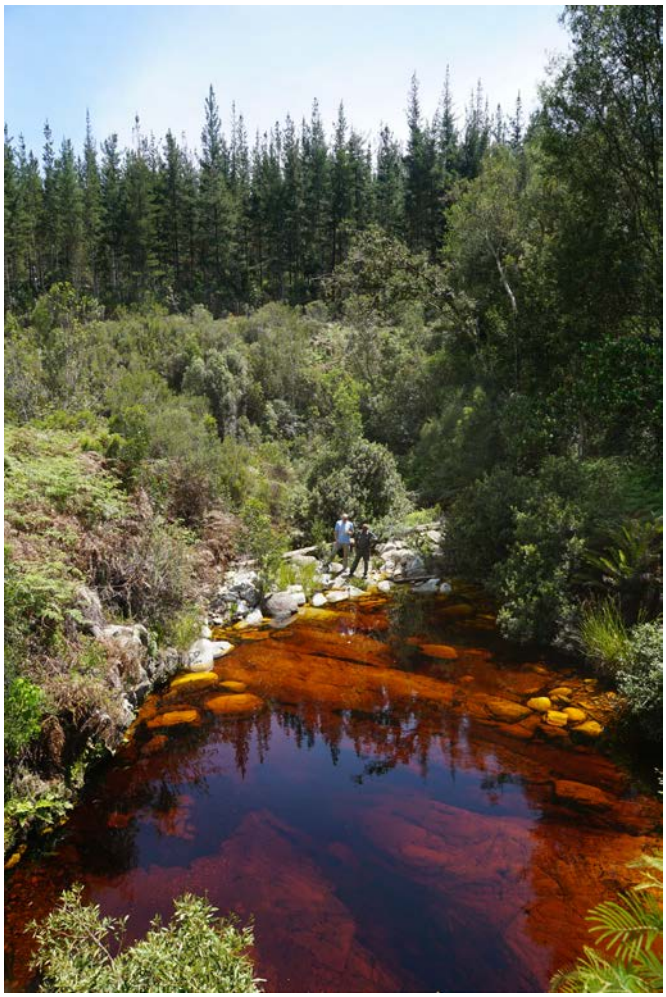

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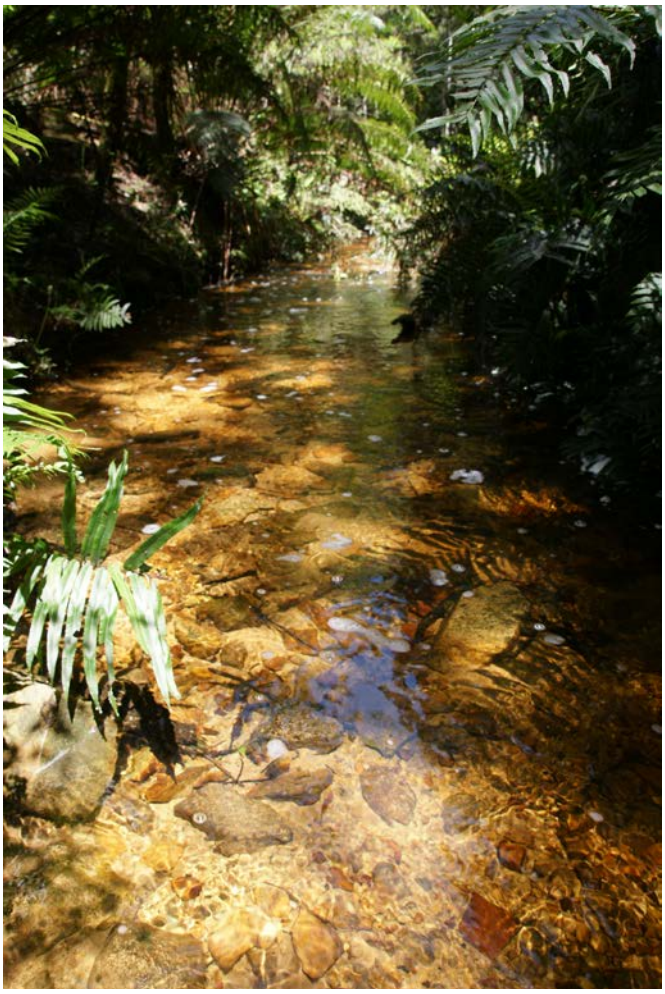

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The blackwater Skeinsbos River flows through fynbos and forestry plantation in the Diepwalle section of the Garden Route National Park, while the less-acidic, 'white' Petrus Brand River flows through its indigenous forest.

SOUTHERN CAPE STREAMS

Chris Curtis reports on the Garden Route's naturally acidic black and white streams

Acidic pollution arising from either point sources, such as acid mine drainage, or more diffuse sources, such as acid rain, is a major threat to freshwater ecosystems in many parts of the world.

In some regions, however, slow weathering of certain rock types – including granite and quartzite – may result in naturally acidic soils that give rise to acidic surface waters draining their catchments. In addition, many wetlands generate acidic water through slow decomposition processes that release humic and fulvic acids and other organic compounds. The water often has a characteristic dark brown colour, and such peat-stained waters are associated with wetlands in many parts of the world and a few areas of South Africa.

