ORANGE - SENQU RIVER COMMISSION

BOTSWANA LESOTHO NAMIBIA SOUTH AFRICA

ORASECOM

Established 2000

ORASECOM

Joint Basin Survey-3

2021


ORASECOM
THE ORANGE-SENQU RIVER COMMISSION
ORANGE - SENQU RIVER COMMISSION
BOTSWANA
LESOTHO
NAMIBIA
SOUTH AFRICA
Established 2000
UNDP
Empowered lives.
Resilient nations.
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LHDA
2021
JBS3
JOINT BASIN SURVEY-3
THE WATER RESOURCES QUALITY - 10 YEARS ON
2.2 6 SPEED

ORANGE - SENQU RIVER COMMISSION
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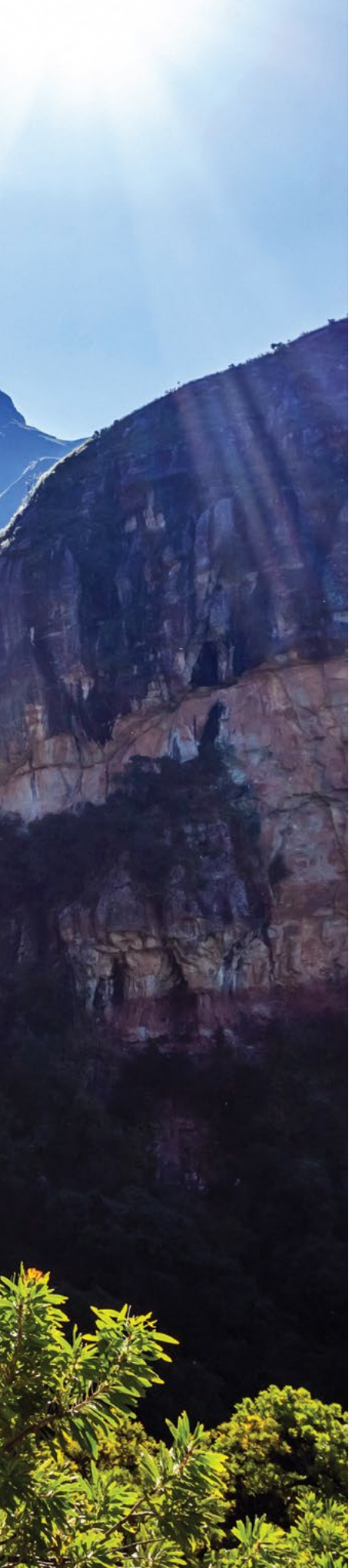
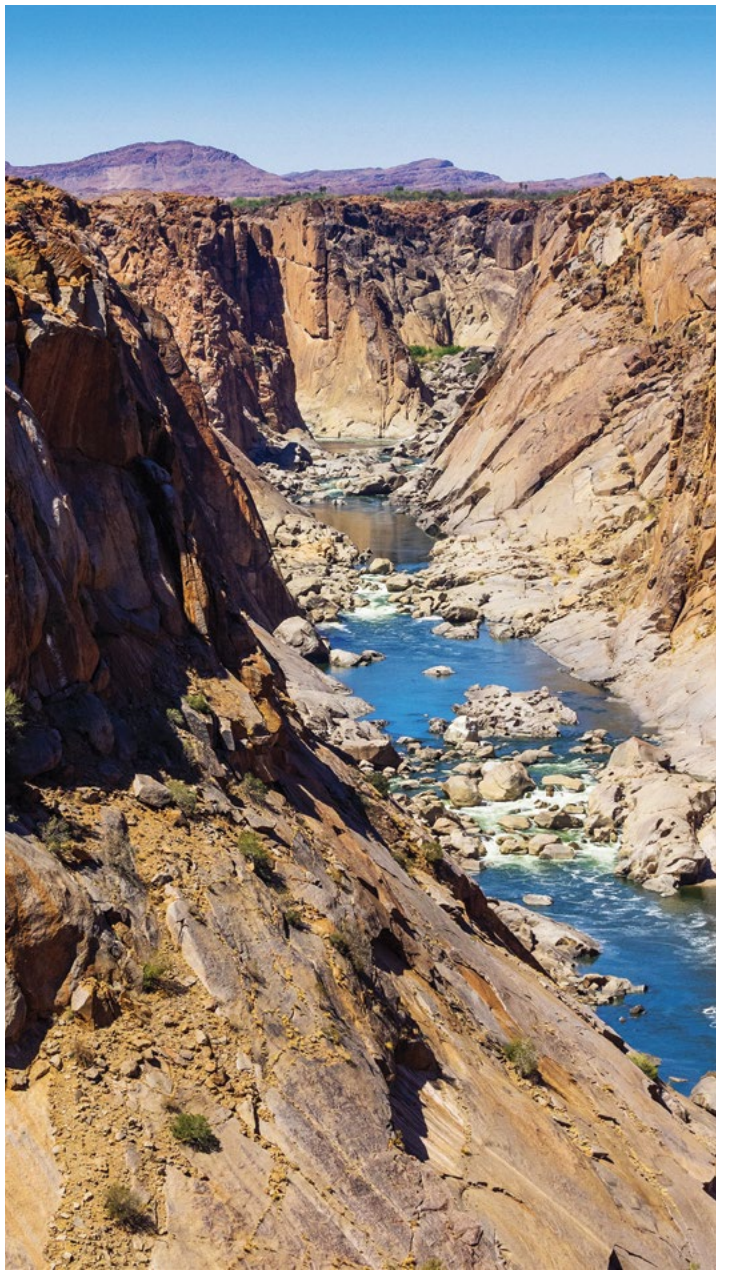




ORANGE-SENQU:
AFRICA'S SEVENTH LONGEST RIVER

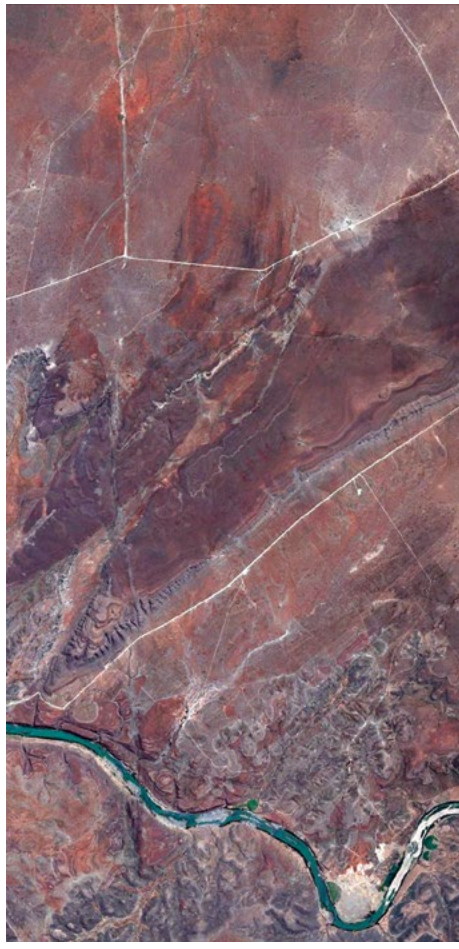
3,200 meters above sea level in the heart of the Drakensberg Mountain range in the Kingdom of Lesotho and a mere 200 kilometres from the Indian Ocean, Africa's seventh longest river rises.

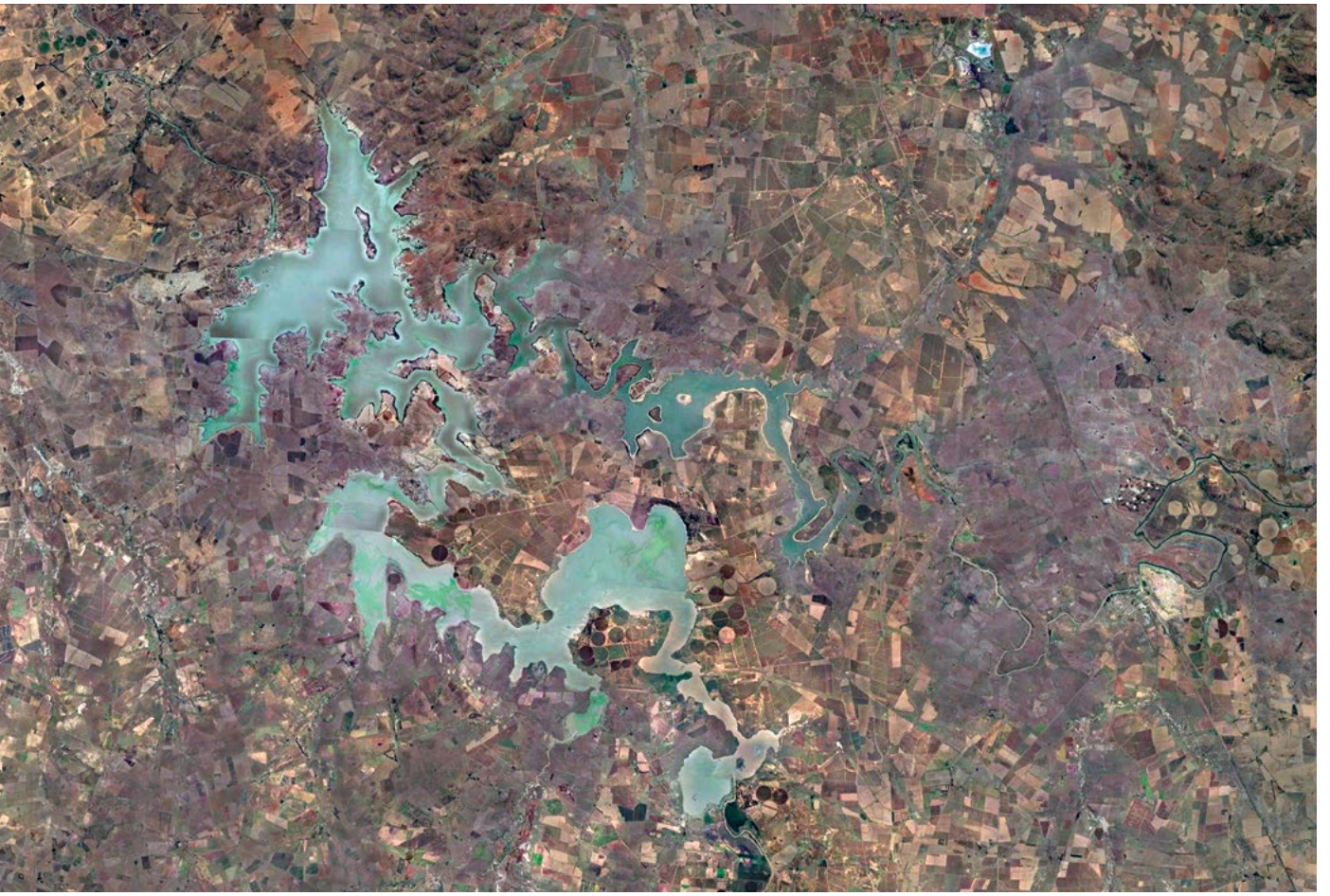
As it carves its way through the deep ravines, the river passes from cool-temperate and moist alpine regions to progressively more arid terrain flowing 2,200 kilometres west through South Africa to the Atlantic Ocean.

