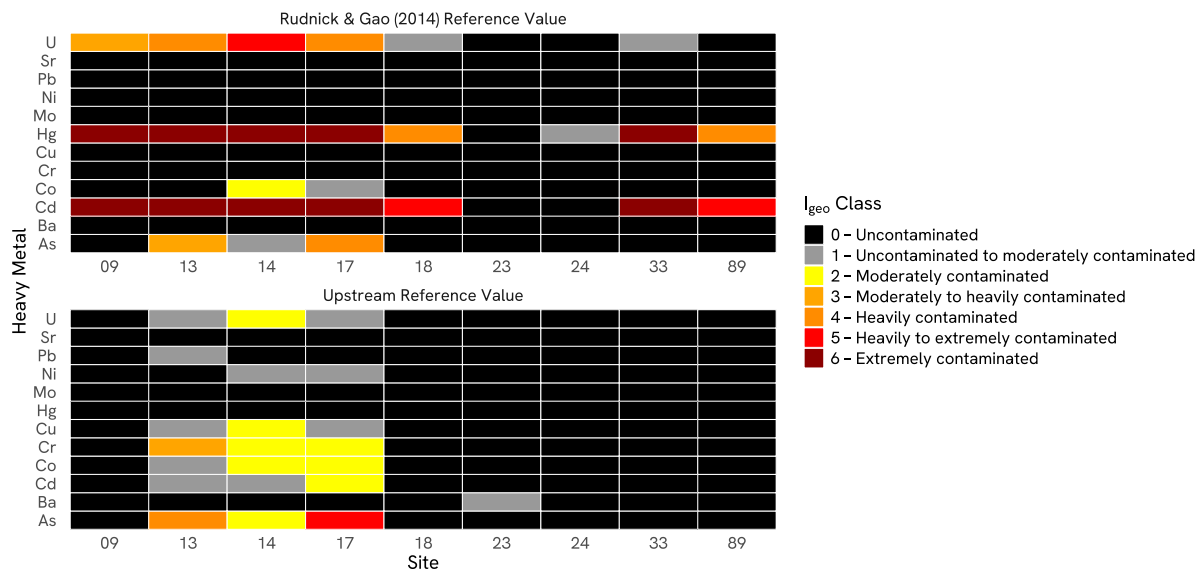


Figure 15. Geoaccumulation index (I_{geo}) heatmaps [9] for sediment samples along the Kabompo River. The top panel shows enrichment relative to global crustal averages [10] and the bottom panel shows enrichment relative to an upstream reference site.

Nutrient sampling was also performed to assess the river's water quality. Nitrate and ammonia rise near settlements, while phosphate is highest near mining activity and within the Dongwe tributary, indicating additional, localised inputs from land use across the basin. Beyond external inputs, the Kabompo's water profile is influenced by natural geothermal activity, with two hot springs sampled at sites 33 and 38. Notably, the spring at site 33 recorded a temperature of 29°C, which was 10°C higher than the average river temperature. This spring also exhibited anomalously low dissolved oxygen levels and elevated mercury (Hg) and cadmium (Cd) concentrations in the sediments relative to global crustal averages, together creating a localised zone of ecological stress. Despite these challenging conditions, a diverse fish community was observed within the spring area, though individuals displayed physiological abnormalities likely linked to the extreme water chemistry (see [Fish](#) section below).

