2019/20

WATER INNOVATIONS REPORT

Innovations for Growth and Sustainability

WATER RESEARCH COMMISSION

SP 137/20

TABLE OF CONTENT

FOREWORD

2020 has been defined by the COVID 19 Pandemic. Its impact has been prolific – the first global health crisis in the digital age. It has fundamentally changed the way we interact, work, live and even breathe. Its impacts have been seen in every facet of human life – health, our social constructs, it is sure to impact every political decision and of course has plunged the world in the biggest economic recession since 2008, with some forecasting a bigger impact than the Great Depression. It has also emphasized the primacy of water and sanitation to human life and wellbeing. Handwashing has made early headlines as a crucial component of the first line of defence against the spread of the pandemic. Along with the other components of WASH, water and sanitation have enjoyed high focus as crucial to both containment of the pandemic on the one hand and successful recovery of the infected on the other.

It has also brought to the fore our vast disparities of access to these basic services worldwide. The global scorecard 5 years into the UN SDGs and 20 years since the global agenda for access to water was launched in the 2000 Millennium Summit in the form of the MDGs, much of the developing world, in particular Sub-Saharan Africa is far off the targets. It is clear that we need technology leap-frogging and innovation in every component of the Water and Sanitation Value Chain if we are to get within touching distance of SDG6 by 2030. It is for this very reason that the UN, led by UNSG Gutteres and UN Water launched the Global Acceleration Framework (GAF) and the Decade of Action. It is unsurprising that one of the five pillars of the GAF is Innovation. Technological, policy, social and business innovation. Let us acknowledge and celebrate our brave Water and Sanitation innovators, and commit to higher levels of support to swell their ranks a hundred fold so that the next ten years can be defined by accelerated action that will not only help us achieve the SDG6 targets locally and globally, but also a trajectory that will set us on a path of higher levels of global Water Security and an expansion of the frontiers of human dignity.

Dhesigen Naidoo
Chief Executive Officer
Water Research Commission

EXECUTIVE SUMMARY

The Water Research Commission invests in research, development and innovation (RDI) through the annual disbursement of levy funds to institutions of higher learning, research organisations and enterprises in the South African National System of Innovation (NSI). As outputs from WRC-supported RDI projects, a total of 42 innovations were reported in the 2019/2020 financial year. Thus, this WRC Innovations Booklet aims to:

- Showcase the range of innovations; technological and non-technological (see Appendix B), emanating from WRC investment in RDI;
- Share information on the level of readiness of the innovations with water sector partners (see Appendix A);
- Matchmake innovations with potential partners for uptake, licensing and commercialization; and
- Publish opportunities to impact investors and the venture capital industry on behalf of the water sector

The innovations, which aim to ensure higher water resource security and improve livelihoods in and around water and related systems, are embedded in all key strategic areas (KSAs) of the WRC as well as the elements of the WRC Knowledge Tree (see Fig. 1). Through the innovations, the WRC also aims to foster implementation partnerships to strengthen institutions, promote the country's manufacturing, supply and service capacity and enhance the customer base for research, development and innovation outputs. The detailed descriptions of each KSA and associated innovations are elaborated further in the innovations booklet.

The WRC 2019/20 innovation portfolio describes a total of 42 innovations that sit at technology readiness levels (TRLs) 3 to 9 (Table 1). The 42 innovations can be broken down into 13 knowledge products and 29 technology transfer products (Fig. 1). The pipeline of innovation is robust, with a range of innovations sitting close to application (TRL 7 – 9 = 14), while 16 innovations are at a medium to late stage of development (TRL 6 – 7), and 12

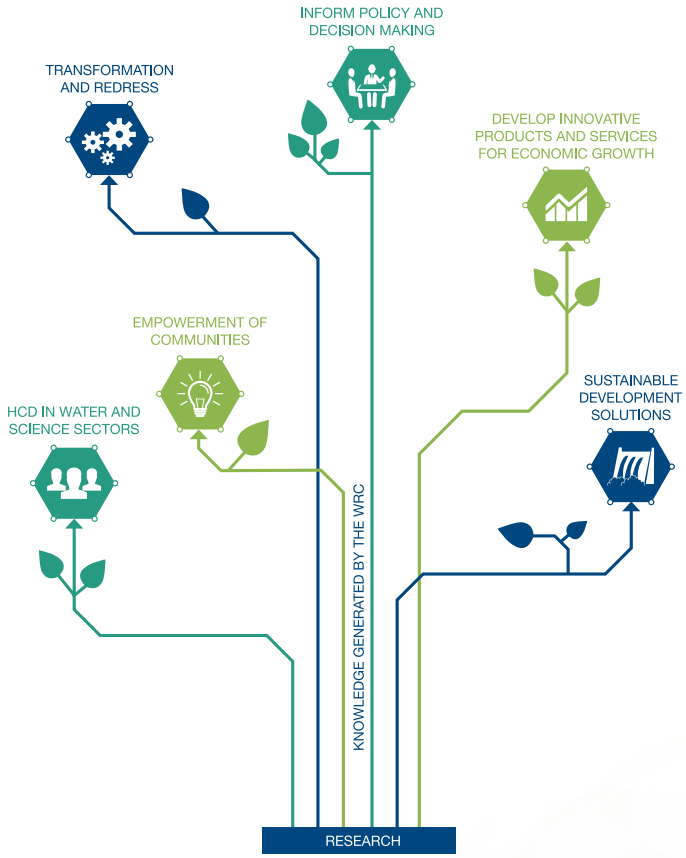


Figure 1: The WRC Knowledge Tree

sit at the early stage of development, i.e. TRL 3 to 4. The innovations in the WRC profile are solutions aimed at improving practice in the water sector and in sectors that are either high consumers or high polluters of water resources while several of the technologies are aimed at improved practice within public institutions but could also be translated into services provided by knowledge consultants, with a few linked to technologies that could significantly change practice. The 2019/20 innovation portfolio shows a breakdown in innovations from both enterprises and universities of 45% and 55%, respectively. More detailed information can be found in Table 1 and in the booklet.

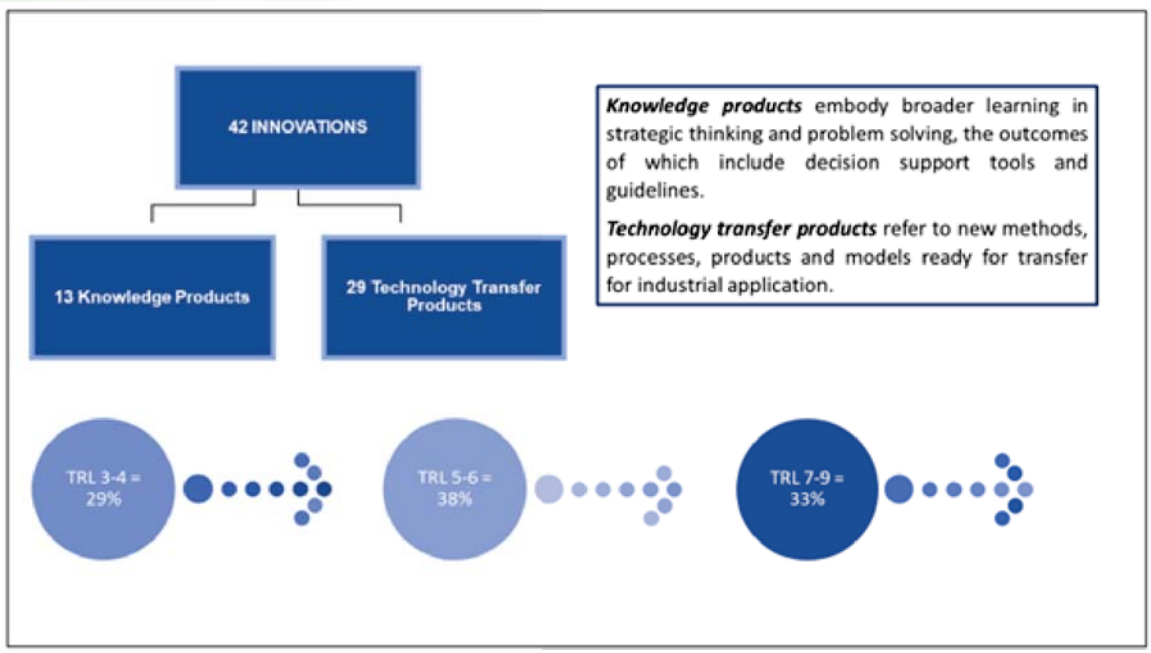


Figure 2: WRC 19/20 FY Portfolio breakdown

A further analysis was conducted using McKinsey's Innovation Horizons of Growth (Fig. 3), which categorised the innovations into Horizons 1, 2 and 3 but using a water sectoral lens for the analysis. In the water sector context the horizons are defined as[1] :

- Horizon 1 type innovations (Keeping the Lights on): innovations that strengthen the core practice or business of water linked to variants, incremental shifts, cost reductions and improvements.
- Horizon 2 type innovations (Building New Businesses) : emerging products and services that explore a shift in a new and improved water sector
- Horizon 3 type innovations (Imagining the Future): Development of transformational shifts in the water sector that are disruptive to the normal system or regime

Since the WRC is a sectoral RDI institution, it is important to work on an innovation pipeline that deals with the present (Horizon 1 – strengthening the core business of water and efficiencies), new business (products and services) that prepares for the immediate future (Horizon 2 – building industry competitiveness on the back of new products and services that shift us to a new improved water sector and water-user sector), and new products and services that are disruptive and uncomfortable to the normal system and regime (Horizon 3 – transformational shifts in the sector such as new industry development).

