THE WILDERNESS PROJECT

STATE OF THE BREEDE RIVER:

What the Data Tells Us

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 km^2 of irreplaceable African freshwater 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 such as the Zambezi, Congo, Nile, and Okavango, among several others.

TWP's pioneering assessments of Africa's major river basins use a standard methodology: following a river by canoe, mekoro or inflatable raft, from source to end, collecting scientific data and documenting stories through powerful imagery and videos along the way. Through the paired lenses of science and storytelling, we are able to provide both the in-depth data to inform decision-making and the compelling narratives to inspire action.

ACKNOWLEDGEMENT

The Breede River research transect was made possible through the collaboration and support of our partners. We acknowledge South African National Parks (SANParks) and the Department of Water and Sanitation, whose ongoing partnership underpins our broader work across South Africa. We are grateful to CapeNature for facilitating the permits and permissions required for the Breede expedition, and to the Freshwater Research Centre (FRC), whose local experitse contributed substantially to the planning and execution of the survey.

We also extend our sincere thanks to the Breede-Olifants Catchment Management Agency (BOCMA) for their stewardship of the catchment and their valuable input into this work. Their review of this report, and the local knowledge they generously shared, have strengthened it considerably. We are grateful for these partnerships and for the shared commitment to the future of the Breede River.

thewildernessproject.org

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INTRODUCTION

The Western Cape of South Africa faces an ongoing and severe water shortage crisis, driven by a combination of rising demand and intensifying climate change impacts. In response, the provincial government has implemented a Water Resilience Strategy designed to secure an additional 341 million m^3 of water by 2035 through augmentation, conservation, and infrastructure development[1]. Within this water-stressed landscape, the Breede River — managed by the Breede-Olifants Catchment Management Agency (BOCMA) — serves as a critical case study.

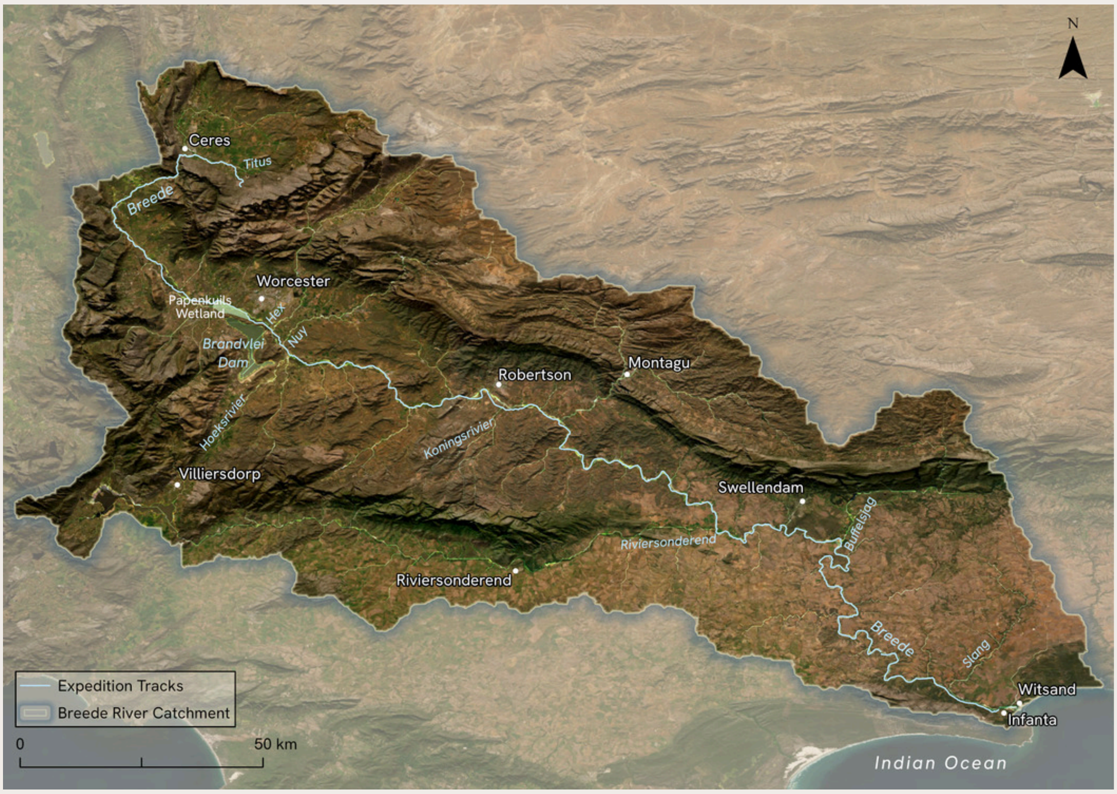
The Breede River drains a vast catchment of approximately 12,600 km^2, connecting the Matroosberg Mountain range to the Indian Ocean. Fed by clear streams around Ceres, the Breede flows southward through Worcester, Robertson, and Swellendam before reaching the sea near Witsand. Several tributaries, including the Hex, Riviersonderend, and Buffeljags Rivers, contribute vital flows to the Breede River in the winter months.

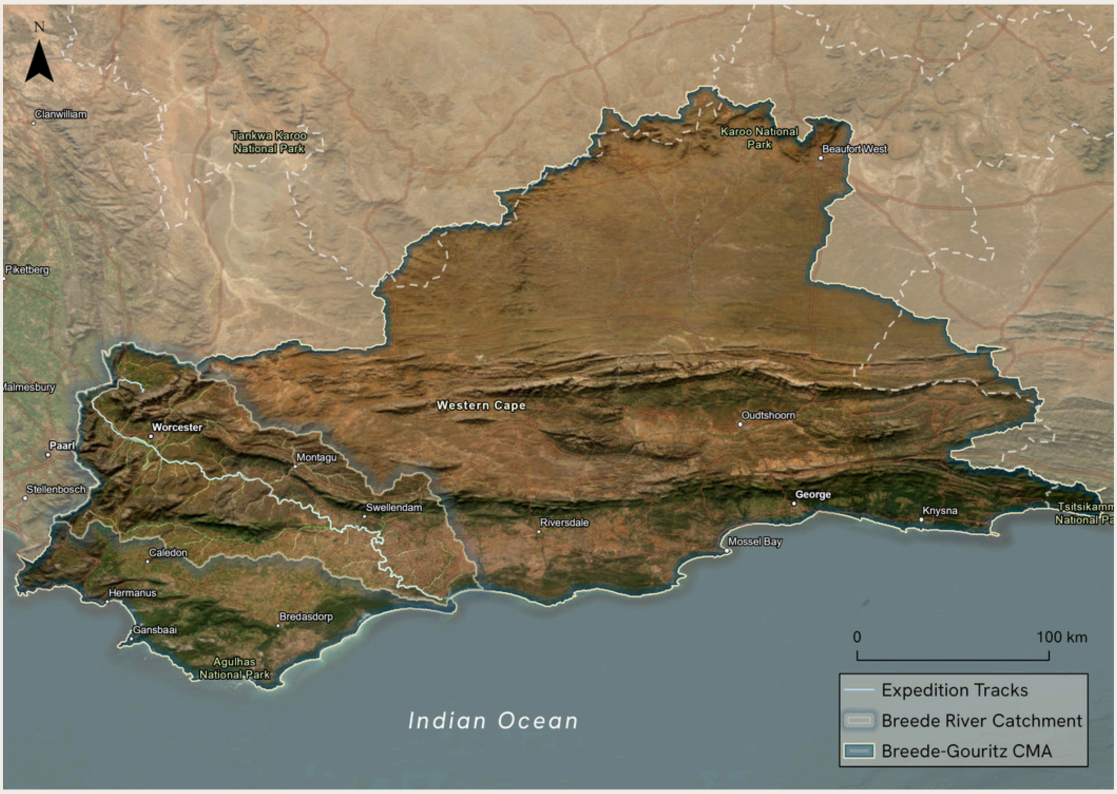
In the dry summer, many of these rivers are reduced to a series of standing pools. Agriculture accounts for 70% of water use within the catchment[2], with extensive fruit, viticulture, and grain production requiring regular irrigation. Additionally, domestic offtake, dam replenishment and thirsty invasive species use much of the remaining water budget, leaving very little for the natural biodiversity in the valley. This has led to calls for an updated water budget that incorporates: i) surface-groundwater connectivity; ii) river-wide water quality; and iii) a robust model of the minimum ecological base-flows needed to maintain downstream biodiversity.

In October 2025, The Wilderness Project undertook a survey of the entire length of the Breede River. This was done to obtain a snapshot of the biodiversity, water quality, hydrology and human presence along the river. This snapshot forms the basis of a 'Breede River Baseline' — repeat surveys will offer deeper insights into the health of the river. Ultimately, we hope that this work will be incorporated into the ongoing management, planning and conservation efforts within the Breede River Valley, securing the health of this iconic river for generations to come.

The Breede River is fed by several small, clear streams in the Matroosberg Mountain Catchment area near Ceres. In this source area, the water gets its natural reddish tinge from tannins from the surrounding fynbos vegetation.

THE BASIN





The Breede Basin is administered by Breede-Olifants Catchment Management Agency (BOCMA). Catchment management agencies are responsible for developing strategies to manage each Water Management Area (WMA), including the protection, use, development, conservation and regulation of water resources[3].

THE EXPEDITION

336 km

traversed on foot, pack raft, and canoe

12

team members

53

research sites established

12

days on expedition

The Wilderness Project Foundation (TWP), in partnership with the Freshwater Research Centre (FRC), conducted a 336 km survey of the Breede River. The expedition ran from the 4th to 15th of October 2025, taking advantage of the late winter rainfall that kept the river flowing in the springtime. Along the transect, researchers measured flow, water quality, biodiversity, and human activity using a standardised protocol that TWP has applied on over 37,000 km of rivers, lakes and wetlands across Africa.

The Breede expedition team comprised African researchers and a land-based support crew. Don Pinnock, a world-renowned South African writer and environmental journalist, also joined the expedition to document the experience. His series is available to read here.

