

From Source to Sea: A River's Journey



A Scientists' Workbook for Princess Vlei Guardians



River journey glossary

Aquifer: a body of rock and/or sediment that holds groundwater

Biodiversity: An abundance of different living organisms in terrestrial (land), marine (sea) and freshwater ecosystems, and the ecological relationships which they form. A high level of biodiversity in the variety of species, the genetic variety within a species, and the variety of relationships in eco-systems, ensures that life can flourish.

Canal: A concrete structure used to control the flow of freshwater moving through the city.

Catchment area: The area where rainfall is captured naturally and flows into rivers and vleis.

Conservation status: Status telling us whether a species still exists in nature, in what numbers, and if the species is in danger of becoming extinct in the near future.

Distribution: How animals or plants are spaced in a natural landscape. Animals and plants are usually distributed where they have access to food, shelter and protection.

Ecosystem: A community of living (biotic) and non-living (abiotic) components with relationships that enable them to co-exist in balance

Endangered species: An animal or plant at risk of going extinct in the wild.

Estuary: A wetland at a river mouth, where fresh and saline water mix

Food web: A model of food chains in an ecological community to show what each organism eats, or is eaten by.

Foraging: The act of looking for food by an animal.

Habitat: The natural home of an animal or plant where it can find food, shelter, protection and mates for reproduction.

Life-cycle: The changes an animal undergoes as it transforms from birth/ hatching to a juvenile to a reproducing adult.

Pollutant: A human-made substance harmful to life found in water, air or on land.

River: A flowing stream of freshwater moving from upper to middle and lower reaches.

Salinity: The amount of salt present in a fluid such as water.

Sewage: Human waste water from toilets, baths and showers.

Species: a group or class of living organisms with shared genetic characteristics, which can interbreed and produce fertile offspring in nature.

Wetland: An ecosystem characterised by the presence of water, either permanently or seasonally.

Water Cycle Terms

Evaporation: water transforms from liquid to gas

Transpiration: evaporation of water from plants

Condensation: water transforms from gas to liquid

Precipitation: water falling from clouds as rain, snow, sleet, or hail

Surface runoff: water that flows over land surfaces

Infiltration: water that soaks into the soil

Groundwater: water that has soaked into the soil and collected in empty spaces underground.



Discuss

Take turns to explain each of these terms in your own words.

The wonder of water

H₂O

This is the scientific equation for water. It tells us that each water molecule is made of two hydrogen atoms and one oxygen atom. This simple formula describes the most magical and precious substance in our universe.

What if all the water in the world disappeared?

Life would die very quickly. If you were a kangaroo rat, or a west African lung fish, you would survive for a few years. A tardigrade can go for thirty years without food or water. But humans can only last about three days.



Did you know?

- More than half of your body is water - about 60 to 70%
- Water enabled life on our planet. All life evolved in water. And all us humans begin our lives in water, in our mother's womb.
- The water on earth today is the same water that's been here for nearly 5 billion years. We have never managed to create new water. The water flowing through our bodies once flowed through dinosaurs.
- Water covers about 71% of the earth's surface. But 97% of the earth's water is found in the oceans and is too salty for drinking, growing crops, and most industrial uses. Only 3% of the earth's water is fresh.

Water is precious, but we don't look after it well. Our ancestors understood the value of water, but nowadays we often waste it, or throw pollutants like litter and toxic chemicals in it.

In this book, we explore the journey of the Diep River, which flows from Table Mountain to the sea, through Princess Vlei and Zandvlei. We explore how it evaporates from the oceans to create clouds and rain, how rain creates rivers which take the water back to the sea. We explore how rivers are precious carriers of water, with a strong spiritual meaning for our ancestors; how they nurture many different life forms - including human - on their journey from their source to sea. We explore how rivers are harmed, and how we can look after them better.



Discuss

How many times you have used water today - to cook, to wash, to drink, to grow the food you have eaten ...? See how many you can list together.

Look at the picture on the cover of this book. Write a few sentences of what it makes you think of, and discuss with a partner.

The river is our mother ...

Many indigenous cultures all over the world recognise rivers and the oceans as living beings. Water is often regarded as a mother because she gives life to every living organism on earth. Cultures which consider the different parts of nature to be alive - the water, the land as well as the plants and animals - treat nature with great respect. If we see a river as our sister, mother or great grandmother, we are likely to treat it with the same respect and kindness we offer to our human families. Let's explore some of these beliefs

The legend of the Princess...

