WATER AND THE ENVIRONMENT

Ecological infrastructure: How caring for nature helps to save money and water in the long run

A five-year research project funded by the Water Research Commission (WRC) has shown several examples of how investment in 'green' ecological infrastructure can deliver tangible benefits to the water sector and delay the need for more costly metal and concrete infrastructure projects, writes Tony Carnie.

Duncan Hay

The uMngeni Vlei is a critical wetland that feeds the uMngeni River.

Most people accept without question the need to have their cars serviced on a regular basis – or the common-sense of replacing leaking tap washers or clearing fallen leaves from roof gutters to avoid water waste or blockages.

Because in the long run, it's wise to spend a little bit of money on regular maintenance to avoid a heftier bill when things really break down due to neglect or lack of maintenance. In much the same way, the environment also needs to be maintained or repaired to ensure a reliable flow of environmental services such as clean water.

Natural scientists have long understood the importance of protecting water security by safeguarding the multitude of free environmental services that are rarely appreciated or costed using conventional economic models. This is why the term 'ecological infrastructure' was coined in the early 1980s, to promote a broader appreciation of the bedrock role of nature in creating and sustaining economic benefits for humanity.

While 'built infrastructure' is widely understood to mean massive metal or concrete structures, such as water pipelines, dams, railways or freeways, South Africa also has vast areas of green or 'ecological infrastructure' such as grasslands, wetlands or rivers that all play a fundamental role in storing or conveying water.

Examples include large marshy areas that act much like sponges, absorbing and then releasing water gradually. Apart from trapping water in a similar way to large, concrete dam walls, these wetlands also purify and filter water to reduce the load of bacteria, nutrients, chemicals or metals that could flow into dams. And they help to anchor soil and sediments that might otherwise erode to silt up and shorten the life span of major dams.

Even so, putting a monetary price on the benefits and savings from this free ecological infrastructure remains relatively poorly researched and quantified.

This was one of the reasons motivating a five-year research project in KwaZulu-Natal funded by the WRC entitled 'Enhancing water security through restoration and maintenance of ecological infrastructure: Lessons from the uMngeni River catchment' **(WRC Report No. TT 815/20).**

The uMngeni River Basin is one of South Africa's most important water catchment areas, supporting over 6 million people and providing water to the country's third-largest regional economy and the cities of Durban and Pietermaritzburg. The catchment is dominated by large-scale farming in the upper reaches (including dairy, beef, poultry, timber and sugar cane) while the middle and lower reaches are impacted by urban development, industry and mixed rural-urban land uses.

It also includes large commercial forestry plantations that are estimated to reduce streamflow by about 64 million m^3 each year. Alien invasive vegetation in the catchment is calculated to consume between 12 and 15 million m^3 of water, over and above what would have been used by natural vegetation.

Though it has four large dams (Midmar, Albert Falls, Inanda and Nagle) the uMngeni River catchment remains a water stressed catchment, which is only just meeting the water demands of its inhabitants. Project leader, Prof Graham Jewitt, explains that while ecological infrastructure projects may not provide a complete solution to reducing water-stress in the catchment, they can help to delay the massive cash investment required for a major new dam and water transfer scheme from the uMkhomazi River.

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DUCT

Staff from the The Duzi-Mngeni Conservation Trust spray water hyacinth in the uMngeni valley.

He says the report also demonstrates how ecological infrastructure (EI) can be used to secure more water through research that has focused on several case studies in the catchment. "This addresses a critical gap in moving from the many vague and broad conceptual ideas of how EI could form part of a catchment management strategy, to demonstrating how this can be an integral component of future water resource management plans in cities and urban areas, and ultimately, in a catchment management strategy."

Jewitt (the former director of the University of KwaZulu-Natal Centre for Water Resources Research and current head of the Department of Water Resources and Ecosystems at the IHE Delft Institute for Water Education in the Netherlands) says the four case studies have helped to reveal how tangible monetary savings can be achieved through strengthening ecological infrastructure.

One example comes from the upper-uMngeni catchment, where alien invasive plants use considerably more water than natural grasslands that have not been invaded. The researchers demonstrated that the cost per unit volume of water (m^3) by maintaining grasslands in good condition is considerably cheaper (31 cents/m^3) than for restoring degraded areas (R2.44/m^3).

This is mainly because rehabilitation of land degraded by soil erosion or invasive alien plants is more expensive and time consuming than maintaining grasslands in a natural condition. But while sound grassland maintenance is "by far the cheapest of all other water related infrastructure options" most farmers, land owners and rural communities still struggle to cover the costs of maintenance.

"This raises several questions around existing legislation. For example, should private land-owners be obligated to adhere to the Conservation of Agricultural Resources Act without financial support?"

This is especially important in strategic water source areas which produce nearly 50% of South Africa's mean annual runoff, but cover only 8% of the surface area of the country.