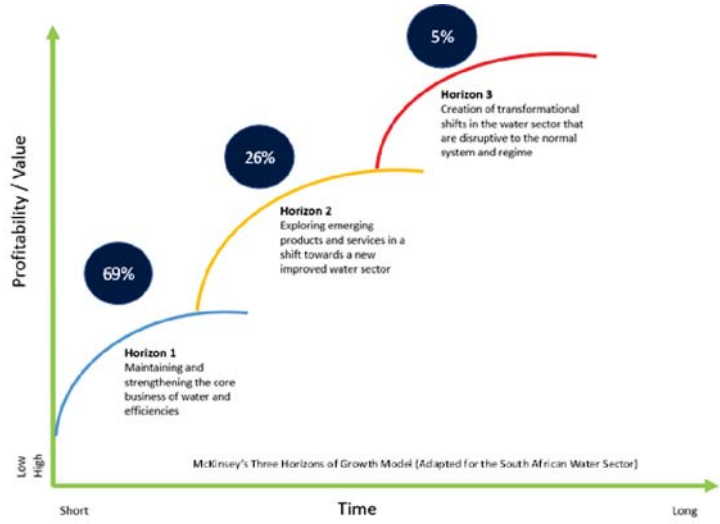


Figure 3: McKinsey's Three Horizons of Growth Model adapted at a sectoral level by the Water Research Commission for the WRC Innovations Portfolio FY19/20

The application of relevant products and services within public sector institutions remains the core business of WRC investment and hence return on investment is measured in not just monetary terms but in social and environmental good. Most of the WRC investment is in the space of Horizon 1 innovation development which is focused on optimization, new improved practices, and products and services that add value to existing knowledge (69% of portfolio). This expected as the WRC caters to immediate and short-term impact in the sector. A small number of innovations are

linked to Horizon 2, which comprises products and services with potential to change regulatory or customer behaviours and hence influence new customer demands (26% of the portfolio). Finally, very few innovations in the WRC R&D portfolio can be considered as disruptive to the current system of practice or products and services rendered in the water sector (Horizon 3) (5% of the portfolio). The latter is expected as this provides only a 1-year view of the WRC portfolio and a multi-year analysis could show a different trend.

It is important to note that within the WRC, two innovation-support platforms viz: WADER (the Water Technologies Demonstration Programme) and SASTEP (the South African Sanitation Technology Enterprise Programme) have been established to stimulate Horizons 2 and 3 innovation outputs that are geared for the market that supports new institutional policy and demands. The SASTEP and WADER platforms are orientated towards moving technologies closer to market readiness and engaging with entrepreneurs and business to stimulate viable businesses that produce market-related products and services. Hence, these WRC platforms tend to provide more technologies linked to Horizons 2 and 3, with SASTEP playing more in a system or regime change space of future sanitation technologies and services. Thus, SASTEP tends to support Horizon 3 products and services and several of the innovations that sit in the programme can be considered to be highly disruptive of the market and sector.

Table 1: 2019/2020 Innovation Portfolio

#	INNOVATION	INNOVATION TYPE	TRL	ORGANISATION	A/CRL	IMPACT	HORIZON
02	Participatory Hydrological Modelling Tool – Theory U	Non-technological	9	Enterprise	Yes	High	1
29	Decision Support Tool for Grassland Rehabilitation	Technological	9	University	Yes	High	1
42	Alternative Land Use Guideline	Non-technological	9	University	Yes	High	1
06	Water Ecosystem Diagnosis: Water Temperature Targets	Non-technological	9	Enterprise	Yes	High	1
08	Wet-EcoServices version-2	Technological	9	Enterprise	Yes	High	1
39	A framework for facilitating the representation of female small-holder farmers in the agricultural value chain	Non-technological	8	University	Yes	High	1
09	National Flood Studies Application (NaFSApp)	Technological	8	University	Yes	High	1
01	Cost Benefit Analysis tool/model for the sugarcane industry	Non-technological	7	Enterprise	Yes	Medium – late stage	1
03	Wet-Health V2.0	Non-technological	7	Enterprise	Yes	Medium – late stage	1
11	Sustainability Guideline: Pit Lakes and Coal Mine Closure	Technological	7	Enterprise	Yes	Medium – late stage	2
22	Illegal Discharge Risk Map Tool (Detection and reduction of illegal discharges into stormwater systems)	Non-technological	7	University	Yes	Medium – late stage	1
24	Tool for evaluating public water literacy	Non-technological	7	Enterprise	Yes	Medium – late stage	1
38	A method for agro-forestry to maximize yield for livestock feed production	Non-technological	7	Enterprise	Yes	Medium – late stage	1
14	Kwa-Madiba Hydropower Innovative Run-of River Scheme	Technological	7	University	Yes	Medium – late stage	2
28	Enhanced Water Footprint Guide for Crops	Technological	6	University	No	Medium - validation	1
30	Adapted MIKE-SHE and SWAT Tools: Hydrological Modelling	Technological	6	Enterprise	No	Medium - validation	1
31	Decision Support Tool to enhance adaptation and the business of farming	Technological	6	University	No	Medium - validation	1

#	INNOVATION	INNOVATION TYPE	TRL	ORGANISATION	A/CRL	IMPACT	HORIZON
32	Computer based Decision Support Tool: Agricultural Nitrogen and Phosphorus Pollution from field to catchment	Technological	6	University	No	Medium - validation	1
04	WetRehabEvaluate V2.0	Non-technological	6	Enterprise	No	Medium - validation	1
35	A training manual for the assessment of the nutritional status of rural communities	Non-technological	6	University	No	Medium – validation	1
36	Enhancing food security, nutrition and production efficiency of high-yielding grain legumes in rural communities	Technological	6	University	No	Medium – validation	1
41	A tool for assessing the water footprint of table and wine grapes	Non-technological	6	Enterprise	No	Medium – validation	1
07	Sustainable Blue Economy Growth Models	Non-technological	6	Enterprise	No	Medium – validation	1
17	Country-Wide Shit-Flow Diagram: Establishing National Excreta Flows in South Africa	Non-technological	6	Enterprise	No	Medium – validation	2
37	The Use of Role Playing Game (RPG) to train smallholder farmers on entrepreneurial development paths	Non-technological	6	Enterprise	No	Medium – validation	1
40	An irrigation scheduling Tool for water use efficiency of pomegranate orchards	Non-technological	6	Enterprise	No	Medium – validation	1
16	Alternative Water Social Accounting Matrix (SAM)	Non-technological	5	Enterprise	No	Medium – validation	2
33	Salt Accumulation and Waterlogging Monitoring System (SAWMS)	Technological	5	University	No	Medium – validation	1
10	Vortex Settling Basin designs for the removal of non-cohesive sediments at small rural river abstraction works	Technological	5	University	No	Medium – validation	2
18	Biobrick: A nature inspired approach for producing bio-cements from urine (continuation)	Technological	5	University	No	Medium – early prototype	3
15	Water Recovery from Flue Gas	Technological	4	University	No	Low – late lab scale development	1
23	Data envelopment analysis (DEA) as a water-use benchmarking tool	Non-technological	4	Enterprise	No	Low – late lab scale	1
05	Microwave Toxic Element Quantification	Technological	4	University	No	Low – late lab scale	1
25	Biosurfactant Compounds	Technological	4	University	No	Low – late lab scale	2
20	Competitive, small scale, solar desalination	Technological	4	University	No	Low – late lab scale	2
21	Energy sensitive wastewater treatment using integrated anaerobic digestion and advanced oxidation processes	Technological	4	University	No	Low – late lab scale	2
19	Vapoorize Toilet: Conceptual design of a dry sanitation toilet	Technological	4	Enterprise	No	Low – late lab scale	3

#	INNOVATION	INNOVATION TYPE	TRL	ORGANISATION	A/CRL	IMPACT	HORIZON
12	Method for the Recovering Semi-precious and Precious elements	Technological	3	University	No	Low – early early scale	2
13	MFC Municipal Sludge Treatment	Technological	3	University	No	Low –early lab scale	2
34	Communication Guide : Knowledge Uptake in the Agricultural Sector	Non-technological	3	Enterprise	No	Low – early lab scale	1
26	Rapid biological assays for the detection of antibiotic resistant genes	Technological	3	University	No	Low – early lab scale	2
27	Dicerocaryum plant extracts as water treatment chemicals	Technological	3	University	No	Low – early lab scale	2
	TOTAL 42	**NT = 19** **T = 23**		**Enterprises= 19** **Universities= 23**			

A/C RL (Application /commercialization Readiness Level) – defines stage of development and readiness for commercial strategies or uptake strategies.

