Ecological impacts of groundwater abstraction investigated

Drilling in the Table Mountain Group aquifer

The Cape's Table Mountain Group (TMG) aquifer has been eyed as a potential source for bulk water supply for some time. A five-year study, led by the CSIR, has shown that whilst the aquifer is contributing significant water to mountainous catchments, abstraction from the deepest parts of the aquifer should have the least ecological impact.

"We have proved links between the TMG aquifer and wetlands, streams and vegetation. However, until the deep aquifer is pumped and monitored we cannot predict specific environmental impacts. As with all good research, we have ended the project with more questions than answers," says project leader Christine Colvin of the CSIR's groundwater science group. "Nevertheless, we have come up with some important findings, which we hope will underpin future sustainable development of aquifer supplies for the City of Cape Town."

The study was commissioned in 2002 by the Water Research Commission as part of a programme of research on the TMG aquifer, and informed a parallel investigation funded by the City of Cape Town to explore the feasibility of using the resource as a bulk water supply.

Rather than being a vast underground pool of water or a porous layer of soggy sand, the TMG aquifer is a fractured-rock system, with groundwater confined to faults, joints and bedding planes in the quartzite. Extending from Nieuwoudtville to Port Elizabeth, it coincides largely with South Africa's winter rainfall region, with precipitation ranging between 600 and 1 000 mm per year. Its footprint matches the distribution of the fynbos biome, so the study focused on unravelling the dependence of fynbos ecosystems on groundwater supplied by the TMG aquifer.

At the outset of the project, a workshop was held with a variety of specialists on TMG ecology and hydrology to inform the study design. Rivers, estuaries, wetlands and seeps were identified as being most vulnerable to changing groundwater conditions, so these ecosystem types were considered in selecting the two study sites, along with a number of other criteria.

During the study, the sites were equipped for long-term environmental monitoring of surface water, groundwater and local climate, and assessments of the flora and fauna were carried out.

Weather stations were installed, boreholes drilled, and piezometers used to monitor shallow groundwater and surface flow in wetlands and streams, respectively. The vegetation and geology were assessed using remotely-sensed satellite data, wetlands were mapped in the field, and various measurements taken on plant and animal communities, as well as the physical and chemical properties of ground and surface water.

"One of our early findings in the project is that the Cape Fold Belt mountains are not very forgiving on scientific equipment!" chuckles Colvin. "While we were still drilling, one of the sites - aptly named Purgatory - was razed by fire. All the vegetation was destroyed so we couldn't do botanical monitoring at that site.

The weather station's anometer, used to monitor wind speed, melted as the fire swept past. And in the first winter of heavy rains, three of our data loggers in the streams were swept away, and two were lost in boreholes. Some of our rainfall collectors were also vandalised, but whether by people or baboons, we'll never know!"

Despite these setbacks, the project has shown that the ecological role of the aquifer is critical in terms of maintaining hydrological heterogeneity - or 'hydrodiversity' - in the fynbos, with both terrestrial and wetland plants accessing groundwater from saturated sources.

"As expected, seeps and wetlands that receive water from the aquifer don't dry out in summer and maintain a saturated water level even after drought periods," says Colvin. "But even in other areas, plants seemed to experience relatively low levels of water stress in summer, which indicate a fairly ubiquitous source of bio-available water within their rooting depths. Microfractures within the TMG may help to explain this."

Studying the hydrogeochemistry of groundwater and river water also allowed the project team to make recommendations about what could be used in future monitoring.

"We found that levels of dissolved silica were significantly higher in water that had spent longer in the aquifer," explains Colvin. "We also found surprisingly high radon radioactivity in the groundwater. Radon has a half life of only 3,8 days, so it can be used as a tracer for active sources of groundwater discharge. Silica is much more conservative and can be used more easily as a cumulative tracer."

"We now have a better understanding of what should be monitored to determine where groundwater is discharging, and to detect any decline in discharge due to pumping," she concludes. "However, hydrogeologists will be able to characterise impacted flow paths with confidence only once a site is actually drilled and pumped." The project team believes that more detailed research and long-term monitoring is needed to better understand the links between the aquifer and the surface environment.

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