The Princess Vlei was named after a Khoe princess. According to local legend, she was abducted by Portuguese sailors while bathing in its waters – her tears of anguish formed the Little Princess Vlei. This story was passed down from Khoe ancestors to the people who live near Princess Vlei today. Some people believed that she lived on in the vlei as a mermaid or water spirit. These strong beliefs, and the connection people felt to the vlei helped to protect the vlei when the City wanted to build a shopping mall on it in 2000. People finally won the battle to stop the development in 2014



Ancient rock painting of an eland in the Drakensberg, KZN

The rain bull...

The San people believed that the eland was an embodiment of water and they would call on this animal to bring the rain through rainmaking dances and rituals. The eland bull brought powerful thunderstorms, and the cow brought the softer rains that followed. The San people painted images of the bulls and cows on rocks and in caves to record their encounters and rituals with these rain-making animals. Rain is the source of all water and life and the rain bull was a very important creature and friend of the San people, who treated the eland with great reverence.



Discuss

Talk to elders in your family about the legend of the Princess. Do they know it? Ask them about stories they heard from their elders about rivers, vleis and water.

The river is a living being...

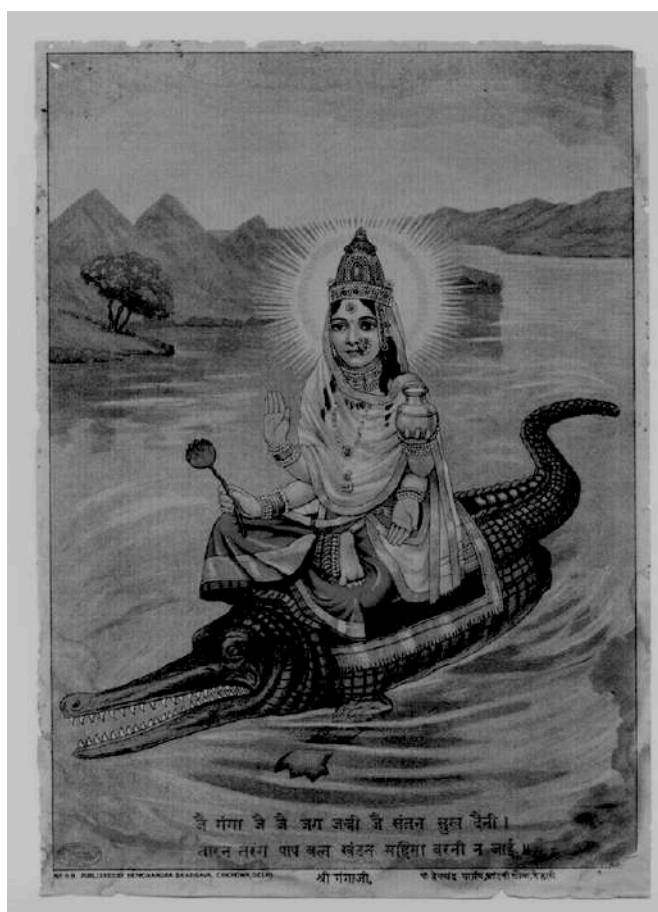
This is what Sicelo Mbatha, a Zulu spiritual nature guide, says about the river that he grew up with:

We saw the river as a living entity. It was not just water, something that you can freely destroy or contaminate. My father said the river carries the life-giving energy of a woman: fish live in water, many insects, water birds come to drink and feed on the insects... it provides life to all these things as well as to humans. It has this energy of generosity, of taking care of one another, of giving life.

We knew from the elders in the village that the rivers are sacred, and you must not contaminate them. You can swim in them, but you must not pee or defecate in the water, you must go 100m away... There was no cholera or bilharzia because we observed these practices. The river was our mother, and just as you would never harm your mother, so we were careful never to harm the river. There was a lot of indigenous wisdom about how to care for the rivers.

Ganga Mata...

In India, Ma Ganga or Ganga mata, is the Hindu Goddess of the Ganges River in India. She is the embodiment of the water and is referred to as the body that is full of fish, and the friend of all that lives. The Goddess Ganga is depicted as a beautiful woman with a white crown, transported by a creature with the head of a crocodile and the tail of a dolphin. This painting is one of many depictions of Ganga Mata.