But how can farmers be paid or incentivised to maintain such land in a natural state? Jewitt and his fellow researchers suggest that the provincial water utility company Umgeni Water could collect revenue in the form of a water resource management charge and hold this in a trust. The trust would then assess applications from landowners and distribute funds through ecological infrastructure partnership projects implemented through the Duzi-uMngeni Conservation Trust (DUCT), a non-profit company set up in 2005 to champion the health of the uMsunduzi and uMngeni rivers.

Over the last 15 years DUCT has been involved in a wide variety of environmental stewardship and restoration projects in the catchment through the removal of aquatic weeds such as water hyacinth; clearing invasive alien plants; donga rehabilitation; installing litter booms in rivers or monitoring sewage leaks and sand-mining degradation of rivers.

The WRC study in the uMngeni has also identified other areas of significant cost-saving made possible through ecological infrastructure. For example, Umgeni Water's energy costs have almost doubled over the past five years, partly due to the increased electricity bills from pumping water from other catchments to meet the needs of the uMngeni system.

Furthermore, because of the low levels of storage at Albert Falls Dam during the recent drought, Umgeni Water was not able to fully supply parts of Durban, so additional water had to be pumped from Inanda Dam to Durban Heights treatment works – at a cost of R32 million.

"The average cost of pumping this water was 46 cents per m^3 of water pumped for the three pump stations. Therefore, it can be argued that every m^3 produced by the catchment upstream of those two dams means that water does not have to be pumped, so saves Umgeni Water at least 46 cents/m^3.

Based on the modelling exercise, every hectare of invasive wattle in the catchment uses about 200 m^3 per hectare per month more than grassland (2 400 m^3 per hectare per year). Thus, at a pumping cost of 50c per m^3, each hectare cleared and maintained – or prevented from being invaded - saves Umgeni Water R1 200/ha per year.

"The project aimed to guide catchment managers when deciding 'what to do' in the catchment to secure a more sustainable water supply, and where it should be done."

"Based on mapping of invasive alien plants undertaken by Mtshali (2017) for the Lions and uMngeni River catchments upstream of Midmar Dam, there are 125 km^2 or 12 500 ha of invasive wattle. In contrast, in 2007, mapping suggested that this area was only 30 km^2. It can therefore be argued that clearing the upper uMngeni of invasive alien plants could save Umgeni Water approximately R15 million per year in pumping costs (at 2017 rates)."

The researchers say that clearing invasive alien plants provides a relatively quick solution to providing additional streamflow without the burden of extensive legal and financial arrangements that affect built infrastructure projects.

"Investments in EI can take place relatively quickly and, in the case of clearing aliens, produce fairly quick benefits. As such, it provides an interim solution to reduce the pressure on water resources during the planning and construction of built infrastructure."

Without the uMkhomazi transfer scheme, water supplies to the residents of the uMngeni catchment are under pressure and while EI cannot provide the additional 200 million m^3 per year forecast to be needed by 2030, "our analysis shows that clearing invasive alien plants in the catchment headwaters would

Duncan Hay

The Duzi-Mngeni Conservation Trust has been involved in a wide variety of environmental restoration projects in the uMngeni catchment for 15 years.

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Environmental hydrology student, Hlengiwe Ndlovu, clambers down an embankment during the WRC ecological infrastructure project.

provide at least 15.6 million m^3 of water at a 90% assurance of supply – enough to fill a significant portion of the planning and construction gap between now and the completion of the uMkhomazi transfer scheme".

A further example of EI benefits comes from saving on chemical treatment costs. In the recent study, the researchers analysed water contaminant data, chemical dosage and cost records for a five-year period (2013-2018) for the DV Harris water treatment works which draws water from Midmar Dam and the Wiggins treatment works, which draws water from Inanda Dam.

