NATURE-BASED SOLUTIONS FOR WATER IN THE PERI-URBAN

CASE STUDY: SOUTH AFRICA, WILDLANDS TRUST, DWARS RIVER

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NATWIP

ABSTRACT

The Wildlands Trust has been coordinating several riparian rehabilitation projects along the Dwars River, a tributary of the Berg River in the Western Cape, South Africa, since August 2018. The Dwars River is heavily transformed, with landcover converted to predominently agriculture over the past 300 years (mainly viticulture and fruit), an inter-basin transfer out of the catchment affecting the hydrological regime, and these disturbances inter alia resulting in infestation of the riparian zone by invasive alien trees and weeds. These invasive alien trees consume high volumes of water, reducing water supply, increasing fire risk, and negatively impacting biodiversity. The nature based solution implemented by Wildlands Trust involves three approaches: (1) the clearing of invasive alien trees, shrubs and weeds from the riparian zone (initially through logging operations, with follow-up clearing), (2) active rehabilitation of the riparian zone, through the planting of indigenous tree seedlings, and (3) engaging the community through creating employment opportunities in the rehabilitation programme, as well as a recycling and native tree growing programme, aimed to keep the river clean, in exchange for rewards (e.g. bicycles). This nature-based solution takes a socio-ecological systems approach and aims to improve hydrological flows (increase water availability) as well as engage the community, and indirectly -if implemented at scale- may improve water quality (dilution effects). The scale of the implementation is currently relatively small (small sections/strips of riparian zone along the river) and therefore the benefits of these interventions are mainly local and difficult to quantify. The nature-based solution appears to have had a very positive reception by the community, and good communication is cited as key in having achieved this. Many community members perceive improvements to nature (improvements in ecosystem services), which are experienced directly in terms of recreational benefits, improvements to aesthetics, and general well-being, social cohesion and nature-connectedness. Any benefits in terms of augmented water supply or quality, though perhaps small due to the scale of the work, would be beneficial to downstream farmers who rely on the Dwars and/or downstream Berg River for irrigation.

PURPOSE OF THE CASE STUDY

The aim of this case study is to evaluate the results of the Wildlands Trust invasive alien clearing and riparian rehabilitation of the Dwars River as a nature-based solution that aims to increase water quantity downstream. The study explores results in terms of all three dimensions of sustainability, namely, social, economic and environmental.

AREA CHARACTERISATION

Country	South Africa
Municipality	Stellenbosch Muncipality
Province	Western Cape
Town	4 towns - Kylemore, Johannesdal, Pniel, Lanquedoc
Surface	63.87 km^2
GPS coordinates	33°53'48.1"S 18°57'32.5"E

PHYSICAL CONTEXT

Local geography/ topography	Formal (small towns) and informal settlements situated in a mountain valley near to the Dwarsriver; Cape Fold Group (predominantly sandstone); Highest elevation: (highest within the community 333 m; highest local mountain peak: 1449 m); lowest elevation 266 m
Main water courses	Dwarsriver, a tributary of the Berg River. The Berg River is approximately 285 km long from source to sea, with a basin area of approximately 9 000 km2. It has its source in the Drakenstein and Franschhoek mountains, south of Franschhoek.
Main soil types	Soil: Plinthic catena: dystrophic and/or mesotrophic; red soils not widespread, upland duplex and margalitic soils rare; Geology: Mainly gritty sand, scree and alluvium covering granite of the Stellenbosch Pluton, Cape Granite Suite.
Precipitation (monthly averages as well as climate change projections)	Mean Precipitation (mm) Annual: 1202 mm; Monthly Medians: JAN - 22, FEB - 16, MAR - 27, APR - 71, MAY - 138, JUN - 154, JUL - 175, AUG - 157, SEP - 91, OCT - 57, NOV - 36, DEC - 27 The difference in median precipitation between the driest month and the rainiest month is 133mm. [Data from Cape Farm Mapper ver 2.2.3]
Temperature range	The monthly distribution of average daily maximum temperatures (centre chart below) shows that the average midday temperatures for Kylemore range from 14.8°C in July to 25.3°C in February. The region is the coldest during July when the mercury drops to 5.8°C on average during the night. So rangeL 25.3-5.8
Critical infrastructure	Pniel Wastewater Treatment needing urgent upgrade & extension - on the river bank (Wildlands monitors overflows & reports to municipality; planned mini SASS -Stream Assessment Scoring System- reporting); water extracted for Boschendal (divider sluice); planned extended bridge construction over river near Lanquedoc. Farms use water for irrigation (even dam a tributary - with Black Alder invasion source)
Other relevant physical factors	Greywater management, solid waste management & stormwater drainage all a concern; concerns of human health & downstream pollution impacts.