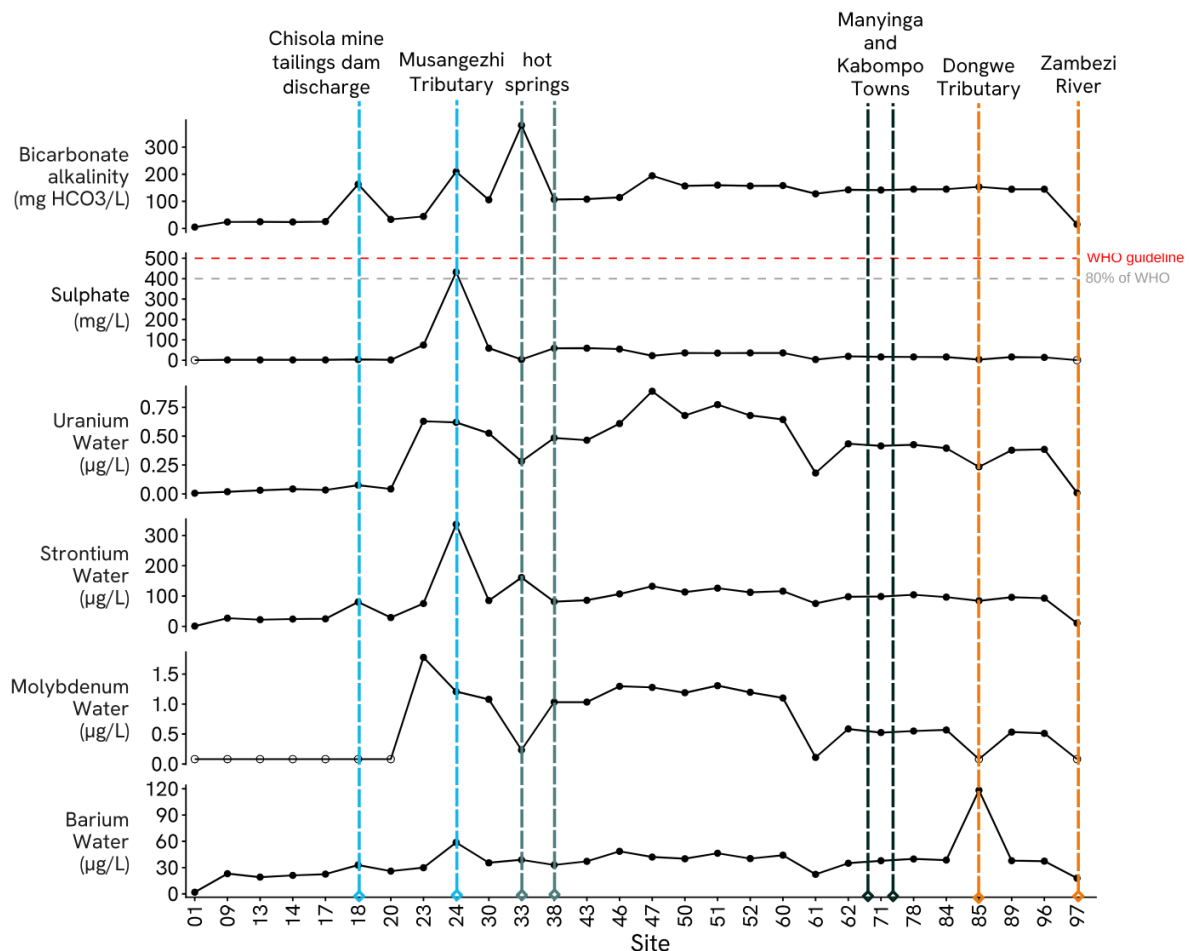


Figure 16. Changes in alkalinity, sulphate, and heavy metal concentrations along the Kabompo River from source to confluence. Water chemistry changes downstream, with noticeable increases near mining areas. At site 24, sulphate levels were less than 20% below WHO guidelines, suggesting that further sulphate inputs may result in WHO guidelines being exceeded. Open circles represent where values were below the level of quantification (LOQ) and are plotted as LOQ/2.

Overall, these baseline measurements indicate that the Kabompo Basin is naturally mineral-rich, and that mining activity is influencing the chemistry of the river. While sediments do not show clear downstream build-up linked directly to discharge points, sustained increases in dissolved solids, heavy metals, and sulphate downstream of mining areas indicate measurable changes in the water column. Metal concentrations remain within WHO drinking water guidelines at present, but these findings establish an important baseline against which future mining expansion and cumulative land-use impacts can be assessed.

BIODIVERSITY

The importance of biodiversity monitoring

The Kabompo River is located in a unique transition zone between the Zambezi and Congo basins, yet it remains a relatively understudied tributary of the greater Zambezi basin. Monitoring biodiversity along the Kabompo is essential to establish a baseline state, detect ecological change over time, and identify opportunities for conservation action.

Wildlife

Large wildlife observations were low along the transect, with an average of just three animals every 10 km, a density similar to that of the other upper Zambezi rivers. Only 14 hippos were recorded along the full transect, clustered near the West Lunga confluence. These sparse sightings are indicative of the long-term historical decline in wildlife across the basin, driven by poaching, habitat fragmentation and loss, and limited investment in protected areas.

West Lunga National Park and its surrounding Game Management Areas (GMAs) once supported a diverse assemblage of species, including elephant, buffalo, sable, roan, hartebeest, leopard, lion, and wild dog. However, limited historical resource mobilisation for the West Lunga NP, and challenging management conditions in the GMAs, have reduced mammal biodiversity to what has been described as a “skeleton ecosystem” [11].

In recent years, an expanded conservation effort has begun to address these declines. The West Lunga Conservation Project (WLCP) now coordinates anti-poaching patrols, ecological monitoring, fire management, and community engagement across the region. Wildlife surveys, GPS collaring of key species, and a growing camera-trap network are generating more regular data on remaining populations, while investments in access, ranger housing, and outposts aim to strengthen day-to-day protection.

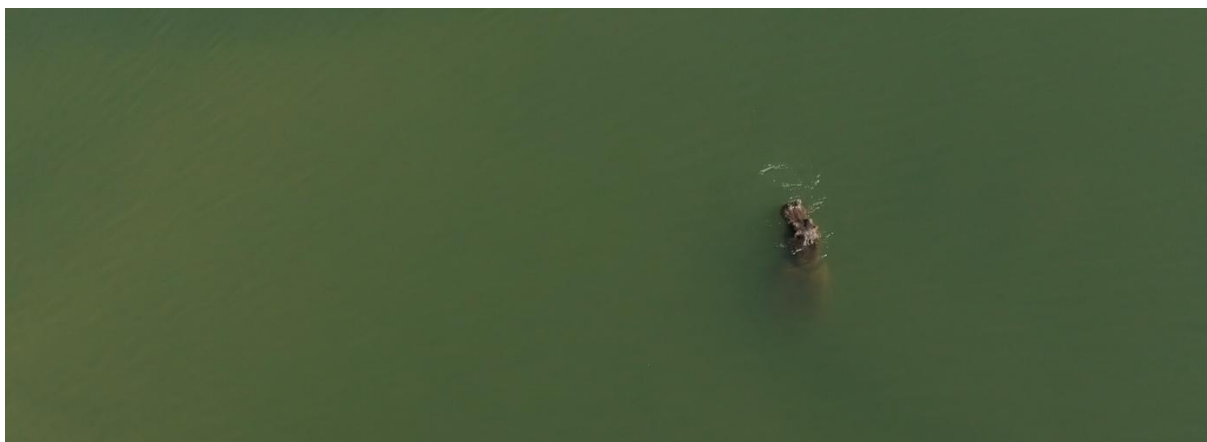


Figure 17. A single, partially submerged hippo. Widespread poaching and habitat conversion have reduced populations of wildlife across the basin, with only one pod of hippos observed along the entire transect, despite suitable habitat.