2019/20 INNOVATIONS

The innovations are classed according to the key strategic areas within the WRC. A description of each key strategic area is provided in detail below, followed by the innovations generated in the 2019/20 financial year.

WATER RESOURCES AND ECOSYSTEMS

The strategic objectives of the Water Resources and Ecosystems key strategic area include the following:

- To establish better governance models aimed at facilitating equitable, productive and sustainable use of water resources and ecosystem goods and services;
- To improve our understanding of hydrological and ecosystem processes that will enable efficient management and decision-making;
- To improve environmental and climate change resilience and disaster and risk mitigation through improved understanding of the atmospheric, water, land and people interactions;
- Converting natural assets into societal, economic and environmental benefits whilst maintaining healthy trade-offs;
- To provide innovative solutions for water and ecosystem degradation and depletion and its impact on public health;
- To provide applicable and marketable technological solutions that will enable improved management of water and land resources.

INNOVATIONS
Water Resources and Ecosystems

Institute of Natural Resources

1. Cost Benefit Analysis tool/model for the sugarcane industry for improved agricultural industry practices:

Innovation Description

In 2015, the WRC released a preliminary guideline for determining buffer zones for rivers, wetlands and estuaries. While this research has advanced the understanding of watercourse management, and in particular the management of wetlands, it does not provide the necessary understanding for determining buffer zones for watercourses within sugarcane plantations planted prior to the promulgation of the National Water Act in 1998.

The proposed innovation is a process which incorporates hydropedological information into a hydrological model to investigate water and nutrient fluxes resulting from various scenarios of watercourse buffers within sugarcane growing regions. Through the inclusion of this information, the buffer zones for watercourse within sugarcane plantations will be accounted for.

Technology Category

Cost-benefit analysis tool/model

Technology Readiness Level

The knowledge has been disseminated to large commercial sugar associations and small sugar growers through training and workshops, therefore the innovation is at a TRL 7.

Benefits

The proposed innovation incorporates hydropedological information into a hydrological model (i.e. soil layers and surface water-groundwater interaction). As a result, the tool is better able to determine the effect of planting (sugarcane) in various areas on the groundwater table.

Research Partner

Institute of Natural Resources NPC

Next Steps

The proposed innovation is currently being further developed through a WRC-funded project. Upon completion of the project, the developed tool will be launched and introduced to planters within the sugarcane industry and further opportunity will be provided to optimise the tool. The Institute of Natural Resources (INR) NPC will remain the primary trainer for the tool while the WRC will disseminate the value of the innovation through its structures. The WRC will be open to INR NPC or any other capable service provider monetizing the tool (non-exclusively) for further dissemination.

livinglands
Collaborations working on living landscapes

2. Participatory Hydrological Modelling – Theory U

Innovation Description

A need exists to find ways to ensure effective water stewardship across a multi-stakeholder and sectoral platform in order to secure water resources and promote socially and environmentally acceptable ways of sharing water. In a complex socio-ecological system consisting of historically antagonistic social relationships, competing perspectives, distrust and other complicated scales of interaction, collective social action and collaboration are necessary to achieve appropriate stewardship of water resources. Hence, reaching a common understanding of the socio-ecological system and a willingness amongst relevant stakeholders to work together to find acceptable ways of addressing problems are an essential stepping stone in this respect.

As a response, a complex spatial hydrological model has been developed based on the Theory U, which includes both social and ecological systems. The development of the proposed model intentionally included all concerned stakeholders, from the developers and, importantly, the ultimate end-users. The systems are being implemented in the Baviaanskloof, Kouga and Krom catchments.

Technology Category

Tool/model

Technology Readiness Level

As the proposed model is currently being implemented, it is at TRL 9.

Benefits

Because the development of the model intentionally included the relevant stakeholders (catchment stakeholders, hydrological modellers, agricultural communities and associations, civil society organisations, consultants, government institutions, irrigation boards, fire protection associations, municipalities, research institutions, businesses, teachers and residents), the model is well understood by both the developers as well as those who will be using the model. This will ensure that the model is not only applicable, but also sustainable in its intended purpose.

Research Partner

Living Lands

Next Steps

The proposed model is currently being implemented by the research team. The impact of the model will be assessed and learnings documented. Full impact of this innovation has been achieved as implementation is occurring. In the long term, Living Lands could monetise this product by offering training or services as a cost.

3. Wet-Health V2.0

Innovation Description

Wetlands provide a range of important ecological services and, as such, management of these ecosystems is of utmost importance not only for biodiversity conservation but also for human well-being. Determining the present ecological status (PES) of wetland ecosystems is therefore central to wetland management and decision-making in South Africa.

The proposed innovation is a guideline to assess the health status of wetlands through the use of a decision support tree in the form of an automated spreadsheet. The proposed innovation is the second version of the guideline. This updated version is capable of handling up to 2000 wetlands, thus enhancing performance and efficiency.

Technology Category

Updated guideline with improved tool to assess health status of wetlands to be used directly by public entities like SANBI and also consultants which provide services to the sector.

Technology Readiness Level

The proposed guideline has been fully developed and adopted. It is therefore at a TRL 9.

Benefits

Compared to the first version of the guideline, the proposed innovation is more enhanced in terms of performance and speed. The guideline consolidates version 1 and the wetland index of habitat integrity (Wetland-IHI), which were developed in isolation. This allows for a less confusing method to authorize developments and assess compliance.

Research Partner

Freshwater Research Centre

Next Steps

The guidelines have been fully developed and are currently being implemented. The next steps will include an assessment of the success of implementation as well as the documentation of learnings.

GroundTruth
Water, Wetlands and Environmental Engineering

4. WetRehabEvaluate V2.0

Innovation Description

Despite the many ecosystem services supplied by wetlands, the majority have been subject to considerable degradation in South Africa, as in most countries. One of the globally accepted responses to this degradation is ecological rehabilitation. Rehabilitating of wetland ecosystems can be very complex given the many interacting biophysical and social factors affecting wetland functioning and the outcomes of rehabilitation projects. The proposed innovation is a guideline for assessing a rehabilitated wetland and prioritizing wetland rehabilitation.

This innovation is the second version of the guideline. The first version provides information pertaining to the rehabilitation of wetlands, including principles for the rehabilitation and a framework with step-by-step guidelines. The second version includes socio-economic aspects which were not present in the first version, making the guidelines more relevant and applicable.

Technology Category

Guideline

Technology Readiness Level

The proposed guideline has been developed but is yet to be adopted. It is therefore at a TRL 6.

Benefits

The guideline provides a means for prioritising wetlands requiring rehabilitation at a given time. Furthermore, the guideline enables the assessment of wetlands which have undergone rehabilitation. Compared to the first version of this guideline, this version also includes socio-economic aspects as part of the assessment package, which increases its value and applicability to the intended users.

Research Partner

GroundTruth cc.

Next Steps

It is envisioned that the guideline will be adopted and implemented by the Department of Water and Sanitation and/or catchment management agencies (CMAs).

5. Microwave Toxic Element Quantification

Innovation Description

Water resources in South Africa are threatened by pollution from industrial sources such as mining, smelting activities, agricultural activities, domestic waste and other commercial organisations. Such heavy metals pollution is a challenge as it poses harm to communities located in mining areas. As such, frequent and efficient monitoring of the levels of metals and their sources is essential in the effective management of water bodies.

The proposed solution is an efficient validated microwave-based method that can be used for the quantification of potentially toxic elements and their species in water and sediment samples. This method works to separate and extract metals from water sediments using microwave methods. It is a fast and cost-effective option to identify toxic elements in water sources, and thus rapid implementation of interventions against this type of pollution and its effects.

Technology Category

New method

Technology Readiness Level

The proposed method has been validated at a laboratory scale. It is therefore at a TRL 4.

Benefits

The method is able to extract toxic metal species from water sediment, which is a novel characteristic. Furthermore, due to the design of the method, the separation and subsequent extraction of toxic elements in samples is much faster than traditional methods such as chromatography and extraction of metals can take place at low concentrations, all while maintaining the same accuracy as existing traditional methods.