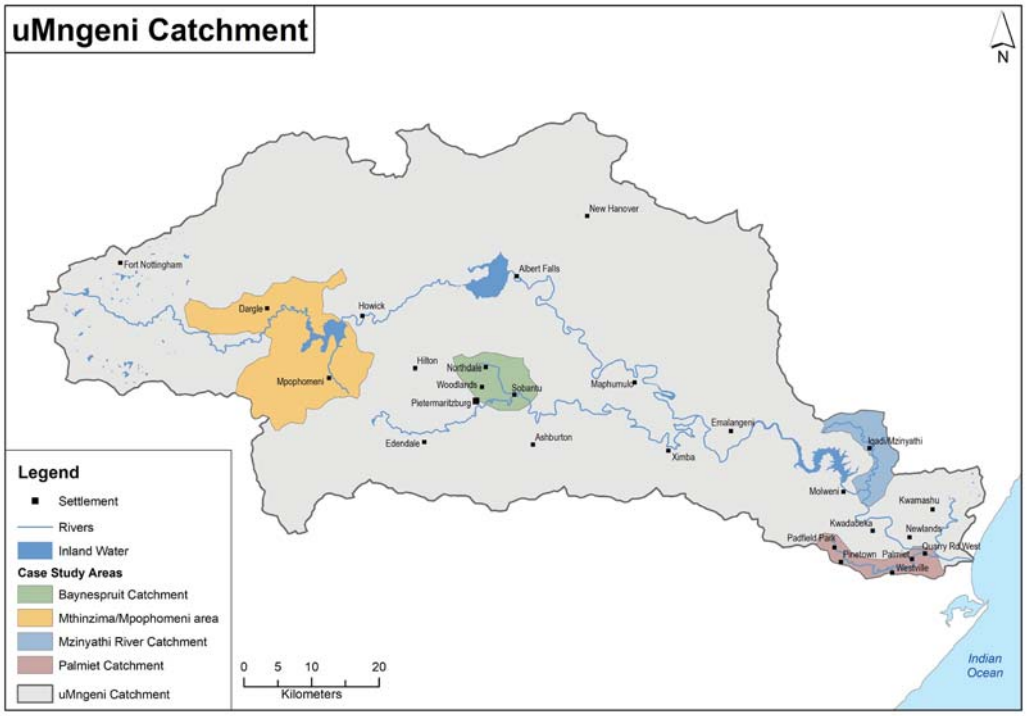
The assessment generated several interesting findings. The average cost of treating water per cubic metre was higher for DV Harris (16 cents/m^3) than for Wiggins (8 cents/m^3) partly due to the higher use of chlorine and other treatments to control E.coli contamination associated with sewage and other pollution entering Midmar Dam.

After assessing the economic and financial benefits of investing in EI from several perspectives, the researchers state: "We can conclude that there are clear water quantity and quality benefits in investing in EI in the uMngeni River catchment and that these opportunities are optimised from a perspective that views water security investments along a continuum - where built environment and ecological infrastructure investments complement each other, rather than being considered as 'one or the other'."

Jewett and his fellow researchers say the overall aim of this project was to identify where and how investment into the protection and/or restoration of EI can be made to produce long-term and sustainable water security returns.

"In short, the project aimed to guide catchment managers when deciding 'what to do' in the catchment to secure a more sustainable water supply, and where it should be done. This seemingly simple question encompasses complexity in time and space, and reveals the connections between different biophysical, social, political, economic and governance systems in the catchment."

The research teams also partnered with the uMngeni Ecological Infrastructure Partnership (UEIP), an initiative involving more than 24 groups including government departments, academic institutions, private companies and NGOs committed to investing in restoring, maintaining and managing EI for water security. This included aligning the WRC research with four restoration case studies -Mpophomeni (upper catchment), the Baynespruit in Pietermaritzburg (middle catchment), the Palmiet



Source: Michela du Sart

Map of the study area.

River catchment and Mzinyathi in eThekwini Municipality (lower catchment).

Jewittt told ***the Water Wheel*** that installing a new artificial wetland near the Mpophomeni township was critical to reducing sewage pollution entering Midmar dam. The artificial wetland would help to further filter water below a new waste water treatment works to serve the rapidly urbanising settlement of Mpophomeni.

Jewitt says another major benefit of the study has been greater capacity development in the field of EI, with more than 30 students now exposed to this concept during the five-year project (3 Postdocs, 9 PhDs, 15 MSc, and 7 Hons students have been affiliated with the project). He hopes many of these PhD students will become leaders in water governance and EI in the future, as a result of the capacity they have built and the experience they have developed as emerging researchers engaged in action research in the uMngeni River catchment.

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More than 30 students were involved in the WRC ecological infrastructure project in the uMngeni catchment.

Though Jewitt would like to see a Catchment Management Agency established for the uMngeni, he notes that the recent establishment of a catchment management unit by Umgeni Water is a "very positive" development.

As part of the study, UKZN research colleague, Dr Cathy Sutherland, also highlighted the importance of ensuring buy-in from affected communities and the need to shift perceptions away from the concept of 'hydro-modernism".

(Hydro-modernism refers to hard engineering approaches to water which rely on built infrastructure, including dams, treatment works and pipes with a focus on technical and economic efficiency using top-down governance approaches.)

"The legacy of both colonialism and apartheid is a major challenge and barrier to improving water security. This coupled with lock-in to hydro-modernist approaches, creates a water security context that can only be shifted by working within the current system, recognizing its socio-economic, political and environmental context and relations, and using innovation through EI interventions, to slowly, patiently and wisely shift the catchment to a more sustainable, just, and socio-ecological centred set of practices and way of being," the report concludes.

To download the report, ***Enhancing water security through restoration and maintenance of ecological infrastructure: Lessons from the uMngeni River catchment*** (**WRC Report No. TT 815/20**) Visit: http://wrcwebsite.azurewebsites.net/wp-content/uploads/mdocs/TT%20815%20final%20May%202020%20web1.pdf