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

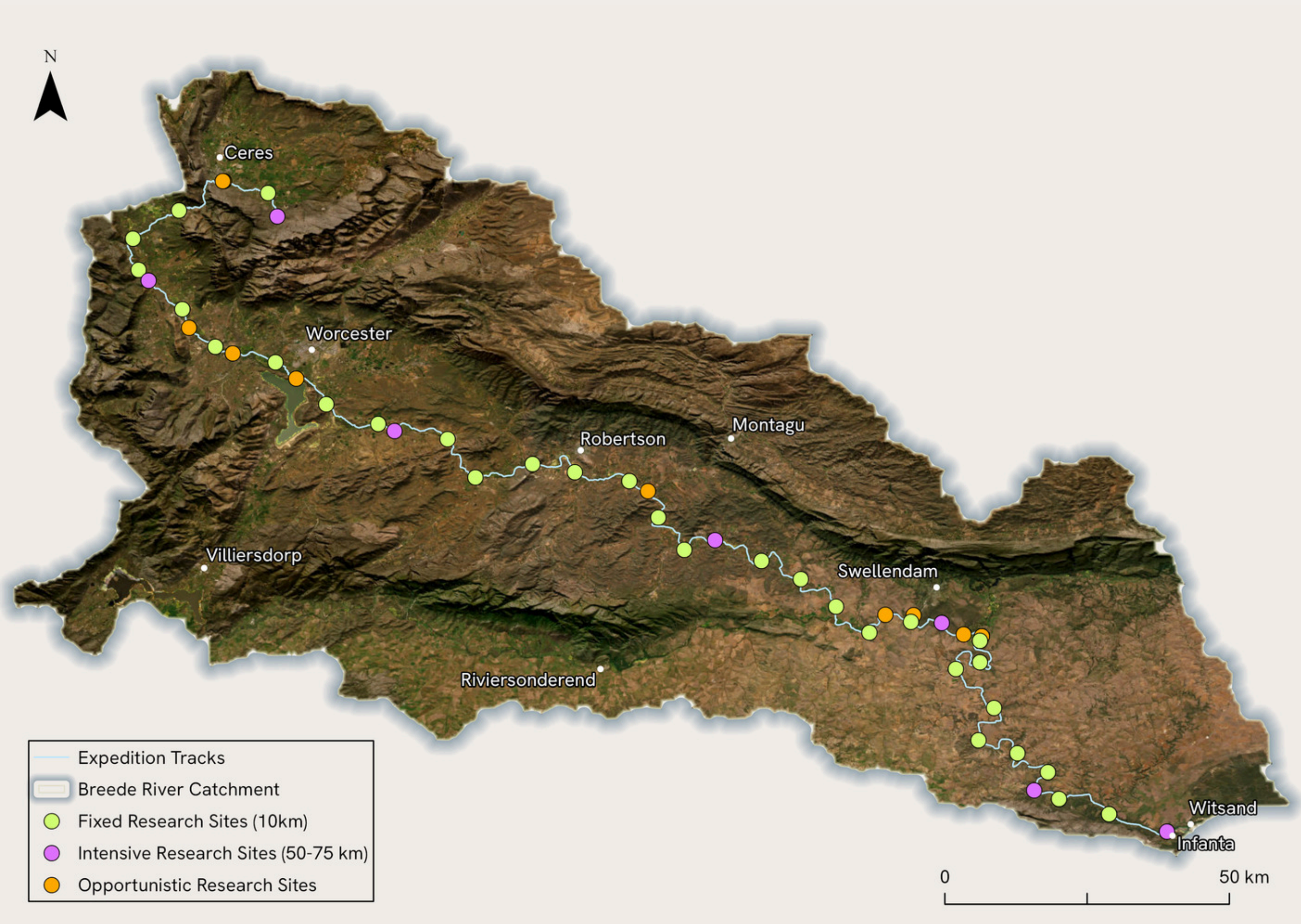
OPPORTUNISTIC SITES

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

53 sites

43	31	21
water quality measurements	aerial drone surveys	eDNA samples



The locations of research sites: 30 fixed, 7 intensive and 11 opportunistic.

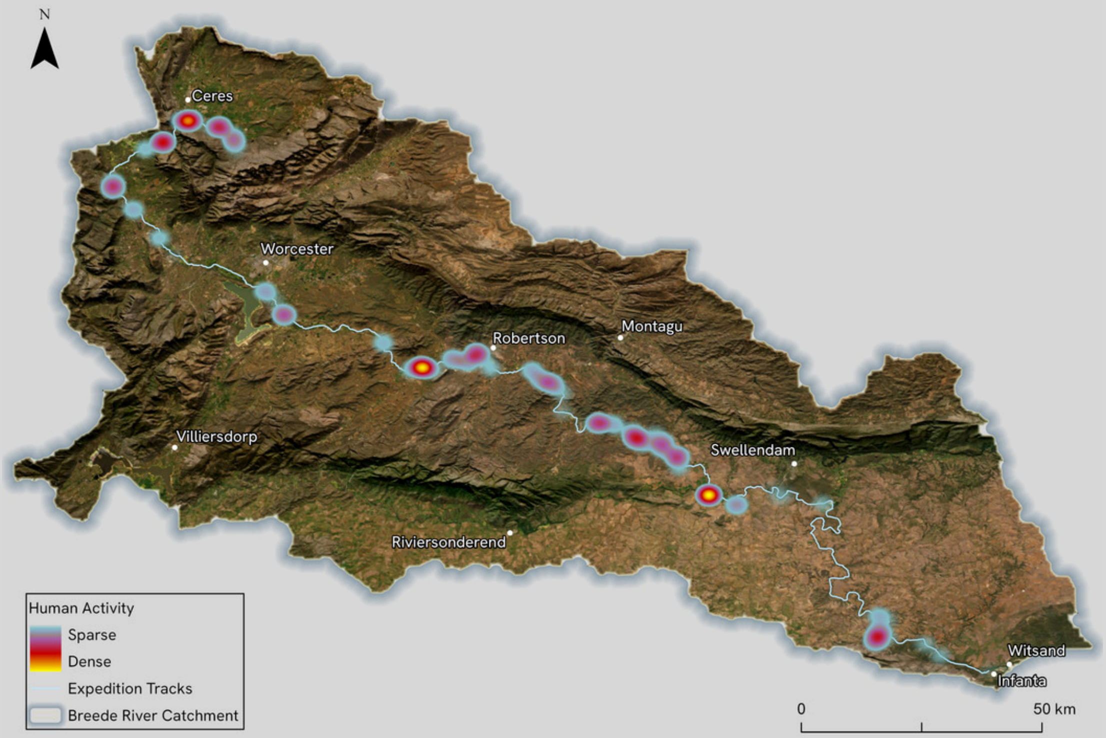
HUMAN ACTIVITY

Over 7 million people reside within the Breede-Olifants Water Management Area. All of these people are directly reliant on the rivers, wetlands and groundwater resources within the catchments. By counting the number of people along the Breede River transect, our survey is able to better-understand how some of these people directly engage with the Breede River, either as a provisioning or recreational resource.

The Breede River had a high population density at the time of the survey — over 170 people/10km of river. This is comparable to other accessible rivers in Africa, including the Kavango (141 people/10km), Luapula (123 people/10km) and Ruvubu (202 people/10km). It is important to note that these results reflect the upper use-case for the river, as the survey was conducted in the springtime, over a long-weekend, when most campsites were full.

People were generally clustered around towns, bridges or private campsites, with large swathes of inaccessible areas in-between, where private land restricts general access to the river. Recreational fishing was common, particularly at riverside campsites. Subsistence fishing was comparatively rare, largely because of restricted access, however, the use of gill-nets was documented at the Angora street road bridge near Bonnievale, likely indicating a small semi-commercial fishery targeting the invasive common carp (*Cyprinus carpio*).

People/10 km	Fishers/10 km	Fishing gear/10 km	Vessels/ 10 km	Livestock/10 km
170	23	13	45	93



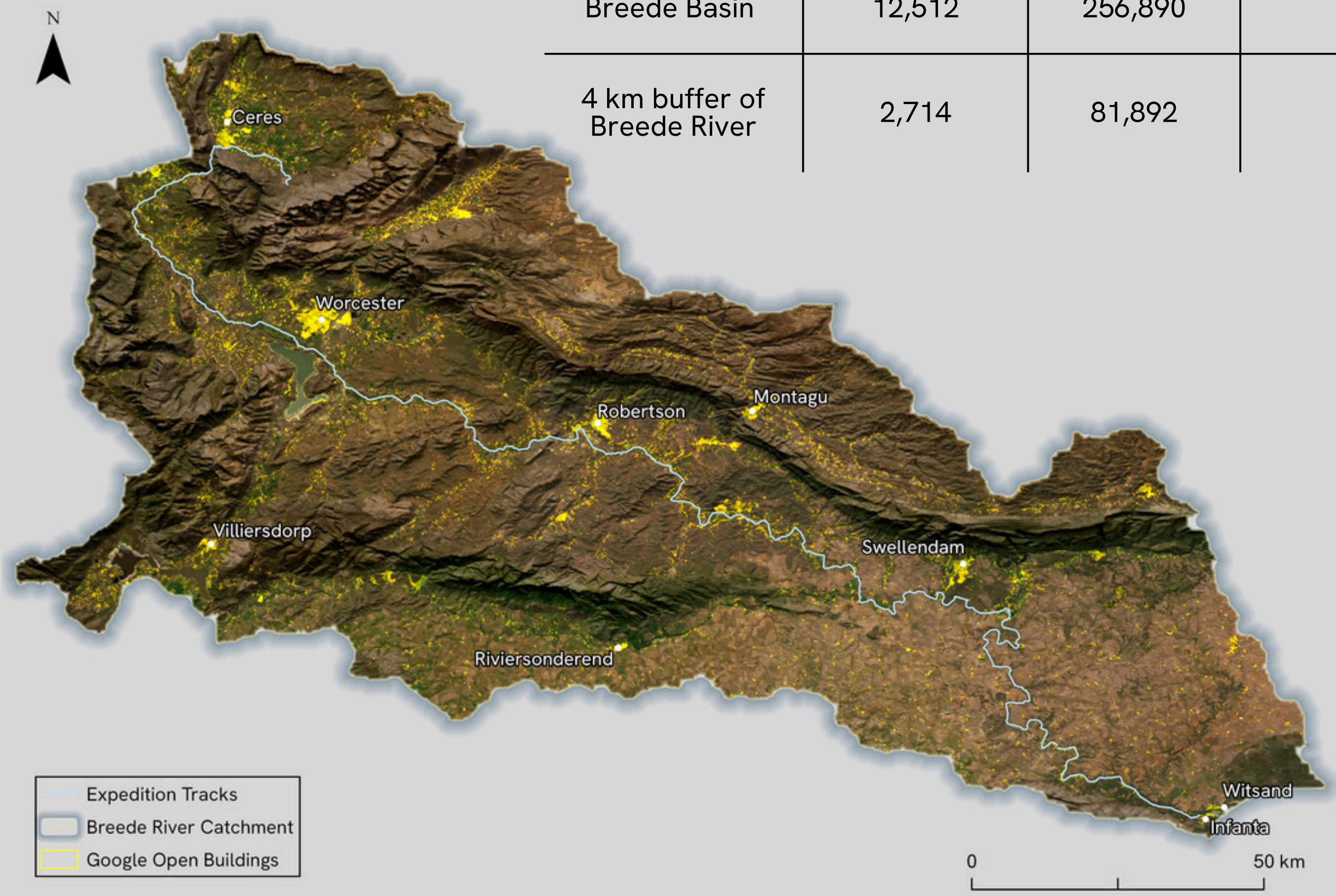
Distribution of people along the transect (bottom). The summary of observations (top) shows several indicators of human activity, averaged per 10 km along the transect.