Research Partner

University of Limpopo

Next Steps

The aim is to obtain accreditation of the method by the relevant bodies in the country. The method has been validated at a small scale, but is now being demonstrated at various testing laboratories.

6. Water Ecosystem Diagnosis: Water Temperature Targets Guideline

Innovation Description

Water temperature is a key component of aquatic ecosystems. Understanding the role of temperature in these systems and the ecological consequences of changes in water temperature is of critical importance. Extremes in temperature affect many species, especially freshwater species, as they are more restricted in movement and the smaller water bodies they inhabit heat up more rapidly.

The proposed innovation is a guideline which provides a procedure for setting water temperature targets in rivers by taking temperature drivers such as directed measures, riparian vegetation, depth, and flows into account. Human activities including catchment transformation have altered natural thermal regimes, with the impact and occurrence of extreme events amplifying the problem. Providing a means of setting temperature targets will water ecosystems managers to better assess when intervention is required through the use of indicators, score and thermographs.

Technology Category

Guideline

Technology Readiness Level

The guidelines have been fully developed and adoption is underway. They are therefore at a TRL 9.

Benefits

The guidelines provide a means to measure temperature taking into account temperature drivers such as directed measures, riparian vegetation and depth flows. This all amounts to a more accurate assessment, and therefore the selection and implementation of more effective mitigation interventions.

Research Partner

Freshwater Research Centre

Next Steps

The proposed guidelines have been fully developed, and adoption is underway. We can therefore conclude that impact has been achieved as they have been adopted into practice.

biomimicry sa
imitate life's genius

7. Sustainable Blue Economy Growth Models

Innovation description

The Blue Economy is defined as a sustainable and equitable oceans economy that provides social and economic benefits for current and future generations. To alleviate unemployment, poverty and inequality, countries are looking to their seas to bolster slowing growth in their terrestrial economies and discover new opportunities for investment and employment. In South Africa, estuaries and marine systems contribute significantly to the economy. However, the development of estuaries and their catchments comes at a high cost annually due to lost fishery benefits as well as unknown costs to society from the overexploitation of resources and loss of biodiversity. The proposed innovation is a decision support tool which provides a guiding framework on planning of sustainable blue economy developmental choices.

Essentially, the tool serves as a framework for structured systematic conversation around different potential development scenarios by informing decision-makers of the implications and consequences of the different development choices.

Technology Category

Decision support tool

Technology Readiness Level

The tool has been piloted at uThukela and Knysna, therefore it is at a TRL 6.

Benefits

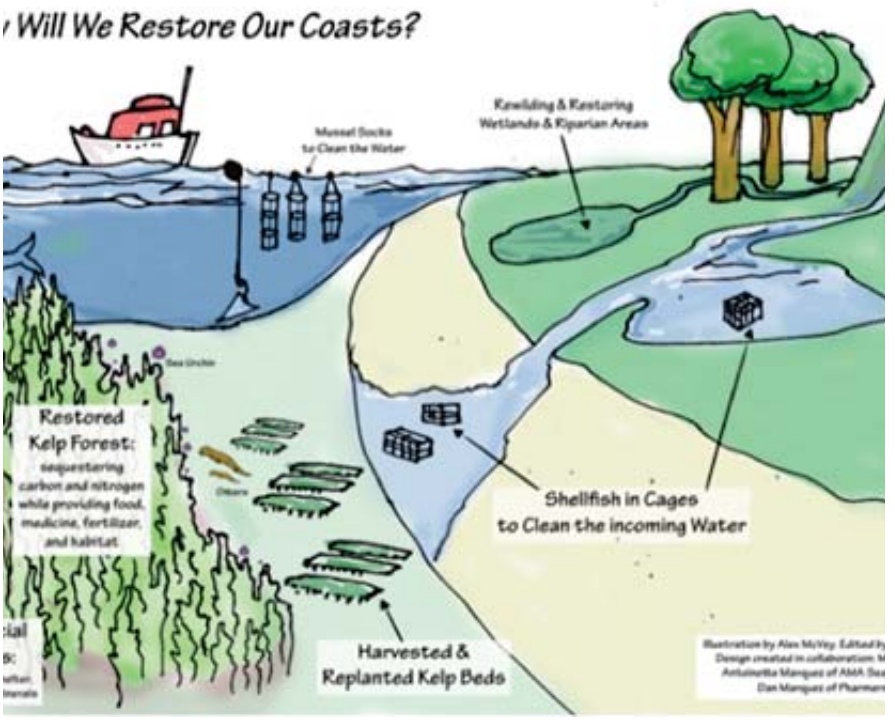
The tool can facilitate comparisons of monetary, social and ecological costs and benefits, thus ensuring that more informed decisions are made regarding the choices associated with Blue Economy development.

Research Partner

Greenhouse Systems Development

Next Steps

The tool will be consolidated with a suite of other related tools for transfer to stakeholders.



8. WET-EcoServices Version-2

Innovation description

The WET-EcoServices tool provides a set of indicators rated on a five-point scale of 0 to 4 that reflect the supply/capability of a wetland for each of 16 different ecosystem services selected (e.g. flow regulation, food, biodiversity, medicinal plants, etc). An Excel-based spreadsheet has been developed to conduct the calculations based on input scores. For each ecosystem service, indicator scores are combined automatically in an algorithm given in the spreadsheet that has been designed to reflect the relative importance and interactions of the attributes represented by the indicators to arrive at an overall supply score.

In addition, the demand for the ecosystem service is assessed based on the wetland's catchment context, the number of beneficiaries and their level of dependency, which are also all rated on a five-point scale. This version of the Services Monitoring Manual has been updated to include river riparian areas/ floodplains which were not included version-1.

Technology Category

Decision support tool

Technology Readiness Level

The WET-EcoServices tool has been adopted by several stakeholders, therefore it is at a TRL 9.

Benefits

WET-EcoServices is designed to assist decision makers, government officials, planners, consultants and educators in undertaking rapid assessments of individual wetlands and riparian areas in order to reveal the importance of the ecosystem services which the individual wetland/riparian areas provide to the society. This is critical in policy decision-making, such as authorizing mining vs tourism, or wetlands offset, prioritisation for rehabilitation, etc.

Research Partner

Eco-Pulse Environmental Consulting Services

Next Steps

The Wet-Ecoservices Version:2 has been adopted by various stakeholders, including national departments. The dissemination strategy is linked to training of stakeholders in order for institutional uptake of the DSS.

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

9. National Flood Studies Application (NaFSApp)

Innovation description

This is an application for the assessment of flood hazard and flood risk. Many of the design flood estimation methods currently recommended in South African manuals were developed more than 40 years ago. Therefore, there is a need to update and modernise methods used for design flood estimation in South Africa. The proposed innovation is a framework for a new web-based design flood estimation app and database, referred to as the National Flood Studies Application (NaFSApp).

The web-based pilot system contains an interface to extract catchment data and parameters for design flood estimation, thus limiting duplication of effort and improving consistency in application of the methods. Unlike housed download links, the system will allow users to geographically refine searches and extract catchment attributes once the databases have been populated.

Technology Category

New method/device

Technology Readiness Level

A demonstration has been achieved in the relevant environment and the system is ready for dissemination, which places it at a TRL 8.

Benefits

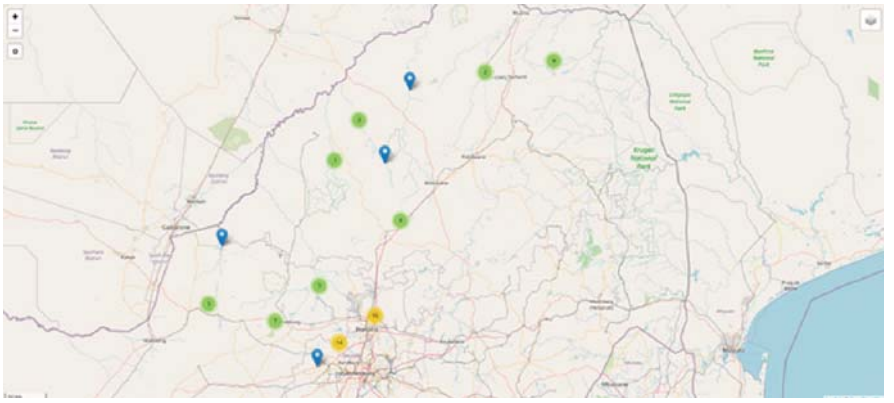
Realistic design flood estimation, where the magnitude of a flood is associated with a level of risk, is necessary in the planning, design and operation of hydraulic structures (e.g. bridges, culverts, dam spillways, drainage canals, etc.) for the preservation of human life and property. Therefore, the proposed innovation is a suitable design flood estimation technique.

Research Partner

University of Kwazulu Natal

Next Steps

The app will be disseminated and applied nationally in design flood estimation. Additionally, a link to the app will be made available on the WRC website.