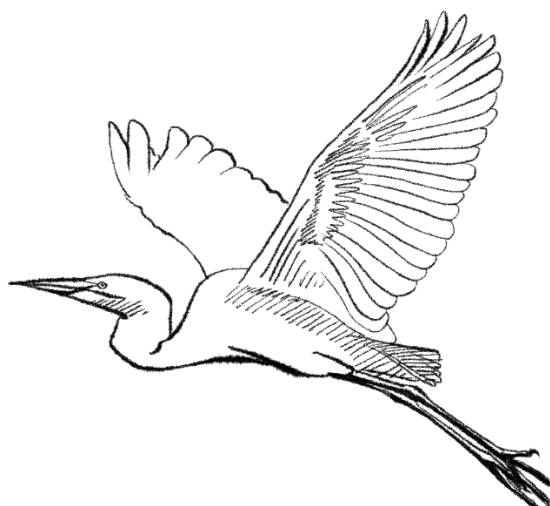
Birds

Birds are powerful indicators of environmental change, especially in wetland systems where their abundance and diversity often reflects water quality, habitat condition, and human disturbance. By regularly monitoring bird populations, we can detect early ecological shifts and identify emerging conservation priorities.

The Kabompo landscape is recognised as an Important Bird Area, with West Lunga National Park and surrounding GMAs supporting an array of suitable forest and floodplain habitats for various bird species. During the expedition, bird diversity peaked in the Ntambu floodplains, within West Lunga National Park, and at the Zambezi confluence. In total, 60 species were recorded, including sensitive species dependent on intact riparian and forest habitats, such as the Half-collared Kingfisher (*Alcedo semitorquata*), Pel's Fishing Owl (*Scotopelia peli*) and African Finfoot (*Podica senegalensis*).

Table 2. Ten most common bird species counted on the transect.

Species	Count
Malachite Kingfisher (<i>Corythornis cristatus</i>)	141
Striated Heron (<i>Butorides striata</i>)	120
Half-collared Kingfisher (<i>Alcedo semitorquata</i>)	118
African Darter (<i>Anhinga rufa</i>)	95
Bateleur (<i>Terathopius ecaudatus</i>)	78
African Pied Wagtail (<i>Motacilla aguimp</i>)	74
Pied Kingfisher (<i>Ceryle rudis</i>)	74
Giant Kingfisher (<i>Megaceryle maxima</i>)	39
Western Banded Snake-Eagle (<i>Circaetus cinerascens</i>)	23
African Fish-Eagle (<i>Ichthyophaga vocifer</i>)	22