Uniquely, in the fynbos biome of the southern Cape, there are many naturally acidic, brown streams that are not associated with the presence of wetlands. Known as blackwater streams, they are recognised for their endemic, acid-tolerant fauna.

As the streams merge into rivers downstream, they are affected by the landscapes through which they flow, as well as human activities. Higher total dissolved solids (TDS) and turbidity in the lower reaches of rivers result in more alkaline, buffered systems that are not as brown. This is why the darkest, most acidic rivers are those that originate in coastal mountains and drain straight into an estuary or directly into the sea, such as the Storms River in Tsitsikamma. By contrast, rivers with well-developed zones – mountain stream, foothills, lower river and estuary – are less acidic and relatively clear. These so-called 'white rivers' tend to be longer and include the Petrus Brand River, which rises near Diepwalle in the mountains north-east of Knysna and joins the Bitou River that discharges into the Keurbooms River estuary at Plettenberg Bay.

The causes of the dark coloration in blackwater streams have been the subject of a few studies but are only partly understood. More than 40 years ago, King et al. (1979) called for further research on the relationship between pH, colour and humic acids and the relative influences of geology, soils, vegetation and aspect for southern Cape streams. The endemic fauna and unique chemical characteristics of these streams mean they are extremely vulnerable to anthropogenic pressures such as invasive species, land cover change and acid rain.

Garden Route stream study

A recent study funded by South Africa's National Research Foundation (NRF) and the Research Council of Norway to investigate the relationships between acid deposition, streamwater chemistry and potential ecological risk for aquatic invertebrates included a comparison of 30 acidic streams of the Outeniqua Mountains, the Cape Fold Belt range behind George, Knysna and Plettenberg Bay. The Outeniqua Mountains are a Strategic Water Source Area, providing 95–100% of the water supply to the Mossel Bay, George and Wilderness areas, and many of the streams lie in the Garden Route National Park areas managed by SANParks. Some of these areas were historically transformed from indigenous fynbos and Afromontane forest to forestry plantations of pine and eucalyptus species. In recent years there has been a move towards removal of some of the plantation areas and the regeneration of natural vegetation, so the study site streams included a range of land cover types, from mountain fynbos and indigenous forest to pine plantation and rehabilitated former plantation areas, with both blackwater and white rivers sometimes in close proximity to each other.

All 30 streams, sampled over a two-year period, were moderately to very acidic, with 22 of them having a mean pH <5 and nine with a mean pH <4. The most acidic stream sampled, with a mean pH of 3.6, was the Swart River, which flows past the Nelson Mandela University campus at George. Stream colour and its relationship with dissolved organic carbon (DOC) in the water was also tested, since DOC is expensive to analyse while colour, represented by absorbance of ultraviolet radiation, can easily be measured in the laboratory with a spectrophotometer.

Streams and the carbon cycle

The role of rivers and streams in the carbon cycle is not well understood, especially in South Africa, but the blackwater streams of the southern Cape have some of the highest DOC concentrations in the world, with a mean value of 48 mg/L in one stream and spot values exceeding 100 mg/L on occasion. These very high levels of DOC suggest that Cape streams may have an important role in delivering terrestrial organic carbon into estuaries and the coastal zone. In fact, the fluxes (per unit area of land) of DOC from some of the studied streams also appear to be among the highest in the world from undisturbed systems,

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Several studies have found that colour increases while pH decreases during high-flow events. This is presumably due to displacement of accumulated organic compounds in soil waters, which may also lead to natural foaming on the water surface.

exceeding 200 kg/ha/yr in some catchments and reaching over 400 kg/ha/yr in a very wet year. These fluxes are approaching those measured in streams draining highly disturbed and degraded swamp forest peats under oil palm plantations in Sarawak, Malaysia, considered to be among the highest of any systems in the world.

While the darkest streams with highest DOC and lowest pH are generally associated with the mountain fynbos catchments, there are some indications that land cover change – whether conversion to forest or rehabilitation to fynbos – may affect both the storage and transport of carbon. Any changes in water colour and DOC transport could have implications not only for biodiversity but also for local domestic water supplies, since DOC can impart a taste to drinking water and bind to toxic pollutants that are both difficult and expensive to remove.

The links between indigenous vegetation, land cover change and the possible impacts of climate change on river flows, water colour and carbon fluxes are the subject of ongoing analysis and planned future research, and could be of interest to SANParks and other local land managers. Research opportunities may also be provided by new research infrastructure under development by the Expanded Freshwater and Terrestrial Environmental Observation Network (EFTEON) in the Garden Route and Cape Town areas. Such research is urgently required to understand the possible impacts of global change processes, such as climate change and land cover change, on these precious aquatic ecosystems, about which there is still a great deal to learn.

Prof. Chris Curtis is with the Department of Geography, Environmental Management and Energy Studies at the University of Johannesburg, having moved in mid 2019 from the University of the Witwatersrand, where he supervised the theses of Mauro Lourenco and Londiwe Khuzwayo, the authors of other articles in this issue of Quest. Prior to that, he was Principal Research Associate at University College London, and ran the United Kingdom's national programme on freshwater critical loads for 14 years.

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