UNIVERSITEIT STELLENBOSCH UNIVERSITY

10. Vortex Settling Basin designs for the removal of non-cohesive sediments at small rural river abstraction works

Innovation description

The innovation is a Vortex Settling Basin (VSB) for small-scale rural water schemes. A VSB is a cylindrical fluidic device with a conical base where the sediment-laden flow enters tangentially to the flow domain and relying on gravity, centrifugal forces, more concentrated flow (underflow) exits at the bottom outlet and more clear water as overflow. The deflectors, inlet and outlet are orientated and positioned to increase the sediment particle retention time enhancing the trapping efficiency.

Guidelines titled "Considerations for the Design of River Abstraction Works in South Africa" were previously generated from WRC-supported research for the hydraulic design of river abstraction works. These guidelines have been used in the designs of many new abstraction works since 2006. The proposed innovation was developed from a study seeking to review and update these guidelines. The innovation comprises two VSB designs developed for 5 L/s and for 10L/s and optimized for the removal of non-cohesive sediments (>0.075 mm) at small rural river abstraction works (pump stations) for potable water use and irrigation.

Technology Category

New method/device

Technology Readiness Level

The knowledge was applied in a number of pilot studies, therefore the innovation is at a TRL 5.

Benefits

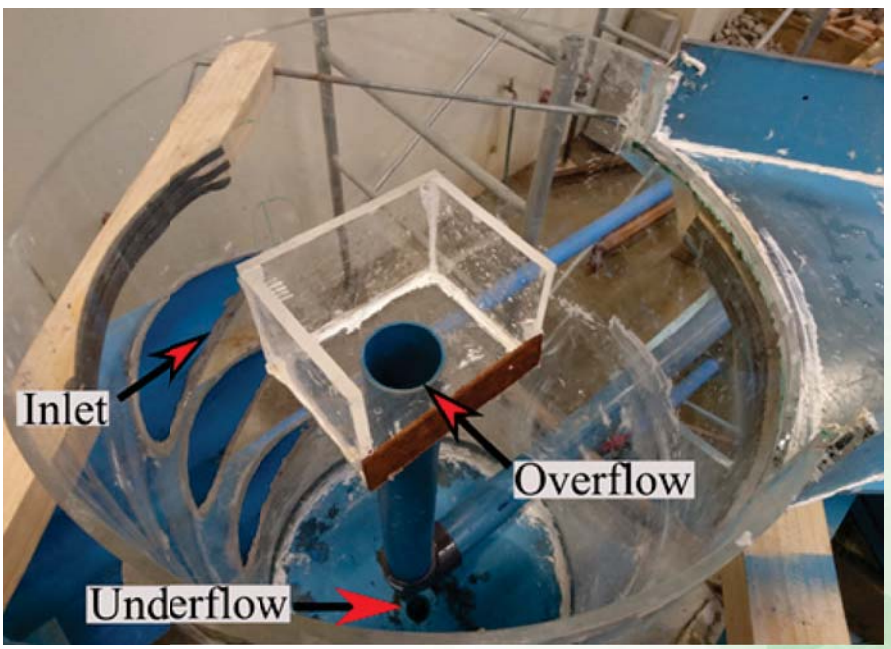
The VSB designs have high sediment removal for sand particles, low head requirement and therefore low energy requirement and could be used in parallel with multiple units to increase the discharge capacity as required. In addition, the VSB has unique positioning and orientation of a deflector which improves the sediment trap efficiency. The deflector slope can deal with cohesive and non-cohesive sediments. Also, the positioning of the outlet at the centre has been designed to maximise the sediment trap efficiency, there are no mechanical moving parts in the VSB and the hopper at the bottom of the VSB has steep slopes in order to deal with cohesive sediments as well as non-cohesive sediments.

Research Partner

University of Stellenbosch

Next Steps

Partnerships are sought with water boards for the demonstration of the designs in a relevant commercial environment.



WATER USE AND WASTE MANAGEMENT

The Water Use and Waste Management KSA focuses mainly on the domestic, industrial and mining water domains. It aims to proactively and effectively lead and support the advancement of technology, science, management and policies relevant to water supply, waste and effluent management, for these sectors. This KSA also supports studies on institutional and management issues, with special emphasis on the efficient functioning of water service institutions and their viability. Research on infrastructure for both water supply and sanitation are included.

A further focus is on water supply and treatment technology serving the domestic (urban, rural, large and small systems) as well as the industrial/ commercial and mining sectors of the economy. Further focuses includes waste and effluent as well as reuse technologies that can support the municipal, mining and industrial sectors and improve management in these sectors with the aim of improving productivity and supporting economic growth while minimising the negative effect on human and environmental health.

INNOVATIONS

Water Use and Waste Management

11. Sustainability Guideline: Pit Lakes and Coal Mine Closure

Innovation Description

Opencast coal mines generally leave a final void as a consequence of the mining method, this being the result of insufficient overburden to fill the voids created by removal of the coal and /or to manage water. In accordance with legislation, these voids need to be filled prior to mine closure. Once mining operations have ceased these final voids fill with water, forming a lake which is generally referred to as a pit lake. These pit lakes may be used in mine closure procedures, but for this to be feasible these lakes need to be understood in terms of their water quality and general impact on the environment.

The proposed innovation is an assessment guideline which outlines the environmental sustainability of using pit lakes as a post mine closure option for new and proposed coal mines in South Africa. The guideline especially focuses on two major aspects, namely i) the water balance and ii) water quality. The ultimate aim of these guidelines is to prevent uncontrolled discharge from open cast mining operations, and therefore avoid the expense of ongoing water treatment.

Technology Category

Guideline

Technology Readiness Level

The guidelines have been developed and tested within an operational environment. They are therefore at a TRL 7.

Benefits

The use of pit lakes as environmentally sustainable options for mine closure provides natural systems that result in significant water treatment costs reduction. Additionally, pit lakes could potentially prevent the uncontrolled discharge from open cast mining operations and as a result protect catchment water resources from potential pollution.

Research Partner

GCS Water and Environment (Pty) Ltd

Next Steps

The proposed guidelines have been developed and tested within an operational environment. It is envisioned that the next step include more widespread demonstration and adoption of these guidelines. The WRC will seek a mining sector partner to demonstrate the effectiveness of the guidelines.

12. Method for the Recovery of Semi-precious and Precious Elements

Innovation description

The discharge of various elements such as mercury and magnesium into anthropogenic and natural water sources can accumulate in these sources and cause pollution. Various sectors such as nuclear energy generation, fertilizer and mining can cover wide expanses of land and produce large volumes of waste and leachates. Apart from the toxic elements, this waste may contain significant amounts of precious elements such as platinum group elements (PGEs) and gold and their recovery could be potentially exploited.

Proposed as a solution are new materials for the removal of toxic elements in mining impacted waters, and a process for the simultaneous recovery of semi-precious and precious elements including gold, copper, platinum, rhodium and palladium. The material comprises natural zeolites as well as functionalised materials which act as adsorbents to remove target trace elements from mining impacted water.

Technology Category

New method

Technology Readiness Level

The innovation is at TRL 3 as components of the innovation have been demonstrated at a laboratory-scale.

Benefits

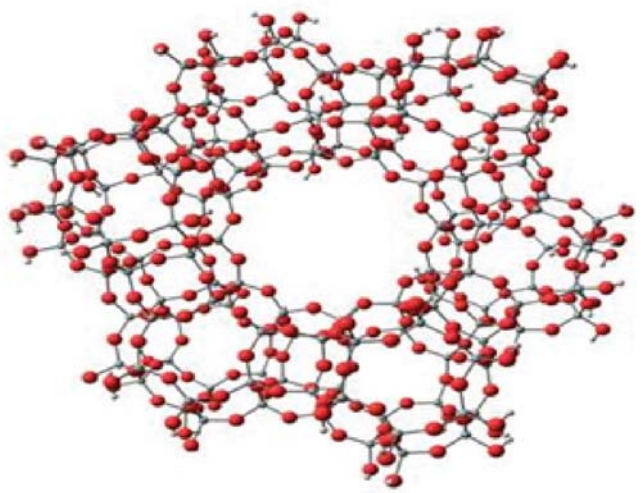
The proposed innovation removes toxic elements from mining impacted water while recovering semi-precious and precious elements. As a result, the innovation could potentially improve the quality of mining impacted water while stimulating new business development in the mining industry from the recovery of precious elements. A lab-scale demonstration conducted on synthetic and real mining water showed a high (%) recovery rate for gold in particular (approximately 300mg of gold per 1g of adsorbent). In addition, the lab test showed that the adsorbents could be recovered and re-used over five cycles.

Research Partner

University of the Witwatersrand

Next Steps

As the proposed innovation has been tested at a laboratory scale, further work is required to validate the proof of concept at a commercial scale. Additionally, further research to assess the possibility of exploiting the recoverable valuable elements is required.



