



THE
WILDERNESS
PROJECT

EXPEDITION OVERVIEW

LUFUBU RIVER

2025



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 km² of irreplaceable African wilderness. Central to this effort is establishing detailed hydrological and ecological baselines of the largely undocumented sources and watersheds of Africa's greatest river basins — Zambezi, Congo, Nile, and Okavango.

ACKNOWLEDGEMENTS

Our research transects would be impossible without the collaboration of our partners, who provide access to the river, permissions to camp, and invaluable local perspectives. For their continued support for our work along the Lufubu River, we thank Department of National Parks and Wildlife, Copperbelt University, Frankfurt Zoological Society, the Water Resources Management Authority, the University of Zambia, and the Wild Bird Trust.



INTRODUCTION

The Lufubu River rises in the Congo-Zambezi divide of Northern Zambia, at an elevation of approximately 1,500 m above sea level. The river descends 375 km, emptying into Lake Tanganyika, which drains westwards into the Lukuga, and ultimately the Lualaba branch of the mighty Congo River. The Lufubu River's steep longitudinal gradient gives it an energetic and turbulent flow, the rumble of which breathes life into the surrounding landscape of closed gallery forests, broadleaf miombo woodlands, and Itigi-Sumbu thickets.

Located in one of Zambia's wettest regions, the Lufubu River is fed by summer rainfall (January-March), generating powerful flows. These pulses transport water and sediments from the upper catchment towards Lake Tanganyika, influencing lake turbidity, nutrient availability, and nearshore habitat conditions at the rivers' delta.

Combined with the river's steep gradient; rapids, gorges and waterfalls create a spatial divide that has isolated freshwater species across its reaches. This has led to the evolution of exceptional freshwater biodiversity and endemism. Several fish lineages, including the ancient *Lufubuchromis* group, are restricted to the upper reaches (above Chika Falls), while downstream communities show increasing affinity with lake-margin habitats. At least 37 species of fish are found in the river¹, many of which are found nowhere else on earth.

The Lufubu catchment faces unprecedented changes that risk its ecological integrity. Deforestation, driven by late dry-season burning, selective hardwood extraction, and agriculture expansion, has the potential to enhance erosion and sedimentation in the river. Additionally, hydropower development threatens to fundamentally alter the flow and water quality of the river, causing irreversible changes in the aquatic biodiversity. This underscores the urgent need for a coordinated, comprehensive river baseline, against which future changes along the river can be assessed and impact measured.



THE CONGO BASIN

The Lufubu River lies within the Congo Basin, the world's second-largest river system. The Congo River Basin holds more than half of Africa's freshwater and supports millions of livelihoods through diverse ecosystem services, including water, food, energy, transport, education, recreation, and climate regulation².



LUFUBU RIVER BASIN

The Lufubu River Basin is a key water source for Lake Tanganyika. A substantial portion of the river flows through the Nsumbu-Tanganyika Ecosystem (NTE), a conservation landscape that includes Nsumbu National Park, the Tondwa and Kaputa Game Management Areas, Mweru Wantipa National Park, and adjoining community-managed areas. Within the basin itself lie small sections of the Tondwa and Kaputa Game Management Areas, alongside most of Nsumbu National Park.

This mosaic of protected and semi-protected land supports one of the most diverse habitat assemblages in northern Zambia, ranging from dense Itigi-Sumbu thicket and miombo woodland to lakeshore wetlands, escarpment forests, and valley-floor riparian corridors. Ecological connectivity between these habitats, maintained by the Lufubu River and its tributaries, underpins the region's role as a refuge for wildlife, stabilises the Lake Tanganyika shoreline, and reinforces the basin's importance as a lifeline for both biodiversity and downstream communities.

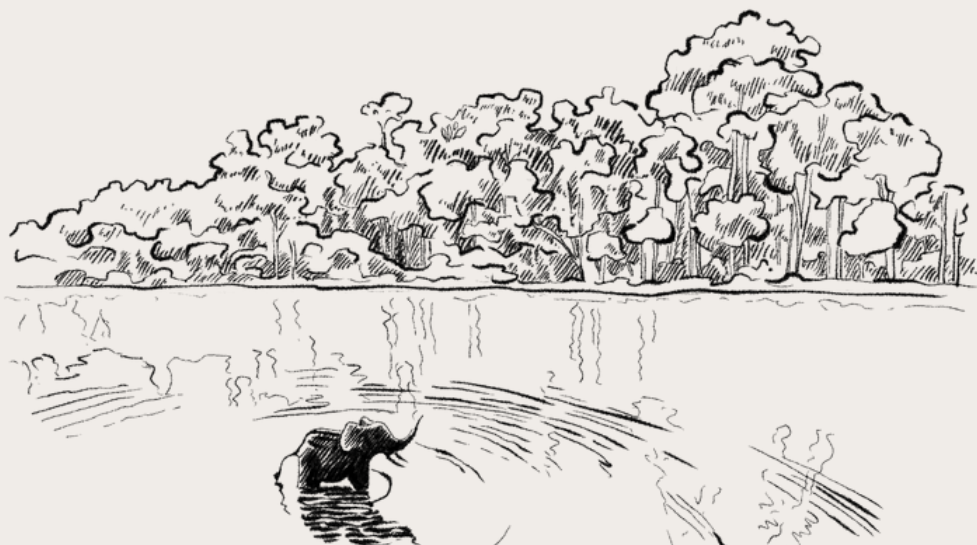


NSUMBU TANGANYIKA ECOSYSTEM

Over the past decade, the ecosystem has been the focus of sustained management and recovery efforts led by the Nsumbu Tanganyika Conservation Programme (NTCP), a long-term partnership between the Department of National Parks and Wildlife and the Frankfurt Zoological Society. These efforts have strengthened anti-poaching operations, expanded ranger training, and established specialised units such as the Tanganyika Boat Unit to secure river and lakeshore access points. In parallel, habitat protection has improved through enhanced fire management and reduced illegal timber extraction, while systematic snare removal has remained a core component of broader resource protection efforts.

Targeted ecological restoration has complemented these protection measures. Building on the 2021 reintroduction of 200 buffalo and 48 zebra, the park's predator-prey balance was restored in September 2024 when three lions were translocated from North Luangwa. Supported by the Nsama Chiefdom—the Abashimba or "Clan of the Lion"—this rewilding effort ended a decade-long absence of the species and signifies a major ecological and cultural milestone. To track this progress, the NTCP's Ecological Monitoring Unit conducts regular aerial surveys, camera-trap grids, and aquatic biodiversity assessments, providing a clear data-driven understanding of the ecosystem's recovery trajectory.

Within Lake Tanganyika, collaborative fisheries initiatives led by the Department of Fisheries in partnership with Conservation Lake Tanganyika (CLT) and the NTCP aim to reduce the use of illegal gear, thereby protecting valuable fish stocks. Together with efforts in Nsumbu National Park, those of the surrounding Game Management Areas (Tondwa and Kaputa) and local communities aim to position the Nsumbu-Tanganyika Ecosystem as a recovering and increasingly biodiverse landscape. Ongoing management will ensure that the Lufubu River continues to provide invaluable biodiversity, provisioning and regulatory ecosystem benefits to Zambians for generations to come.