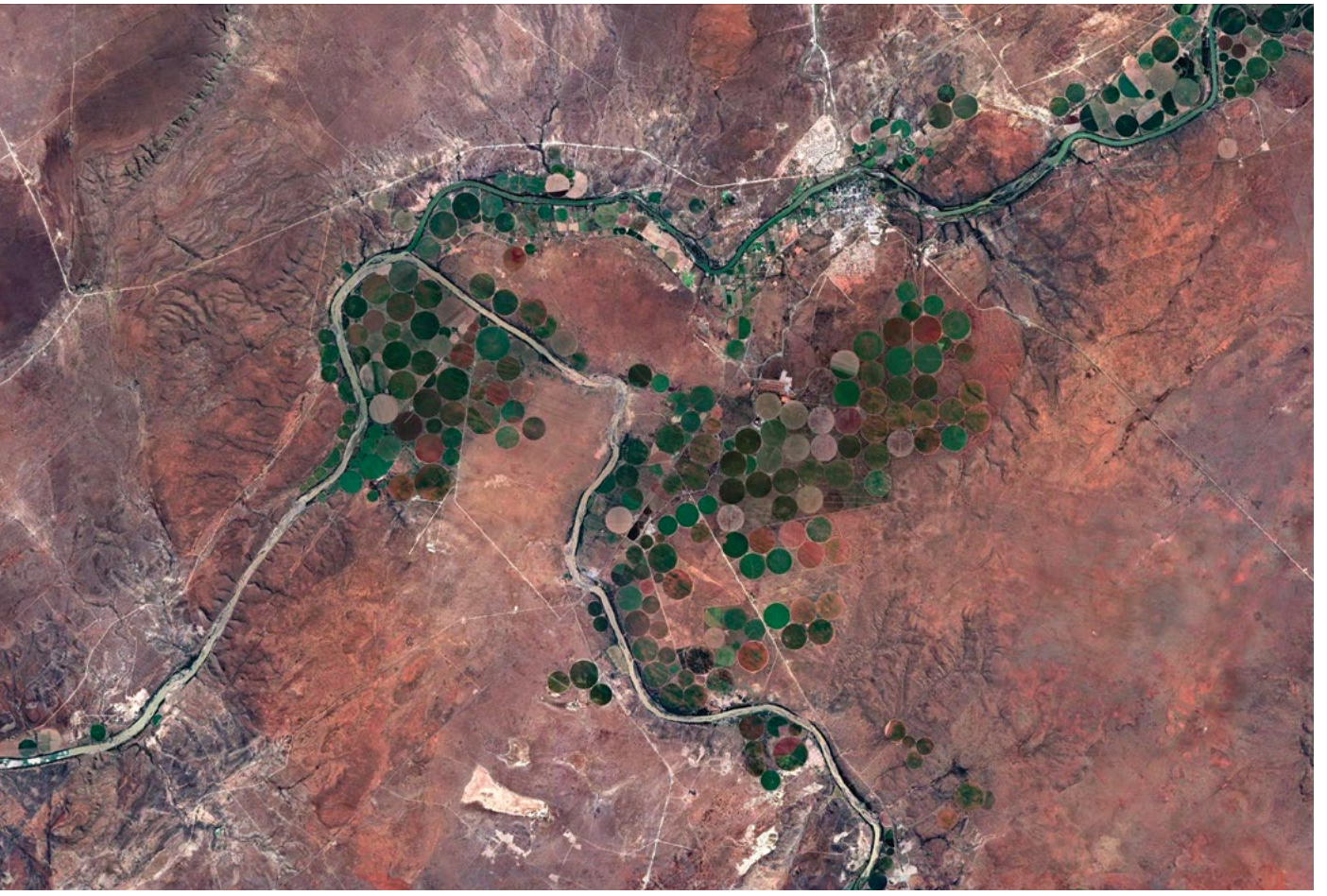
Before the arrival of the White settlers, the Khoi people referred to the river as the "Gariep" or Great River. In 1779 Colonel Robert J. Gordon, commander of the United East India Company garrison at Cape Town named it the Orange River in honour of the Dutch prince of Orange.

Today, the river system is known as the Orange-Senqu, a blend of the river's South African and Lesotho names.

William V (Willem Batavus; 8 March 1748 – 9 April 1806) was a prince of Orange







SA's THIRD-LONGEST RIVER

South Africa's third-longest river has its source near the town of Breyten in the Mpumalanga province. The Vaal River takes its name from the Afrikaans word meaning "drab" or "dull", which refers to the colour of the waters.

Flowing westwards, the Vaal River joins the Wilge River at the Vaal Dam.

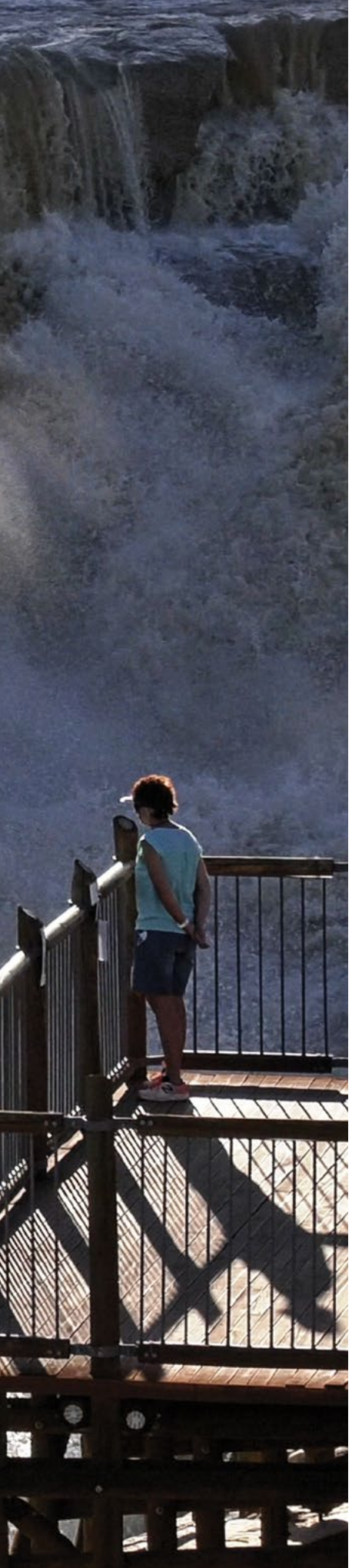
Below the dam wall, the Vaal flows west into the Bloemhof Dam before joining the Orange River confluence downstream from the town of Douglas.

Top left: Breyten

Top right: Vaal Dam

Bottom left: Bloemhof Dam

Bottom right: Douglas



AUGRABIES FALLS

The largest waterfall on the Orange River is the 56 meters deep Augrabies Falls; its name is a derivative of the Khoi word "Aukoerebis", a place of great noise.

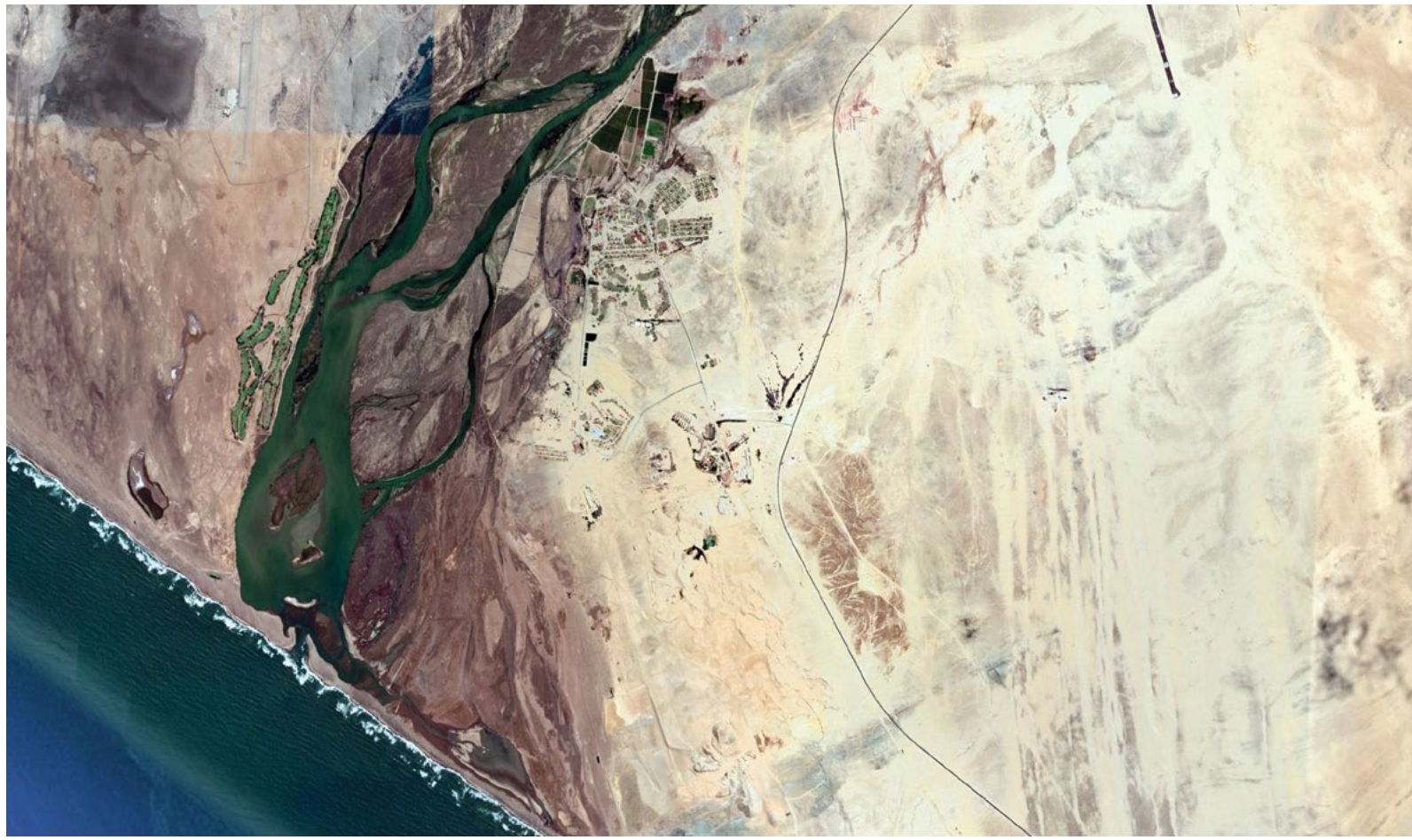
The gorge at the Augrabies Falls is 240 meters deep and stretches over 18 kilometres.