13. MFC Municipal Sludge Treatment

Innovation description

In developed economies, the treatment of wastewater accounts for approximately 3-5% of the total electricity demand. However, wastewater itself is estimated to possess 9.3 times more energy than that required to treat it. A possible way to harness this energy within wastewater is to use a sediment microbial fuel cell (SMFC) to treat it, whilst also producing electricity through the use of organics found in the wastewater.

The proposed innovation is a set of plant microbial fuel cells to treat municipal sludges while producing power. This innovation essentially turns municipal sludge beds into bio-power plants. The innovation overcomes issues of efficiency and longevity by growing plants within the traditional SMFC systems to form plant microbial fuel cells (PMFC). These plants release oxygen into the rhizosphere, effectively increasing microbial growth and thus the oxygen at the cathode of the cell, which in turn increases the efficiency of the fuel cell.

Technology Category

Wastewater treatment.

Technology Readiness Level

The proposed innovation is still at the proof of concept stage. It is therefore at a TRL 3.

Benefits

The overarching aim of the proposed innovation is to use the energy contained within wastewater to treat wastewater. This offers an opportunity to recycle energy, thus reducing dependence on already constrained electricity sources in the country.

Research Partner

University of Cape Town

Next Steps

Further development work is required in order to validate the concept for the proposed innovation.

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

14. Kwa-Madiba Hydropower Innovative Run-of River Scheme

Innovation Description

The electrification of urban areas in South Africa including many informal settlements reached its culmination during recent years. However, the electrification of rural areas has still a long way to go before most rural communities will be provided with reliable and sustainable electricity supply. The primary electricity infrastructure i.e. coalfired power stations, major supply lines and distribution of electricity within urban areas, has proven insufficient and unable to sustain the supply against the demand for electricity by the existing and future users connected to the national grid. Small-scale hydropower systems (SSHPs) can play a critical role in providing energy access to remote areas in South Africa, either in standalone isolated mini grids or as distributed generation in national grids.

The Kwa-Madiba SSHP scheme is designed as a run-of-river scheme on the Thina River within the Mhlontlo Local Municipality in the OR Tambo District Municipality of the Eastern Cape Province. The intake is located at the top of the Thina Falls and the turbine room and tailrace is located at the bottom of the Thina Falls approximately 65 km downstream of the N2 Thina River Bridge. The system is closed to prevent exposure of the water resource to any chemicals or lubricants other than in the event of a leak. The turbine and generator set installed in the containerised turbine room utilize the 150L/s of flow along with the 50m of head gained by the penstock, to generate 50kW of electricity which is distributed by transmission and distribution lines to the end user within the Kwa-Madiba community in the Mhlontlo local municipality.

Technology Category

Hydro-energy generation.

Technology Readiness Level

The proposed small-scale hydropower station is being tested in an operational environment and is therefore at a TRL 7.

Benefits/Impacts

Hydropower is not only a renewable source of energy, but it is non-polluting. A high efficiency of energy conversion means that small-scale hydropower plants produce about 60-80 % of the total energy consumed into power output. Therefore, small-scale hydropower would be a suitable option to generate electricity in rural areas. Further, it has been shown to be cost-effective technology for rural electrification over the lifetime of the system. The initial capital costs of such a project are high, but with low operating costs. This is diametrically opposite to, for example, the application of a diesel generator, for which the initial capital cost is low, but the operating costs are high. The operation and maintenance of the small-scale system is relatively simple and can be undertaken by appropriately trained local community members. Furthermore, it is an environmentally friendly and sustainable solution that does not consume water and can be retrofitted to existing infrastructure, establishing a multipurpose scheme. For example, SSHP plants can be retrofitted to existing dams and integrated into a water reticulation network or within irrigation canals.

Research Partner

University of Pretoria

Next Steps

Electricity from the system has been reticulated from the turbine room to the Kwa-Madiba Community comprising of 55 households, and the system continues to supply this community with electricity.

UNIVERSITY of the WESTERN CAPE

15. Water Recovery from Flue Gas

Innovation Description

In accordance with legislation, power generation stations need to comply with the air quality act of 2010. In order to ensure the required air quality, Wet Flue Gas Desulphurization (WFGD) technology would need to be applied to clean the flue gas generated during powewr generation. The issue is that these systems require a vast amount of water to operate. One of the mechanisms to generate this water is to separate it from the generated flue gas streams, and recycle it.

The proposed innovation is a water selective membrane which is applied to produce a curtain shape membrane module. The use of this membrane allows for the extraction of water from the near-saturated flue gas plume. By doing so, all the water put into the flue gas during the desulphurization process can be recovered and recycled.

Technology Category

New method/ device.

Technology Readiness Level

An early prototype of the innovation was developed and tested at a laboratory scale. It is therefore currently at a TRL 4.

Benefits

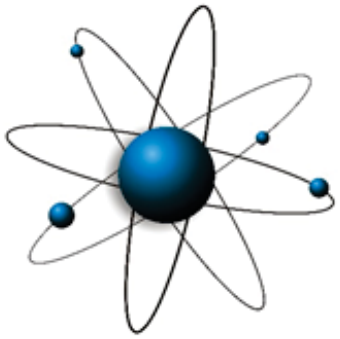
The proposed membrane boasts large distances between fibres. This has the benefits of allowing for a low gas flow resistance within the membrane, as well as negating the need to pressurize gas flow in order to extract water from the flue gas. Additionally, the design of the membrane is such that its production would be relatively low in cost.

Research Partner

University of the Western Cape

Next Steps

The innovation has been developed into an early prototype which has been tested at a small scale. It envisioned that the next steps would involve its development into a full prototype, and the demonstration of this prototype on a larger scale, particularly at a powerplant.



16. Alternative Water Social Accounting Matrix (SAM)

Innovation Description

The need to maintain a sustainable environment, economic growth and to increase agricultural production to meet global food requirements has increased the demand for the world's water resources. This has raised concerns about increasing the efficiency of water use. In the last decade, the number of countries facing the problem of water scarcity and insufficient water supply has increased sharply. At the global level, while per capita water availability is declining, withdrawals are projected to increase more rapidly, especially in developing countries.

The proposed innovation is a tool which provides users with a means to make decisions with respect to water source management. It is an alternative water social accounting matrix (Alternative Water SAM) that contains detailed agricultural accounts and water usage information for 22 spatial areas. The tool makes predictions which give users information pertaining to various water source management scenrios, and how best to implement alternative water supply interventions.

Technology Category

Tool/ Model

Technology Readiness Level

The tool is still under development, but components of it have been tested in a simulated environment. It is therefore at a TRL 5.

Benefits

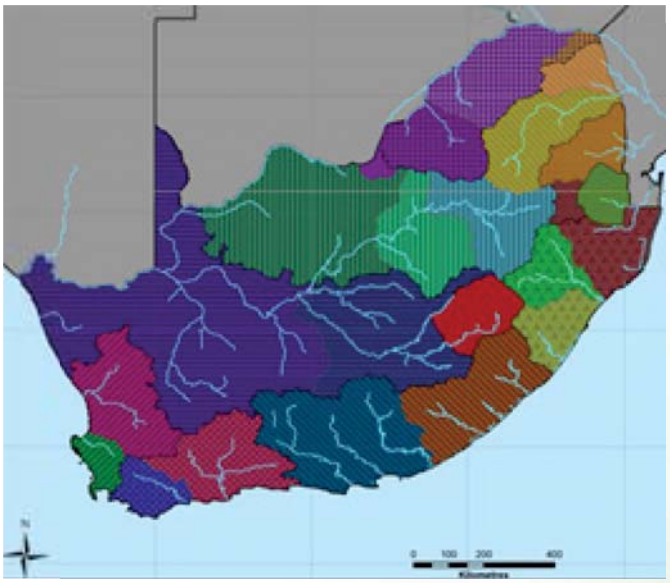
The proposed tool provides greater flexibility in the level of detail which accrues various benefits. Firstly, this flexibility allows for combined financial opportunity cost analysis and economic impact analysis of unnerved water which is novel. Furthermore, it allows for the identification of key strategic interventions required to enable alternative water resources. It also allows for the development and inclusion of different intervention and pricing scenarios.

Research Partner

EScience Associates (Pty) Ltd

Next Steps

The proposed tool is still under development through a WRC-funded project. Upon completion of this project, decisions will be made in respect to further steps to be taken.