THE EXPEDITION

375 km



traversed by foot,
ark and canoe



The Wilderness Project (TWP) conducted a 375 km research transect along the Lufubu River from 4th – 20th September 2025. The aim was to collect baseline data on hydrology, water quality, biodiversity, and human activity to inform future monitoring and support sustainable river management. The study also identified key conservation insights, including ongoing threats to the river.



METHODS

CONTINUOUS MONITORING

During the transect, teams collected continuous survey data and 360° imagery. Each team included an observer and a recorder. Observers scanned the river and both banks — up to 100 m from the edge — identifying features such as 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 10km:* using drone imagery and water analysis, researchers revealed patterns not visible through observation alone.
- *Every 50-75km:* eDNA sampling, macroinvertebrate surveys, and further testing provide 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 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

50 fixed sites

52

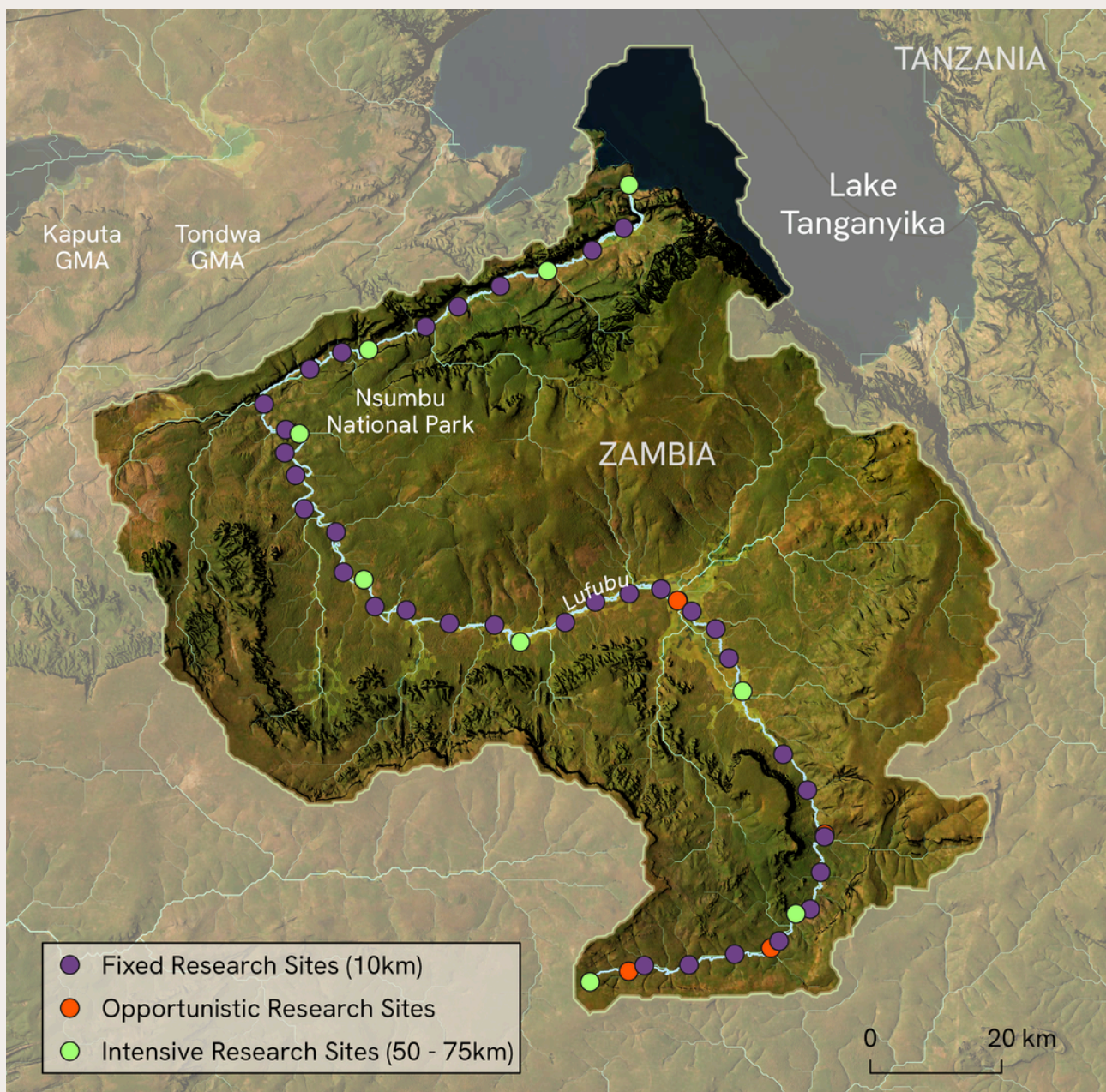
water quality
measurements

45

aerial drone
surveys

61

wetland bird
species recorded



The locations of 50 fixed and 9 intensive research sites.

LUFUBU BIOBLITZ

In parallel with the expedition, a targeted biodiversity survey was conducted between 21 August and 1 September 2025 at selected sites along the Lufubu River, from a base camp at Chika Falls. The survey sought to rapidly document species diversity, identify potentially undescribed or range-restricted taxa, and establish baseline ecological data to support long-term monitoring and conservation planning. These data provide a robust scientific basis for understanding the river’s biodiversity value and conservation relevance and for informing future management decisions.

The survey was led by a multidisciplinary team of specialists, including ichthyologists, lepidopterists, ornithologists, and a herpetologist, supported by generalist scientists who assisted with field sampling and specimen processing. Sampling techniques included: electrofishing, nets and traps for fish; active searches and aquatic sampling for amphibians and reptiles; sweep netting and light trapping for butterflies and moths; and point counts for birds.

Detailed taxonomic assessment is underway. Once verification is complete, a full Lufubu Bioblitz report will be made available. The results presented elsewhere in this report are based solely on data collected during the longitudinal river expedition and are independent of the targeted biodiversity survey. A preliminary summary of records from the bioblitz is presented below:

Taxonomic group	Preliminary summary of records
Fish	37 species
Amphibians and reptiles	23 frog species, 3 lizard species, 3 snake species
Butterflies and moths	142 species
Dragonflies and damselflies	25 species