SOCIO-ECONOMIC CONTEXT

Population	In 2011 there were around 1 975 people living in Pniel, 4 328 in Kylemore, and 4 289 in Lanquedoc (South African census 2011).
GPD/capita	No info.
Economic status (i.e. low income, high income)	Low-income communities contrasting with rich farm/land-owners.
Other relevant socio-economic factors:	Working population in the small towns are mostly seasonal workers from surrounding farms (mostly wine farms). The community is affected by crime and drug abuse.

PHYSICAL CONTEXT

The steep and rugged mountains surrounding the Dwars River are predominantly sandstone and quartzite, reaching up to over 1500 m above sea level (Simonsberg is at 1399 mamsl), whereas the wide valleys are highly arable (around 300 mamsl), dominated by decomposed granite and shale soils with good drainage (Forsyth, Le Maitre, & Lötter, 2016; Forsyth, Le Maitre, Smith, et al., 2016). The Dwars River (or Dwarsrivier) is a tributary of the Berg River. The geology of the Dwars river catchment is similar to that of the Upper Berg but also incudes gritty sand, scree and alluvium covering granite of the Stellenbosch Pluton, with Cape Granite Suite in the valley. Soils are mainly dystrophic and/or mesotrophic. The mean annual precipitation of the catchment is around 1202 mm, most of this received in the winter. The difference in median precipitation between the driest month and the wettest month is 159 mm. The Dwarsrivier valley (63.87 km2) is an important agricultural area, predominantly for viticulture and fruit farming, forming part of the Cape Winelands.

Many of the farmers in the area are part of the Simonsberg Conservancy, which is the implementor for some of the alien clearing using Working for Water funding (Natural Resource Management, Department of Environmental Affairs), and some

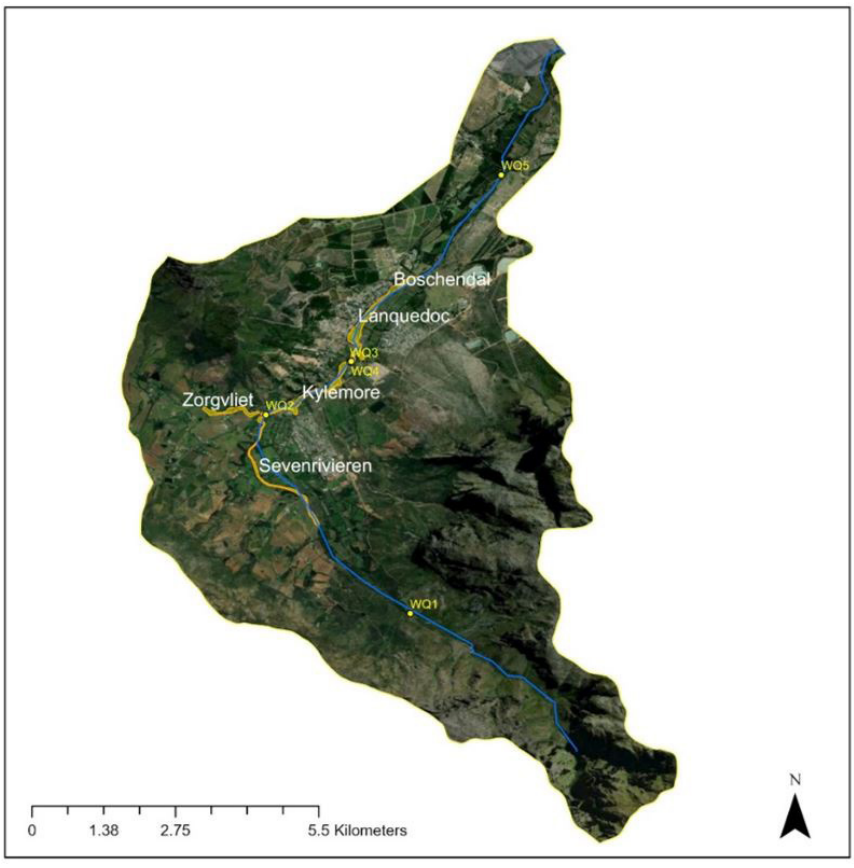

Figure 1. Rehabilitation sites for the Wildlands Trust along the Dwars River (orange polygons and labels in white) and water quality sampling locations in yellow.