Activity

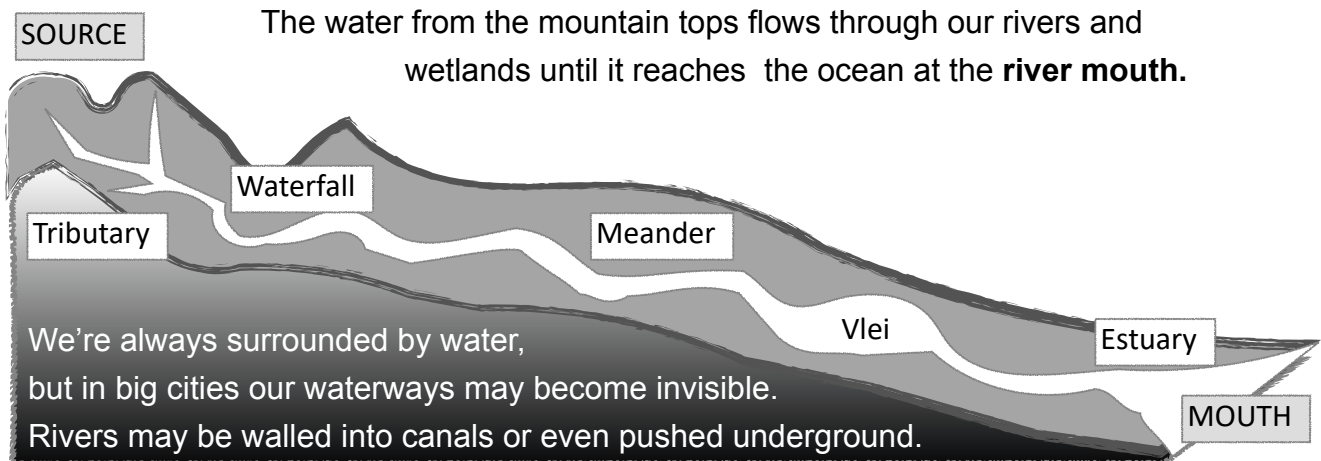
Circle the word/s which express how you feel about water.

love indifference respect gratitude wonder not sure

Have your feelings changed since reading this workbook and talking to your elders?
Discuss your feelings in your group

The river's journey from source to sea

The source of a river is where it begins. Most rivers are born in the mountains. When it rains, water collects in rocky pools on the mountain top and makes its way down the slopes when it overflows. As the stream carves out a channel in the rocks and soil, more water flows into it. These small streams come together to form a bigger river, which flows slowly or 'meanders' when it comes down into the flatter landscape. Some rivers flow all year, some are seasonal and flow only in the rainy season.



River underground...

The Camissa river (from *llkhamis sa*, meaning "sweet water for all" in Kora the Khoe-language of the Cape) flows from Table Mountain to the sea at the harbour. This river supported many Khoe families long ago. When the Dutch settled in the Cape, they pushed out the Khoe, and used the river to grow their crops. Over the last two hundred years, the river has been forced into canals and drains and now runs underneath the city.



Above: Dutch settlers forced the Khoe people to move away from the Camissa River

Left: The Camissa River today



The Diep River begins

The Diep River was formed eons ago when rainfall on Table Mountain caught in cracks in the shale below the granite and sandstone. As the water overflowed, it formed a stream, which carved out a channel down the mountain, over the valleys and Cape Flats, and into the sea. Many other rivers flow off Table Mountain. Near its source, the Diep River is a fast flowing stream that tumbles down the rocks, creating big and small waterfalls in its hurry to reach the sea. As it rushes down the mountain, the river nurtures many life forms, which are adapted to the rocky banks and fast flowing streams. Let's explore some of these:

Did you know?

Sphagnum moss has antiseptic properties and been used for centuries by many cultures to treat wounds. It was used in the First World War to treat wounded soldiers, as it was better for their wounds than modern bandages and dressings.

Mosses

Moss grows in damp places all over Cape Town, but it flourishes at the Cecilia Waterfall, in the upper reaches of the Diep River. Here, the constant source of water trickling down the rocks has created a thick bed of different kinds of moss, which is in the bryophytes family. Moss species are ancient plants, dating back 450 million years (200 million years before the first dinosaur), and they can live in many different climates. Like ferns, they reproduce with spores, not seeds.

Activity

Look at the moss with a magnifying lens, and draw what you see in this space. How many different types can you find? Try to match them with the colour pictures on the inside back cover.



Moss frogs

Genus: *Arthroleptella* Species: *A. lightfooti*

These tiny dark-coloured frogs thrive in moss and leaf litter. They are only 2 centimetres long and hard to spot. They call with a high-pitched chirp, which sounds like a cricket. They lay their eggs in the mud, or damp vegetation. The tadpoles do not develop in water, but squirm around in the damp moss. They cannot survive in developed urban areas.

Table Mountain Ghost Frog

Genus: *Heleophryne* Species: *H. rosei*

These animals are called ghost frogs because they were first discovered in Skeleton Gorge. They are about 5 centimetres long, with a flat body that can easily hide in rock crevices. Their toes have suckers to enable them to cling to rocks in the fast flowing waters of their homes. Tadpoles live in the water and use their sucker-like mouthparts to cling to rocks in fast flowing streams and have strong muscular tails to assist in swimming. Their call is a brief click. They are only found in the perennial streams on Table Mountain, and are critically endangered.



