Figure 3: An aerial view of Tierberg Nature Reserve near Prince Albert in the Karoo, where riparian zones characteristically snake through the landscape. Image: CJ Crous

Casparus J Crous, **Shayne M Jacobs**, and **Karen J Esler**
explain the importance of rivers in the South African ecosystem.

Conserving our rivers: a meander

Figure 1: The Palmiet River is an example of a typical fynbos riparian zone, taken at Kogelberg Nature Reserve, Western Cape. Image: M. Naude

What is a riparian zone?

Most South Africans live close to a river and riparian zones can be found along most of these rivers. In fact, they straddle the boundary (or ecotone) between terrestrial and aquatic ecosystems, occupying river banks, and the banks of wetlands and estuaries. The areas that surround waterbodies are composed of soils that range from moist to water-saturated. They contain water-loving plant species and their associated ecosystems, which are important transition areas that connect the water with the land, and host a wide array of plant and animal life. The word riparian is from the Greek word for river, '*ripa*', and literally means 'belonging to the river' (Figures 1 and 2). Most of us use riparian zones in some way, either for recreation, food production, or indirectly as a source of clean water. Since riparian soils are usually rich in resources such as nutrients, they are often degraded as a result of human activities such as clearing for agriculture, grazing, and are also frequently invaded by alien trees, grasses and herbs. However, these areas benefit humanity in preventing pollution of rivers, mitigating floods, providing habitats for plant and animal species and providing recreational space for people.

The ecology of riparian zones

Ecology is the study of the interaction between all living and non-living elements in nature. In riparian zones this means the interaction between plants, animals, microorganisms, soil and water, particularly because these zones are next to waterbodies. Because riparian zones are usually at the bottom of valleys, this means that water, sediment and dissolved material such as nutrients usually flow towards riparian zones because of gravity. This means that riparian zones are not only fed by streams (along with the sediment and nutrients accompanying the streamwater), but also by nutrients via overland flow and groundwater from the adjoining terrestrial areas, which may be natural areas, or cultivated fields. These nutrients feed the plants. The vegetation around most of South Africa's rivers consists of large shrubs and trees, which is distinct from the surrounding lower growing vegetation, for example

along riparian zones

Karoo bushes and grasslands. This can easily be seen on aerial and satellite pictures (Figure 3).

Riparian zones contain many plant and animal species that are adapted for wet conditions. Plant species such as reeds, bulrushes and some trees have special cells called parenchyma that possess large air pockets so the organs that are covered by water for part of the year can be supplied with oxygen. Because riparian zones are rich in nutrients and typically flooded, the vegetation grows dense and tall. This environment acts as a habitat for a host of different animal species – ranging from small invertebrate animals such as dragonflies to the large predators of the African savanna. The dragonfly relies on riparian habitats to complete its life cycle – its larval stage is aquatic and requires flowing water to survive. The larvae also need shade, which makes riparian areas shaded by trees ideal. After emerging from the larval stage (Figure 4) the adult dragonflies then live along the riparian zone, and lay the next batch of eggs in the water. Any disturbance at this stage may interupt the life cycle.

The resources available in riparian environments attract large numbers of different animal species, and frequently support several trophic levels. In savannas, herbivores are attracted to the lush green grass in riparian zones, which in turn attracts predators such as lions and leopards. Because riparian zones have such complex and dynamic trophic interactions, we need to conserve all the different elements and ensure that water and nutrients continue to supply these areas.

Natural disturbance

Contrary to what we might expect, riparian plants and animals are dependent on occasional disturbances such as floods and fire. Floods may occur every year and may spread the seeds of riparian plants and wash them out onto sandbanks where they can germinate. Large floods can uproot trees and create microhabitats on the banks where branches and sediment are deposited, which in turn can be recolonised by plant communities and used as habitats by riparian animals, such as small mammals and birds. Juvenile lizards and various invertebrates such as spiders seek shelter within these areas during vulnerable stages of their life cycle. Floods also redistribute sediment and nutrients within the river, which is especially important for human communities living downstream, where crops are dependent on these life-giving resources. A good example are the farmers who use the sediment in the Nile River to farm vegetables.