Top: From the Augrabies Falls to the sea, the river's lower course is often called the Gorge Tract.

Bottom: Where the rock surface is soft, the river valley is generally open, but where it traverses harder igneous rock, it is confined between almost vertical cliffs more than 300 meters high in places.

Top: Some of the most rugged territory on the river's course is found in the mountain desert wilderness of the Richtersveld.

Bottom: The final section of the Orange River flows through the Namib coastal desert to the Atlantic Ocean at Alexander Bay.



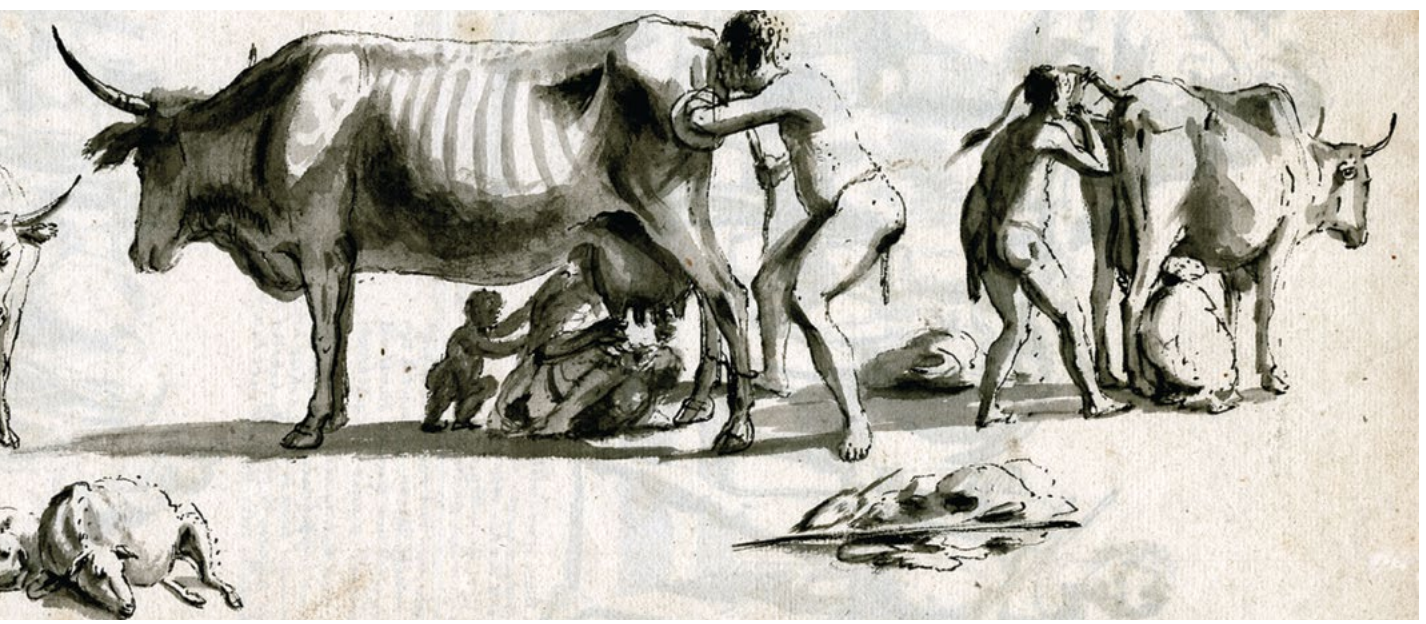
Top: The delta-type mouth is less than 5 kilometres wide and almost sealed off by sandbars. The gap at the southern end is maintained by the outflow of water from the river mouth during low tides and by the tidal inflow at high tides.

Bottom: The river's seasonal influence is an essential factor in the functioning of the Benguela ecosystem and biodiversity around the mouth.

The area is a Ramsar wetland site covering some 2,000 hectares.

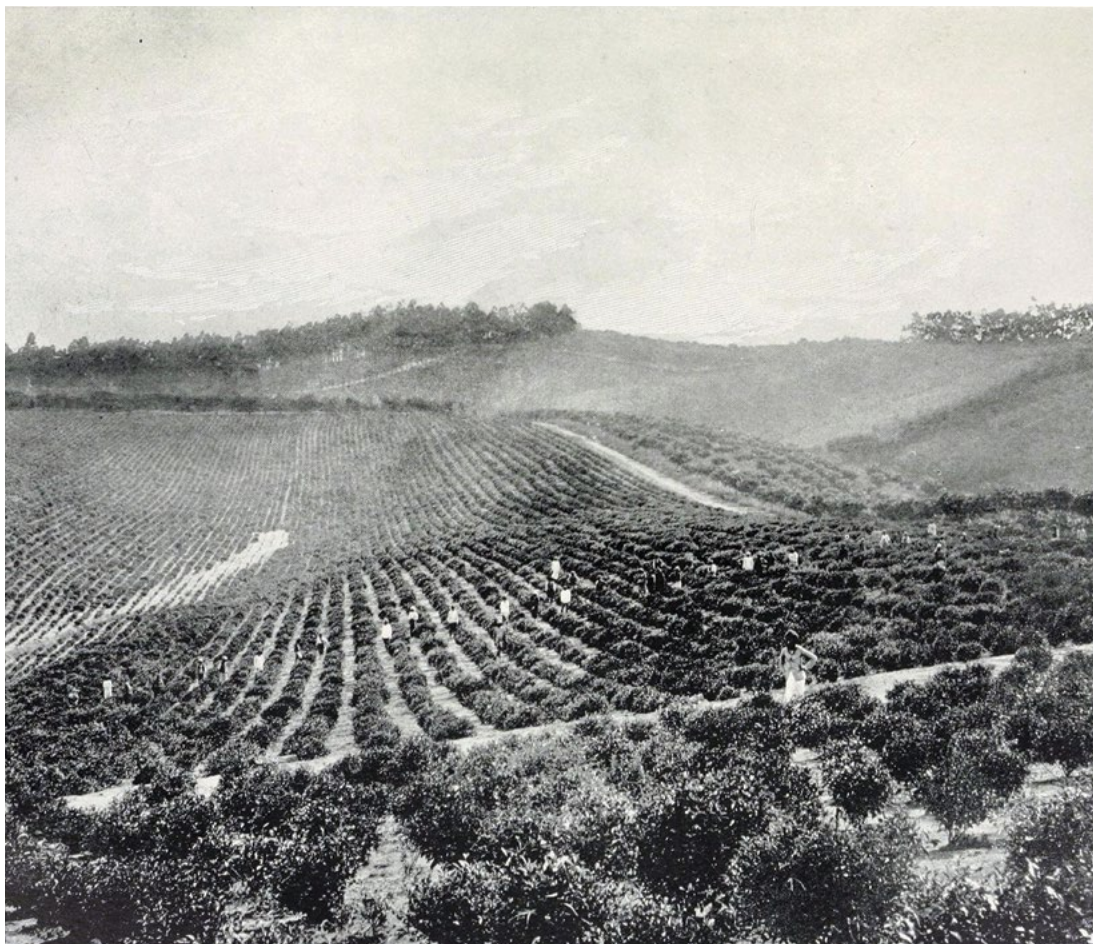
Top: The Orange-Senqu Basin was populated from the earliest days of humankind, and hominid fossils have been discovered within the Basin in the Taung area.

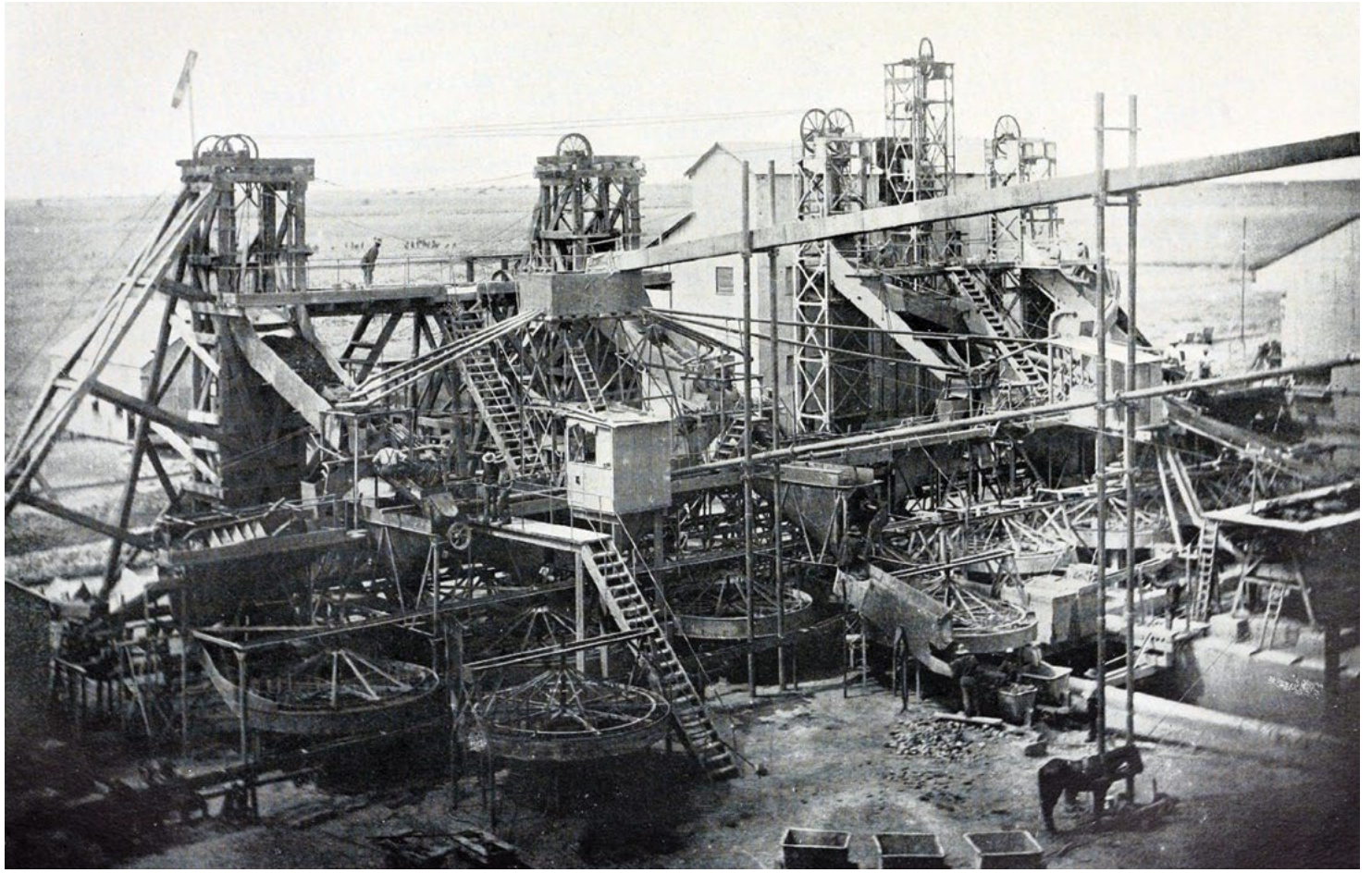
Bottom left and right: The San people were the only inhabitants of the Basin until some 2,500 years ago when the Khoi-Khoi pastoralists arrived.



