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Borehole drillers at work at a private residence in Kyalami. There is a concern by some geologists that if many people drill boreholes we might run out of underground water in future.
PICTURE: PABALLO THEKISO

Is groundwater an unlimited resource?

Researchers will use tritium to measure the sustainability of water

Jodie Miller and Jared van Rooyen

UNLIMITED, endless, huge, more than enough. These are the descriptions we often hear about groundwater. But is it really the case? The drought in the Cape has focused people's attention on the possibilities of groundwater and many people are looking to install boreholes to tap into this unlimited resource. But as we watch the dam levels continue to drop, it's worth taking a step back to consider where groundwater comes from and how long it takes to get there.

All groundwater ultimately comes from rainfall. It might not be last month's rainfall, or last year's rainfall or even rainfall in the previous century. But the presence of groundwater means that at some time in the past, somewhere, enough rain hit the surface of the Earth, penetrated through the soil, down into the rocks and into an aquifer system where it has stayed until a borehole was sunk into it and out it came again. So what happens if there is dramatically reduced rainfall in the future? The obvious response to this is that there is dramatically less or even no recharge going into the system. So how can people visualise this if they are not a scientist working on these issues?

Imagine you have a piece of hollow flexible tube in your hands so that it makes a U-shape and you hold each end so that they are level. Recharge goes in one end by, for example, attaching your hose pipe and turning it on. So long as the hose is on, "groundwater" comes out the other end, which represents a "borehole". Now turn the tap off and tip out some of the water. The water balances in between the two ends, so now you have say 5 cm of tube without water in it, on each end. The line that the water is sitting at is equivalent to the water table underground. Now tip out a bit more water as though you pump some more water out of your borehole. Where does the water table sit now? A bit lower, like the water table when there isn't a lot of recharge.

But let's recharge the system a bit. We can simulate recharge by rain by turning on the tap again. Now the tube fills up, the water balances on each side, the water table has gone up. Now tip some water out again. The water table goes down. This is what happens normally, year in year out. The action of tipping out the water is a proxy for groundwater exiting the system through springs or seeps or through pumping.

Hopefully you can see where this is going. Turn off the tap. Don't turn it on again. Keep "pumping" though by tipping water out of your tube. What happens to the "water table"? It's getting lower and lower and lower. This is what is happening to our groundwater as we continue to sink boreholes and we continue to pump out more and more and more groundwater.

The sustainable situation is where the amount of recharge going into our groundwater system is equal to the amount coming out. This isn't happening at the moment because we are in a drought situation.

Will it change in the future? Probably, but will it change enough to recover the decline in the water table that we are seeing at the moment and how can we work out which parts of the groundwater system we can sustainably use and which parts we can't?

This is the objective of a Sustainable Groundwater research project at Stellenbosch University being led by myself and involving the co-author, as well as two BSc Honours students Yaa Agyare-dwomoh and Zita Harilall. The project aims to use tritium, the heavy radioactive isotope of hydrogen, as a tracer of rainwater-groundwater interaction. Tritium is typically produced in the upper atmosphere and gets incorporated in to rainwater. Thereafter it gets rained out on the surface and makes its way into the groundwater system.

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Tritium has a half-life of 12.3 years which means that after 12.3 years we have half as much tritium as we started with. After 50-70 years the amount of tritium has declined to such a level that it becomes hard to detect. After 120 years, if no recharge is taking place its concentration is below detection levels and we can say that the concentration is zero.

So if we measure the concentration of tritium in groundwater and we have detectable tritium we can say that the groundwater in which it was measured was in contact with the atmosphere sometime in the last 50-70 years, whilst groundwater that has no tritium has not been in contact with the atmosphere in the last 50-70 years.

Although this simplifies the system a bit (there are some ways of getting tritium in groundwater other than through interaction with the atmosphere), as a general approximation it holds true. This means that measuring the distribution of tritium in groundwater would allow us to work out which parts of the groundwater system are being actively recharged and which are not and potentially place some constraints on exactly how much of South Africa's groundwater is renewable and sustainable.

Groundwater is an important resource for the future. We don't know exactly what the distribution of precipitation in the future will be but one thing we do know is that water demand in many regions, Cape Town included, is on track to exceed that available in surface storage dams in the near future. So whilst a great deal of effort is going into working out how much of our groundwater system is sustainable and how much is not, one thing is definitely not sustainable and that is the installation of private boreholes across metropolitan areas. The only sustainable way to manage our current water resources is for everyone to reduce their water consumption. Permanently. To find out more about the Sustainable Groundwater Project visit. https://www.thundafund.com/project/knowyourwater or https://weknowwater.wordpress.com/

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