Site	Electrical Conductivity (mS/m)	NO3-N (mg/l)	COD (mg/l)	Suspended solids (mg/l)	Faecal Coliforms (CFU/100ml)
WQ1	5	<0.36	8	0	2
WQ2	40	1.18	96	37	>2420
WQ3	11	1.28	8	0	109
WQ4	10	<0.36	7	0	38
WQ5	11	1.02	7	0	142

Table 1. Water quality sampling in September 2018 by the Wildlands Trust along the Dwars River (see Figure 4 for sampling locations). WQ2 (shaded) results show the influx of sewage.

landowners are World Wide Fund for Nature (WWF) Champion Farmers (a biodiversity and water stewardship programme). There are many small towns in the Dwarsrivier valley, including Pniel, Kylemore, Johannesdal, and Lanquedoc (Forsyth, Le Maitre, & Lötter, 2016; Forsyth, Le Maitre, Smith, et al., 2016). One of the major issues in the Dwars River catchment is invasive alien trees, which are high water users. In the high-lying areas, pines are the major invasives (Pinus pinaster and P. radiata), and in the rest of the catchment, wattles (Acacia mearnsii, A. spp.) and gums (Eucalyptus camadulensis, E. spp.) are dominant, and major riparian invaders include Black Alder (Alnus glutinosa), poplars Oaks, and Elms (Forsyth, Le Maitre, & Lötter, 2016; Forsyth, Le Maitre, Smith, et al., 2016). Failing infrastructure (Pniel Wastewater Treatment Works) is also an issue, leading to sewage flowing into the rivers, as indicated by the high faecal coliforms and electrical conductivity entering the river through a dysfunctional sewage system (Figure 1, Table 1, source: Wildlands Trust). This is a health threat to those using the river recreationally (often children) as well as to agricultural produce that is irrigated by river water downstream, and may impact international certification. The river plays a strong buffering role for this sewage, probably largely through dilution effects (Table 1). Besides water security, invasive alien trees pose a major fire risk, through increased fuel loads. Fires are a natural part of this ecosystem, and are common in summer, between December and March (Forsyth, Le Maitre, Smith, et al., 2016). These fires perpetuated the invasive alien tree problem through stimulating the germination of large numbers of pine, gum and wattle seedlings (Forsyth, Le Maitre, & Lötter, 2016; Forsyth, Le Maitre, Smith, et al., 2016), all of which are fire-adapted, posing a risk to bordering infrastructure.

SOCIO-ECONOMIC CONTEXT

The Dwars River Valley has its recent roots in the colonisation of the Cape and has ties to slavery and oppression. As a result, the current socio-economic context is highly complex, with large inequalities between wealthy landowners (in some cases luxury properties) and people residing in the local towns (van der Waal, 2005). The communities are affected by high crime levels and drug abuse (Methner & Midgley, 2020). The valley may be classified as peri-urban given the fast paced, and highly contested, spatial transformation currently taking place (van der Waal, 2005). New forms of land-use have led to conflict between farm workers and developers, especially where linked to heritage conservation (van der Waal, 2005). In terms of population, in 2011 there were around 1 975 people living in Pniel, 4 328 in Kylemore, and 4 289 in Lanquedoc (South African census 2011). In terms of the economic status of the catchment, there is a very high contrast, with rich farm owners adjacent to low-income communities. Much of the working population in the small towns are seasonal, working on surrounding farms (Methner & Midgley, 2020).

OBJECTIVE OF THE NBS

The Wildlands Trust implements invasive alien clearing and riparian rehabilitation of the Dwars River using a socio-ecological systems approach as a nature-based solution that aims to increase water quantity downstream (addresses water shortage).

POLICY AND GOVERNANCE CONTEXT

There are three levels of governance involved in the nature-based solution (riparian rehabilitation) in the Dwarsriver, including national, some regional involvement, and to a lesser extent, local. National governance is primarily through providing funding for the riparian rehabilitation, funding is from National Treasury and channelled through the Department of Environment, Forestry and Fisheries (Midgley et al., 2020). Non-Governmental Organisations administer the funds and coordinate the work, and in the Dwars river these include the Wildlands Trust, and the Simonsberg Conservancy. There is some regional government interest in the rehabilitation work along the Dwars River, primarily that of the Department of Environmental and Development Planning (Western Cape Government). In terms of local governance, the Stellenbosch Municipality is involved, mainly through their role in wastewater treatment and maintenance of local parks close to the river. There is some cross-pollination between tiers of government, for example the Department of Environment Affairs, Forestry and Fisheries specify catchment-based units of importance, and interventions are to be based on these specifications. National funding is in tandem with provincial planning, especially in the Natural Resource Management Programme; previously Working for Water, and all its affiliate groupings Working for Wetlands, Forests, etc.