Activity

- In the space above, draw a picture of how you imagine a ghost frog might look, then look at the picture on the inside back cover.
- Discuss how these two frogs have adapted to their habitats. What do you think can be done to protect them?
- In the space below, draw a life cycle of the Moss frog or Table Mountain Ghost Frog. What is different about their two life cycles?

The meandering middle

As a river meanders into the lower lands, it slows down and widens. Our Diep River grows as other streams join it. Many creatures live in and around a natural river in its middle course. Kingfishers make nests in holes in the banks, ducks and coots swim on the surface; reeds grow on the banks, offering homes to weaver birds and places for frogs to hide.

But as the Diep River travels further into the city, it cannot follow its natural course. The water is pushed into concrete canals, and sometimes goes underneath roads and buildings. When it rains, water rushes very fast through canals, fed by storm water drains. The hard surfaces of the roads and pavements do not absorb water, so it rushes out through the drains, instead of soaking down to the aquifer. Any rubbish or pollutants thrown in the street are washed into the storm water drains and into the canals. When there is no rain, the water goes slowly, and may grow algae because there are too many nutrients in the water from garden fertilisers, sewage leaks and other pollutants. The high walls make it hard for frogs, turtles and ducklings to climb in and out of the canals. There are few sheltered places where birds can nest or raise their young.

Many people do not recognise the canals as rivers. They see them as containers for rubbish and sewage. But these concrete containers are still part of the water system, and as they flow into our wetlands and into the ocean, they carry all the waste with them.

Despite these hardships, even these canalised rivers can support life. It is difficult to take the concrete away now, but they can be cared for in ways that encourage biodiversity to thrive.



Activity

Interview people living on the banks of the Diep River canal. What do they think about it? How do they think it can be improved? Write some notes here.



Activity

- Above is a scene of how the Diep River might have looked before it was canalised and impacted by the city. Can you name the species shown here? Discuss how each species might be affected by the canalisation of the river. You can also compare the two photographs of the Diep River on the inside back cover.
- Discuss what might be done to make a canalised river more supporting of life, and note your ideas here.



The Two Princesses

On its journey to the sea, the Diep River widens into a vlei (the a local word for a lake or wetland). Wetlands are freshwater systems that are home to many diverse fauna and flora. There are two water bodies in the Greater Princess Vlei Conservation Area: the Greater Princess Vlei and Little Princess Vlei. The Diep River flows into and out of the Little Princess Vlei. These two vleis were once linked with flood waters. They have been separated with a canal, but water still seeps underground from one vlei to another.

Vleis and wetlands are valuable because they:

- Clean and purify water before it reaches the ocean.
- Act like a sponge to soak up water and prevent flooding
- Give life to many different creatures and plants

Princess Vlei was once much bigger, with many shallow pools and islands. Older people remember the flamingos that used to visit, and the water blommetjies that grew all over the vlei. When the M5 was built, the City dug out the Princess Vlei to make it deeper, to stop the seasonal flooding over the road. Now the Princess Vlei cannot function as well as a wetland, but it still nurtures many living plants and creatures.



Activity

- Imagine Princess Vlei through the eyes of the Khoe Princess who visited it in the 1500s. What do you think the vlei looked like when she bathed its waters? Write a poem or paragraph describing her experience of Princess Vlei in the space below.
- Think about how dredging the vlei might have affected its functioning. What could be done to help it function better as a wetland?

The flourishing vlei

Much life flourishes in the reed beds and on the banks of a healthy vlei. Now that the community is restoring the Princess Vlei to life, it is giving a home to many bird species, mammals such as otters, and dune mole rats, insects, amphibians such as the Western Leopard toad, reptiles, fish, and over a hundred plant species.