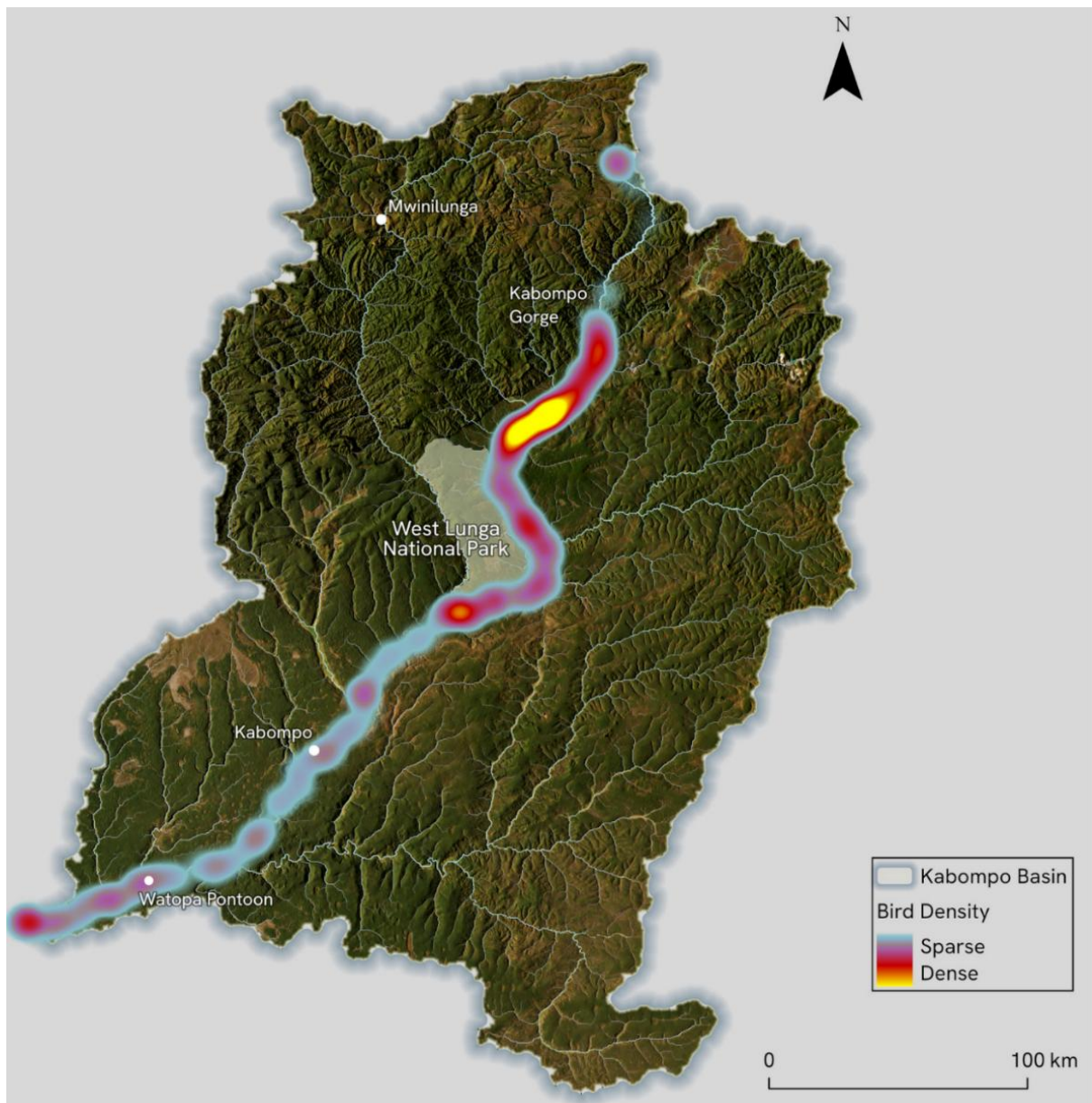


Figure 18. The Kabompo landscape is recognised as an Important Bird Area. During the expedition, bird observations peaked in the Ntambu floodplains, within West Lunga National Park, and at the Zambezi confluence.

Fish

The Kabompo hosts a highly diverse fish community, shaped by its complex geological history and biogeographic linkages. Using dip nets, fyke nets, and electro-fishing, the 2025 expedition team detected an estimated 80 species, including rheophilic taxa such as *Chiloglanis* sp. and *Amphilius* sp. in the gorge, and floodplain specialists such as cichlids, *Nannocharax* sp., and sand catlets. Several potentially undescribed taxa were collected, highlighting the Kabompo's significance as a reservoir of freshwater biodiversity. However, the invasive Nile tilapia was also detected in the lower Kabompo, echoing broader Zambezi Basin trends that threaten native *Oreochromis* populations.



Figure 19. Top panel: environmental DNA samples were collected at 15 sites and, once analysed, will provide further insights into contemporary fish community patterns across the Kabompo basin. Bottom panel: electrofishing was conducted at opportunistic sites to sample a diversity of fishes usually not detected using other conventional sampling techniques.



Figure 20. Headwater streams supported small-bodied species like Enteromius and Lacustricola.

Signs of possible fish disease were also recorded during the expedition. Individuals with what is believed to be Epizootic Ulcerative Syndrome (EUS) were observed throughout the transect, while fishes collected at the hot spring showed visible physiological stress, including protruding eyes and abnormal swimming behaviour. Whilst the hot spring is an anomaly, the potential occurrence of EUS within the Kabompo River reinforces the need for routine monitoring and focused research to determine if the underlying drivers are linked to water quality perturbations or other human disturbance.



Figure 21. Signs of fish disease were also recorded during the expedition. Individuals with Epizootic Ulcerative Syndrome (EUS) were confirmed in downstream reaches, while fishes at a hot spring showed visible stress, including protruding eyes and abnormal swimming behaviour.

Invasive Plants

Alien invasive plants pose significant threats to river systems across Africa. They displace native vegetation and alter nutrient cycling, leading to declines in native biodiversity [12]. AIPs also affect water quality by increasing evaporation, reducing stream flow, and limiting the river's natural dilution capacity [13]. Regular monitoring is therefore critical for detecting new invasions and implementing interventions for limiting their spread.

During this expedition, invasive plants — including Mexican poppy (*Argemone mexicana*), Giant sensitive plant (*Mimosa pigra*), and Castor oil bush (*Ricinus communis*) — were first observed near Manyinga Town and became most dense around Kabompo Town, indicating a strong link between their presence and areas of higher human activity. Although currently sporadic, these infestations are likely to spread. If left unmanaged, their spread could alter riparian vegetation structure and affect downstream ecosystems, including the Barotse Floodplain. Ongoing monitoring should form the basis of an invasive species management plan for the river.