Top left: Agropastoral Bantu-speaking peoples migrated into the Vaal basin some 1,500 years ago.

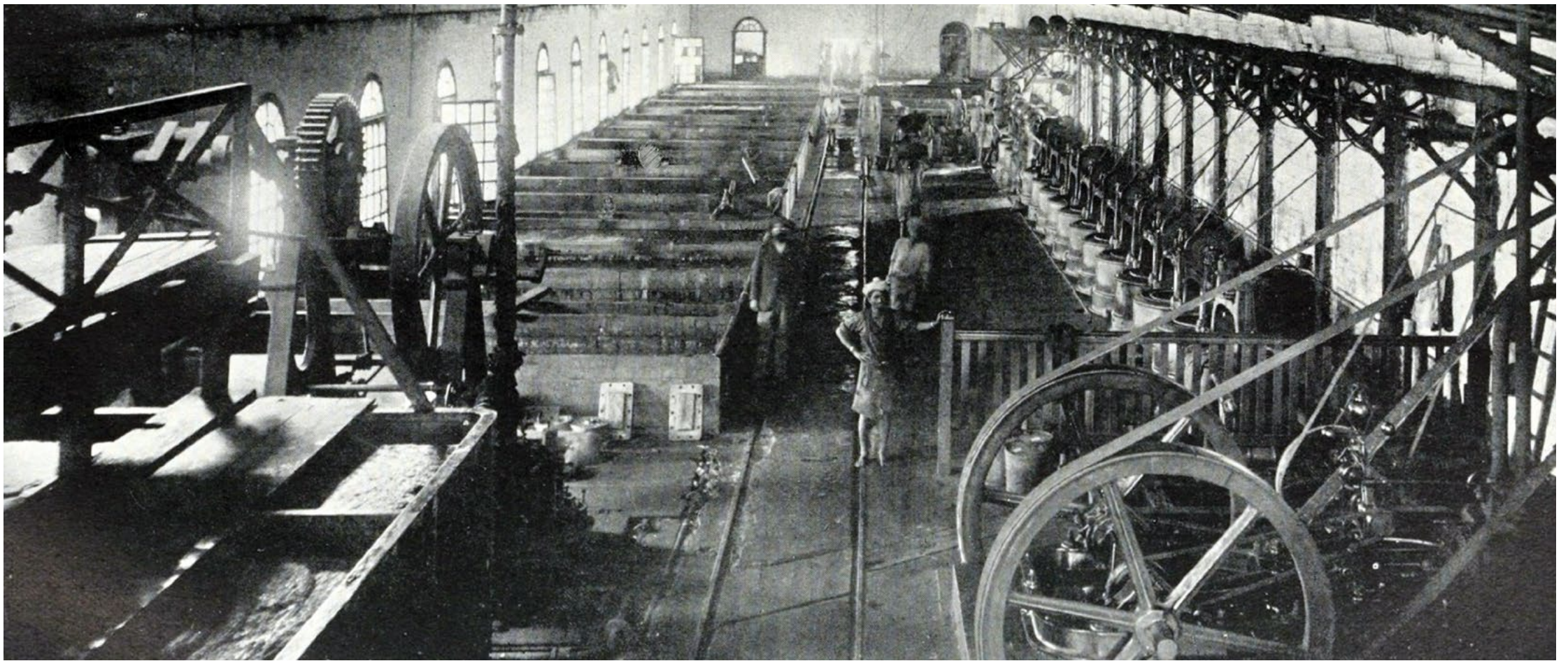
Top right: After 1690, European seminomadic livestock farmers spread into the Basin from the southwest.





PRESSURE ON WATER RESOURCES

European settlement intensified in the late 19th century, accompanied by extensive livestock farming, crop production, gold and diamond mining, and burgeoning industry which placed increasing pressure on the water resources.



The geographical Basin of the Orange-Senqu River system covers an area of almost 900,000 sq. km across four countries. It provides the single largest water resource south of the Zambezi River in a region that is classified as semi-arid and subject to increasing water stress.

The mean annual precipitation across the Basin varies from as high as 1,200mm in the Lesotho Highlands, the only region where annual rainfall exceeds evaporation, to less than 50mm in the Richtersveld, where the climate is classified as arid to hyper-arid.

The four riparian states of Lesotho, South Africa, Botswana, and Namibia rely to varying degrees on the river system as a source of water for mining, manufacturing, agriculture, energy, tourism, conservation, and residential uses.

95% of all water demand is from South Africa, of which around 60% comes from the irrigation sector.

In the southern region of Namibia, the Orange River is a crucial resource for commercial agriculture and mining activities.

In Botswana, the Basin is very flat and arid and has not contributed water to the main stream in recent history. The principal form of land use in the catchment is traditional livestock rearing, and groundwater is exploited via the Tsabong Groundwater Resources project.

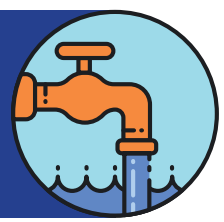
The national water demands are relatively small in Lesotho, but the Lesotho Highlands Water Project allows the country to receive royalties from South Africa for water delivery and electricity generation.


BOTSWANA
LESOTHO
INDIAN OCEAN
SUNDAYS RIVER VALLEY
WITWATERSRAND
DRAKENSBERG MOUNTAIN RANGE
Limpopo
Orange
Vaal
Molopo
Harts
Groot-Harts
Skoonspruit
Moos
Gelukspruit
Klip
Kalkspruit
Sandspruit
Vals
Sand
Vet
Modder
Riet
Tierpoort
Ongers
Brak
Klein Brak
Seekoei
Kraai
Caledon
Mohokare
As
Elands
Wilge
Senqu
Tugela
Great Fish
Kang
Molepolole
GABORONE
Jwaneng
Kayne
Lobatse
Makopong
Good Hope
Mahikeng
Tsabong
Rustenburg
PRETORIA
Johannesburg
Potchefstroom
Klerksdorp
Orkney
Vaal Barrage
Vryburg
Kuruman
Taung
Bloemhof
Delportshoop
Springfontein
Riverton
Kimberley
Douglas
Bloemfontein
Ficksburg
Maputsoe
MASERU
Katse
Welbedacht
Prieska
Vanderkloof
Philippolis
Trompsburg
Springfontein
De Aar
Gariep
Aliwal North
Mount Moorosi
Quthing
Middelburg
Polokwane
Nelspruit
Durban
East London
Port Elizabeth
22°S
24°S
26°S
28°S
30°S
32°S
34°S
24°E
26°E
28°E
30°E
32°E
34°E
LEGEND
Place
Perennial river
Ephemeral river
Dam
Ramsar site
Protected area
Pan
Orange–Senqu River basin
Provincial boundary
International boundary
National parks
1 /Ai-/Ais–Richtersveld Transfrontier Park
2 Augrabies National Park
3 Golden Gate Highlands National Park
4 Karoo National Park
5 Kgalagadi Transfontier Park
6 Maloti–Drakensberg Transfrontier Conservation Area
7 Mokala National Park
8 Sehlabathebe National Park
9 Tsau//Khaeb National Park
10 Ts'ehlanyane National Park
Ramsar sites
A Barberspan
B Blesbokspruit
C Lets'eng-la-Letsie
D Orange River estuary
E Seekoeivlei

FIVE MAJOR ENVIRONMENTAL CONCERNS

Across the Orange-Senqu basin, five major environmental concerns and their immediate causes have been identified.

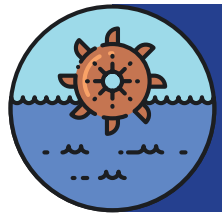
ONE



STRESS ON SURFACE AND GROUNDWATER RESOURCES

Reasons: Over abstraction

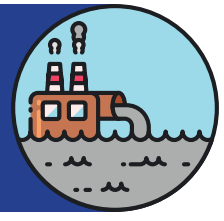
TWO



ALTERED WATER FLOW REGIME

Reasons: Impoundments

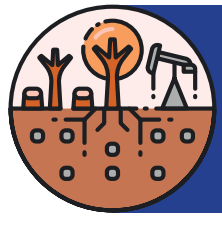
THREE



DETERIORATING WATER QUALITY (SURFACE AND GROUNDWATER)

Reasons: Pollution from agriculture, mines, and urban areas

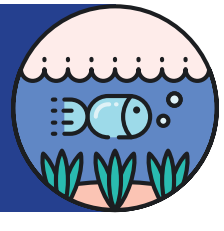
FOUR



LAND DEGRADATION

Reasons: Poor mine rehabilitation, range management, and cropping practices

FIVE



SPREAD OF ALIEN INVASIVE PLANTS AND ANIMALS

Reasons: Deliberate or accidental introductions

ORASECOM

THE ORANGE-SENQU RIVER COMMISSION

Against this background, the Orange-Senqu River Commission (ORASECOM) was established in November 2000 by the governments of Botswana, Namibia, South Africa, and the Kingdom of Lesotho with a clear mandate to promote integrated water resources management and development within the Basin.

One of the principal functions of ORASECOM is to give guidance and advise its member states on interventions needed at a national level to ensure the sustainability and use of the system. That guidance needs to be based on scientific data to recognise the problems, and this is how as ORASECOM, we advise member states to deal with such. It's not just about collecting the information. It's also taking the recommendations that come with such an analysis to strategically address the problems.

Within the operational level, the right expertise, people within a specialization are needed who will be able to assist with this kind of work. We're talking about limnologists, water quality specialists, and hydrologists.

JOINT BASIN SURVEY

An Aquatic Ecosystem Health monitoring program, known as the Joint Basin Survey (JBS), is conducted every five years.

The first JBS took place in 2010 and the second in 2015.

ORASECOM commissioned GroundTruth to implement the third JBS in October 2021.

GroundTruth
Water, Wetlands and Environmental Engineering

The primary driving reason for the JBS is to try and assess the health of the river system that so many people rely on. The Orange-Senqu River Basin is one of the highly developed river basins in the world. It faces a lot of pressure from various economic activities.

The whole idea of this project is to primarily look at the ecological status of the system, from its upper catchment right down to the mouth.