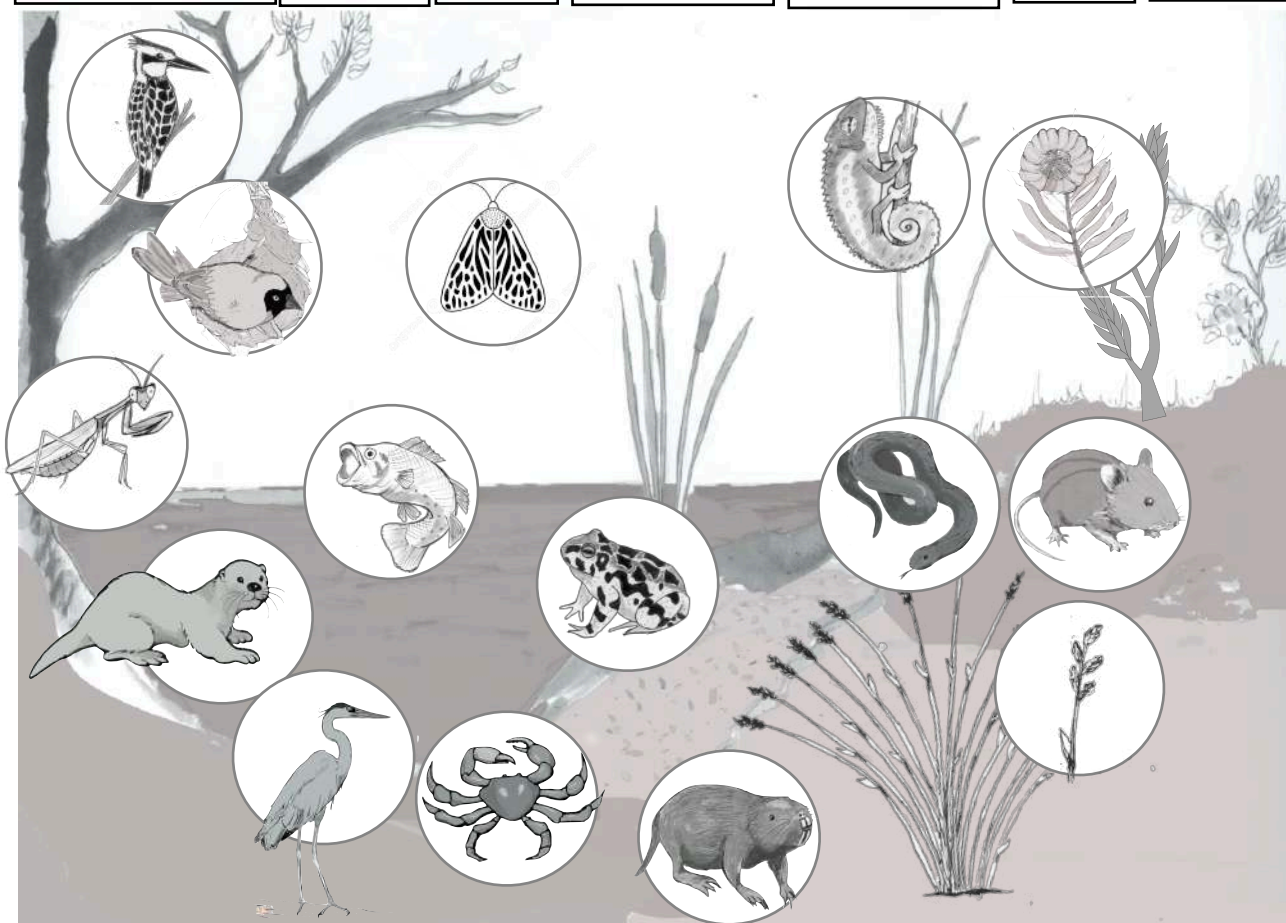
These species all connect to each other in different ways - the animals shelter in the plants, they fertilise the plants with their bodily waste, predators keep species in balance. All the energy for the animals to grow and breed is provided by the plants, which turn sunlight into food through photosynthesis. Plants are the producers. Food for plants is produced by the decomposers, such as earthworms and fungi which break organic matter into nutrients. A **food web** can show how different creatures link to each other

Activity



- Look at the picture below showing some of the species at Princess Vlei. Can you match the species to the names ?
- Draw arrows to show how the species are connected in a food web. The head of the arrow should point to the animal which feeds off the other species.

Otter	Chameleon	Moth	Heron	Protea	Restio	Mouse	Mole
Leopard toad	Weaver	Bass	Kingfisher	Mole snake	Crab	Mantis	



The river comes home to the sea

The Diep River flows into the Little Princess, and out through the Sand River canal. It creates the Zandvlei estuary at the river mouth. An estuary connects a freshwater system to the ocean, as salt water flows into the river when the tide is coming in, and freshwater flows out when the tide is going out. This mingling of sea and freshwater allows particular species to breed and live. The estuary is protected by the Zandvlei Nature Reserve.