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 activity. This perspective allows for consistent, basin-scale analyses that help to identify areas of potential environmental impact.

Building density across the Breede Basin averages 21 buildings per km^2, but within a 4 km buffer of the Breede River, this rises to 38 buildings per km^2. This concentration reflects the tendency for settlements to cluster along the river corridor, where development is supported by flatter terrain, fertile soils, and direct water access. Although the buffer zone makes up only 17% of the basin's area, it contains nearly a third of all recorded buildings, showing how strongly human activity is oriented toward the river system. This spatial pattern also highlights the vulnerability of river-adjacent settlements to flooding, as a greater proportion of buildings and infrastructure lie within the floodplain.

	Basin Area (km^2)	Number of buildings	Number of buildings/km^2
Breede Basin	12,512	256,890	21
4 km buffer of Breede River	2,714	81,892	38



The distribution of buildings within the Breede Basin.

AGRICULTURE

Agriculture is the dominant land use in the Breede River Basin, supporting one of South Africa's most productive agricultural regions. The basin contains approximately 80,000 ha of irrigated cropland[4] and contributes around 40% of the country's wine grape tonnage[2], highlighting its national importance for agricultural production. Farm irrigation predominantly draws from groundwater, supported by direct abstraction from the Breede River at several locations. Stone fruits, grapes, berries and grains are all farmed in the basin, contributing significantly to local livelihoods and the region's export economy[6].

Most croplands along the middle and lower Breede are not visible from the river because of steep riverbanks. Despite this, ~41 km of cropland was counted within 100m of the river's edge, representing ~6% of the total riverbank. Fruit orchards and vineyards represented up to 90% of crops counted within the floodplain, predominantly in the upper and central parts of the catchment.

The southern and southeastern parts of the basin were dominated by cereal crops — particularly around Caledon, Riviersonderend, and Swellendam, and extending towards the coastal plains near Witsand and Infanta (see page 12).

Main crop types:

Crop Type	Distance along the riverbank (m)
Fruit (incl. stone fruit)	21,000
Grapes	14,000
Blueberry	1,950
Wheat	500
Mixed vegetables	400
Lucerne	300
Olives	200
Total	**38,350**

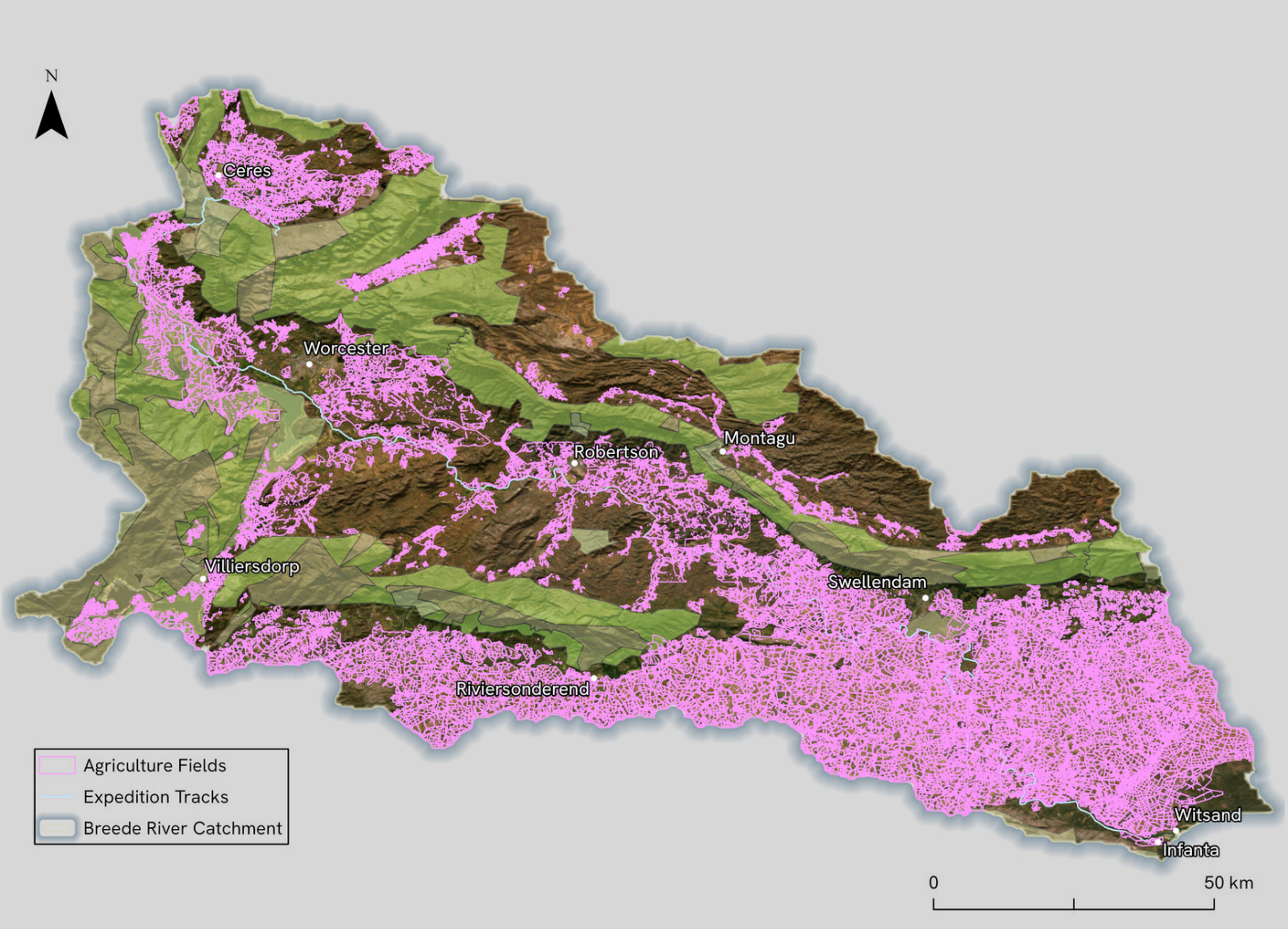
The distance of crops along the riverbank

CROPLAND ANALYSIS

To complement the visual counts of cropland along the river, a satellite-based analysis of cropland cover was conducted. This made use of the Field of the World (FOW) layer, which highlights the boundary of all cultivated field types within the Breede River Basin[5].

The most striking feature is the heavy concentration of croplands in the southern and southeastern parts of the basin, covering a total area of ~3,814 km^2. Smaller clusters appear in the Ceres valley and near Worcester, Robertson, and Montagu. In contrast, the mountainous interior and northern basin remain largely unsuitable for cereal production. Combined with the visual survey data collected in this study, these results highlight agriculture as the predominant land-use across most of the Breede river.

The croplands in the Breede Basin, based on the Fields of the World (FOW) layer.