Some of the major governance-related challenges include the lack of transdisciplinary engagement and operating in silos (Rebelo & Methner, 2019). Another major challenge includes the building of trust (Rebelo & Methner, 2019), within government tiers, departments and with communities, especially where there are diverse interests and agendas. How to sustain engagement and funding through various project cycles; how to mobilise the community (stakeholder engagement) and change patterns in decision-making are other major challenges that need to be addressed. Other stakeholders involved in the nature-based solutions in the Dwars River include community stakeholders (community committee, local residents, landowners such as Old Bethlehem, Boschendal, Alleé Bleué and Solms Delta), other non-governmental or non-profit organisations, recreational groups (e.g. Simonsberg Conservancy, Banhoek Conservancy, RANYAKA, Stellenbosch Trail Fund), other government departments (e.g. Department of Agriculture - LandCare) and universities. The potential for opportunities for socio-economic development and tourism opportunities is a leverage point that may bring this diverse group of stakeholders together to engage.

ACTIONS

The Wildlands Trust has been coordinating several riparian rehabilitation projects along the Dwars River since August 2018 (Figure 1). Funding is provided through the Natural Resource Management programme of the National Government Department of Environment, Forestry and Fisheries. This riparian rehabilitation involves three approaches and takes place either on municipal or privately owned land. Firstly, the clearing of invasive alien trees, shrubs and weeds from the riparian zone. The trees are cleared initially through logging operations, whereas subsequent follow-up clearing may involve foliar spray of herbicides, cutting and spraying of herbicides or hand-pulling, depending on the target invasive alien species. Secondly, there is active rehabilitation of the riparian zone, through the planting of indigenous tree seedlings. Thirdly, there is an attempt to engage the community through creating employment opportunities in the rehabilitation programme, as well as a recycling programme, aimed at keeping the river clean, and Treepreneurs Project. The Treepreneurs Project encourages and empowers school learners to grow trees and sell the seedlings to the project seven to eight months later

for a reward (e.g. a bicycle). Environmental outreach days were held at schools (with tree-planting initiatives). The project informed the community, and asked for input on how to involve the community. Therefore this project takes a socio-ecological systems approach and aims to both improve hydrological flows (increase water availability), as well as engage the community (Adams et al., 2020). The scale of the implementation is relatively small, and there is a gap in South Africa in understanding how to upscale, or finance these nature-based solutions at scale (Midgley et al., 2020). Therefore the benefits of these interventions are anticipated to be mainly local, however any benefits in terms of augmented water supply or quality, would be beneficial to downstream farmers who rely on the Berg River for irrigation.

POTENTIAL (OR ACHIEVED) IMPACTS AND BENEFITS

Results of the case-study interviews: (in brackets '%' refers to the number of agreements; total sample sizes: n=20 and n=3 for the community and implementers respectively)

- Connection to nature improved after the NBS (Community: 80%; Implementers: 0%)
- The NBS changed how the community used nature for recreation (Community: 70%; Implementers: 66%)
- The NBS shaped/changed cultural values and practices (Community: 50%; Implementers: 0%)
- The NBS improved community health and wellbeing (Community: 75%; Implementers: 33%)
- The community perceived that water supply (riverflow) has increased, and water become more available for other uses (for example: gardens and farms) (Community: 40%)
- Reduced crime following the NBS (Community: 55%)
- Improved social cohesion (connectedness, sense of community) (Community: 65%)
- The NBS created new jobs in the community (Community: 65%, Implementers: 100%); community members were employed in the NBS work, and there were also jobs created indirectly, e.g. through recycling, a gate keeper.
- There was an improvement of income for 9/10 (90%) of the workers interviewed in relation to their previous employment situation.
- Additional economic benefits of the alien tree clearing were cited by implementers to be reduced fire risk (66%).
- Ecosystem services: community mostly perceived increases in provision of ecosystem services, particularly aesthetic services (85%), heritage (75%), soil quality maintenance (75%), energy provision (75%) and recreation (70%) (Figure 2). Implementers agree that there were improvements to water provisioning, provision of materials, energy, ornamental services, as well as water purification, regulation and life cycle maintenance (all 100%).