We look at general indicators of environmental quality. It's indicators of habitat quality, water quality, and water quantity quality.
There are a number of new issues that have arisen since the previous surveys, particularly related to emerging contaminants such as microplastics. It also includes radionuclides from the mining regions in Gauteng. The study, which has been ongoing for the past 10 years, the previous surveys were looking at the levels of persistent organic pollutants (POPs) in fish and sediments of the river.
This is a large-scale study looking at the largest river basin in South Africa.
It requires a lot of logistical planning. It's all about the three respective teams sampling on three different systems. Being able to get their samples to the laboratories and the laboratories then being able to analyse all of the samples together at the same time.

Prof. Victor Wepener
Aquatic Ecotoxicology & Ecological Risk Assessment

CITIZEN SCIENCE PROGRAM

JBS 3 also included a stakeholder engagement program to build capacity and expand opportunities for citizen science throughout the Basin.

We are monitoring the water quality, the size of aquatic macroinvertebrates, the vegetation, the geomorphology, and the index of habitat integrity. The new concept of monitoring is the gathering of aquatic ecosystem DNA which is so exciting.

My venture is mostly working with macro-invertebrates. Through citizen science, I engage school kids to participate in biological research. I take them to the river system, where we then disturb the substratum, and we scoop with a net and put that in the tray. Then we start counting the macroinvertebrates we find in the river system. Remember, if we take care of the river system, the river system will take care of us.

THE START OF JBS3

A workshop was held in the town of Douglas at the start of JBS 3. The morning was spent getting all the teams together.

Top: The instruments need to be calibrated due to mechanical error, and we're just bringing them back to set standards so that we know the exact water quality within the systems. We're calibrating pH at 4, 7, and 10. Once you start going past the three points in pH, the scale starts to waver. By calibrating those three points, we ensure that we cover the full pH range without getting any disparity. The other instrument we'll be calibrating is electrical conductivity. We just need one point, and then it's able to read that across the board.

Juan Tedder
Ecologist

Middle & Bottom: We are using this site as an opportunity for the teams to confirm that they are on the same page, to harmonize the methods, to understand the different protocols that we're going to follow, and to take it from theory into practice and to collect the actual samples at the site.

Those who are doing riparian vegetation, for example, will be coming together from each of the three teams running through their field sheets and making sure their interpretations on those are correct. The fish teams are going to be putting nets out, sampling, calibrating, ensuring that they're all doing the same method of testing on the fish. So it's really just a cross-calibration with the teams. This is the first site. Initially, it's always a little bit chaotic, as everyone settles down and gets their gear together, making sure we're all on the same page.

Dr Mark Graham
Specialist Aquatic Scientist

Top: Byron Grant is currently working on the fish using an electrofisher. The electrofishing apparatus deploys an electric field into the water, and the fish gets stunned by that. You're then able to net them without them swimming away.

Gary De Winnaar
Terrestrial/Aquatic Ecologist

Bottom: We just caught a school of yellowfish. We used a seine net to pull through the water column to capture them. So it is a good sign that there definitely are yellowfish still in this river system. We also caught some catfish. Again, a good sign that they are spawning in this system.

Top: Parasites have gotten a bad rap. These won't be detrimental. As long as the fish is alive, they can live. It feeds off the mucous and the blood of the fish. If parasites disappear off the fish, then generally, the water quality is poor, and the fish are in a bad condition.

Prof. Victor Wepener
Aquatic Ecotoxicology & Ecological Risk Assessment

Middle: We're collecting environmental DNA (eDNA) of all the animals in the river system, not necessarily fully aquatic animals, but also otters that are swimming in the water, cows that are coming here to drink, and birds that are fishing here.

The whole idea is to take a sample at a good spot in the middle of the river, and from that sample, we draw 20 syringe fulls of water and push it through a membrane. This is a very fine microscopic membrane, so if there are any microscopic particles of eDNA, it will be caught in that little filter paper. That filter paper gets packaged very carefully and sent to the laboratory in England, where they will analyse the eDNA and come back to us. Once the database that the DNA is being compared to has been fulled, we'll have a comprehensive way of finding out what's in the river system and what's making use of the river system.

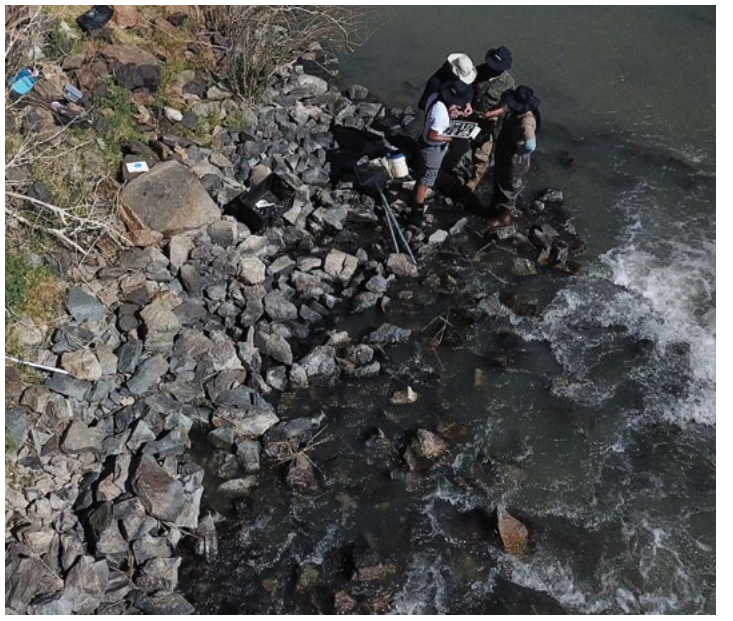
Bottom: Kyle and Michael are working on the macroplastic nets, collecting any solid waste drifting down the river. Afterward, we will analyse what's in the net and break it down into the categories of plastics and all different types of solid waste. Kylie is working on the macroinvertebrates, looking at all the aquatic insects. The three main biotopes are vegetation, stones, as well as gravel, sands, and mud biotope.

Gary De Winnaar
Terrestrial/Aquatic Ecologist

PERSISTENT ORGANIC POLLUTANTS

Leaving the town of Douglas, the teams set out in different directions to begin their work on the various sections of the river system.

Persistent Organic Pollutants are organic compounds of natural or anthropogenic origin that resist photolytic, chemical, and biological degradation and have toxic properties.



Right: South Africa is Africa's largest user of pesticides, and these pesticides end up in our waterways, and because they are highly persistent, they accumulate in organic-rich sediments as well as organisms such as fish.

We have sites that have been monitored on the previous surveys. So we're going back 10 years already, and what they do is they collect fish from these sites. The fish are then dissected, removing the muscle tissue from the fish, and this gets prepared for analysis. The laboratories then test for these persistent organic pollutants.

Far Right: The African sharptooth catfish (Clarias gariepinus) is a very popular eating fish among people who are reliant on natural resources for their source of protein. The main reason is that it has a lot of meat. They also grow very big. That's why the persistent organic pollutants would increase in concentrations within these fish.

Prof. Victor Wepener
Aquatic Ecotoxicology & Ecological Risk Assessment

We are upstream of the Vaal-Orange confluence. This is the Vaal River by the barrage, and the flow is higher than yesterday.

It seems as if these catfish are responding to the increase in flows. So they are swimming upstream, most likely to spawn.

There are several barriers within this river system that the fish can't pass. Here, it's essentially a vertical wall, so it'd be very difficult for the fish to pass.

When we sample for fish, we use both active and passive methods. One of the passive methods is using a fyke net. The fyke net is basically a wall with a funnel made out of mesh. When the fish swim into the wall, they can't move further, so they move down the wall and into the funnel. It's a practical method for catching nocturnal species that usually hide away during the day.

I placed the fyke net closer to the reed bed. It seems that the catfish are not actually using the centre of the channel but sticking more towards the margins.

We caught 26 quite large specimens. We have kept some of the barbels to dissect for microplastics, as we don't fully realize the amount of plastic pollution in our river systems.

We might see the visible macroplastics, but the tiny plastic fibres in the river system find their way into the food web. Fish are consuming them and blocking their digestive tract with plastic. It impacts the gut, and they can't feed as well as they should. So the point of this survey is to figure out the level of microplastics present within particular fish species, and then, hopefully, someone will take it up as a research project.

Barbara Creecy, the Minister of Environment, Forestry, and Fisheries, indicated that parliament has now approved a policy on the development of inland fisheries. This means that there is going to be a greater harvesting of fish from freshwater systems.

The Vaal and the Orange-Senqu River systems have some of the largest impoundments, which would be targeted for these inland fisheries.

This will provide protein, but will the protein be safe for human consumption? This is something that has not been studied well enough in South Africa. This study will most definitely contribute, for instance, to flag fish from *dam x*, not suitable for human consumption, or by all means, it can be utilized for human consumption.

Prof. Victor Wepener
Aquatic Ecotoxicology & Ecological Risk Assessment

DRY BRAK RIVER TRIBUTARY OF ORANGE RIVER

DRY BRAK RIVER

The dry Brak River is a tributary of the Orange River.

Overgrazing by livestock has damaged rangelands in large parts of the catchment, causing erosion and changes in species composition.

Goats and sheep are eating too much of the grass in this buffer zone of the river, creating lots of runoff when it rains. Where the water is rushing off the banks, it drops into the riparian zone and causes a lot of erosion. So along this whole reach are lots of very deep dongas and banks as a result of overgrazing number one, and then when the rains come, lots of runoff.

With this particular site, because it's an ephemeral system that flows only briefly during and following a period of rainfall, we have to come and assess it still from a riparian habitat point of view. The only real assessment tool that we have is the VEGRAI model. It's the vegetation response assessment index. We need to compare how has the riparian system changed in its natural state. So we do that by looking at the indications of the system and the different zones. We look at the marginal zone, which is the zone closest to where the river typically would be. Then we extend out from that marginal zone into the non-marginal zone, which is basically sitting between the main channel and the terrestrial environment.

Gary De Winnaar
Terrestrial/Aquatic Ecologist

This area is impacted by growing infestations of Prosopis species, more commonly known as Mesquite. This woody shrub species is often encountered in riparian areas and is responsible for significant river yield losses and land degradation. The species, introduced into Namibia from South America in 1912, has spread across 60,000 square kilometres in South Africa and threatens another 560,000.

The seed pods have a high protein content, making the plant popular with small livestock farmers.