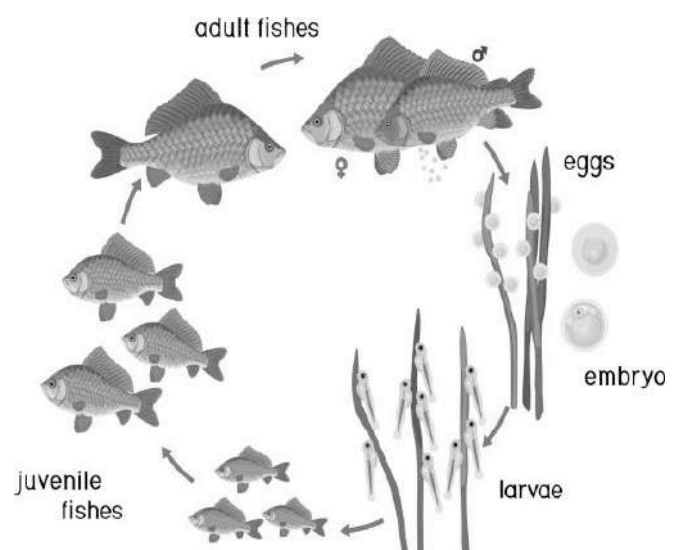
An estuary provides a nursery for many big ocean fish, and helps to keep their populations healthy. Species such as the leervis, stumponose and steenbras can be found in the Zandvlei estuary. Like many estuaries, Zandvlei is threatened by pollution, plastic litter and development, and other human activity.

Clever cormorants

Many bird species can be found in estuaries. The Cape Cormorant (*Phalacrocorax capensis*) is endemic to Namibia and the Western Cape. **They have feathers that become easily waterlogged, which allows them to dive deeper by preventing air bubbles from getting trapped underneath their feathers.** This is why you often see cormorants standing with their wings spread to dry them after diving. Cormorants can hold their breath for several minutes and dive 150 feet underwater to catch fish. In Asia, indigenous fishermen have trained cormorants to catch fish for them. Their numbers have dropped and they are now on the red list of endangered species. They can be found near the ocean or inland water bodies

Activity

- Watch the cormorants swimming or diving, or look at the picture below. Discuss: how does the cormorant's body help it to be a good swimmer and efficient fish-catcher?
- Look at the picture of the life cycle of the fish. Which parts of their life cycle do you think take place in the estuary? What features of the Sandvlei estuary make it a good nursery for fish?



The plastic tides

Plastic pollution has become one of the biggest threats to ocean life, and to our water ways. **Between 1.15 million and 2.41 million tons of plastic waste enters the ocean every year** from rivers around the world - and the amount increases every day. This kills many birds, turtles and other marine life, but it is also affecting humans. **Scientists have found tiny plastic particles in the blood of almost 80% of the people tested.** This is from plastic breaking down in our water sources and entering the food chain. Recycling helps, but it is not a magic solution. The only way to solve this is to produce less plastic.



Activity

- Do a litter clean up on the beach at Zandvlei. Divide your litter into different types: Plastic bottles; plastic bags; plastic containers; polystyrene containers, fishing waste etc, and fill in the table below. Discuss how each item of litter you find might threaten sea fish or birds, or other marine life.
- Post pictures on the social media pages of the companies which make or distribute the litter you find, with a caption calling on the company to take responsibility.
- With your family, discuss what plastic pollution you cause, and how you can limit it by reducing how much you buy, and by reusing it and /or recycling.

Item	No. found	Used by humans for	Company that sells or makes this	How might it hurt fish/ birds/ other marine life



The river endangered

Our rivers face many threats because of human activities. Here are some of them:

Alien vegetation

During colonialism, the settlers brought and planted many alien plants. Plants and animal species have also been moved by accident, for example a beetle may be on fruit that is imported. Alien species can cause big problems because the ecosystem has evolved without them. This means they are not part of a food web, and are not kept in balance with other species. Here are some of the problems caused by alien plants to rivers in South Africa:

- Water Hyacinth: this decorative water plant has taken over rivers, lakes and dams all over Africa. It multiplies rapidly, covering water surfaces and depriving the water and subaquatic species of oxygen.
- Some alien trees, such as Port Jackson, pine trees, and black wattle consume a lot of water. They infest river beds and dry up the water. They also displace natural vegetation which is part of a healthy river ecosystem.

Human development

Humans have been constructing dams and irrigation systems on rivers for centuries. These can bring social benefits such as growing food crops, but they also have negative impacts on the rivers:

- Dams and irrigation systems reduce the flow of water in the river below the dam, disrupting the ecology of the river.
- Dams block the movement of species such as fish, affecting the eco system.
- Dams lose a lot of water through evaporation.
- Canalisation.
- Hard surfaces and storm water drains: the hard road surfaces stop the earth from absorbing water. The water rushes into the rivers through storm water drains, bringing pollution and damaging eco-systems.



These people are on a home-made boat on a river in the Philippines - the water is completely hidden by the plastic pollution

Pollution

Rivers are polluted by chemical pollution from factories and farms and sewage. They are also badly damaged by plastic pollution. This impedes the flow of water, entangles wildlife, and can poison or choke birds and fish that swallow it. All pollution that enters rivers will end up in the ocean

Climate change

Climate change is caused by warming gases, such as carbon released by the burning of fossil fuels, and methane which comes from farming livestock and other human activities. The warming gases lead trap heat in the atmosphere. As these gases have increased, so has the heat trapped in the atmosphere. This warms the oceans and causes the world's average temperature to rise, and destabilises the climate, leading to heat waves; droughts; floods and extreme weather events. All of these negatively impact rivers and oceans:

- Droughts dry up water sources;
- Floods and storms destroy river banks and riverine ecosystems.
- Flooding urban areas washes much pollution into the rivers and seas, including sewage.
- Heating the ocean is having a devastating effect on coral reefs and other marine life.