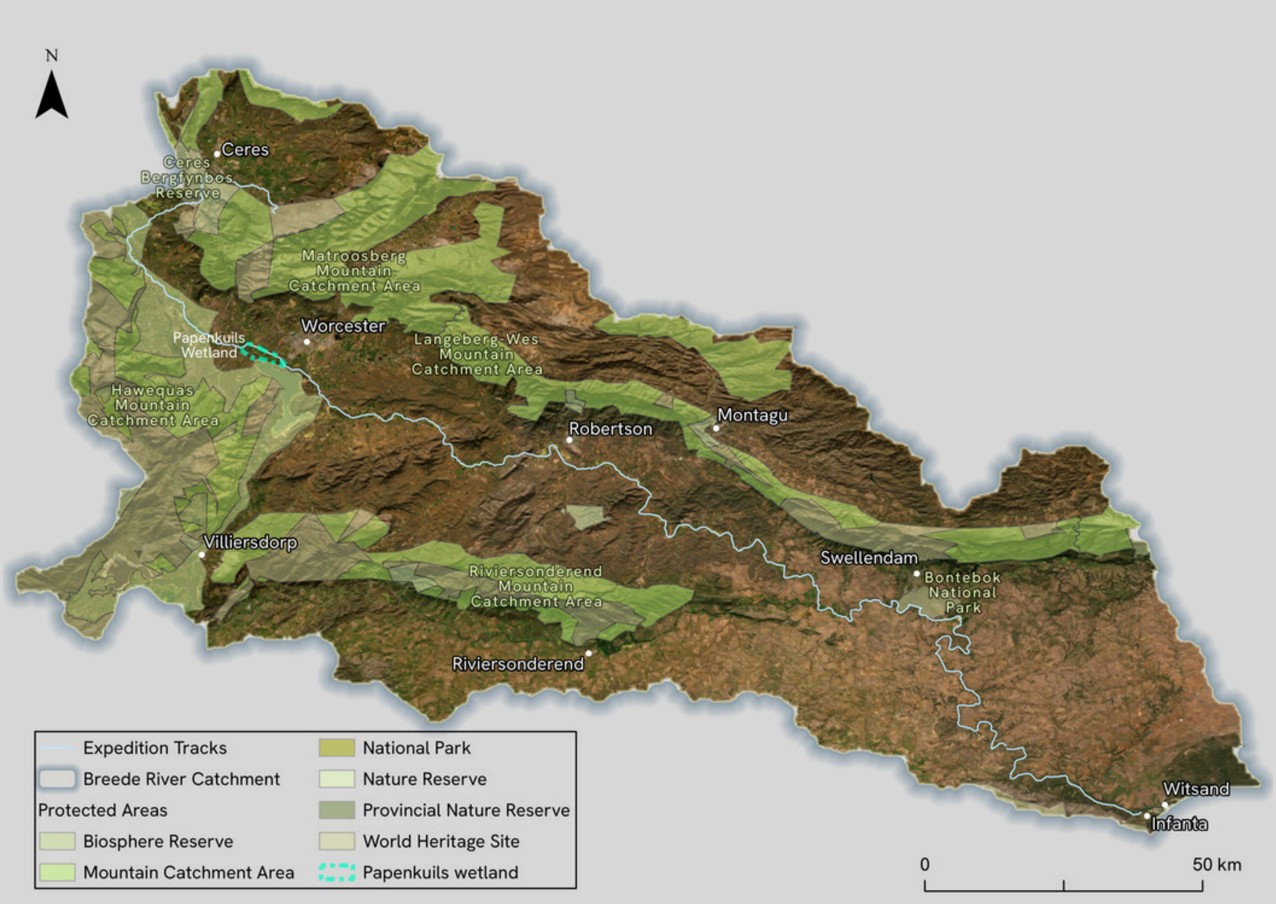


CONSERVATION AREAS

The Breede Basin has several important riparian ecosystems, including wetlands and an extensive estuary. The river's headwaters arise in the Ben Etive Nature Reserve, an area of largely intact mountain landscape within the Hexriver Complex. This headwater region provides vital habitat for rare, threatened, and endemic species, including the Cape Kurper (*Sandelia capensis*), which is likely extirpated elsewhere along the river[7].

In its lower reaches, the Breede River forms the southern boundary of Bontebok National Park. Although originally established to protect the iconic bontebok, the park now supports species such as the Cape mountain zebra, red hartebeest, grey rhebok, and ~200 bird species[8]. Over time, as the surrounding landscape has been transformed by agriculture and alien invasive species, the park has become increasingly vital as a refuge for native biodiversity.

Nearing its end, the Breede meets the sea, forming a tidal estuary that extends 50 km inland. The estuary is an important habitat for at least 59 fish species — most of them estuarine endemics — and represents the southernmost distribution of the Zambezi shark (*Carcharhinus leucas*). It also supports at least 48 waterbird species, many of which are migratory, with populations that are threatened by estuarine habitat degradation and wetland development elsewhere in the world[9].



Protected and semi-protected areas along the Breede River, including the Papenkuils Wetland near Worcester — the largest and most ecologically significant wetland in the catchment.

PAPENKUILS WETLAND

Situated between Rawsonville and Worcester, the Papenkuils Wetland is the largest wetland in the Breede River catchment, consolidating flow from the Breede, Holsloot, Smalblaar, Jan du Toits, Brandwacht and Hartebeestmond rivers. As water moves slowly across the floodplain, the wetland acts as a natural filter, trapping suspended sediments and reducing nutrient loads before the water continues downstream[10,12]. This floodplain supports at least seven IUCN Red Listed plant species and the endangered Breede Alluvium Fynbos[13], and is characterised by dense stands of endemic palmiet (*Prionium serratum*), a structural plant whose fibrous root mats further stabilise riverbanks and slow floodwaters.

The wetland, once home to elephants and hippos, is designated as a high-priority conservation area by both UNESCO and the WWF[13]. In 2021, the Western Cape DEA&DP commissioned a formal evaluation of the wetland's ecosystem services, identifying nine key functions: flood attenuation, groundwater recharge, sediment retention, water quality amelioration, carbon sequestration, agricultural provisioning, natural resource harvesting, tourism and recreation, and intrinsic conservation value[10]. Sediment input from the Holsloot River alone is estimated at 200 tonnes/km^2 per year, much of which is trapped within the wetland before reaching the main channel. The economic equivalent of its water quality function has been valued as the cost of constructing and operating a water treatment plant of the same capacity[12].

Despite its conservation status, the wetland faces ongoing pressure from water abstraction, a diversion weir that redirects inflows into Brandvlei Dam, agricultural runoff, and the spread of alien invasive plants[12,13]. In 2010–2012 the Department of Agriculture and BOCMA worked with the Central Breede River Water Use Area to remove large volumes of blue gum and other alien species from Papenkuils. Additionally, Merwida Wine Farm, a WWF Conservation Champion since 2006, has set aside more than 600 ha as a formal conservation area and led sustained alien plant clearing to support palmiet recovery[11]. The sustained protection of this wetland, and an accurate evaluation of its ecosystem services, will contribute substantially to securing the health of the Breede River.

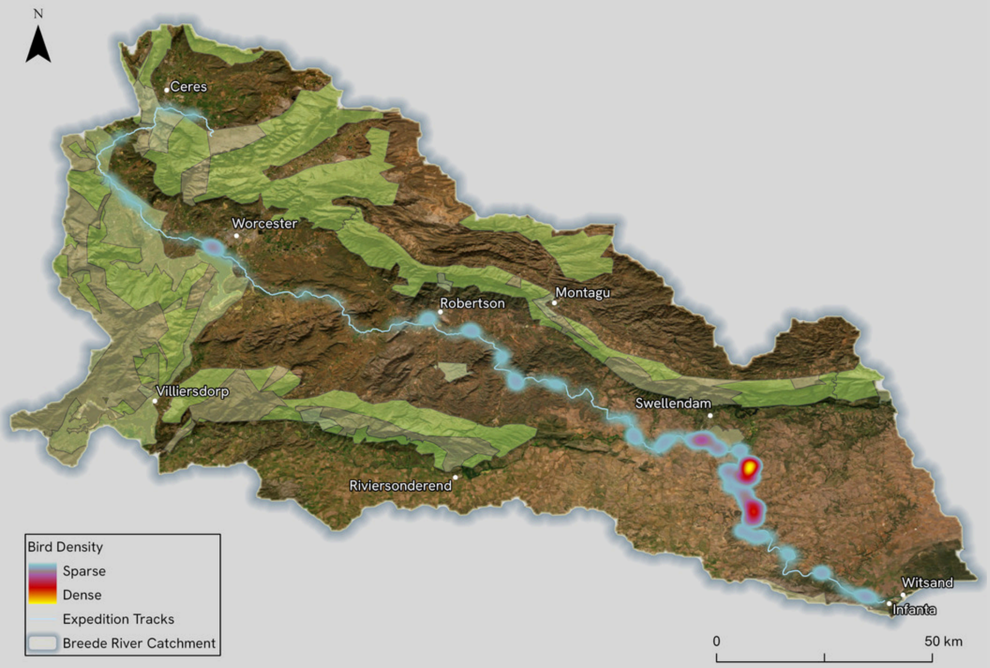
Water recedes from the tidal flats of the Breede River Estuary. The estuary is protected under a comprehensive Estuarine Management Plan and the Lower Breede River Conservancy Trust. Key efforts include a strict zonation plan that integrates conservation, tourism, and sustainable use, as well as continuous monitoring of biodiversity and water quality[9,14,15].

WETLAND BIRDS

Birds are among the most responsive indicators of habitat availability. Wetland birds in particular depend on healthy, intact wetlands to forage, breed, and roost, making them sensitive to habitat degradation. Continuous monitoring of birds can reveal early warning signs of environmental degradation and help to identify critical nesting and foraging areas that require conservation attention.

A total of 5,337 wetland associated birds and raptors, representing 48 species, were recorded along the transect. Egyptian geese and spur-winged geese were the most abundant species, with breeding colonies of up to 550 individuals recorded. Approximately 55% of all birds were concentrated within a 60 km stretch of unprotected river downstream of Bontebok National Park, where the river widens and slows, creating pools and sandbanks that support immense congregations of waterfowl. Bird density in this stretch was 4 times higher than in other areas of the river.

The Papenkuils Wetland and Breede River Estuary also had higher densities of wetland birds. This is linked to riparian habitat intactness and the relative refuge offered by their protection status. The high density of wetland birds in these areas contrasts with areas invaded by gums and wattles, where degraded riparian habitats support low diversity and abundance of wetland birds.



Wetland bird distribution along the Breede River.

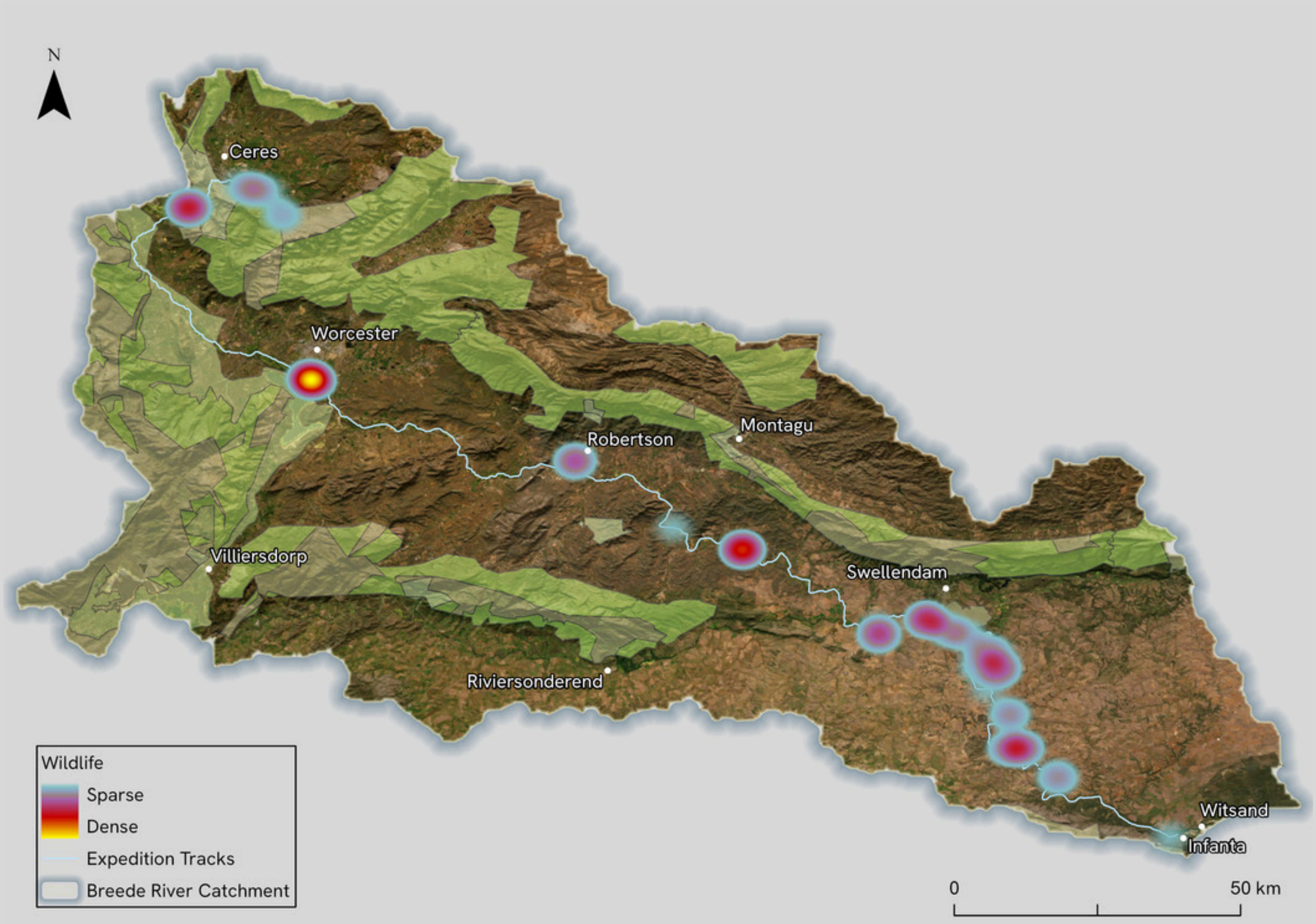
The 10 most common bird species:

Bird Species	Count
Egyptian Goose	2,122
Spur-winged goose	1,300
Yellow-billed duck	578
Hadeda ibis	162
Reed cormorant	156
Western cattle egret	84
Common sandpiper	72
Blacksmith lapwing	64
African sacred ibis	62
Giant kingfisher	60

WILDLIFE

Non-avian biodiversity was low along the Breede River. Just 92 animals were counted, most of which were rock hyrax (N = 81 individuals). These typically occupied inaccessible cliffs lining the river. The general scarcity of wildlife is attributed to the lack of available habitat in the valley. Nonetheless, areas of conservation importance provide critical refugia for wildlife along the river.

While just three klipspringers, two bushbuck and a duiker were counted along the transect, the Bontebok National Park is known to support a large population of antelopes. These include ~ 158 bontebok and smaller populations of red hartebeest, grey rhebok, steenbok, and Cape grysbok[8]. Eight Cape Mountain Zebra are also present in the park.



Wildlife distribution along the Breede River.

ALIEN INVASIVE PLANTS

Invasive species have transformed the riparian zone of the Breede River. Within the catchment, an estimated 702 km^2 of land and over 70% of the riparian zone is affected by alien plant species[16-22]. These invasions have degraded the health of the river, leading to poorer water quality, a 'flashier' river that is defined by rapid flood and drought cycles, and deep erosion of the fertile floodplain topsoil. Alien invasive plants both directly and indirectly reduce biodiversity along the river by displacing native vegetation and enhancing the frequency and intensity of fires.

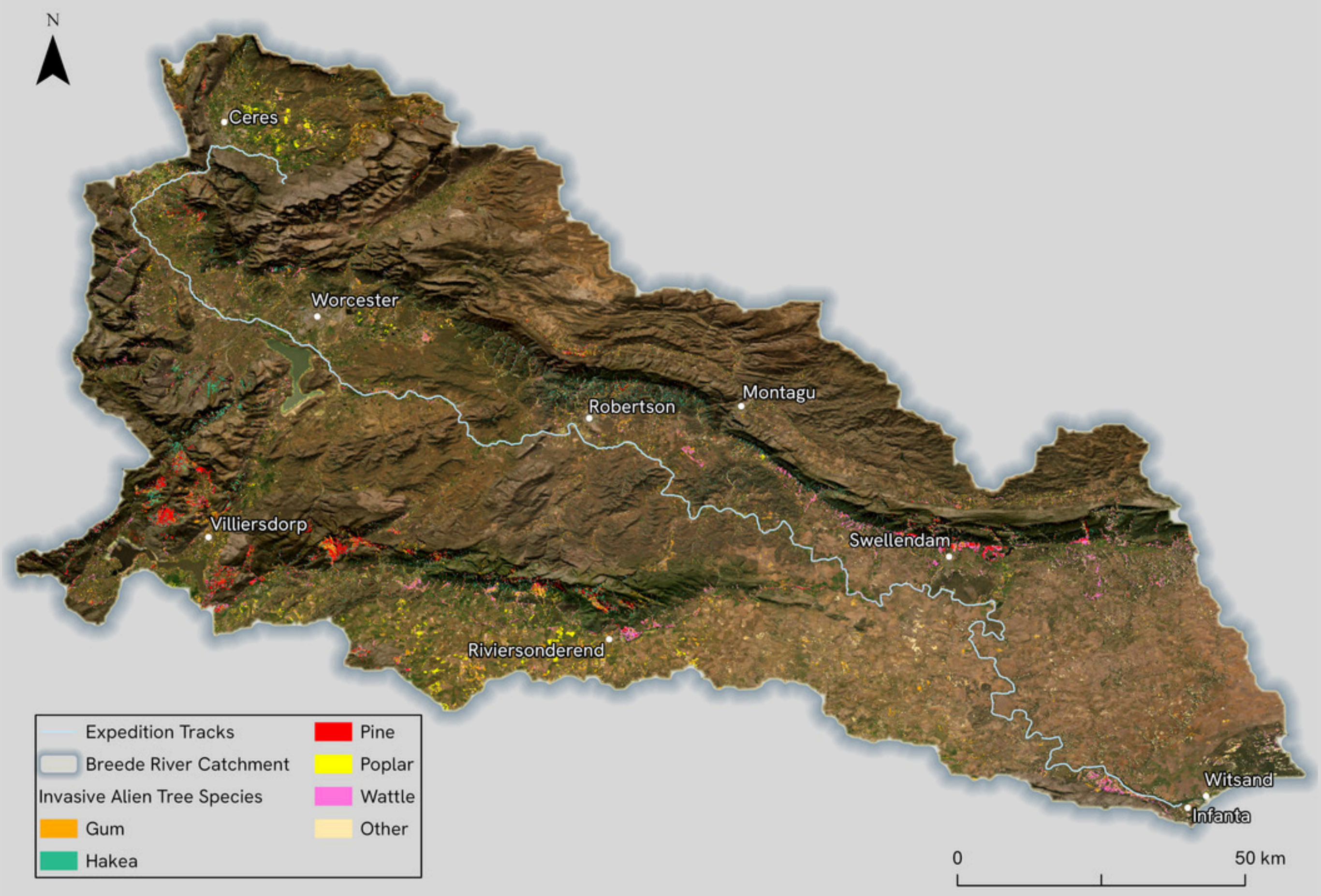
Gum (Eucalyptus sp.) was prominent along the Breede River, often forming dense stands along both riverbanks.

Alien invasive plant removal is a priority in the upper catchment of the Breede Basin, where several projects have made strides towards clearing these thirsty species are restoring the cleared land[20,21].However, comparatively less attention has been directed at the middle and lower reaches of the Breede. This is in part because effective catchment management often begins in the upper reaches of river basins, however there is also a dearth of information on the distribution and extent of invasive species along its entire length.

To better understand the distribution of invasive species, terrestrial and aquatic invasive species were identified and recorded along the Breede River. Their abundance (i.e., as isolated patches, individual plants, or several plants) and spatial extent (m^2) was noted, with observations limited to 100 m from the riverbanks. By documenting both species composition and the size of the invaded area, the survey provides a baseline dataset to inform ongoing invasive species management in the catchment.

In 2019, the distribution of alien trees in the upper catchment was mapped by the Socioeconomic Benefits of Investing in Ecological Infrastructure (SEBEI) Project (see below)[16]. According to this spatial dataset, gum and wattle are the most widespread invasive alien trees in the Breede Basin, estimated to occupy ~132 km^2 and 120 km^2, respectively. Within the river corridor alone, up to 3.2 million eucalyptus trees are estimated to be present. Based on figures from the nearby Berg River catchment, clearing these trees could release an additional 3–9 million m^3 of water per year — equivalent to up to 10% of river flow during low-flow periods[17].

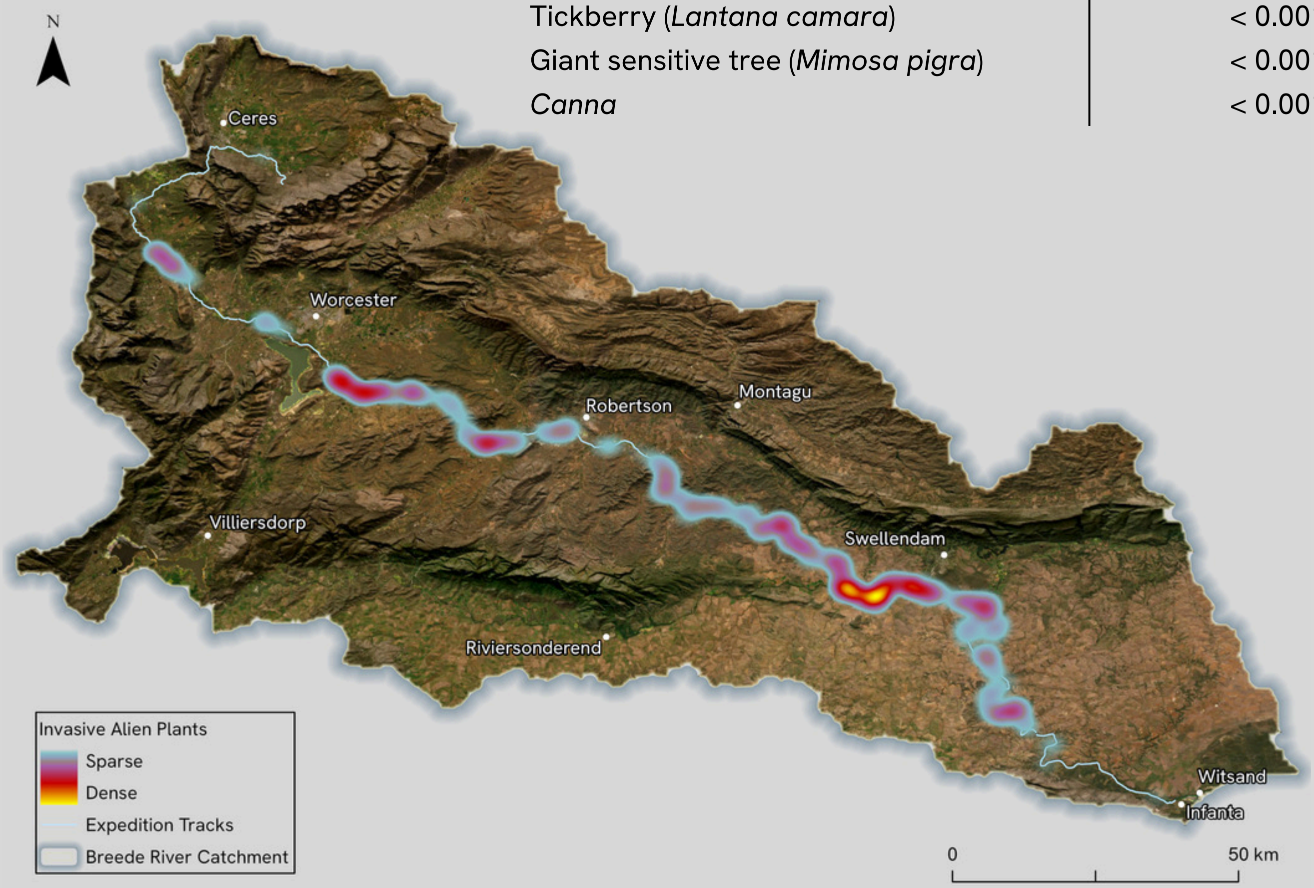
The distribution of alien trees in the Breede Basin derived from the BioSCape Invasive Alien Tree and Uncertainty Maps for the Cape Floristic Region[16].