Fire is also known to redistribute nutrients by converting organic material to ash, from which phosphorus and nitrogen are put back into the soil for plant growth, and also deposited downstream. In riparian zones, fires occur less frequently than in some of the adjoining terrestrial ecosystems such as the fynbos or grasslands. However, most riparian plants are adapted to the effects of fire, and can regenerate by re-sprouting from the base or from branches. ▹▹

Figure 2: A gallery forest riparian zone, in the dry season, in Kruger National Park, Mpumalanga province. Here, the riparian zone is easily separated from the surrounding matrix, through distinctly taller, denser and greener vegetation. These are important areas for elephants, especially in the dry season. Image: SM Jacobs

Figure 4: A dragonfly's transition from water-living nymph to a terrestrial adult stage, taken at Wit River in the Bainskloof Valley, Western Cape. Image: CJ Crous

Figure 5: Above: Large herbivores such as elephants. Right: hippopotamus use riparian areas, as seen here in Kruger National Park in the Mpumalanga province. Image: SM Jacobs

What makes a riparian zone useful?

Riparian zones fulfil several functions that are important to human wellbeing and quality of life. People have long relied on riparian areas for the abundant food, water and material resources they supply. Since riparian zones are usually found at the bottom of valleys, they have 1) more fertile soil, with more nutrients available such as nitrogen and phosphorus, and 2) a greater availability of water. This makes riparian zones attractive for agriculture, including crop production and for grazing livestock. A good example of this is the Orange River valley (e.g. Kakamas and Keimoes) where farmers are using the riparian environments in a very dry region to produce the grapes and wines sold locally and internationally. Without the riparian zone, this agricultural activity would not be possible within this semi-desert environment. Subsistence farmers also use the areas near rivers to grow maize, beans and other crops for their families.

Many animals also congregate around rivers, and use riparian zones for food and shelter. Large animals in savanna ecosystems use the rivers extensively during the dry season (Figure 5). Without the nourishment provided by the river and its riparian zone, these animals would not be able to survive in these harsh climates. Several large antelope such as nyala, bushbuck and kudu use riparian zones as corridors to move along rivers, while enjoying the relative cover available in these areas to hide from predators such as lions.

The Cape clawless otter uses riparian zones extensively, while the riverine rabbit, a critically endangered animal, is almost entirely dependent on Karoo riparian areas for its survival. Of course, bird species are a major feature of riparian zones. Smaller birds may use these areas to feed, hide from predators, nest and rear young. The larger predatory birds use the areas for nesting and hunt the smaller animals within the zone.

Any degradation of riparian zones will endanger a whole variety of plants and animals that depend on this narrow green ribbon along rivers, wetlands and estuaries. Humans are not immune to the effects of riparian zone degradation, with consequences for agriculture and other economic activity.

Ecosystem services

Riparian zones prevent river pollution by trapping potential pollutants as they move downhill into the rivers. Complex interrelationships between microorganisms, plants and nutrients in riparian areas help to break down contaminants discharged into the environment. This is particularly important close to farms, where fertilisers are used and there is the potential for the accumulation of excess nutrients such as phosphorus and nitrogen, as well as pesticides, sediments and particulate matter. The usable matter, such as phosphorus, gets taken up by riparian plants and animals, while soil processes convert excess nitrogen to nitrogen gas, which is released back into the atmosphere. Because of the moist conditions, there is heavy decomposition of plant organic matter and some of this decomposed matter will be removed during flooding. Healthy riparian zones help to filter and purify water for drinking, irrigation and recreation.

Riverine areas are also an effective buffer against flood damage. Floods are natural events in river ecosystems. The vegetation and soils in riparian zones soak up and store water during high rainfall events, reducing the speed of the mass of flood water and stabilising stream banks and preventing surface erosion. If the natural riverside vegetation is replaced with vegetation that is less dense or of a different structure this reduces the ability of riparian zones to reduce the impact of floods (e.g. Figure 6). This can lead to catastrophic flooding in damaged areas.

Lastly, riparian areas are focal points for education, recreation and simple enjoyment – bird watching, angling, water sports and so on. But if we transform the riverside areas by putting up picnic areas and camping sites, this may also damage the natural ecosystem.

Degradation and conservation of riparian zones

Anthropogenic disturbances

Riparian areas are threatened by expanding urban and agricultural neighbourhoods, which can lead to large-scale destruction. South Africa is a water-scarce country with an average rainfall of around 450 mm per annum compared with a global average of 860 mm. With only 8.6% of rainfall available as surface water, fresh water is a limiting resource, making its conservation vital.