EMANTI Water & Environmental Engineering Services

17. Country-Wide Shit-Flow Diagram: Establishing National Excreta Flows in South Africa

Innovation Description

During 2012/13, the Water and Sanitation Program (WSP) of the World Bank carried out an analysis of excreta management in 12 cities and developed new tools for assessing the context and outcomes relating to the flow of excreta through each city. The purpose of the exercise was to provide a comprehensive understanding of excreta management along the sanitation service chain. Further in 2014, a group of institutions active in the field of excreta management built on this work to develop Shit Flow Diagrams (SFDs) under the Global SFD Promotion Initiative. The proposed innovation was developed through the application and modification of the SFD Promotion Initiative tools to fit the South African environment.

The innovation is a country-wide SFD which provides an easy visualised representation of excreta flows and serves as an advocacy tool to ensure human excreta is managed safely through the sanitation supply chain including storage, collection, transport, treatment and safe end-use or disposal of faecal sludge. In addition, the tool is designed to not only identify gaps/problems but to also recommend remedial action plans for user municipalities.

Technology Category

Decision support tool

Technology Readiness Level

The proposed innovation has been shared with various stakeholders. It is thus at TRL 6.

Benefits

SFDs provide a way to monitor the sanitation service chain by offering a new and innovative way of engaging sanitation experts, political leaders and civil society in coordinated discussions about excreta management using an easy visualized informative graphic.

Research Partner

Emanti Management (Pty) Ltd

Next Steps

An approach for implementation of the tool across the country is under development.

18. Biobrick: A nature inspired approach for producing bio-cements from urine

Innovation Description

Urine is a pollution waste and the conversion of pollution waste into a product of economic value can reduce urine pollution pathways. Previous WRC research showed for the first time that stabilised synthetic urine can be used to facilitate a microbial induced calcium carbonate precipitation (MICP) reaction at elevated pH values which can subsequently be used to cement loose sand particles into a solid shape. The proposed innovation is a method for producing bio-cements (biobrick) using collected and stabilised human urine.

The process involves biocementing a mould containing ordinary masonry sand using feed material derived urine through the action of specific bacteria to form a biobrick.

Technology Category

Sanitation

Technology Readiness Level

The technology has undergone early stage commercial demonstration, therefore it is at a TRL 5.

Benefits/Impacts

Urine is pollution waste which contains a large percentage of the nutrients wastewater treatment plants seek to remove from wastewater. Therefore, the conversion of pollution waste into a product of economic value can reduce urine pollution pathways.

Research Partner

University of Cape Town

Next Steps

The technology will be demonstrated under the WADER programme.

Photo by Candice Lowin.

19. Vapoorize Toilet: Conceptual Design of a Dry Sanitation Toilet

Innovation Description

The Vapoorise technology is an innovative new design for a dry sanitation toilet with in-situ treatment and disposal incorporation, that results in the collection of a carbonaceous material obtained by heating faeces. The technology utilises a screw conveyor tunnel to dry fresh human faeces once deposited into the toilet. Dry faeces are then collected into a pit and stored for pyrolysis. The toilet negates the need for the emptying of toilets as is the case with other on-site systems, such as pit latrines and septic tanks utilises drying and pyrolysis to treat solid human waste at the source by first drying the faeces and then by thermochemical treatment of the dry faeces.

Although individual components of the toilet, such as the urine diverting pedestal, screw drying system and combustion stove, are not new, the combination and the application of the different components within a standalone toilet is innovative. The challenge of severe water constraints in South Africa is well documented. It thus necessitates the development of innovative water-saving solutions across technology domains, including sanitation.

Technology Category

New method/device

Technology Readiness Level

The proof-of-concept has been validated through laboratory-scale trials, therefore the technology is at a TRL 4.

Benefits/Impacts

The toilet is an alternative water-efficient solution as it operates without flushing water. In addition, due to its conversion of faeces into biochar, a charcoal-like product, the technology negates the need for the emptying of solid waste as is the case with other on-site systems such as pit latrines and septic tanks. Also, the biochar product has commercial potential for use as a composting agent or fertilizer, among others.

Research Partner

BAAS Technology and Consulting

Next Steps

Further research will be carried out to develop a prototype and validate the technology in an operational environment.

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

20. Competitive Small-scale Solar Desalination

Innovation Description

A low-cost portable water purifier and desalination device powered by renewable energy. The approach used to develop this innovation entails a transparent cover which allows for solar radiation to enter the still where it is absorbed by an absorber plate beneath the water, consequently causing the water to heat up and evaporate where it can then condense on to the cover. The innovation is a competitive small-scale desalination system which uses direct solar energy (solar basin still) for water purification. Unlike other existing products in the market, the system uses low-cost construction materials which make the solar still cost-effective without significantly reducing the yield.

Small-scale solar desalination of sea water and brackish water sources is a viable option to produce fresh water for South African rural communities that do not have access to municipal water, since the country receives more than 5.0 kWh.m-2 of global horizontal irradiation per day. Simple basin solar stills have been proven as a well-developed method for improving the water quality from saline or brackish water sources.

Technology Category

Desalination

Technology Readiness Level

The proof-of-concept has been validated through laboratory-scale trials, therefore the technology is at a TRL 4.

Benefits/Impacts

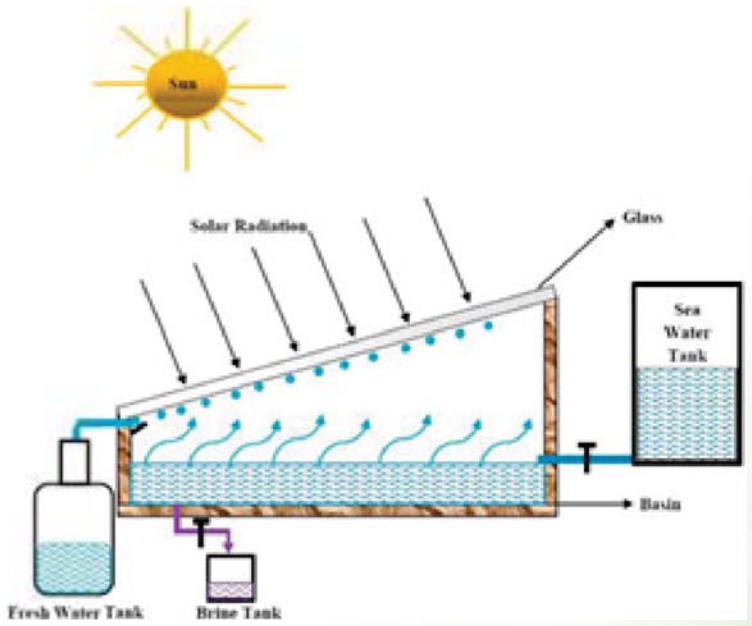
The innovation provides a solution to augment and supplement constrained water sources. Also, it is a viable option for communities with limited or no access to municipal water supply, especially those in coastal regions. Moreover, the innovation uses solar energy to power the desalination process, a renewable and environmentally-friendly form of energy.

Research Partner

University of Pretoria

Next Steps

Partnerships and further funding are required to demonstrate the technology in a relevant environment.



Vaal University of Technology

21. Energy sensitive wastewater treatment using integrated anaerobic digestion and advanced oxidation processes

Innovation Description

A novel wastewater treatment process which is energy sensitive. In previous research funded by the WRC, it was shown that combined anaerobic digestion and photocatalytic treatment of industrial wastewater was effective for organic load and colour reductions, and bioenergy production in the form of biogas. The proposed innovation built on this previous research to integrate anaerobic digestion with ozonolysis as an advanced oxidation process for treatment of distillery wastewater (for removal of odour and colour) and waste activated sludge wastewater (for enhanced biogas production).

The process yields different results at pre-ozonolysis and post-ozonolysis states. The pre-ozonolysis configuration is most effective for treatment of waste activated sludge wastewater, while the post-ozonolysis configuration favours treatment of distillery wastewater. This ability to switch between configurations based on the available feed substrate provides flexibility in dealing with different types of wastewaters.

Technology Category

Wastewater treatment

Technology Readiness Level

The proof-of-concept has been validated through laboratory-scale trials, therefore the technology is at a TRL 4.

Benefits/Impacts

Energy efficiency and cost savings: The innovation is effective in the treatment of both distillery wastewater and waste activated sludge wastewater and, in addition, provides an added advantage of potential increase in biogas production. The biogas, when converted to heat and electricity and reused in the treatment system, can lead to 50% savings on energy cost and reduced carbon dioxide emission.

Research Partner

Vaal University of Technology

Next Steps

Partnerships are sought to establish pilot-scale studies to validate the applicability of the technology at a larger scale.

Cape Peninsula University of Technology

22. Illegal Discharge Risk Map Tool (Detection and reduction of illegal discharges into stormwater systems)

Innovation Description

This is a data visualisation tool for communicating and detecting illegal discharges into stormwater systems. This risk map helps local government identify and prioritize the risks associated with their water security and safety. As population, urbanisation and industrialisation continue, and pollution problems increase amidst climate change impacts on water availability, illegal discharges move into the spotlight of environmental regulators. As a result, enforcement and public awareness campaigns become critical components of local government's plans to affect changes in human behaviours and practices that lead to many illegal discharges in water bodies.