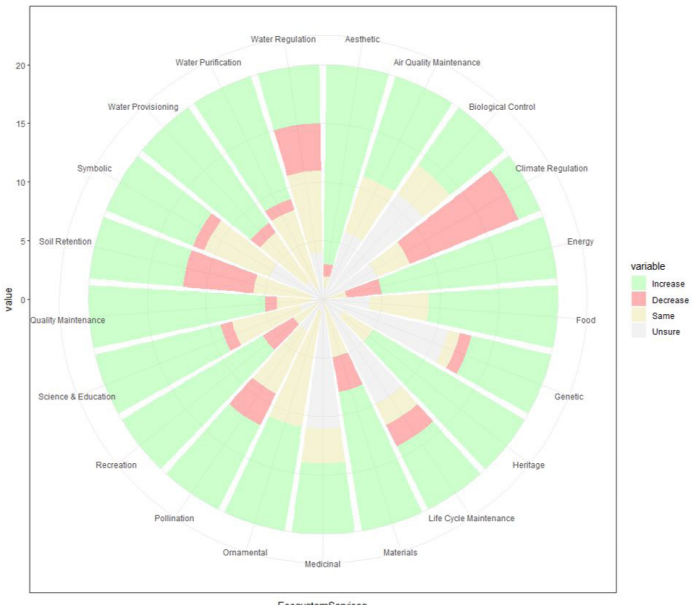

Figure 2. The perceived impact of the Dwars River NBS on ecosystem services according to community members (n=20).

SUSTAINABLE DEVELOPMENT GOALS AND/OR ANY OTHER WATER-RELATED DEVELOPMENT GOALS ADDRESSED

SDG1 -> Job creation for the impoverished.

SDG3 -> Dilution effects of sewage (more water available due to lower water use of indigenous vegetation), resulting in positive health impacts for those using the water for irrigation, or recreation.

SGD6 -> Improvements in water quality through the NBS (dilution effects)

SGD8 -> Employment opportunities provided through the NBS

SGD10 -> Improved equality (income provided for workers through the NBS)

SDG11 -> Improvement of the sustainable use of water within these communities (and peri-urban areas)

SDG12 -> Improved quality and quantity of water for agricultural irrigation (responsible consumption improved through removal of invasive alien trees, but also responsible production -less impact of sewage)

SDG14 -> Water quality improvements (dilution effects) and associated impacts on aquatic life.

SDG15 -> Improvements to the riparian ecosystem (improved biodiversity following alien tree removal, of plants and also animals)

LESSONS LEARNT

- Challenges: The greatest challenges for implementation identified by implementers were (in order of importance): Sustainable funding, silo-mentality, sufficient funding, multi-level collaboration, socially vulnerable communities.

Ecological

- Due to social and governance barriers (was there any information barrier here too?), implementation often had to take place in an ecologically inviable manner (e.g. tackling dense infestations of invasive alien trees first, and the lower reaches of the river) risks compromising project success in the long term. This is especially in the context of extremely insecure funding for the medium to long-term and the unreliability of these funds, where having secure funding for follow-ups in this area, at least for the next 30 years, is essential.

Dense infestations of Black Wattle (Acacia mearnsii), Black Alder and poplars cover the disturbed and degraded banks of the Dwars River, Western Cape, South Africa.

Social/governance

- The involvement of a champion in implementing the NBS is key.
- There are significant barriers to undertaking an ecologically strategic approach in the case of this NBS in the Dwars. These are cited as: (1) the absence of a platform to engage these landowners (privately owned land vs community trust land which they opted to work on), (2) insufficient funding to seek out and engage private landowners, or establish such

platforms, (3) private landowners are difficult to find, communicate with, are often not willing to grant access to their land by workers, and have high turn-over, (4) in some cases, the invasive alien trees hide illegal activities like water abstraction, adding an additional challenge in working with the landowners involved in these practices. Recommendations: (1)The major NBS funder (DEA-NRM) should allow more budget for engagement, (2) perhaps there is the need to make more use of directives on uncompliant landowners.