Human-induced disturbances (anthropogenic disturbances) are increasing, placing enormous pressure on South Africa's current water situation. One of the main pressure points is rising population numbers. By 2025 there will be approximately 60 – 75 million people in South Africa, compared with 50 million today. This will place huge pressure on our already strained water resources. The tragedy is that most of South Africa's surface and groundwater resources have already been developed, so it is essential to develop strategies for sustainable water management.

Climate change is likely to

Figure 6 (Above left and right): Soil erosion as a consequence of removing natural vegetation and replacing it with alien vegetation. This has detrimental effects on water quality and quantity. Image: SM Jacobs

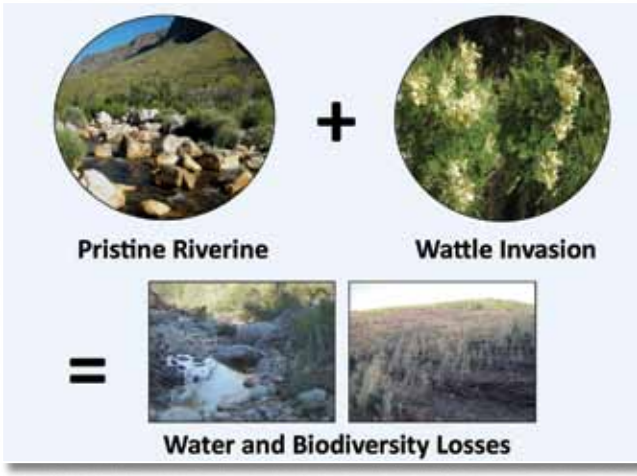

Figure 7: A schematic diagram of the effect of black wattle invasion on pristine riverine or riparian areas. Image: CJ Crous

exacerbate South Africa's water shortages, with a predicted 195 000 km^2 (16% of the country) likely to experience increasing water shortages as the country dries. This would reduce riparian biodiversity further and lead to reduced water quality.

Alien invasive plants (IAPs) are also threatening South Africa's riparian zones, particularly alien trees such as species within the genera *Pinus* and *Eucalyptus*. These invasions reduce water yields from catchments and affect riverine functioning and biodiversity (see Figure 7). Sustainable forestry policies today do not allow exotic timber to be planted in the riparian zone of the catchment. However, the problem of runaway invasion of certain species into the riparian zones still exists, especially *Acacia mearnsii* (black wattle). Models predicting future consequences of a lack of management of IAPs and water resources in the Western Cape indicate that if the current growth of alien plants goes unchecked for 100 years, some species might invade up to 62.4% of the catchment areas. This would cause a loss of about 87 million m^3 of water. This translates to a 34% decrease in annual water availability for the City of Cape Town municipal area. This alien biomass needs to be removed to conserve water quality and sustain crucial ecosystem services.

What can be done to restore riparian zones?

South Africa has ratified the Convention on Biological Diversity's 2010 target, which was to significantly reduce the loss of biodiversity in the country by that year. Government and scientific agencies have attempted to lessen the effects of factors such as IAPs over the year, through different conservation initiatives.

One such is the Working for Water (WfW) programme that started in 1995. This project set out to eradicate IAPs in the riparian zones, to maintain and restore ecosystem services, and to improve the livelihood of impoverished people by providing jobs. The programme is locally and internationally renowned as being truly proactive in the battle against biodiversity loss and the subsequent water losses. Government has also improved outdated policies, such as the Conservation of Agricultural Resources Act (Act no. 43 of 1983, amended March 2001), to ensure that valuable water resources are properly protected by law, particularly the removal of thirsty IAPs from riparian zones. All IAP plants growing within 30 m of the 1:50 flood line of a river or water body must be removed. The onus is on responsible land management and usage, which requires public awareness of the issues, so that people can take responsibility for the conservation of water resources by removing alien plants from their properties, preventing fires in riverine areas and reporting excessive littering and pollution in these areas. People need to understand the value of riparian zones and take part in the conservation of this life-giving resource that is so easily taken for granted. ❑

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Suggested reading

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More information can also be found at:

Department of Conservation Ecology and Entomology - http://consent.sun.ac.za/

Stellenbosch University Water Institute - http://www0.sun.ac.za/water/

Centre for Invasion Biology - http://academic.sun.ac.za/cib/