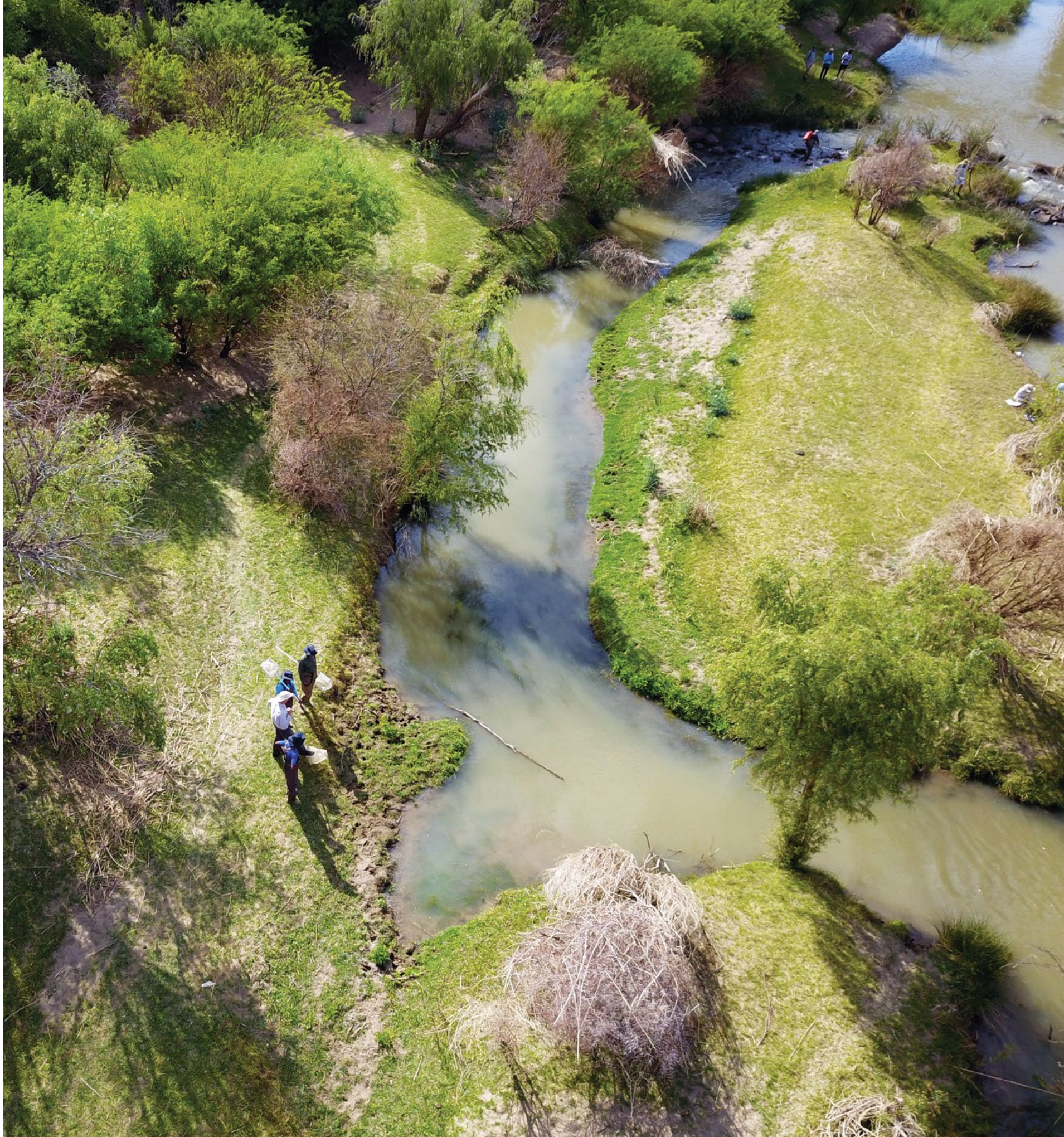
One of the big factors with the riparian assessment is the comparison between woody and non-woody vegetation. Greater than 80% of this riparian system is Prosopis. It's a huge problem in these dry arid areas because of its very deep root systems. Prosopis out-competes all other plants and creates these very dense thickets, soaking up all the groundwater and speeding up the vapor transpiration process. Then, as a result, dropping the groundwater table so that other plants can't get to it.

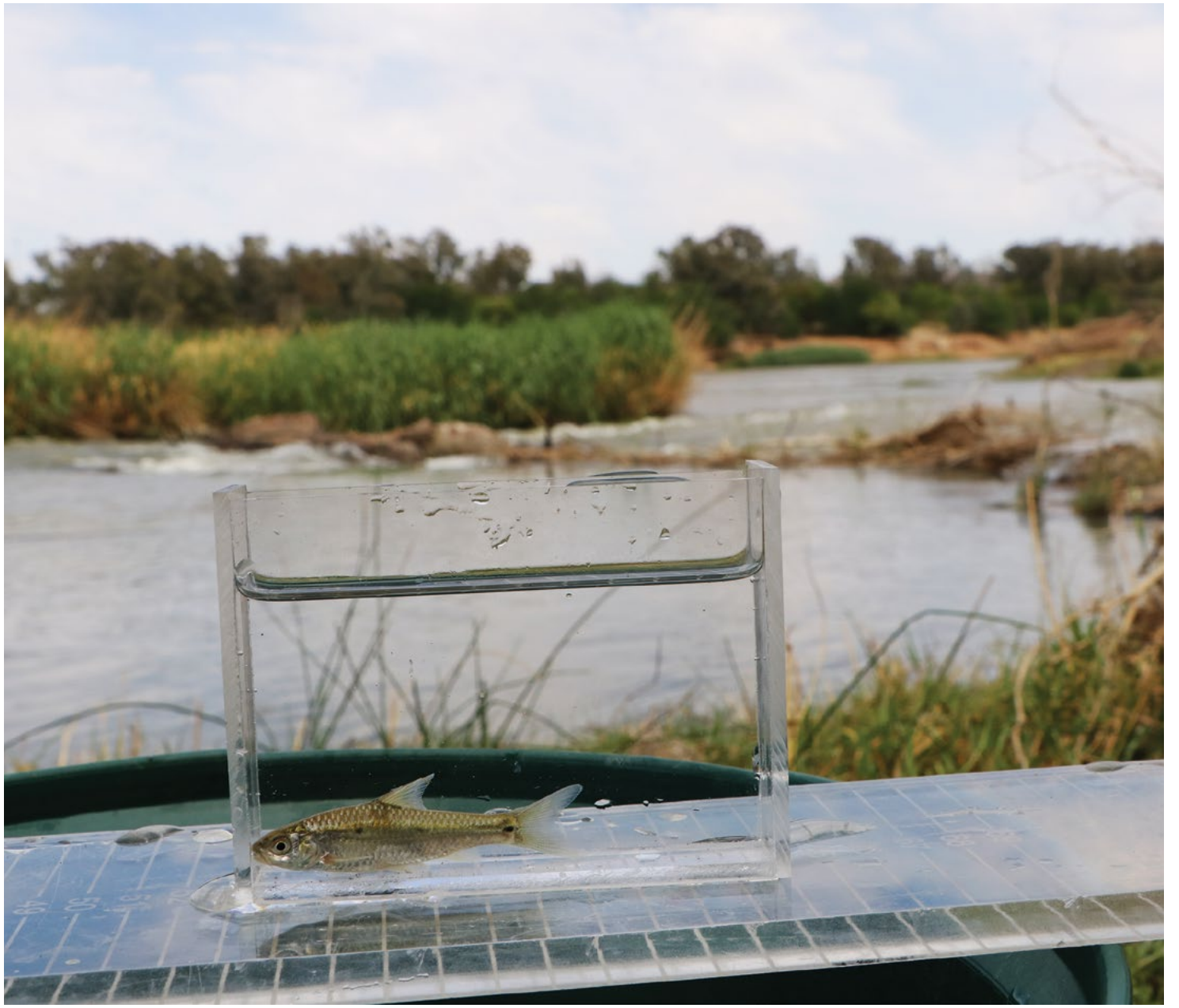
In terms of this particular plant, I know they've tried the mechanical and chemical approaches. Their root system remains a challenge because it's so deep and robust. I would imagine a cut treat, but with good follow-ups, and with that, good rehabilitation to get some kind of decent groundcover. One has to be very careful not to cause erosion forces because if you remove this cover, the resistance to the flow will suddenly be much less, and the flows are just going to speed up.

Gary De Winnaar
Terrestrial/Aquatic Ecologist

Fishing at fish spawning site.

We didn't get a lot of fish at this site the last time because it was during winter, but now it's spring with warmer weather, so it'll definitely be interesting to see what species we get and what species are spawning at this site.





It's usually quite useful to take macro photographs of diagnostic features. We normally look at the scale counts and the number of dorsal fin spines versus rays. If we're unsure of the species, we can zoom in on those features on our monitor.

Top Left: We caught six different species of fish and carp. We picked up a lot more carp here than the other sites, which is a concern from a fisheries point of view and fish ecology because they modify the riverbed.

Gary De Winnaar
Terrestrial/Aquatic Ecologist

Top Right: This is the first Rock-catfish (Austroglanis sclateri) that we've caught on the trip. It only occupies fast-flowing biotopes within the river system. Austroglanis sclateri are well adapted to living in consolidated substrates and fast-flowing water. They've got a ventral mouth with a body profile adapted to stay in the current at the bottom, feeding on invertebrates on the substrate.

Middle: I'm very impressed to see compared to the last time we were here in 2015, the effect that the floods had in terms of resetting some of the vegetation components. I'm encouraged that at least some of the floods are getting down here and allowing the vegetation to get those disturbances, to allow them to then reset and get some of those more terrestrial species out of the main channel to allow the system to respond accordingly.

Gary De Winnaar

Bottom: The team did well. They ran through the OSPAR protocol and collected a fair amount of litter, confirming a source coming from upstream. It might be just because we are close to Douglas town. So perhaps that's a source for solid waste coming into the river here.

Gary De Winnaar

FRAGILE ECOSYSTEM OF LESOTHO

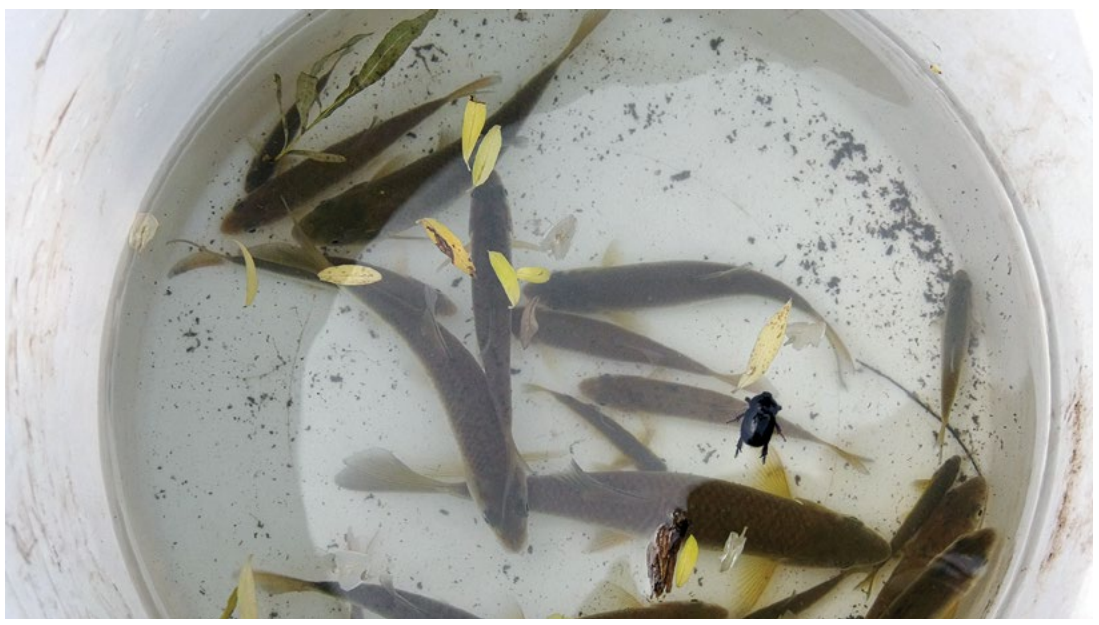
The steep terrain and harsh climatic conditions in Lesotho have created a fragile ecosystem that is vitally important to the Orange-Senqu River catchment.