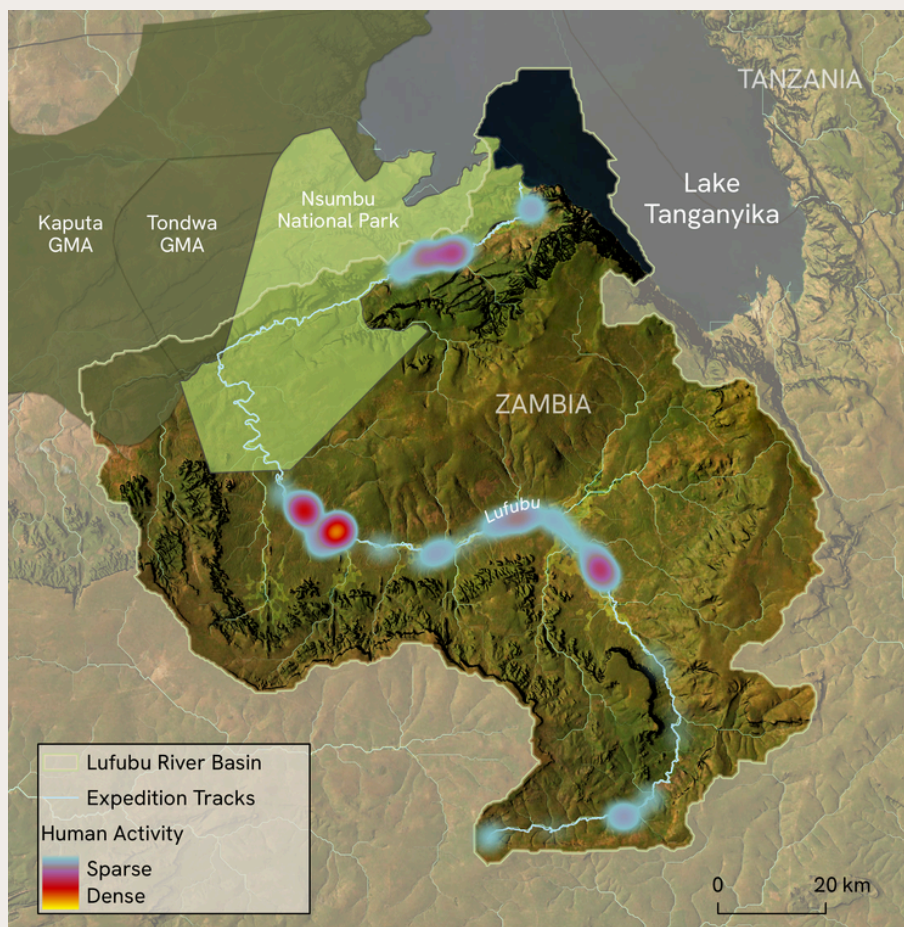
Bioblitz Highlights. A snapshot of the Lufubu River’s diverse biota. Rapid biological assessments identified a wide array of specialized taxa, from lepidoptera to reptiles, emphasizing the basin’s role as a critical biodiversity hotspot.

HUMAN ACTIVITY

The Lufubu River flows through a remote and sparsely populated area of northern Zambia. Much of the river channel is deeply incised and bordered by steep slopes or dense woodland, which limits direct access and results in few settlements close to the riverbank. Villages and homesteads are concentrated in the upper catchment and around the lower floodplain, while the section within Nsumbu National Park has no permanent settlements. The presence of tsetse flies (*Glossina spp.*) across much of northern Zambia has also contributed to lower rural population densities^{3,4}.

While Northern Province has a population density of 20.9 people/km², the Lubufu catchment remains far more remote⁵. Along the river itself, the 2025 TWP survey recorded a density of just 5 people/10 km. This is sparse compared to similar rivers in Zambia, for example the Kabompo (25 people/10 km) or Chambeshi (34 people/10 km).

The primary form of agriculture was small-scale cassava cultivation mostly adjacent settlements. Fishing occurred throughout the system but was most intense in the lower reaches near Lake Tanganyika, where nets, traps, and temporary fishing camps were common. In the upper and middle sections, fishing activity was more limited, although several instances of illegal or prohibited fishing gear were encountered, including nets placed in restricted areas.



| Spatial distribution of human activity along the Lufubu River corridor.

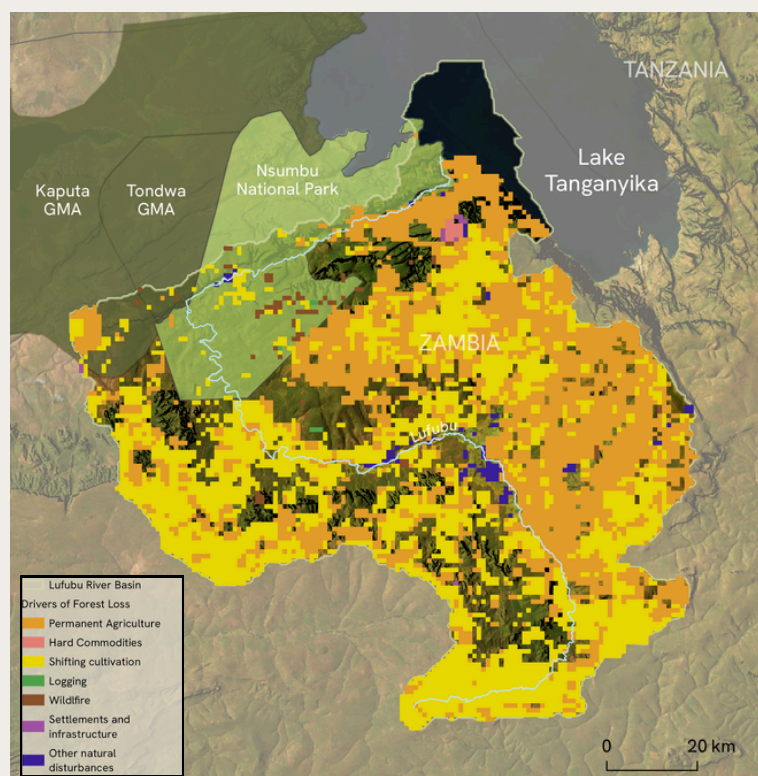
FOREST LOSS

Forest loss in Zambia is driven primarily by agriculture and fuelwood demand. Estimates suggest approximately 250 000–300 000 ha of forest is lost annually, equating to around 0.5–0.6 % of total forest cover per year^{6,7}.

Charcoal production was noted in the upper Lufubu catchment, where a small number of kilns and stockpiles were observed in forested areas, often associated with selective hardwood harvesting. Agriculture was more common, suggesting that this is the primary driver of deforestation within the Lufubu Basin.

To examine the drivers of forest loss within the Lufubu Basin between 2001–2024, data was extracted from the WRI–Google DeepMind global driver dataset at 1 km resolution. This dataset uses annual tree cover loss data from the University of Maryland Global Forest Change dataset, derived from Landsat satellite imagery, and applies spatial modelling to assign each 1 km grid cell the primary direct driver of loss over the study period across seven categories.

7,254 km² of forest was lost to potential deforestation in the Lufubu Basin between 2001–2022. This was overwhelmingly driven by permanent and shifting agriculture, representing 3268 km² of deforestation. While forest loss to shifting agriculture may be temporary, allowing for some regrowth, it is clear that agriculture is the primary driver of land cover in the basin, shaping the woodland catchment that sustains the Lufubu River and its tributaries (see map below).