Activity



- Discuss how each of these threats affects the Diep River in the places you have visited.
- Draw a river spirit like the one on the cover, but add a depiction of the some of the threats described here



Activity

Draw a map or picture of the Diep River showing some of the creatures and plants you have seen at each stage, and some of the threats.

How healthy is our river?

There are many signs to show whether a river is healthy. This table will help you measure the Diep River at each stage when you visit it. You will need use a net to catch aquatic creatures to help you assess the diversity. **Remember to be gentle, to put the creature quickly into a container of river water, and release it where you found it.**



Activity

Score the Diep River on the table below using the following rubric

	Living organisms	Invasives	clarity	Rocks & pebbles	Pollution & litter
0	None	All plants invasive	Very murky	No rocks or pebbles - Only concrete	River choked with litter, oil or chemicals present
1	Poor - few specimens and little diversity	Most plants invasive	Quite clear	A few rocks	Heavy infestation of litter,
2	Fair - some specimens, fair diversity	Few invasives	Almost clear	A number of rocks/ pebbles	Some litter
3	Good - Lots of specimens and diversity	Only indigenous plants	Crystal clear	River bed mostly rocks/pebbles	No litter

	Living organisms					Water Quality		
	Fish	Amphibia & reptiles	Invert-ebrates	Plants	Invasive species	Clarity	Rocks & pebbles	Litter/ pollution
Cecilia waterfall								
Diep River canal								
Mocke river								
Princess Vlei								
Sand Vlei.								

	Cecilia waterfall	Diep River canal	Mocke river	Sand Vlei.
TOTAL				

The right to flow

All humans on earth have rights protected by the Universal Declaration of Human Rights. In recent years, many people have argued that rivers, like people, should have rights protected by law. The Earth Law Centre drew up a Universal Declaration of River Rights in 2020. This declared that Rivers should have

1. The right to flow,
 2. The right to perform essential functions within its ecosystem,
 3. The right to be free from pollution,
 4. The right to feed and be fed by sustainable aquifers,
 5. The right to indigenous biodiversity, and
 6. The right to regeneration and restoration
- (<https://www.rightsofrivers.org/>)

In 2017, four rivers across the world received recognition of their legal rights –the **Whanganui River** in New Zealand, the **Atrato River** Colombia and the Ganga and Yamuna River in India. **In California, a Yurok Native American tribe granted personhood rights to the Klamath River.**



Activity

Discuss: Should rivers have rights? Write a letter from the Diep River to the citizens of Cape Town explaining what you need to be a healthy river and why your right to be healthy should be protected.

Dear people of Cape Town

Yours faithfully
The Diep River



Activity

Choose one of the threats to rivers described on page 14 and 15. Design a poster on this page to raise awareness about the issue at your school. Ask your teacher to photocopy it and stick it on the school notice board.



Moss frog *Arthroleptella lightfooti*



Table Mountain Ghost Frog
Heleophryne rosei



Arum Lily Frog
Hyperolius horstockii



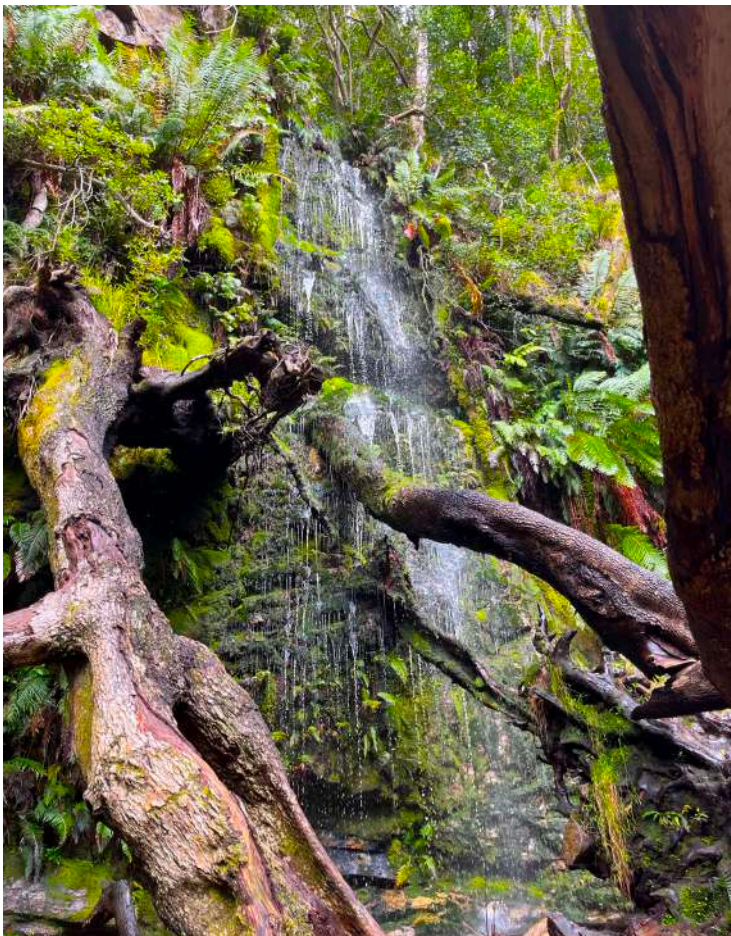
Fissidens fasciculatus, member of
Joint-toothed Mosses Class Bryopsida