The country has an egalitarian society, and access to land is unrestricted, but less than 10% is suitable for cultivation. Increasing human population pressure has led to the cultivation of steep highland slopes resulting in severe soil erosion.

Sponges and grasslands have degraded, species diversity is declining, and soil is exposed to wind and water erosion, impacting the river's health.

We should be finding lots of yellowfish and a couple of muddies coming up, not a lot of big fish swimming around at all. This is due to a multitude of factors; there are movement barriers downstream, possible water quality issues coming downstream here, and a lot of pressure on the fish population from local fishermen.

Byron Grant
Aquatic Ecologist and Biodiversity Specialist



Chubbyhead barb (Enteromius anoplus)

ABSENCE OF SUSTAINABLE PRACTICES

Grazing land is open-access and common property, which means that sustainable management practices are seldom in place and difficult to enforce, resulting in overstocking.

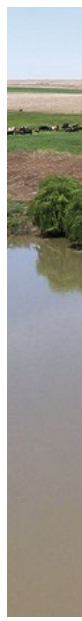
The pressure on woody vegetation for fuel has led to severe deforestation with associated exposure of soil and resulting erosion.

One of the key issues that we have to address is the amount of topsoil that is being carried from Lesotho all the way down to Gariep Dam. Soon it will be no more than an evaporation pan. There is so much silt coming down.

It's not just a simple siltation issue. We will no longer have the topsoil that we need to produce food. It would make it even impossible for the Lesotho government to drive its development agenda. I mean, with no topsoil, no food, you have a food-insecure country.

The Vaal River system is regarded as a working horse river. A working horse river means that it's critical to the industrial and financial heartland of South Africa, the Gauteng region. Therefore, we cannot manage the river as a pristine river. It's regarded as a Class D river, which means it's right on the edge of not being allowed to degrade even further.

Prof. Victor Wepener
Aquatic Ecotoxicology & Ecological Risk Assessment



Our rivers aren't what they were historically. They would be low in the low-flow season, and during high-flow, the floods would take vegetation away and push it downstream.

These days, with dams, erosion, and bridges, driftwood gets stuck trying to get under the bridges. It tends to block absolutely everything, and it causes inundations, or the water tends to build up, flooding the banks and causing more habitat destruction. Naturally, this would have washed all the way down to the coast. It stops the water for a long time. Regulating the flow in the low-flow season to provide water for crops affects how the vegetation reacts to the amount of water present.


FOIL
REFILL
25m

EUTROPHICATION

Eutrophication is defined as the process by which a body of water becomes enriched in dissolved nutrients such as phosphates that stimulate the growth of aquatic plant life, usually resulting in the depletion of dissolved oxygen.

Livestock has environmental impacts such as the nutrients from their feces, overgrazing, trampling of the riverbanks, and all that affect how the vegetation reacts. In many cases, as with this site, there are infringing alien invasive plants that are out-competing the indigenous species.

Top: The impact that alien invasives have on the rivers, for instance, eucalyptus trees, which can be found among the upper Vaal, is that they use a lot of water. Big eucalyptus trees use up to a thousand litres of water a day. An entire reach infested by eucalyptus, not allowing indigenous species to occur, reduces the number of diversities, and indigenous species in and out of the water that uses those plants can't use them anymore because the space for those plants has been taken over by the exotic plants.

Middle & Bottom: Watercress is classified under Category 2 of invader plants. Category 2 plants have a value, and watercress is used medicinally. In this case, the watercress occupies a lot of the marginal zone where indigenous aquatic and non-aquatic plants should occur. As they are more efficient than our indigenous species, they are taking up valuable nutrients, sunlight, and growing faster, allowing no space for our indigenous species to occur.

If this watercress starts crowding the habitat of a certain fish or invert, then that invert will become less, and if the whole reach gets infested, that invert, fish species, or organism will then potentially become lost. If the overspread continues, the entire reach will be full of alien invasives, which is the case in most of our rivers.

Top & Middle: We're currently on the Suikerbosrand, which is one of the bigger tributaries of the Vaal. A large part of this study is to look at those tributaries to identify the impacts before they reach the Vaal system. In doing so, we can root out the causes or the impacts at their source, rather than trying to fix them once they've already reached the Vaal, which is such a large system to try and control.

Bottom: There are a few informal settlements upstream, and certainly, some raw sewage flowing into this river. Kicking up some of the sediments in the river and moving around the stones, that odour is coming up.

If we find the root causes here in the smaller systems, we can target them and inform the municipality that they are clearly pumping sewage into this system that needs to be fixed.

The eDNA samples are quite a costly process. The more eDNA we can collect, the better representative sample the labs have to work with. In systems like this with high turbidity, we tend to clog up these filters quite quickly. We try to push a range of about 15 to 20 syringe fulls through the filters, but in some of the sites, especially with sewage in the system, you get a lot less, and there's nothing you can do about that.

Top: I'm measuring in situ water quality. So I'm just checking the pH, temperature, conductivity, as well as dissolved oxygen to see if it's within the target water quality requirements. The pH is sitting at 7.26, which is within the requirements. The temperature is 19 degrees and a bit, which is fine. Dissolved oxygen is quite low. Anything below five milligrams per litre is considered low. We're sitting at 3.7, indicative of nutrients in the water that use up oxygen. The conductivity is reasonably high. It's sitting just under a thousand microsiemens per centimetre. The in situ water quality is a mixed bag at this stage. Some good and some bad.

Middle & Bottom: I have an expectancy to catch eleven fish species in this system. I have five different species so far.

Here we have a banded tilapia *(left)*. One can see the tilapia spot at the top here and the clearly visible bands.

The Southern mouthbrooder *(right)* is quite a pretty fish, and they keep their young in their mouth.

We've collected some macroplastics along the banks of the river. Essentially what we do is we come approximately five meters up from the waterline, and we do a 100-meter transect, and we collect anything plastic along the way. Once we've done that, we weigh and count every piece of macroplastics that we've picked up.

We've collected bits of rope, some polystyrene cups, pieces from yogurt containers, lots of plastic, and bottle caps, which is a major issue. We have noticed that within the upper reaches of the Vaal and likely in the upper Orange, these macroplastics start to break down as they move further down into the lower Orange. It might be that there are a lot more microplastics there than up here. We'll have to see what the results say.


Electronic
Kitchen scale


BIODIVERSITY

RADIONUCLIDES

Radionuclides are species of atoms that emit radiation as they undergo radioactive decay through the emission of alpha particles, beta particles, or gamma rays.

Radionuclides can have severe impacts on all forms of life, including mutagenic and carcinogenic effects with sufficient exposure over time.

The causes of radio-nuclide contamination in water can mainly be ascribed to a lack of adequate environmental management and control in the mines (primarily gold and uranium) and at other industrial sites where radioactive materials may be produced or stored.

CAPACITY BUILDING

Today, we've taken the Namibian group from ORASECOM and the Department of Water Affairs to site with us. They are usually always in the lower Orange catchment, and they were interested in seeing the Vaal River, as they've never seen it before.

We are doing a full aquatic ecosystem health monitoring. So we are doing fish, aquatic macro-invertebrates, water quality sampling, E. coli, diatoms, and then we're going to be looking at the persistent organic pollutants within the sediments, heavy metals, as well as methylmercury.

It's a whole capacity building for everybody here, where we are learning and sharing our catchment experience with each other.

E. COLI

If I were to take the vial and just scoop water, the chance of that powder coming out in the water is quite high. Whereas using a syringe, all I have to do is open the vial, fill it, close it, and give it a bit of a shake. To keep the sample warm, it is plugged into a belt that gets strapped onto the chest. Body warmth allows the metabolisms of the E. coli to function well.

When the sample turns bright green, a lot of E. coli is present, and timing how long it takes for the E. coli to produce this colour indicates how much there is.

WATER TURBIDITY

We use the clarity tube to measure water turbidity by filling the tube, and with the use of a magnet, the observer moves the inside black target further down the tube to the exact point where it's not visible anymore. This exact point determines the water turbidity.

Increased turbidity is not necessarily an indication of pollution. It's more an indication of factors such as erosion and sedimentation. Large systems tend to deposit things further down as they no longer have steep gradients carrying masses of water very quickly, so they start depositing stuff, and that causes turbidity.

POP's & METHYLMERCURY

We will be digging five centimetres of sediment, very carefully not to disturb the sediments. The metal scoop is used to collect sediment for the persistent organic pollutants and the plastic spade for collecting sediment for heavy metals and methylmercury. We'll take composite samples consisting of five subsamples and record the coordinates of each point, five meters apart. We'll be using different bowls to mix each composite sample, and then we'll decant it into containers.

Scoop the top layer of sediment, trying not to go deeper than five centimetres. Going deeper will dilute your sediment sample, making it harder for the lab to detect these elements. So you're just trying to get the surface where everything has settled. Drain off most of the water. Small organisms such as algae are fine to include because these elements will have settled in the algae as well.

Different flows along the riverbanks cause the sediment in moving water to deposit unevenly. By creating a composite sample for each analysis, we get a good general idea of the percentages and volumes that are being deposited within this river channel.

BENTHIC DIATOM MONITORING

Benthic diatom monitoring is another core tool within the JBS 3 program that we're assessing throughout the three catchments. Benthic diatoms are unicellular microscopic organisms, and they give us a really good idea in terms of the ecological water quality, as well as historical water quality within the systems. So they are a vital tool to this program.

We collect the stones, pieces of vegetation, sticks within the system, even plastic bottles, and the diatoms stick to these different types of substrates. We take a toothbrush and gently rub off the diatoms from the various substrates and into the water, where we decant that into a little bottle and preserve it with ethanol.