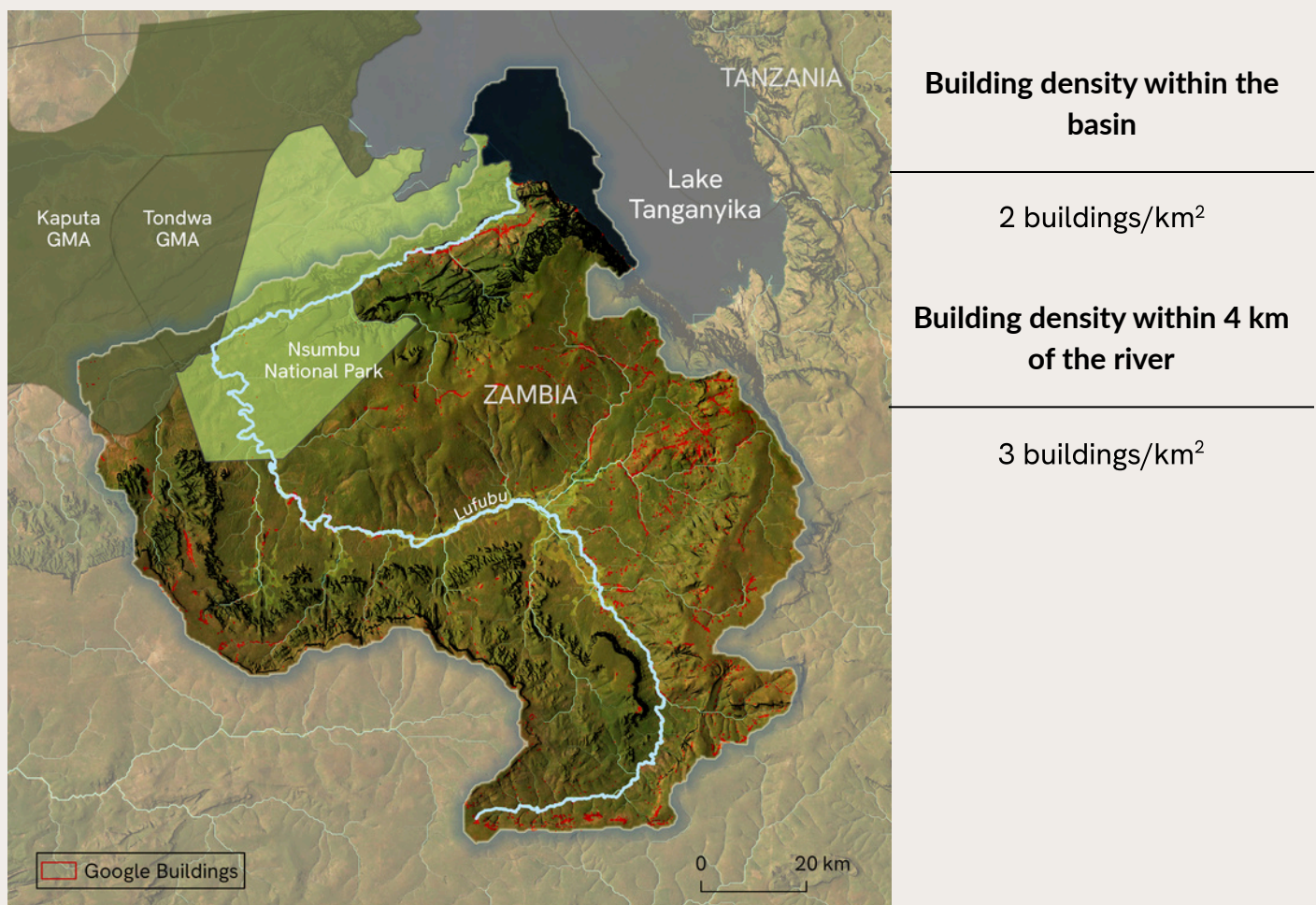
Dominant drivers of tree cover loss in the Lufubu River Basin, 2001–2024.

BUILDING ANALYSIS

Google's Open Buildings dataset is a global mapping resource that uses high-resolution satellite imagery to identify and outline individual building footprints. By mapping the location and density of buildings, the data provides a landscape-wide view of human activity⁸. This perspective allows for consistent, basin-scale analyses that help to identify areas of potential environmental impact.

The Lufubu River has an average building density of 3 buildings/km² (within a 4 km buffer of the river) indicating a relatively low level of development compared to other major river systems in Zambia. By comparison, the Kafue River averages around 24 buildings per km². This makes the Lufubu River one of the least developed major river corridors in Zambia.

Several factors explain the low development levels. Much of the Lufubu flows through steep, fault-controlled terrain in the southern Lake Tanganyika basin, where deep valleys, rugged escarpments, and dense woodland constrain road construction and permanent settlement. Long sections of the river also run through or alongside protected areas, including Nsumbu National Park, where regulations limit infrastructure development.



| The distribution of buildings within the Lufubu Basin.

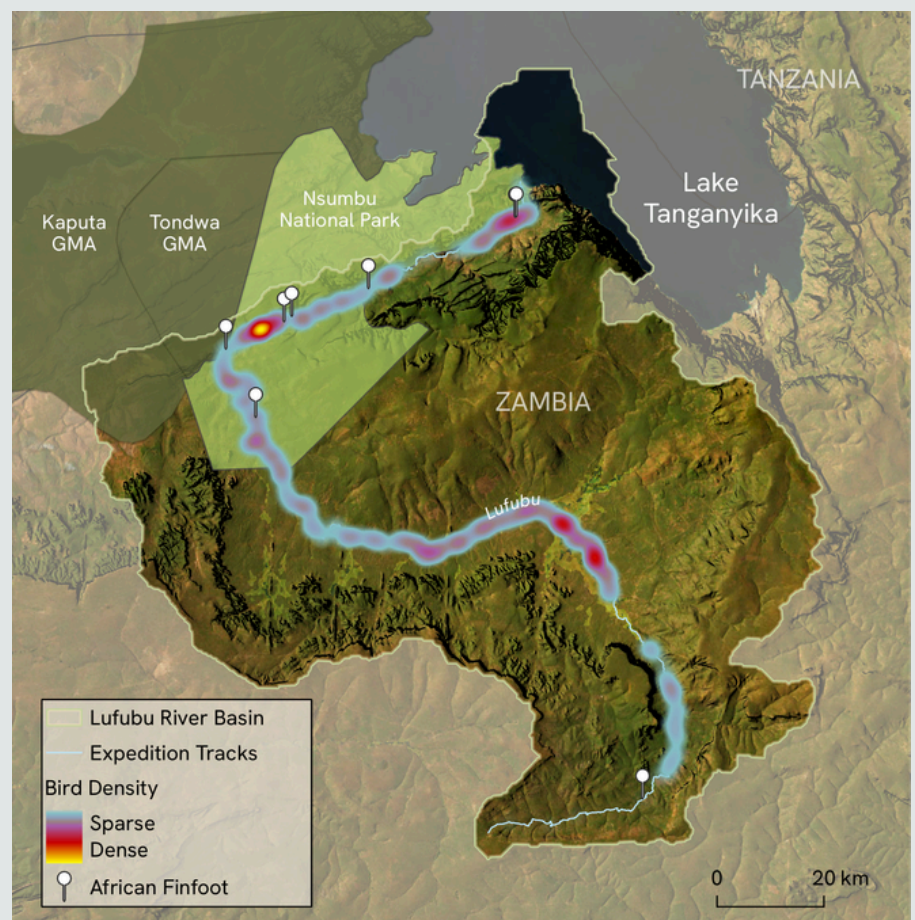
WETLAND BIRDS

Wetland-associated birds respond rapidly to changes in habitat availability and condition. Their diversity and abundance can provide an indication of habitat degradation, as they rely on intact riparian habitats for foraging, breeding, and roosting. Monitoring wetland bird communities can therefore reveal early signs of environmental change and help identify areas of conservation importance.

