Chasing the rain in Jonkershoek

Retang Mokua tells us about her experience sampling a storm event to study streamflow-generation processes

It was a dark and stormy night. The wind whipped through the trees and sheets of rain lashed down on the tent.

It was almost midnight and I was ready. Gumboots on and sample bottles in hand, I stepped out into the storm and made my way to the river...

Never in my academic life have I imagined myself sitting in a small tent under the bushes with a torch, anxiously waiting for raindrops to hit the ground, but this is what we recently experienced in the Jonkershoek catchment, just north-east of Stellenbosch.

On 6 July 2019, SAEON's Dr Julia Glenday and two MSc students, Bongiwe Seleka and Kamohelo Mokoena, joined me as I set up camp in the Jonkershoek catchment to sample a heavy rainfall event as part of my PhD research on streamflow-generation mechanisms. We waited all afternoon, watching the clouds build up over the rocky mountains.

Just as it was getting dark, the rain started. We knew it would be a long night!

Our purpose

Mountain headwater catchments, such as those in the Jonkershoek Valley, are an important source of runoff, feeding rivers and dams. These catchments supply water downstream for domestic, industrial and agricultural use. Understanding how the rainwater is partitioned in these catchments – between water that stays caught on leaves and evaporates, water that reaches the ground and flows over the surface, water that enters the soil and rock layer and flows underground, or is stored and potentially used by plants – and how much reaches the stream is fundamental for water resource management. To gain a better understanding of these processes for Jonkershoek, I wanted to see how the water chemistry changes as the river rises and falls in a storm. Water that has been stored in soils and rock can have different chemical signatures to rainwater.

The storm event sampling was done in two of the headwater subcatchments, Bosboukloof and Langrivier, which have different vegetation covers: pine plantation and fynbos.

Background: How can we tell which water comes from where and how much of it reaches the river?

Streamflow can be thought of as having two main components, namely surface runoff (quickflow or storm flow) and base flow, the latter fed by subsurface flows such as groundwater and soil water. The stream hydrograph – the variation in streamflow over time – can be separated into these components to detect their relative contributions to average annual outflow or to flows at different times and seasons.

Early pioneers of tracer-based hydrology have shown that water chemistry data can further help to differentiate streamflow into more specific components, identifying contributions from direct rainfall and surface runoff, soil water, and groundwater from different distinctive aquifers.

Chemical tracer studies have highlighted the importance of 'pre-event' water contributions during storm events – the water that has been stored in the catchment prior to the runoff event, such as groundwater and shallow subsurface water (soil water). This investigation aims to

The V-notch gauging weir used to measure streamflow in the Langrivier before and after the rain event.

determine which components contribute to Jonkershoek streams during wet and dry periods using tracer-based approaches.

Tracer-based approaches to hydrograph separation make use of naturally occurring environmental tracers such as stable isotopes of water (δ18O and δ2H/D), major ions and dissolved silica, and composition indicators like electrical conductivity and pH. They provide an understanding of runoff-generation processes by revealing what portion of the stream water existed prior to a rain event, what portion was added to the stream during the event and where this water came from.

Commonly used tracers are selected for their conservative nature: they do not become completely altered as they travel through the water cycle, therefore they carry characteristics of their original source. The spatial and temporal variations in hydrochemical and stable isotope patterns can provide useful information on geographic water sources and pathways followed by rainwater in the catchment until it reaches the stream outlet.

Methods: Event sampling

The latest storm sampling fieldwork took place over two days, including an overnight event. To be able to perform the hydrograph separation, we collected water samples from groundwater boreholes, streams, springs and piezometers (shallow subsurface water). The base flow component was sampled a day before the expected rainfall event and again four hours before the rain started. At the start of the rainfall event, water samples from the streams and piezometer were collected every hour until peak flow, and later every two hours during the recession period.

Rainfall water samples were collected using sequential samplers equipped with 50 ml bottles assembled near the rain gauge to enable sample volume to be related to the rain intensity and rainfall period. Physico-chemical (EC, pH) measurements were also taken from all the sampled sources. Hydrometric measurements such as stream discharge, temperature and piezometer water levels were taken on an hourly basis.

After doing the laboratory analyses of the samples, the chemistry and stable isotope data from stream water, rainwater, soil water and groundwater will be incorporated into hydrographs to differentiate components of the stream over time during this rain event.

I plan to sample a summer storm later this year to compare the streamflow-generation mechanisms in different seasons. This will hopefully be a warmer affair!

Retang Mokua is currently pursuing her PhD at the University of the Western Cape under the Fynbos Node of the South African Environmental Observation Network (SAEON). This article is republished from the August 2019 issue of the SAEON newsletter and builds upon a previous article by Retang in the October 2018 issue, providing the background to her research: http://www.saeon.ac.za/enewsletter/

Retang installs the sequential rainfall sampler near the tipping bucket rain gauge.

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