A total of 18 AIPs were recorded on the 2025 transect, the most common of which were gum (*Eucalyptus* sp.), followed by black wattle (*Acacia mearnsii*) and long-leafed wattle (*Acacia longifolia*). The total area of invaded riverbank was ~71 km^2, however this count did not include tributaries or backwaters of the Breede River. As a result, this is a conservative estimate and the actual invaded area is likely far greater.

All alien invasive plant species recorded along the Breede River transect

Plant Name	Invaded Area (km^2)
Eucalyptus sp.	45.09
Black wattle (*Acacia mearnsii*)	17.05
Port Jackson willow (*Acacia saligna*)	4.41
Long-leaf wattle (*Acacia longifolia*)	3.22
Pine (*Pinus* sp.)	0.50
Poplar (*Populus* sp.)	0.31
Wattle sp. (*Acacia* sp.)	0.20
Castor oil bush (*Ricinus communis*)	0.01
Texas prickly pear (*Opuntia engelmannii*)	0.001
Willow (*Salix* sp.)	0.001
Hakea	0.001
Tickberry (*Lantana camara*)	< 0.001
Giant sensitive tree (*Mimosa pigra*)	< 0.001
Canna	< 0.001



Invasive plant distribution along the Breede River.

AQUATIC INVASIVES

Several aquatic invasive plants were also widespread along the river, including parrot's feather (*Myriophyllum aquaticum*), water hyacinth (*Eichhornia crassipes*), red-water fern (*Azolla filiculoides*), Kariba weed (*Salvinia molesta*), and water lettuce (Pistia stratiotes). Although at lower densities relative to the terrestrial invasives, these aquatic plants form dense mats that can degrade water quality, disrupt aquatic ecosystems, and limit water flow[19]. Aquatic invasives are also known to block weirs, dams and irrigation pumps, reducing the operational efficiency of water infrastructure.

Aquatic invasive plants often thrive in nutrient-rich conditions, where they outcompete native vegetation. In dense infestations, particularly in standing or slow-moving water, aquatic plants naturally die and fall to the bottom. As they do this, they slowly decay, reducing oxygen content in the water. Compounded with lower light penetration from dense surface cover, this process can alter entire waterbodies, shifting them into states of eutrophy or hypoxia, with significant consequences for aquatic biodiversity and ecosystem function.

All aquatic invasive plant species recorded along the Breede River transect

Plant Name	Invaded Area (km^2)
Water hyacinth (*Eichhornia crassipes*)	0.21
Kariba weed (*Salvinia molesta*)	0.10
Parrot’s feather (*Myriophyllum aquaticum*)	0.01
Red water fern (*Azolla filiculoides*)	< 0.01
Water lettuce (*Pistia stratiotes*)	*Individual plant

Dense growth of Parrot’s feather along the banks of the Breede River.

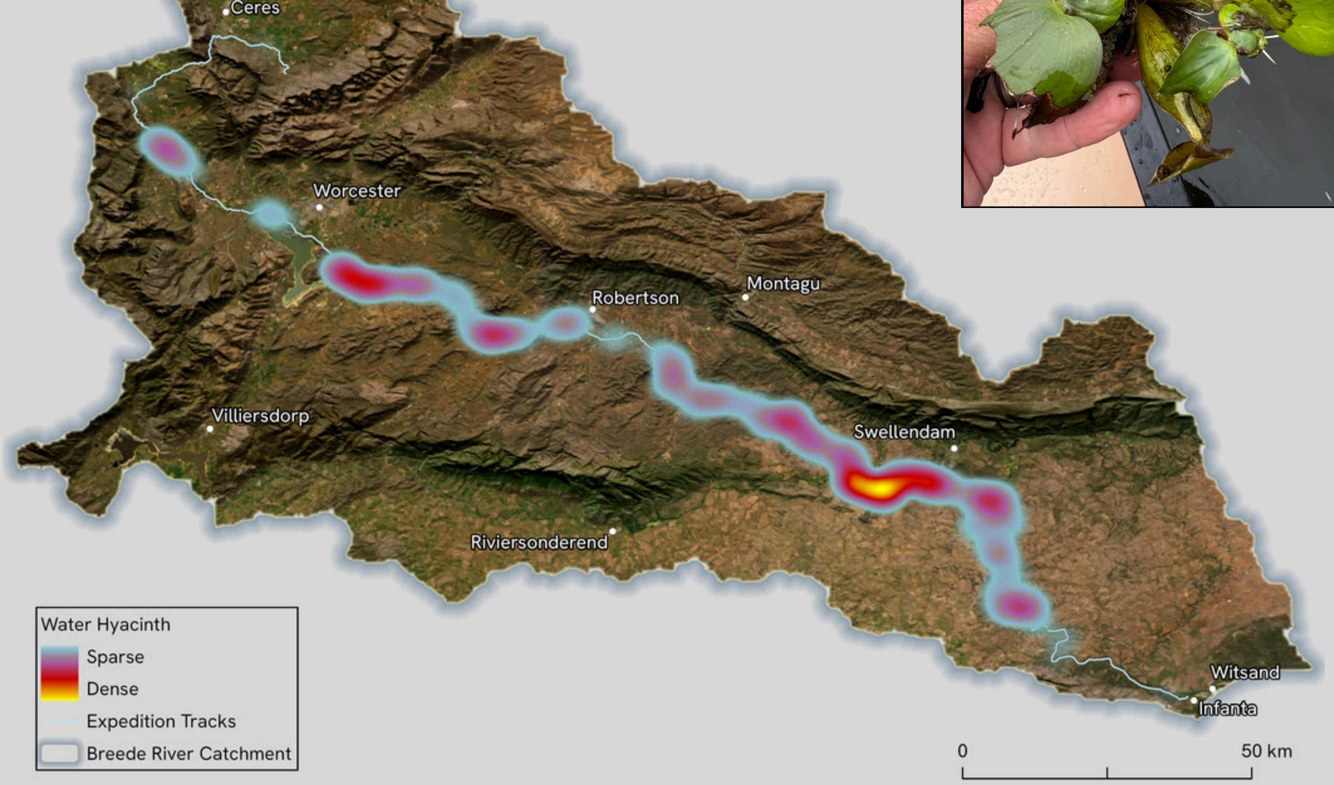
WATER HYACINTH

Water hyacinth was the most abundant aquatic invasive plant recorded, concentrated predominantly downstream of Swellendam. During low-flow periods in late summer, this stretch of river is often completely inundated, with dense mats of water hyacinth smothering the surface and blocking light to the water below.

Originally introduced as an ornamental plant for garden ponds, water hyacinth has spread across the country and is now regarded as one of the most harmful aquatic invasive species in South Africa[23]. Elevated nutrient inputs from sources such as wastewater effluent, industrial discharges, and agricultural runoff directly encourage the spread of water hyacinth[23].

The prevalence of this species in the lower reaches of the Breede River is linked to slower flowing water, creating suitable habitat for the species. In addition, the cumulative effects of nutrient inputs from Swellendam wastewater treatment and upstream agricultural sources likely encourages growth. In many stretches of the river, fallen eucalypts create backwaters and eddies for the hyacinth to colonise — an example of the synergistic relationship between invasive plants in heavily modified river systems.

Distribution of water hyacinth along the Breede River, mainly concentrated in the lower reaches.