A total of 1,374 wetland-associated birds from 61 species were counted along the Lufubu River, with the highest concentrations in wetlands and floodplains. The little bee-eater and malachite kingfisher were the most common birds, both of which roost and feed in riparian vegetation.

African Finfoots are also charismatic indicators of healthy riparian vegetation. These were recorded primarily within Nsumbu National Park and were scarce elsewhere, despite suitable habitat. This indicates that the protections offered by the national park effectively extend to the biodiversity of the Lufubu River.

Bird Species	Count
Little bee-eater	204
Malachite kingfisher	142
Yellow billed kite	109
Southern carmine bee-eater	101
Pied kingfisher	75
Striated heron	68
Rock Pratincole	64
Common sandpiper	55
Grey-headed kingfisher	42
Half-collared kingfisher	42



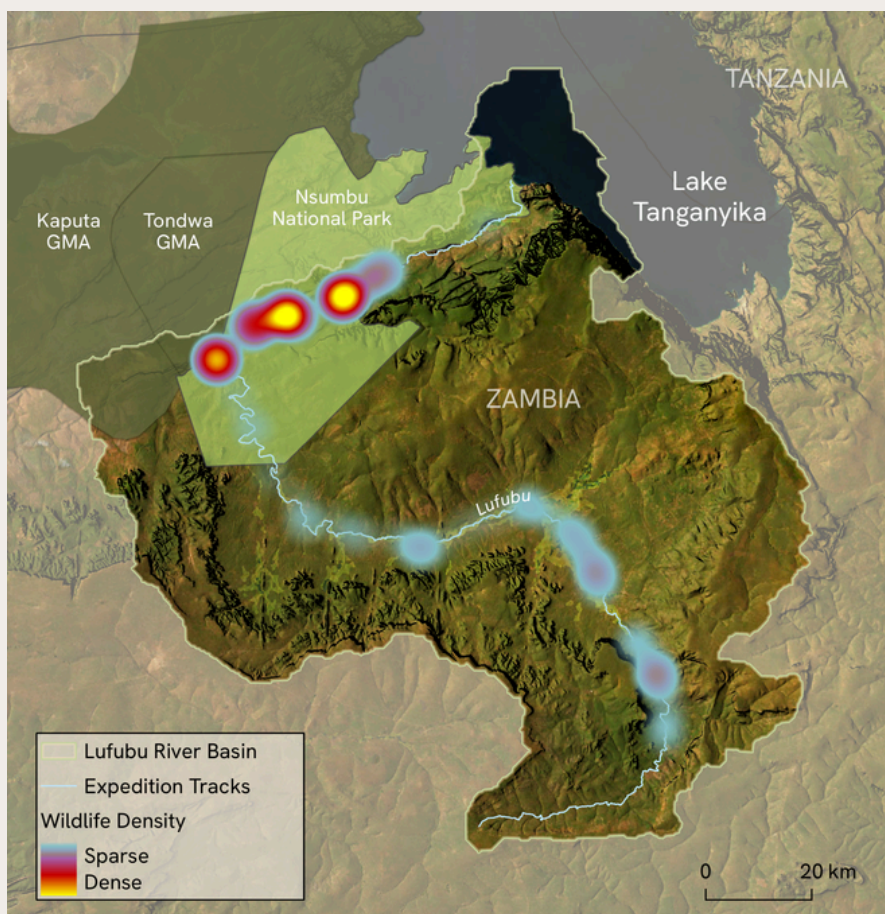
The ten most frequently recorded bird species in the Lufubu River Basin (left), and the distribution of African finfoots and bird density (right)

WILDLIFE

Larger animals were rare along the Lufubu River, including within the Nsumbu National Park. Just four hippos and one crocodile were counted along the entire transect, with the total wildlife count equating to just 6 animals/10 km.

The Lufubu River has steep riverbanks and a flashy hydrology, possibly leading to a naturally lower carrying capacity for hippos than some other rivers in Zambia. However, other rivers in the region, including the Chambeshi/Luapula and Kabompo systems, also have very low wildlife densities, despite suitable habitat.

In the late 90s, the wider Nsumbu-Tanganyika landscape experienced intensive poaching and widespread bushmeat hunting. The Lufubu River was a highway for this trade, and, although protection and law enforcement have strengthened in recent years, pressure along the river corridor persists. During the expedition, the team recorded multiple snares and crocodile traps along the riverbanks, indicating ongoing illegal hunting activity.



Outside Nsumbu NP	Inside Nsumbu NP
2 animals /10 km	11 animals / 10 km

Wildlife distribution along the transect, highlighting a significant concentration within Nsumbu National Park

FISH SAMPLING

Fish sampling provides the baseline data needed to document species richness, assess community structure, and evaluate ecosystem condition. In river systems with limited historical records, such surveys are particularly important, as gaps in past sampling constrain understanding of species distributions and conservation status. This is especially relevant in the Lufubu River, a major tributary of Lake Tanganyika within a region recognised for exceptional freshwater fish diversity and endemism.

To sample fish diversity, a fyke net was set overnight at 14 sites along the Lufubu River. Additional sampling was carried out opportunistically using a dip net. Specimens were identified in the field, with photographs and vouchers collected for verification and future study. Sampling yielded 161 fish specimens representing 27 species (see Appendix 2 for a provisional fish species list).