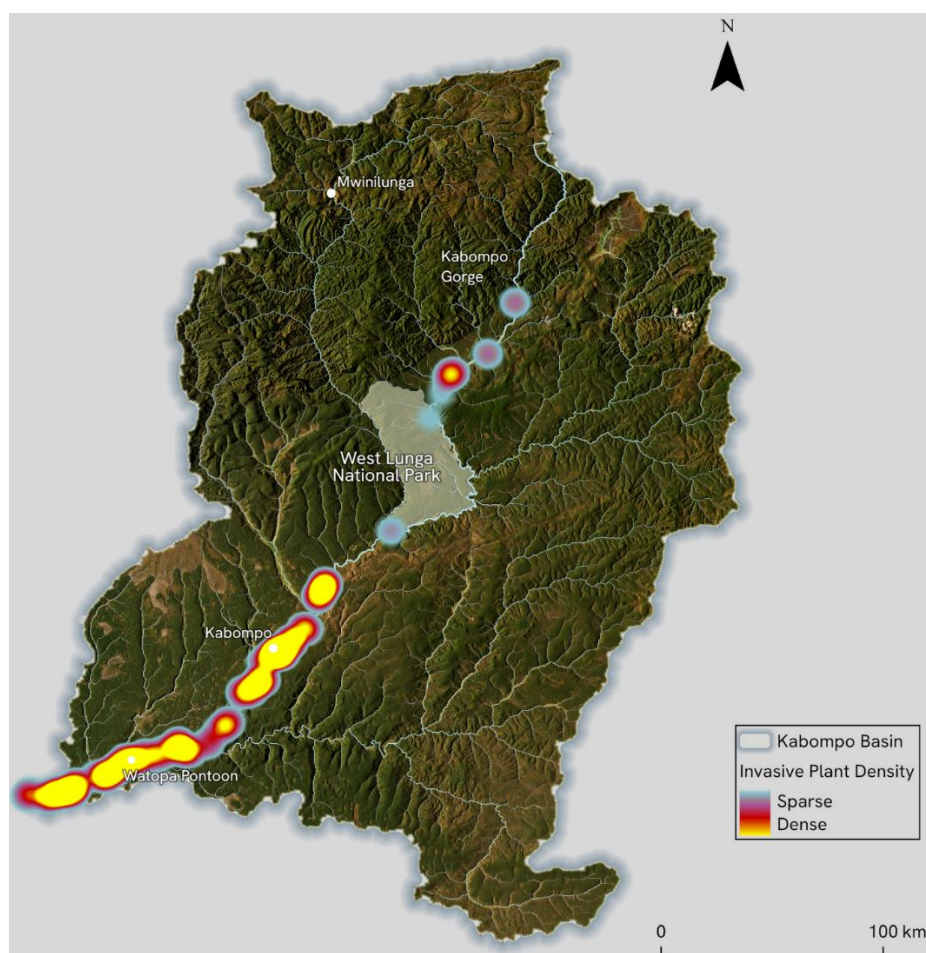


Figure 22. During the expedition, invasive plants, including Mexican poppy (*Argemone mexicana*), Giant sensitive plant (*Mimosa pigra*), and Castor oil bush (*Ricinus communis*), were first observed near Manyinga Town and became most dense around Kabompo Town, indicating a strong link between their presence and areas of higher human activity. Although currently sporadic, ongoing monitoring will be imperative for limiting their spread.

KEY INSIGHTS AND RECOMMENDATIONS

Safeguard a hydrologically strategic headwater system

The Kabompo contributes approximately 20% of the flow entering the Barotse Floodplain during the late wet season, making it one of the Upper Zambezi's most important tributaries. The West Lunga River is particularly influential, more than doubling discharge at its confluence with the Kabompo mainstream.

Given the reliance of downstream ecosystems and communities on the seasonal flood pulse, changes in flow volume or water quality within the Kabompo Basin have basin-wide implications.

Recommendations:

- Establish **long-term water quality and flow monitoring** at key bridges and confluences; in particular, at the West Lunga and Zambezi confluence.
- **Integrate** Kabompo monitoring data into broader Upper Zambezi and Barotse Floodplain water resource planning frameworks.
- Strengthen **coordinated monitoring within the Barotse Floodplain** to better understand how upstream conditions influence downstream water quality and flood dynamics.

Strengthen proactive monitoring in a rapidly changing basin

While the Kabompo has a lower human density than the Zambezi River, rapid urbanisation driven primarily by the growing mining economy in the region is likely to drive fundamental changes.

Water quality data collected during this survey indicate measurable downstream shifts in river chemistry coinciding with industrial and land-use activity in the upper basin. While dissolved metal concentrations remain within drinking water guideline thresholds, sustained increases in conductivity, dissolved solids, sulphate, and several heavy metals were recorded downstream of discharge areas.

Continued observation is important to understand cumulative trends over time, especially given the basin's limited wetland buffering capacity.

Recommendations:

- The 2025 TWP Kabompo survey forms a unique baseline for the river, and efforts should be made to **repeat this survey** in coming years, preferably using an entirely Zambian team, to detect changes in the ecological state of the river.

- **Expand sediment sampling** in floodplain and low-energy depositional areas to assess longer-term metal accumulation dynamics.
- **Targeted monitoring** should be conducted at the Chisola mine tailings dam and Musangezhi tributary to ensure that contaminant pathways and seasonal variation are well understood.
- **Ongoing monitoring of dissolved metal concentrations** should be prioritised to build the longitudinal dataset needed to develop stronger, regionally appropriate drinking water guidelines, particularly for metals currently lacking established WHO thresholds.

Maintain aquatic biodiversity and address emerging ecological pressures

Large mammal densities along the Kabompo are low, reflecting long-term regional pressures. However, bird and fish diversity remain high, including sensitive riparian species and potentially undescribed fish taxa.

At the same time, invasive Nile tilapia, alien riparian plants, and cases of Epizootic Ulcerative Syndrome (EUS) were observed, indicating emerging ecological pressures.

Recommendations:

- **Sustained management effort and continued monitoring** in West Lunga NP and surrounding GMAs is important to reduce poaching and increase conservation focus in the Kafue–West Lunga corridor.
- Develop an **invasive species monitoring framework** to track the spread of Nile tilapia and invasive riparian plants.
- Promote **community-driven biodiversity monitoring programs**, such as eDNA citizen science initiatives.