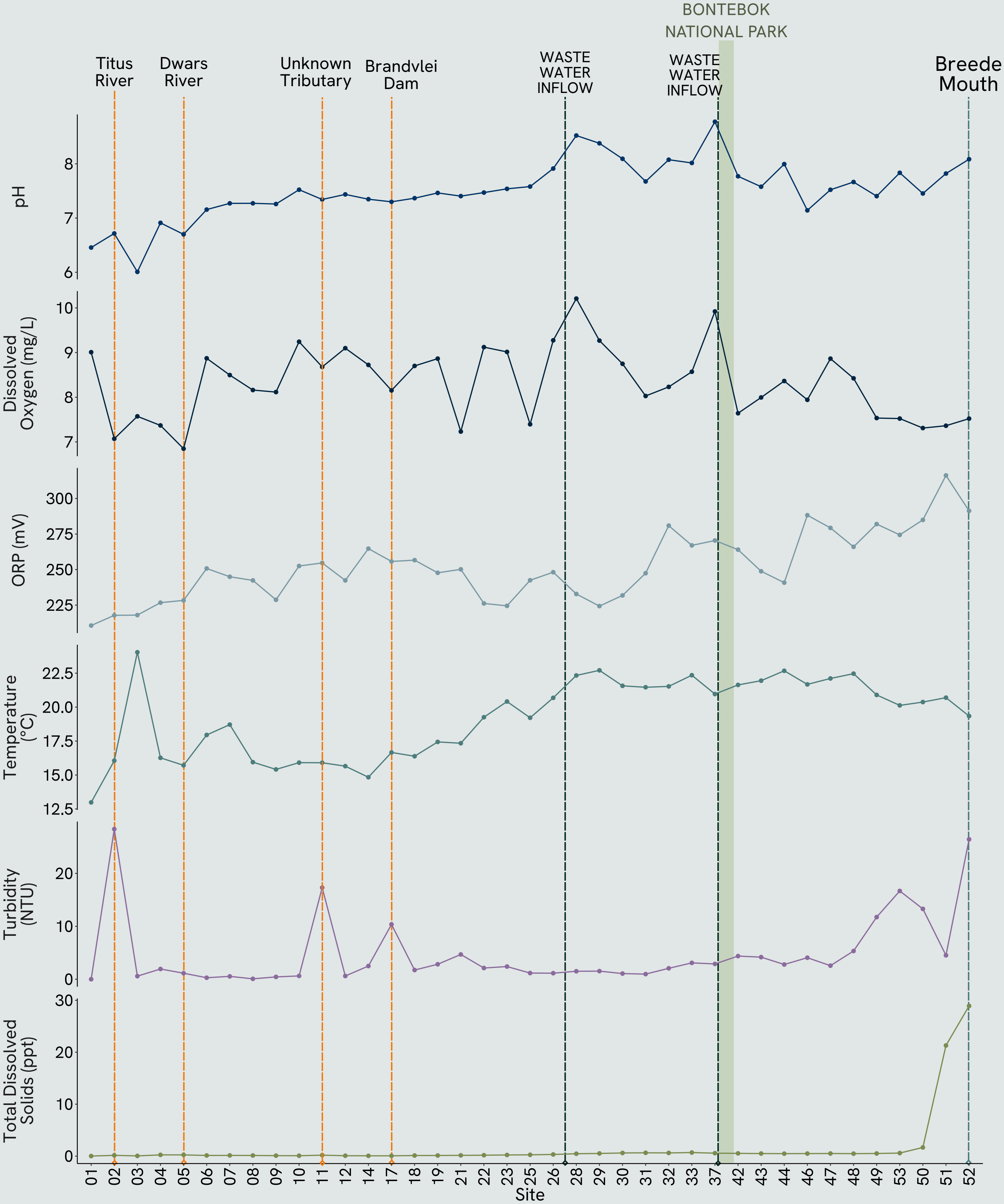
WATER QUALITY

Water quality in the Breede River is monitored by the Breede-Olifants Catchment Management Agency (BOCMA)[6], and in the estuary by the Lower Breede River Conservancy Trust (LBRCT)[15]. This monitoring has identified clear spatial trends, with generally good water quality in the headwaters. Water quality gradually declines downstream, associated with agricultural expansion, urban development, and other land use pressures[2,24]. Reported impacts include elevated phosphorous and nitrogen concentrations and increased organic loading.

To assess water quality conditions at the time of the survey, TWP measured standard water chemistry at approximately 10 km intervals along the river. Key physical and chemical parameters were measured, including temperature, pH, dissolved oxygen, conductivity, and turbidity. These reflect the water's suitability for uses such as drinking, recreation, and sustaining aquatic life. The river-wide survey allows for a spatial analysis of water quality along the entire river, identifying contamination sources and other drivers of water quality changes.

Overall, water quality was largely within ranges expected for freshwater ecosystems. However, several sites along the river are associated with water quality perturbations that may indicate contamination or disturbance. The primary drivers of water quality perturbations along the Breede River are runoff from agriculture and municipal wastewater. These contribute nutrients to the river that may encourage the growth of invasive species.

The Titus River (left) joins the Vals River (right) in the upper reaches of the Breede catchment. While the Vals flows from the Ben Etive Nature Reserve, the Titus originates in an area of heavily modified farmland. Without a wide buffer of riparian vegetation, the Titus is exposed to disturbance that may reduce water quality, as shown by its brownish-yellow colour.



Note: Water samples were collected from 39 sites for isotope, heavy metal trace element, and anion analyses. Ongoing monitoring will be essential to track long-term trends, and support effective conservation and land-use planning along the Breede River.

NUTRIENTS

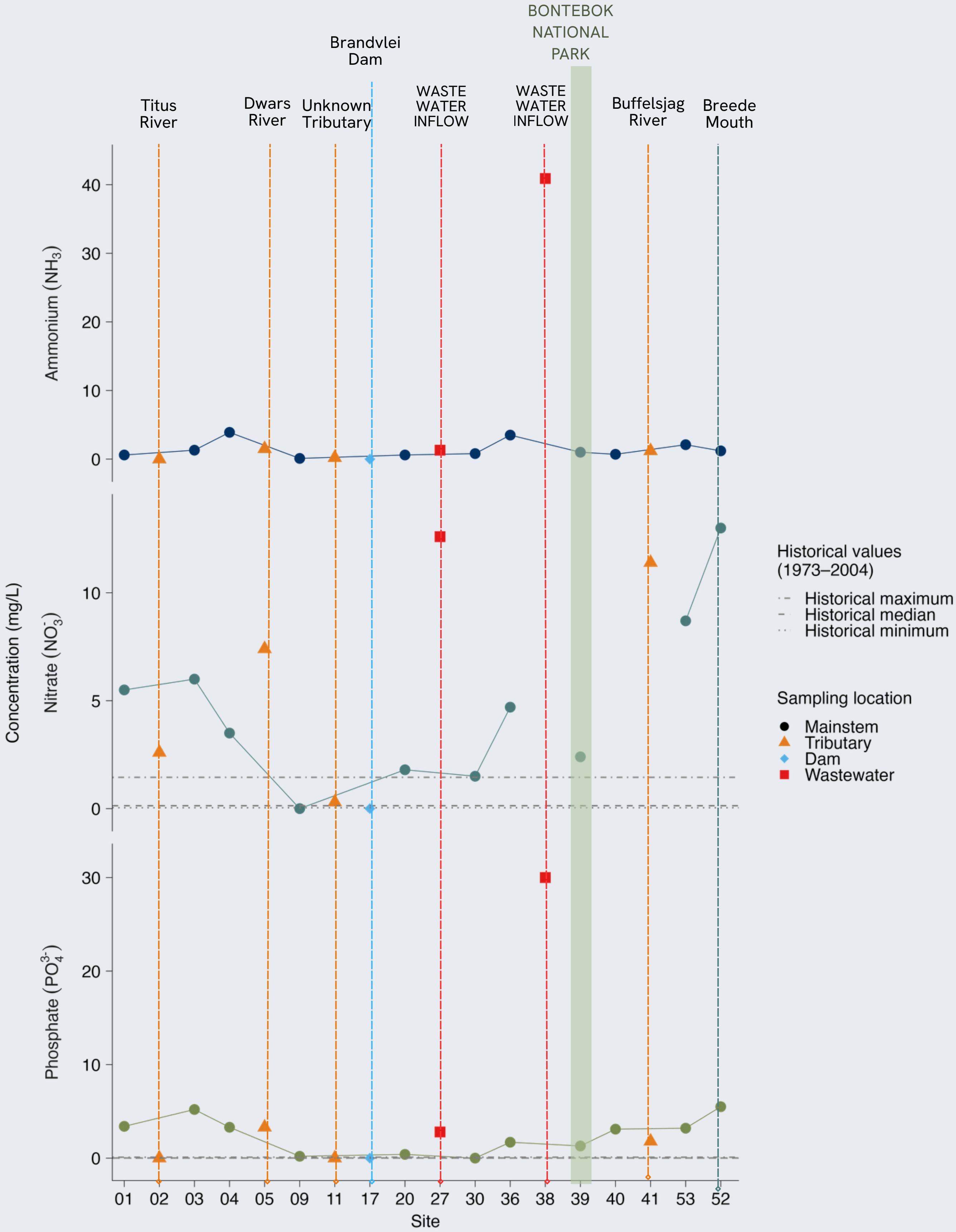
Regular water chemistry testing was complemented by nutrient analyses at strategic sites, particularly tributaries. These were conducted using a desktop Hanna Photometer, which provided rapid, in-situ levels of phosphates, nitrates and ammonium. These can be an excellent indicator of nutrient enrichment, often associated with runoff of agricultural fertilizers. If not properly managed, nutrient enrichment can cause eutrophication of riverways and has historically contributed to algal blooms and proliferation of invasive species in the Middle Breede, particularly during low-flow periods[2,25].

Elevated nutrient concentrations were recorded at Dwars River (site 5) and at wastewater inflow points into the river (Sites 27 and 38). While the elevated nutrient levels observed in the Dwars River are likely associated with agricultural runoff from surrounding farmland, the considerably high nutrient concentrations recorded at site 38, were identified as untreated sewage entering the river system.

Extremely high concentrations of phosphate and ammonium were measured at site 38, indicating significant organic and nutrient contamination consistent with sewage inputs. This site is located directly upstream of Bontebok National Park, which is concerning as any contaminants in the river are transported downstream directly into the protected area. Elevated nutrient levels entering the park’s river system may result in broader ecological impacts that are highly likely to affect aquatic habitats and biodiversity within the park.

A wastewater inflow entering the Breede River upstream of Bontebok National Park. Nutrient analysis from collected water samples indicated elevated ammonium, phosphate and nitrate concentrations.

NUTRIENT LEVELS



Nutrient concentrations were measured at 18 sites using a Hanna Photometer, enabling rapid in-situ quantification of ammonium, nitrate, and phosphate levels. Note: Nitrate levels at sites 38 and 40 could not be determined using the Hanna Photometer, as its detection range is 0-30 mg/L. It is possible that nitrate levels at these sites exceed the upper limit of that range.

RIVER FLOW

Understanding the flow of the Breede River is vital for river management. River flow directly determines water availability for agriculture, urban supply, and ecosystem function. In addition, flow monitoring can contribute to early warning systems for floods and droughts — both of which are expected to rise in frequency and intensity under climate change conditions[28,31].