AQUATIC MACROINVERTEBRATES

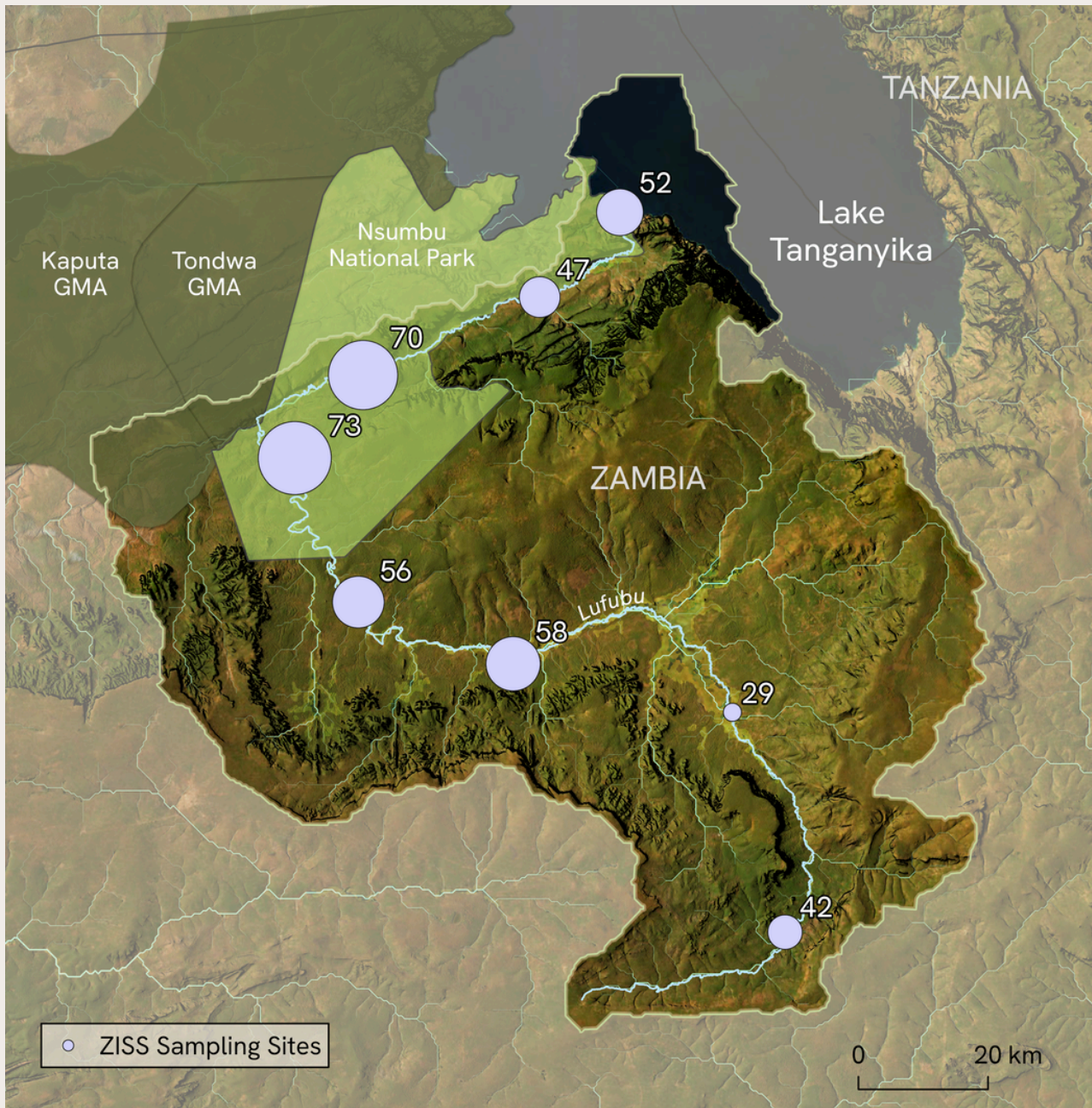
The Zambian Invertebrate Scoring System (ZISS) is a standardised field-based bioassessment protocol for rapidly assessing the health of perennial rivers in Zambia. The protocol involves three stages: i) collecting aquatic macroinvertebrates from several habitats within the river; ii) identifying these organisms to a family level; and iii) comparing the identified macroinvertebrate families to a peer-reviewed matrix of predetermined scores. Using this information, the protocol allows researchers to infer the health of perennial rivers⁹. Generally, higher ZISS scores indicate healthier and more diverse aquatic habitats. Additional metrics for comparison include the total number of taxa recorded and the average score per taxon (ASPT).

The average ZISS score for the Lufubu River was low (53.3). This result reflects the limited availability of suitable habitat, to which ZISS is particularly sensitive, rather than degraded river health. In this context, the scores provide an important baseline against which future ZISS assessments can detect ecological change associated with land conversion, impoundment or other drivers of change along the river.

Summary of ZISS results for each sampling site along the Lufubu River, showing ZISS score, number of taxa recorded, and Average Score Per Taxon (ASPT).

Site	Ziss Score	No. of Taxon	ASPT
LUFU25_008	42	7	6
LUFU25_018	29	6	4.8
LUFU25_029	58	13	4.5
LUFU25_035	56	9	6.2
LUFU25_043	73	13	5.6
LUFU25_048	70	10	7
LUFU25_052	47	8	5.9
LUFU25_055	52	12	4.3

AQUATIC MACROINVERTEBRATES



The distribution of ZISS scores along the river, note the higher scores within Nsumbu National Park

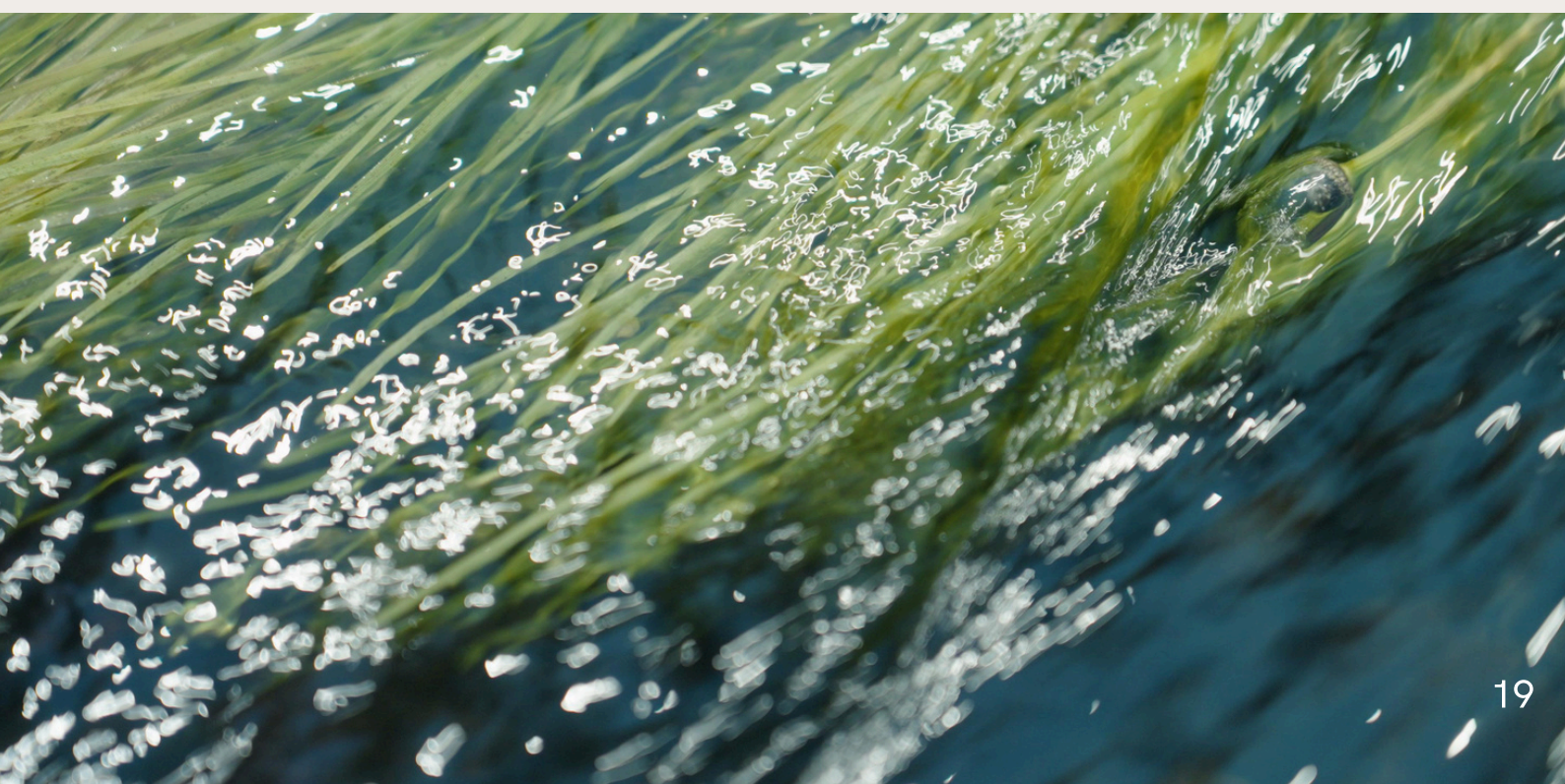
WATER QUALITY

Water quality along the Lufubu River was generally good, with stable pH, dissolved oxygen, and temperature values typical of a clear, fast-flowing river draining a high-rainfall woodland catchment. Turbidity, a measure of water clarity, remained low across most of the transect, suggesting limited sediment runoff from the surrounding catchment. However, a marked local increase occurred at the Luchenche tributary, which entered the Lufubu carrying murky water.