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Appendix A: Satellite Analyses

BUILDING ANALYSIS

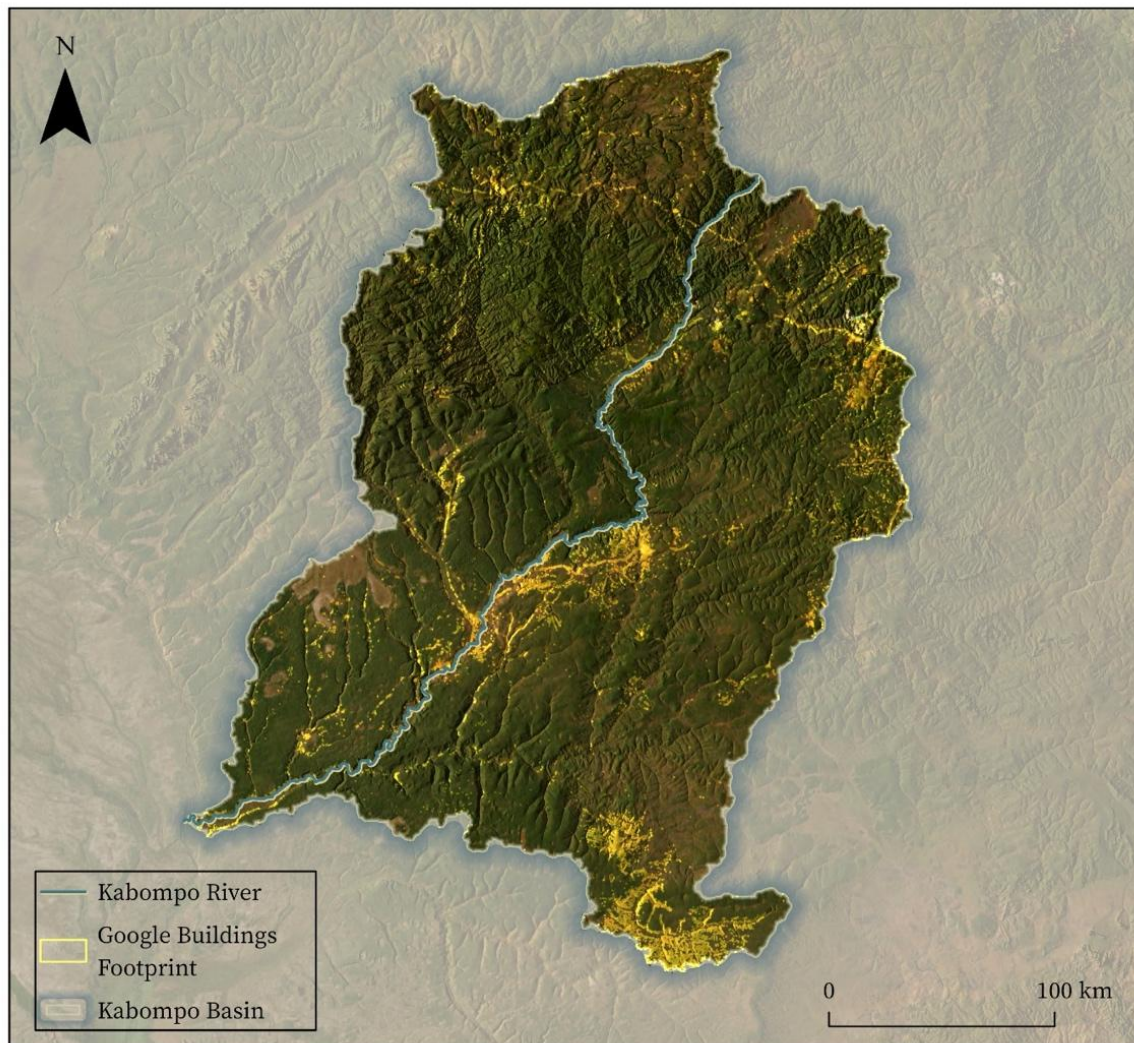
Method

The Google Open Buildings dataset, which provides building footprints derived from satellite imagery [14], was used to calculate the number and total area of buildings within a 4 km buffer zone around the Kabompo River. Additionally, the number and total area of buildings were also calculated for the entire Kabompo Basin. This dataset complements and improves the observational data from the June 2025 river survey, offering a more comprehensive understanding of building distribution and size beyond the river's riparian zone. By highlighting the proximity of human settlements to these key ecological areas, the dataset also aids in assessing human impact on these critical ecosystems.

Results

The Kabompo River Basin has a total of approximately 173,301 buildings, spread across an area of 72,293 km², resulting in an overall density of 2.40 buildings/km². Despite this large absolute number, the actual footprint of built structures remains minimal. The total building area within the entire basin is only 6.30 km², representing just 0.009% of the basin's surface. This very low percentage highlights that, although human settlements are present, they are sparsely distributed and have not significantly transformed the landscape in terms of built infrastructure.

Closer to the Kabompo River, within a 4 km buffer zone, settlement intensity increases. This zone contains 39,163 buildings over an area of 4,074 km², resulting in a much higher density of 9.61 buildings per square kilometres. However, even here, built structures occupy only 1.41 km², which equates to just 0.035% of the buffer area. This suggests that while settlement clusters are more common near the river, the physical footprint of buildings remains very limited relative to the available land.



	Area (km ²)	Total no. of buildings	No. of buildings/km ²	Total building area (km ²)	Building area (%) within buffer
4km River Buffer	4,074	39,163	9.61	1.41	0.035%
	Area (km ²)	Total no. of buildings	No. of buildings/km ²	Total building area (km ²)	Building area (%) within basin
Kabompo Basin	72,293	173,301	2.40	6.30	0.009%

Figure 23. Analysis of human settlement patterns in the Kabompo Basin. While the building density increases nearly fourfold within 4 km of the river, the total built footprint remains below 0.01% of the land area.