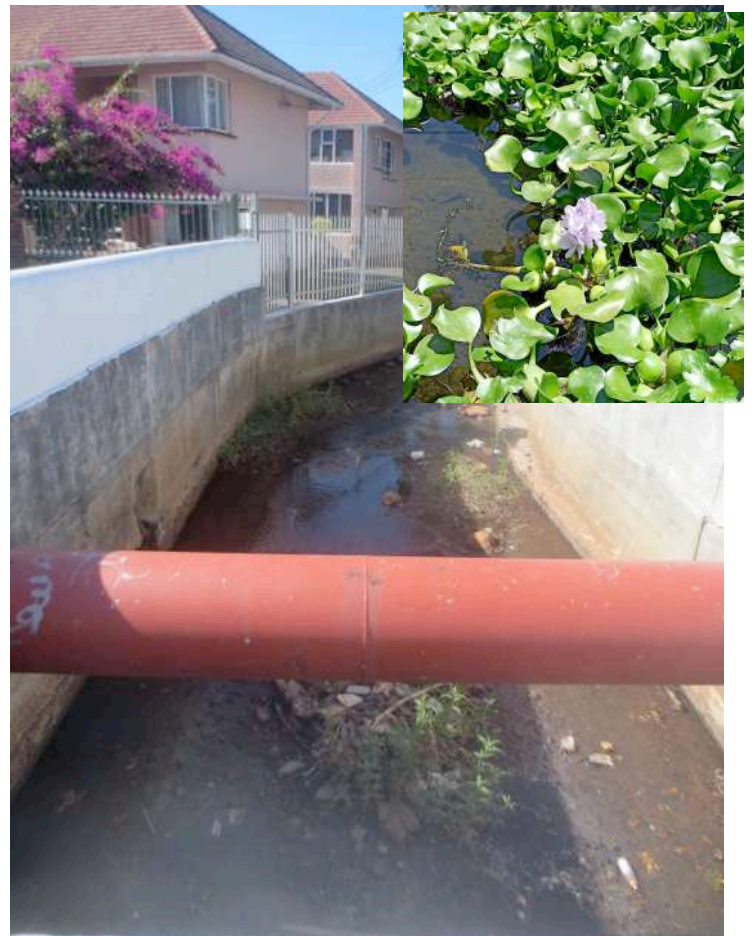
Heath Star-Moss
Campylopus introflexus



Fringed bogmoss
Sphagnum fimbriatum



Near its source: The Diep River at Cecilia Waterfall



Human impact The Diep River canal. Insert: Invasive
Water Hyacinth

About the Princess Vlei Forum

The Princess Vlei Forum is dedicated to the ongoing conservation of the Greater Princess Vlei Conservation Area (GPVCA) for the benefit of communities and nature. The Forum was formed in 2012 to co-ordinate the struggle to protect the vlei from commercial development. On March 22, 2014 the City announced its decision to scrap the proposed mall and to work with the community on restoring the site. Since 2014, the Forum has worked with the City to ensure that the area is transformed in accordance with the community's vision of a nature and heritage park at Princess Vlei.

Local school learners actively campaigned against the mall, and have formed Guardian clubs to help restore and protect Princess Vlei from harmful development. Their passion, scientific curiosity and creativity drive the project. The Forum collaborates with the Peter Clarke Art Centre and Jungle Theater Company to run a dynamic and creative programmes for local youth aimed at evoking passion for sustaining the wildlife at Princess Vlei and elsewhere.

- For more information, email imagine@princessvlei.org, or look at our website www.princessvlei.org or Face book page.
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