Upstream of its confluence with the Luchenche, the Lufubu remained very clear, with turbidity values of approximately 1.9 NTU. At the confluence, however, the Luchenche entered at roughly 49 NTU, causing turbidity in the Lufubu to rise sharply to around 30 NTU immediately downstream. This abrupt increase indicates that the tributary is transporting substantially higher sediment loads than the mainstem.

Inspection of recent satellite imagery suggests that large-scale forest clearing for agriculture is occurring in the Luchenche headwaters. This pattern is consistent with the forest loss analysis presented above, which identifies agricultural expansion as the dominant driver of land cover change in the basin. Clearance in these upper catchments likely reduces vegetation cover and soil stability, increasing erosion and sediment delivery to tributaries such as the Luchenche.

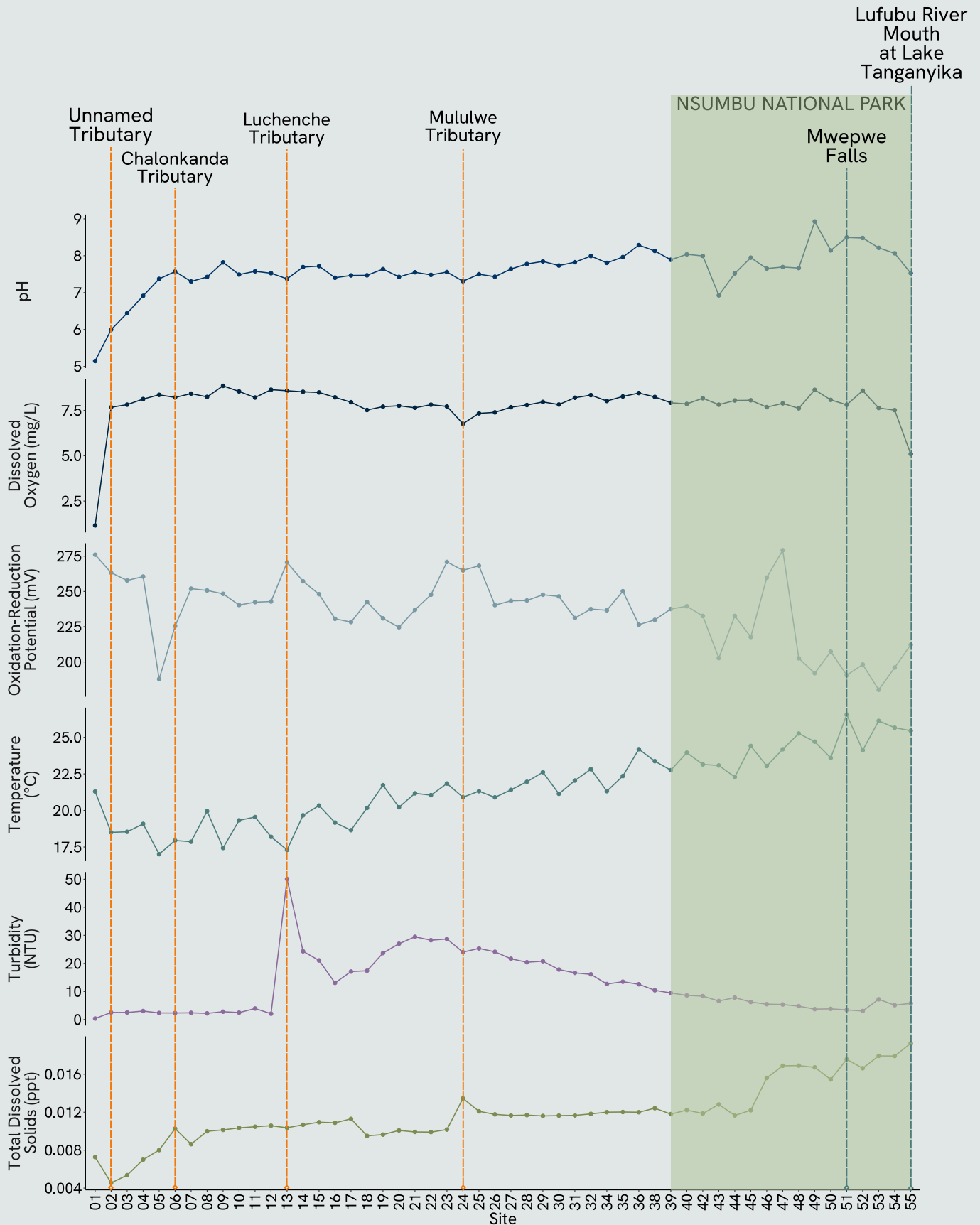
Further downstream, turbidity gradually declined as suspended sediments settled and the river flowed through sections with intact riparian vegetation, particularly within protected areas. The return to clearer water highlights the Lufubu's capacity to buffer localised sediment inputs and underscores the role of intact floodplain and riverbank habitats in maintaining water quality.





Drone image of the confluence between the Luchenche Tributary and the Lufubu River mainstem, illustrating contrasting water clarity and physicochemical conditions. In situ measurements highlight higher turbidity in the tributary relative to the Lufubu mainstem.

WATER QUALITY



It's important to note that these findings represent a snapshot of water quality during the time of sampling, and conditions may shift seasonally or in response to land use changes, rainfall, or other environmental factors. While field parameters offer valuable insight into the river's condition, they cannot detect all contaminants — such as heavy metals or certain organic pollutants. To supplement this dataset, water samples from selected sites have been submitted for laboratory analysis, with results pending.

RIVER FLOW

The Lufubu River is perennial but exhibits a strongly seasonal flow regime typical of northern Zambian rivers. Discharge declines progressively through the dry season to a minimum of around $17 \text{ m}^3/\text{s}$ in October, before increasing rapidly following the onset of the rains to peak flows in March of up to approximately $301 \text{ m}^3/\text{s}^{10}$. This wide range between low-flow and high-flow conditions highlights the river's strong responsiveness to seasonal rainfall. A runoff coefficient of approximately 20% places the Lufubu among the highest runoff rivers in Zambia, indicating efficient conversion of rainfall to streamflow relative to many other Zambian catchments^{11,12}.