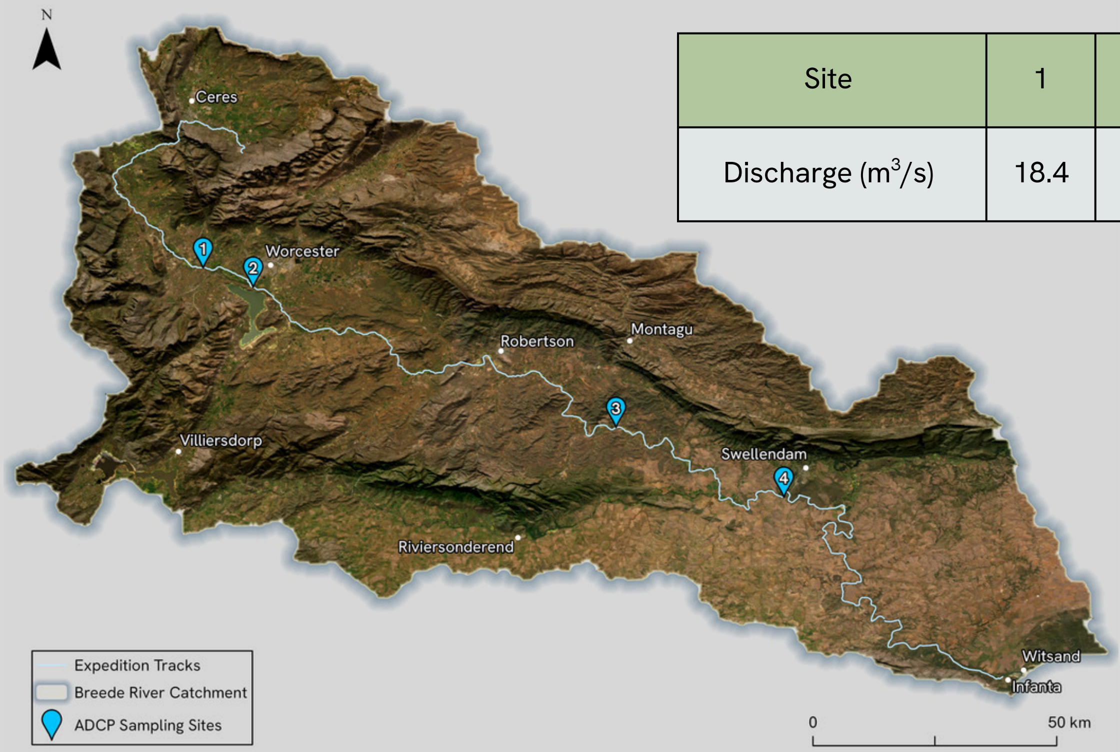
To assess the flow of the Breede River, an acoustic doppler current profiler (ADCP) was used to measure discharge at four sites along the transect. These sites were: i) at the R101 road bridge; ii) near Brandvlei Dam; iii) near Bonnievale; and iv) upstream of Bontebok National Park. Flow between Worcester and the Cogmanskloof confluence is artificially managed (October–May) via Greater Brandvlei Dam releases to supplement irrigation abstraction — so summer flow is not entirely natural.

The Breede River was flowing at a rate of 18.4 m^3/s at the R101 road bridge at the time of the survey. Over the course of ~160 km, flow declined to just 5.7 m^3/s directly upstream of Bontebok National Park, representing a ~70% reduction. This decline is likely driven in large part by extensive water abstraction for irrigation, which accounts for nearly all of the Breede River's total water use (see page 29).

Intensive irrigation demand is reflected in the 261 water abstraction points recorded along the river, most of which (70%) are believed to supply agricultural activities. In addition, the high density of alien invasive plants along the river substantially reduces downstream discharge, although the exact impact of this on the surface flow of the Breede River has not been quantified. Groundwater interactions, although important, are also poorly understood.

River flow in the Breede River was measured at four sites along the transect using an acoustic doppler current profiler (ADCP).

Site	1	2	3	4
Discharge (m^3/s)	18.4	12.0	7	5.7



RIVER FLOW

A 'water budget' describes the balance between water inputs, outputs, and storage within a system, showing how much water is available, where it goes, and how these change over time. Existing water budgets for the Breede catchment are calculated annually, based on data collected prior to the 1990s or early 2000s[4].

The Breede River has a mean annual runoff of approximately 1,800 million m^3/year, of which only ~990 million m^3/year (55%) is considered exploitable. The system is effectively at full water-use allocation — current demand stands at ~971 million m^3/year, up from ~658 million m^3/year in 2004[6], representing a near 50% increase in two decades. Agriculture accounts for approximately 70% of this demand, while ~20% is transferred out of the catchment entirely. A further ~5% is attributed to water loss from invasive alien trees, with the remaining ~5% supporting municipal and domestic use[6,29]. In the dry summers, the remaining water either replenishes depleted groundwater reserves or is lost to evapotranspiration, leaving just a trickle of surface flow in the river.

Climate change is expected to alter the water budget by increasing water losses and reducing effective inputs. Mean temperatures are projected to rise by 1–1.8 °C by mid-century[32], driving higher potential evapotranspiration across all seasons, while rainfall is likely to decline[31]. This shift will reduce runoff and baseflows and increase drought frequency from roughly once per decade to as often as every second year, undermining the reliability of historical water yield estimates used to calculate the Breede River water budget[30].

This reduction in surface flow is likely to have serious implications for the ecology, water security, and economic productivity of the region. In a fully allocated system, lower river flow directly reduces the volume of water available for irrigation and municipal supply, increasing competition among users. Reduced flow also elevates downstream salinity levels and limits the river's capacity to dilute pollutants, leading to declining water quality.

Given these risks, it is essential to implement and maintain a functional, integrated system for monitoring surface and groundwater flows along the Breede River. Existing hydrological data should be used to develop an updated water budget that explicitly incorporates long-term climate change projections.

Ongoing invasive alien plant removal efforts, particularly those led by BOCMA, the Department of Agriculture, the Western Cape Government and local farmers, should be prioritised and expanded to reduce unnecessary water losses. In parallel, there is an urgent need to develop farm-level water-use monitoring and reporting systems, which could support a payment for ecosystem services (PES) scheme, providing financial incentives for sustainable catchment management.

BIODIVERSITY THREATS

Between 2017 and 2023, the Western Cape lost over 1,020 km^2 of habitat, primarily to agriculture[33]. While vital to the economy, agricultural expansion needs to be carefully balanced with ecosystem health. Intact riparian habitats provide vital services, including flood attenuation and water filtration, that are economically under-valued in most development plans. Ongoing efforts should aim to balance the economic gains from commercial agriculture with the integrity of ecologically sensitive areas within the Breede Valley.

Conservation areas along the Breede River face increasing pressure from reduced flows, water quality degradation, and the spread of invasive plants. These pressures contribute to habitat fragmentation, altered ecosystem functioning, and declining ecological resilience. Without effective management, and the balance of sustainable farming, the long-term integrity of these sensitive habitats — and the species they support — is at risk.

Urgent research is needed to determine the minimum ecological water reserve required to sustain the Breede River Estuary's functioning under increasing pressure from abstraction and flow regulation. This assessment must incorporate projected climate change impacts, particularly reduced inflows and greater variability, to ensure that water allocation decisions do not compromise the estuary's long-term ecological integrity.

RECOMMENDATIONS

STRENGTHENING THE BASELINE

By combining hydrological analysis, water quality monitoring, biodiversity surveys, invasive species assessments, and spatial land-use data, this study consolidates an important contemporary baseline for understanding the current ecological and hydrological condition of the Breede River under increasing climate and development pressure. However, as with all single-period assessments, it provides only a snapshot in time and cannot fully distinguish seasonal variability from longer-term trends in ecosystem change.

In alignment with 'Task 1: Monitor Water Quality, including River Health' in the Environmental Resources Protection Plan for the Breede River Catchment in the Western Cape (2017)[33], we recommend that the baseline river survey is conducted biannually with key partners to continually assess the state of the Breede River. The Environmental Resources Protection Plan provides a comprehensive framework for the long-term management, monitoring and protection of the Breede River Catchment, spanning water quality, wastewater treatment, agriculture, riparian rehabilitation, ecological integrity, and environmental governance. All future planning and stewardship efforts should be aligned with its objectives.

WATER USE

Although not measured, the water loss to invasive species likely represents a substantial segment of the Breede River water budget, which is already fully allocated. This leaves less water in the river for people and biodiversity, and places water-stress on farmers in times of drought. In alignment with the ongoing efforts of several actors in the basin, a comprehensive, river-wide plan is required to remove thirsty invasive species from the river margins. To support this plan, further research should:

i) Calculate the total water-loss to invasive species within the Breede River Basin;
ii) Map areas where targeted invasive species removal will have maximum benefit for the water budget of the Breede River;
iii) Develop farm-level water-use monitoring and reporting systems; and
iv) Integrate these findings into an updated water budget for the Breede River.

RECOMMENDATIONS

WATER QUALITY

The Breede River is contaminated with nutrients at several sites by effluent from agricultural and sewage discharges. These may lead to eutrophication of the river, particularly in drought periods. Although not measured in this study, coliforms from these discharges may pose a risk to human health. Implementation of water quality interventions at these sites will substantially improve the condition of the Breede River.

For the protection of both biodiversity and water quality, buffer zones of riparian vegetation should be expanded along the Breede River. Additionally, existing buffer zones that are invaded by non-native species, particularly eucalypts, should be urgently restored to prevent ongoing degradation of the river.

PAPENKUILS WETLAND

The Papenkuils Wetland is vital to the health of the Breede River, acting as both a biodiversity refuge and a key hydrological regulator within the basin. The floodplain system consolidates flows from multiple tributaries, retaining sediments, cycling nutrients and improving downstream water quality. The wetland also supports endangered vegetation types such as Breede Alluvium Fynbos and multiple Red Listed plant species, whilst sustaining high densities of wetland birds relative to other sections of the river.

Ongoing monitoring of the wetland should focus on quantifying its role as a natural filter along the Breede River. This may include conducting water-quality testing across seasons, both above and below the wetland. Additionally, the wetland's ability to reconcile flow from several tributaries and regulate discharge of the Breede River should be studied, particularly as this relates to mitigating downstream flooding and drought.

The important role of the Papenkuils Wetland should be emphasised in all management planning for the Breede River, with particular focus on maintaining sufficient and natural upstream flow regimes to sustain its ecological and hydrological function.

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