LAND-USE CHANGE ANALYSIS

Methods: LULC change analysis

The land-use and land-cover (LULC) change analysis for the Kabompo River Basin was conducted using 300 m resolution maps from the European Space Agency Climate Change Initiative. These maps, covering 1992 and 2020, were reclassified into broader categories based on user guidelines for change detection.

Results and Discussion: LULC change analysis

The landscape of the Kabompo River Basin between 1992 and 2020 remained largely dominated by natural vegetation, particularly forest and woodland. Forest and woodland covered 64,602 km² in 1992 and still accounted for 64,293 km² by 2020, marking only a slight decrease of 0.48%.

Other natural land covers such as grassland, shrubland, wetlands, and water bodies also experienced changes. Grassland area increased modestly by 2.79%, while shrubland expanded by 2.44%. These increases could be a consequence of localised forest degradation, natural ecological succession, or climate-driven shifts favouring more open vegetation types. Wetlands, which increased by 3.84%, are especially important as they act as natural filters and buffers for the river, absorbing floodwaters and improving water quality.

While the natural vegetation of the Kabompo Basin remains largely intact, human-modified land covers have expanded over the past three decades. Agricultural land grew from 2,219 km² to 2,382 km², reflecting a 7.35% increase. Although modest in area relative to the size of the basin, this agricultural expansion is significant because it signals greater pressure on the landscape. Conversion of forest and woodland into farmland can introduce increased soil erosion, nutrient runoff, and habitat fragmentation, all of which can degrade the health of the Kabompo River. Runoff carrying fertilizers, pesticides, and sediments from new agricultural fields risks polluting the river, altering its water quality and threatening aquatic life. Settlement areas also grew, from 7 km² to 16 km² — a rise of 143.59%. Settlements typically bring with them intensified land clearing, construction of roads, and an increase in impermeable surfaces, all of which can significantly affect local water cycles.

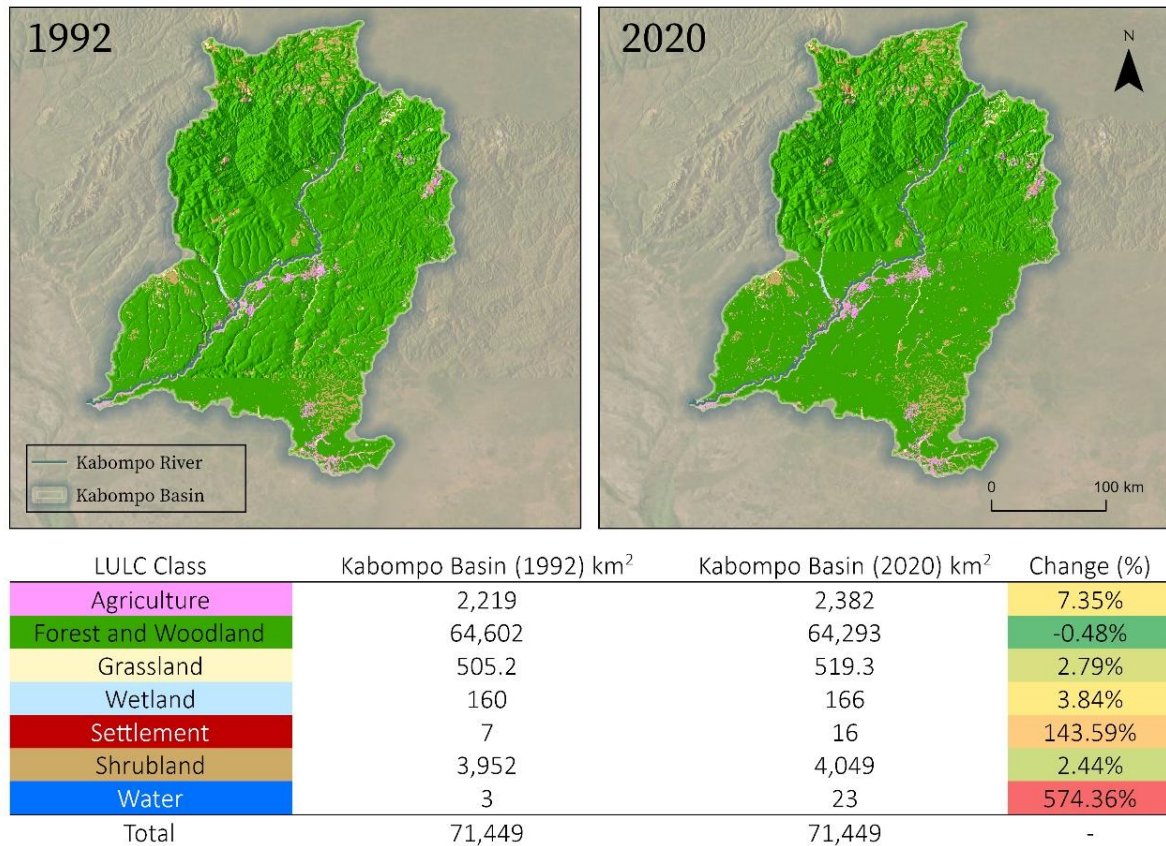


Figure 24. The land-use land change analysis of the Kabompo Basin from 1992 to 2020.