- Tension was occasionally felt between implementers and community, or implementers and workers. There was an attempt to encourage community buy-in, via a trading project (i.e. litter collection/tree-planting for bicycles).
- The community felt that employment from the local community could be increased, and more people involved. Better communication was also mentioned: that the public should be notified about plans. However many community members also felt that communication about the project was good. Better community engagement upfront was proposed (a multi-phased approach), as well as improved education and awareness around invasive alien trees.
- This catchment is complex, for example the sewage works discharging into the river is a major issue. There are some people who drink water from the river, and children play in it, and this water is not safe. It has also affected livelihoods: a local rosemary farm tried to sell their produce, but could not, due to this contamination. The value of the river is not recognized and funding to maintain and restore ecological infrastructure should be improved.
- Emerging from the results of perceptions in changes of ecosystem service provision is the strong need for ecological education. There appears to be general misconceptions about the value of trees, which do not apply in the case of alien trees in fynbos ecosystems, which may be being propagated in South African communities by the international discourse and aggressive marketing/publicity on tree planting (i.e. Bonn initiative). People hold two major misconceptions relating to fynbos ecosystems identified through this research: (1) that alien trees are valuable in soil retention and erosion prevention, and (2) that alien trees combat global warming by sequestering carbon. Many invasive alien trees outcompete indigenous flora, and due to competitive advantage and lack of pests, form closed canopy systems which result in little to no vegetative ground cover. The lack of cover results in soil loss and erosion. People perceive trees to be “holding onto the soil” because their roots become exposed through erosion, creating the impression that the trees hold back the soil, when the opposite is the case. In terms of the carbon sequestration ability of alien trees in fire-prone ecosystems, due to regular fires burning above ground biomass, any sequestration will need to be taking place below ground. The native fynbos, with its resprouters and rich geophytes and bulbs, are thought to store far more carbon below ground than invasive alien trees, as well as trap more

Working for Water teams (under the implementing agent: Wildlands Trust) clear foliage following logging operations of mature alien trees in the riparian zone.

carbon in soils due to better ground cover of vegetation (less erosion), as well as support more healthy microbial communities, which are an important factor in carbon sequestration. Education on these points is essential to improve local appreciation of native flora and their role in regulating the environment.

Economic

- Unsustainable funding is a huge challenge, resulting in not being able to pay workers or work to schedule, compromising the project (and leading to loss of workers).

TRANSFERABILITY OF RESULTS

Some of the major challenges has been the silo mentality in government as well as multi-level collaboration with both government and landowners. This affects where in the landscape the nature-based solution is able to be implemented, with consequences for riparian rehabilitation success. For example, ecological theory and experience dictate that catchments should be cleared of invasive alien vegetation from the top-down, and that sparse invasions should be tackled first, and dense infestations only tackled if sustainable funding is available and secured to continue the follow-up clearing in the long-term (Holmes et al., 2020). In the case of the Dwars, this ecologically-viable alien clearing approach has not been able to be followed, due to the complexity of land-ownership and multi-level collaboration dynamics, lack of funding for engagement, challenges engaging with multiple private land-owners, and uncompliant landowners. This is an important lesson for planning and communication in future nature-based solution projects of this type.

CONTACT INFORMATION

Prof Karen Esler: kje@sun.ac.za
Dr Alanna Rebelo: arebelo@sun.ac.za

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Working for Water teams in operation. Working for Water is part of the Expanded Public Works Programme (EPWP) funded by National Treasury to create jobs).

The Dwars River is located in the mountainous parts of the Upper Berg catchment and has been intensively farmed for almost 400 years, and is currently an important agricultural catchent, particularly for viticulture. Landcover is therefore highly transformed, and the hydrology of the system is altered by an inter-basin transfer, and there is much abstraction from the river, some legal and some illegal -like this sluice pictured here.

WHAT IS NATWIP?

NATWiP is an acronym for a project entitled: Nature-Based Solutions for Water Management in the Peri-Urban: Linking Ecological, Social and Economic Dimensions.

This is an EU-Cooperation project funded under the Water Joint Programming Initiative (JPI) Call 2018 and is led by an international consortium of scientists. The NATWiP team works towards promoting sustainable implementation of nature-based solutions to address water challenges in peri-urban areas.

EDITORS

Amy Oen
RiSC, Norwegian Geotechnical Institute, Oslo, Norway

Sarah Hale
Sustainable Geosolutions, Norwegian Geotechnical Institute, Oslo, Norway

AUTHORS

Alanna J. Rebelo
Conservation Ecology and Entomology, Stellenbosch University, South Africa

Karen Esler
Conservation Ecology and Entomology, Stellenbosch University, South Africa

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