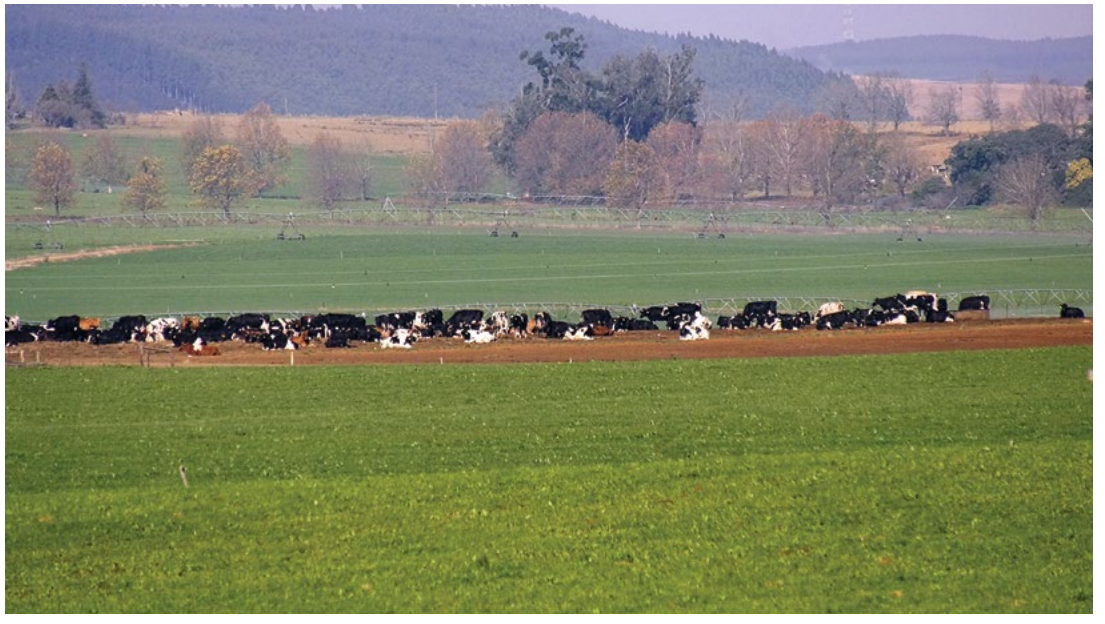
It's then sent off to the lab to get processed, where they calculate what the specific pollution sensitivity index is. With this data, they're able to record what the biological diatom index is in terms of Category A to F. Category A, being very good water quality, and F being very degraded poor water quality. Another reason why these diatoms are such an important tool is that it tells the story. It leads us and directs us in terms of where the sources of the impacts are, and what nutrients are impacting the water quality within our rivers.

CONCLUSION

In terms of the aquatic macroinvertebrate communities that we've seen through the Vaal catchment, we are picking up those communities that are tolerant to impaired or poor water quality.
Whether some of the tributaries in the Vaal River system have flow or diversity of biotopes, we are still picking up those invertebrates that prefer the degraded water quality.

The Vaal catchment is a hard-working catchment with much pressure on the Vaal River system.
Traveling through the Vaal catchment on this JBS 3 journey, we are noticing that the primary impact in the Vaal River is sewage. This is untreated, raw, or semi-treated sewage getting discharged within the tributaries as well as directly in the main stem of the Vaal River. Thus, the water quality within this catchment is severely degraded.
The reason why a lot of the sewage is getting discharged into our systems is that some of our wastewater treatment plants within our catchment are either not being maintained or non-functioning. Although there are other catchment activities, namely industry, as well as just general dumping in the river, it appears that the sewage is overshadowing all the other activities and impacts.

The sewage is the primary impact in the system, particularly from the upper reaches of the Vaal, up until the Bloemhof Dam. We then noticed from Bloemhof Dam, downstream, towards the confluence of the Vaal and Orange River, that it's more agricultural impacts on the river system. So that's irrigation, high nutrients, grazing and trampling from the cattle, and erosion.



SAMPLES FOR LABORATORIES

We are starting to send off a number of our samples to the various laboratories that are part of this survey's journey.

We're sending our water quality samples to Talbot Laboratory, who will be doing the Physico-chemical analysis.

The sediment samples that we've taken along the riverbanks will be going through to the Council for Scientific and Industrial Research (CSIR) for methylmercury assessments.

These fish tissue samples from catfish and carp will be going to iWater for the assessment of persistent organic pollutants within their tissues. The tissue is wrapped in tin foil, and this is essential to eliminate any contamination and the fish tissue touching the plastics. These will need to be kept frozen during their journey to iWater.

The radionuclide samples will be going through to Japie van Blerk who used to work for the South African Nuclear Energy Corporation (Necsa).

Our persistent organic pollutants (POPs) sediment samples will be going to Prof. Brenda Moodley, who'll be drying the sediment samples, sieving them out, and then doing the POPs assessment on the sediment.

The microplastics sediment samples will be going off to the Centre for Environment, Fisheries, and Aquaculture Science (CEFAS), as well as the atmospheric fallout plastics and fish stomach contents.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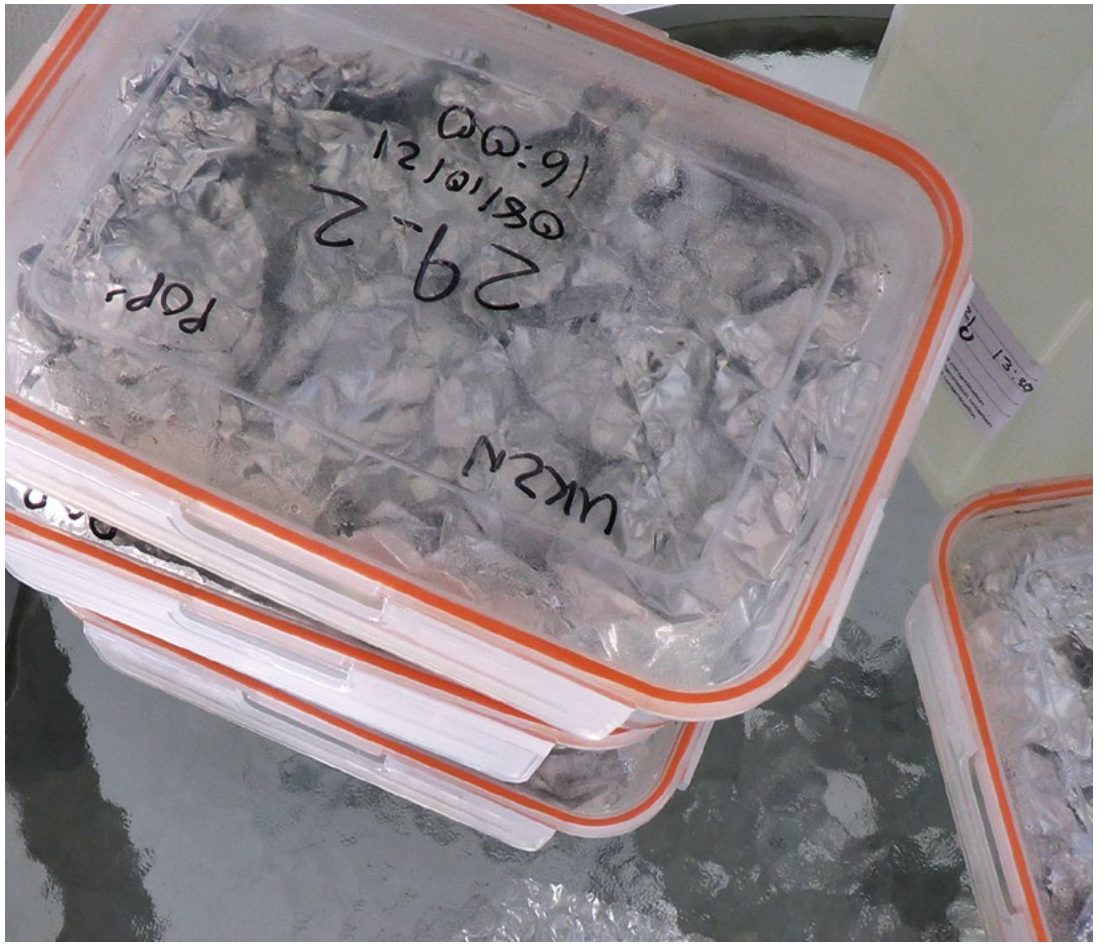
Freezer Flex
Vaal
Bloemhof
Dam
16:30
07/10/2024


CHAIN OF CUSTODY
SAMPLER/FIELD SCIENTIST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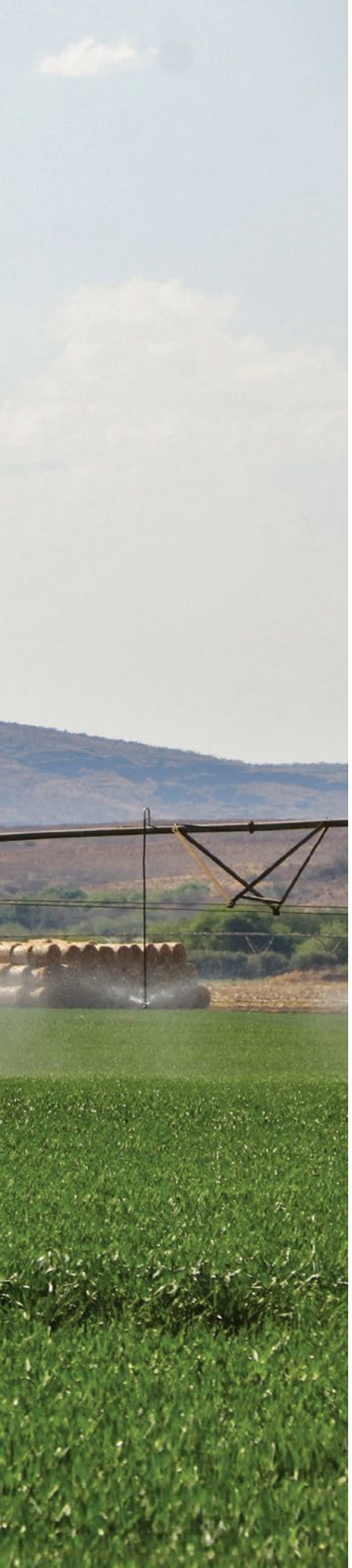

ENSURING LONGEVITY

The main purpose of the JBS 3 has been to generate scientific data that can then be used to advise the member states on actions to take to ensure that this river system continues supporting the various economic activities. So I think we need to take a step back and ask: "Where can we correct this?"

Part of what we were doing during this JBS 3 was to build the capacity of the national institutions. I strongly feel that in their quarterly monitoring, they will be able to take up some of the things they have learnt and bridge the gap that we normally have between the five years that we undertake the JBS. Firstly, it would bridge that gap, and secondly, it would ensure that they are able to address some emerging situations.

INTERGOVERNMENTAL STUDY

This study will not only provide a very important long-term monitoring record, but it also highlights hotspots of where pollutants might occur and hotspots that require urgent remediation. All the countries making use of these very important water resources must be on board with this type of intergovernmental study because it's at the level where action can be taken.

Prof. Victor Wepener
Aquatic Ecotoxicology & Ecological Risk Assessment

BACK COVER