WorldCereal CROPLAND ANALYSIS

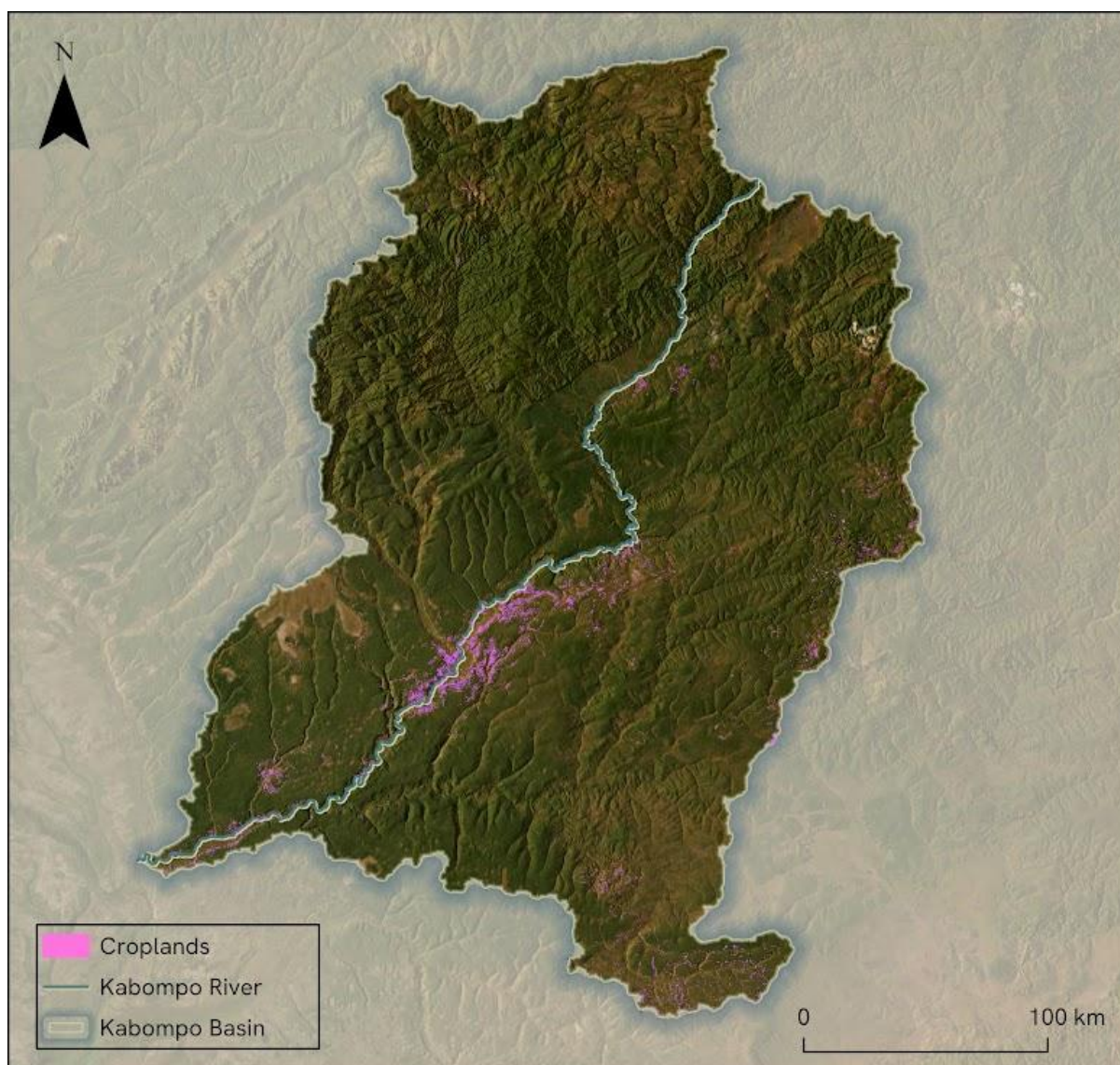
Methods: WorldCereal Cropland Analysis

WorldCereal is an open-source system, developed under the European Space Agency's initiative, that provides comprehensive, seasonal, and reproducible maps of global crop extents [15]. In this analysis, WorldCereal data was used to calculate the extent of cropland within a 10 km buffer zone around the Kabompo River. The total cropland area within this buffer zone was determined by summing the areas of identified croplands.

Results and Discussion: WorldCereal Cropland Analysis

Cropland is extremely limited across the Kabompo River Basin. Out of a total area of 72,293 km², only 49.06 km² is classified as cropland, representing a mere 0.07% of the basin. This very small proportion underscores the largely natural character of the landscape, with agriculture exerting minimal direct pressure on the wider basin at present. Croplands are not evenly distributed but are instead concentrated along specific parts of the river corridor and southern basin, as shown by the localized pink patches on the map.

Within a 10 km buffer surrounding the Kabompo River, croplands cover 22.76 km² out of 9,556 km², accounting for about 0.24% of the buffer zone. Although still representing a tiny fraction of the landscape, croplands are more common near the river compared to the entire basin.



	Area (km ²)	Total cropland area (km ²)	Cropland area (%) within buffer zone
Kabompo River 10km Buffer	9,556	22.76	0.24%
	Area (km ²)	Total cropland area (km ²)	Cropland area (%) within basin
Kabompo Basin	72,293	49.06	0.07%

Figure 25. Distribution and extent of cropland within the Kabompo Basin versus a 10 km riparian buffer. Analysis indicates that agricultural activity is concentrated near the river corridor, though it remains a minor component of the overall landscape.