Discharge measurements collected during the September expedition show a clear downstream increase in flow along the Lufubu River, from approximately $2 \text{ m}^3/\text{s}$ in the upper reaches to around $18 \text{ m}^3/\text{s}$ farther downstream. An intermediate increase of approximately $5 \text{ m}^3/\text{s}$ was associated with the Muluwe Tributary, demonstrating the importance of tributary inflows during the late dry season.

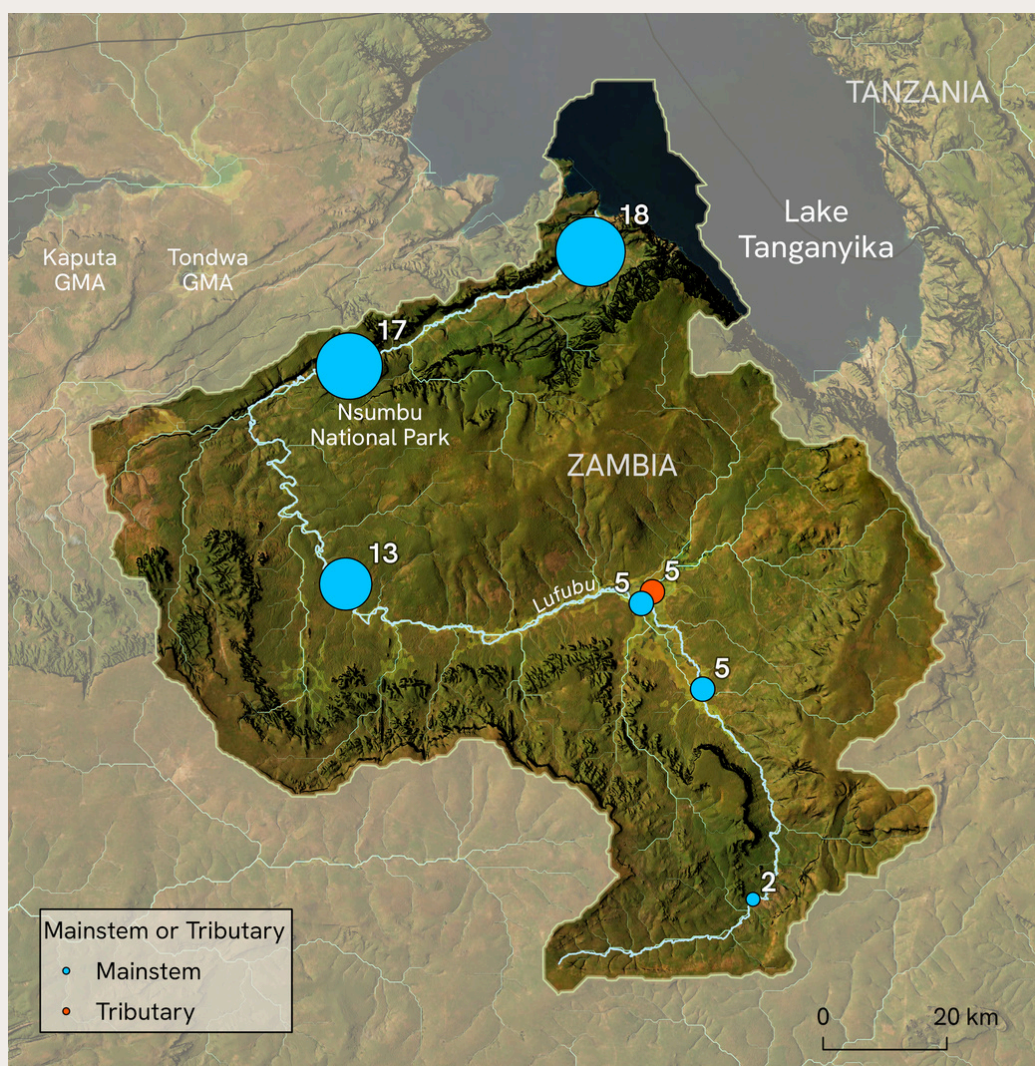
| *Chika Falls: Embodying the Lufubu's intense seasonal pulses.*



RIVER FLOW

| Flow results along the Lufubu River and an adjacent unnamed tributary during September 2025.

Description	Discharge (m ³ /s)	Date
Lufubu	2	5 Sept 2025
Lufubu	5	9 Sept 2025
Muluwe Tributary	5	10 Sept 2025
Lufubu	5	10 Sept 2025
Lufubu	13	13 Sept 2025
Lufubu	17	17 Sept 2025
Lufubu	18	19 Sept 2025



| River flow was measured at seven sites along the river using an acoustic doppler current profiler (ADCP)

CONCLUSION

The 2025 transect highlights the substantial biological value of the Lufubu River and its role in sustaining diverse riverine and aquatic communities. Surveys recorded a broad assemblage of wetland-associated birds (61 species), a range of freshwater fish species (27 species), and generally good water quality along much of the river, patterns that align with low levels of settlement and infrastructure across the catchment.

Targeted biodiversity surveys conducted alongside the transect further documented high taxonomic diversity across aquatic and terrestrial groups, reinforcing the importance of the Lufubu. This value is closely linked to long-term conservation initiatives within the wider Nsumbu-Tanganyika landscape, where sustained investment in protection, habitat management, and ecological monitoring has helped maintain riparian integrity and supported wildlife recovery.

In the context of proposed hydropower development, the baseline established by this expedition provides a critical reference for understanding how future changes may interact with existing ecological conditions and conservation efforts. Recognising both the biological importance of the river and the value of ongoing conservation investment will be vital to secure the health of the Lufubu River for generations to come.



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APPENDICES

Appendix 1. The observational results of wildlife along the Lufubu River.

Species Names	Total individuals
Water monitor	52
Kinda baboon	120
Sykes monkey	17
Vervet monkey	10
Banded mongoose	5
Puku	5
Waterbuck	4
Warthog	3
Spotted necked otter	3
Hippopotamus	3
Bushbuck	2
Sable	1
Crocodile	1
Total	226

APPENDICES

Appendix 2. The provisional results of fish sampling; some species identifications are pending confirmation.

Species	Total individuals (n)
Amphilius sp.	1
Chiloglanis productis	1
Clarias sp. 1 (mottled)	2
Clarias sp. 2 (plain)	2
Enteromius bifrenatus	1
Enteromius cf. kersteni	9
Enteromius cf. thalamakanensis	19
Enteromius multilineatus	2
Enteromius sp.	3
Heteromormyrops sp.	1
Kneria sp.	4
Labeo cylindricus	1
Labeobarbus sp.	14
Lacustricola sp.	1
Lacustricola sp. 1 (blue)	11
Lacustricola sp. 2 (yellow)	2
Micralestes stormsi	26
Mormyridae sp.	1
Nanocharax multifasciatus	15
Petrocephalus sp.	1
Pseudocrenilabrus filander	4
Raiamas sp.	9
Rhabdalestes sp.	5
Rhabdalestes sp. Lufubu	10
Serranochromis sp.	2
Tilapia ruweti	2
Tilapia sparrmanii	11



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