Thus, the proposed innovation is a risk map useful as a tool to identify and prioritise high risk areas with illegal discharge potential (IDP). The risk map is aimed at enabling municipalities to direct their limited resources to problematic areas, therefore saving costs. In addition, the risk map is complemented by a flowchart technique was developed to determine the presence of illegal discharge in a specific flow.

Technology Category

Tool/Guideline

Technology Readiness Level

The proposed innovation has been applied in a relevant environment, which places it at a TRL 7.

Benefits/Impacts

Better planning, coordination and increased efficiencies: The risk map enables municipalities to identify and prioritise high risk areas with IDP so that limited resources are directed to problematic areas to save on costs. The flowchart technique isolates, tracks and identifies the source of the illegal discharge. Comprehensively, the tool promotes the adoption of Water Sensitive Design (WSD) and Sustainable Drainage Systems (SuDS) principles by municipalities as part of urban water management planning in support of future water security.

Research Partner

Cape Peninsula University of Technology

Next Steps

Demonstration partnerships are sought to tailor-make the risk map for adoption by other municipalities.

23. Data Envelopment Analysis (DEA) as a water-use benchmarking tool

Innovation Description

Performance indicators have been developed for water usage to track system performance. This tool proposes a set of normalised and time-integrated benchmarking performance indicators for sustainable long-term management of water distribution. The benchmarking performance indicators are aggregated into three categories: (1) infrastructure, (2) socio-political, and (3) financial. To demonstrate the use and value of the benchmarking performance indicators, a system dynamics model per capita water use is commonly employed as baseline for estimation of water demand and is utilised in many countries.

Per capita household water use benchmark studies based on South African data are limited and outdated. Also, international studies do not cater for typical South African levels of service or dwelling types. Thus, the proposed innovation is a Microsoft Excel-based tool, which allows the user to change parameters and arrive at an estimated water use per capita for a specific use scenario, as a function of selected inputs.

Technology Category

Decision support tool

Technology Readiness Level

The proof of concept has been achieved through a trial, therefore the innovation is at a TRL 4.

Benefits/Impacts

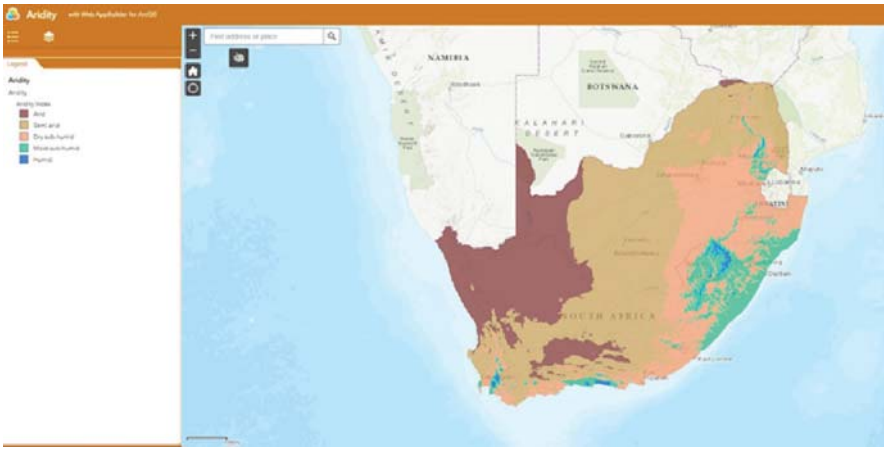
The planning and management of water supply and distribution institutions would benefit from this study that collates and reports on per capita water use, consistent for South African conditions. In addition, the tool aims to help managers assess their municipalities' relative performance in water use, identify top performance in water and sanitation providers and identify ways to improve their performance. The tool also enables self-assessment among water and sanitation providers in South Africa.

Research Partner

Bernoulli (Pty) Ltd

Next Steps

The tool will be shared widely with municipalities when ready. Also, it is accessible to entrepreneurs who may be interested in translating it into a software system.



24. Tool for evaluating public water literacy

Innovation Description

Much work has been done on the social, technical, financial and environmental aspects of water and water supply alternatives, in general. Research done on public perceptions on water reuse has shown that lack of understanding of the water cycle and treatment technology is a major factor in the rejection of water reuse schemes by the public. In this regard, a communication strategy, whose focus is public education on water reuse is necessary. This strategy must be informed by a baseline assessment of public knowledge on water and water-related aspects, including reuse. The proposed innovation is a structured questionnaire for evaluating public water literacy which is designed to be administered to the public by any water services authority/ provider (or delegated authority) as part of planning for water activities.

A communication strategy can then be formulated based on the responses. Also, the questionnaire covers knowledge aspects that were identified in a literature review and the stakeholder consultations as important.

Technology Category

Guideline

Technology Readiness Level

The questionnaire can be tested in its relevant environment, therefore it is at a TRL 7.

Benefits/Impacts

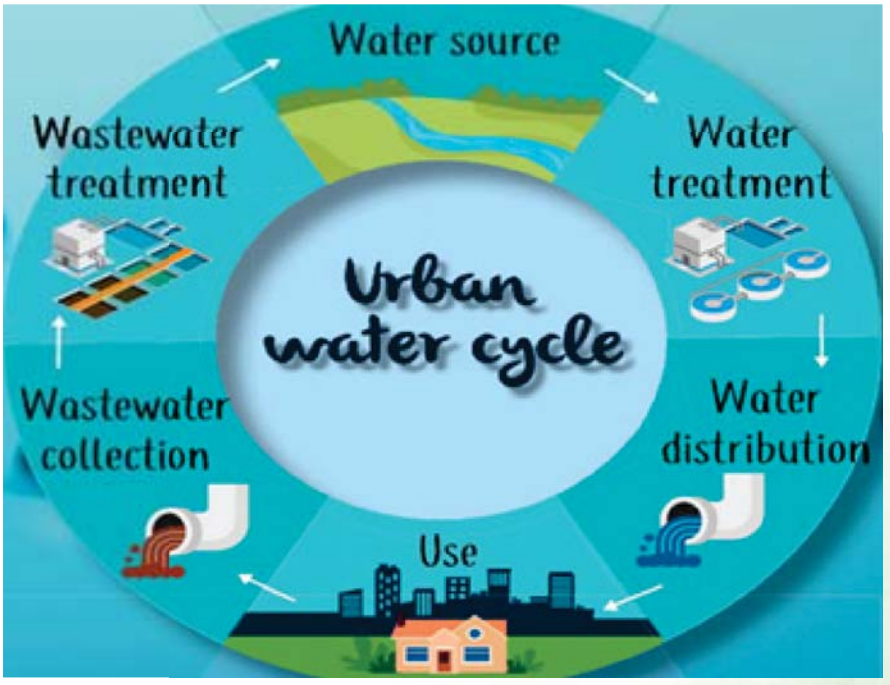
The questionnaire can inform the communication strategies of Water Services Authorities in disseminating knowledge associated with water-saving behaviours. In addition, the questionnaire can guide the identification of potential subgroups who may require additional targeting to build knowledge and support for water management initiatives.

Research Partner

Chris Swartz Water Utilisation Engineers and BHI 32 (Pty) Ltd

Next Steps

The project is in progress. Findings will be disseminated to relevant stakeholders.



The following innovations cannot be disclosed due to an expressed desire by the project leaders to pursue intellectual property protection:

25. Biosurfactant Compounds (K5/2728)

26. Rapid biological assays for the detection of antibiotic resistant genes (K5/2803)

27. Dicerocaryum plant extracts as water treatment chemicals (K5/2808)

WATER UTILISATION IN AGRICULTURE

The strategic focus of this KSA is increasing the efficiency and productivity of water use for production of food, forage, fibre, and fuel crops; improving food security; reducing poverty and increasing the wealth of people dependent on water-based agriculture; and ensuring sustainable water resource use. The needs and requirements of present and future generations of subsistence, emergent and commercial farmers is addressed through creation and application of water-efficient production technologies, models and information systems within the following interrelated sub-sectors of agriculture, namely:

- Irrigated agriculture
- Rainfed agriculture
- Woodlands and forestry
- Grasslands and livestock watering
- Aquaculture and fisheries

The challenge for applied research is contributing to finding sustainable solutions for water use in agriculture, with priority given to innovative new products which support economic development and inform decision-making for private business and public policies. In the process of undertaking these research projects, the composition of research teams endeavours to broaden representativeness of black and female researchers; post-graduate students are trained to improve the expertise of human capital, with research empowering individuals and groups in rural communities.

INNOVATIONS
Water Utilization in Agriculture

UNIVERSITY OF THE FREE STATE
UNIVERSITEIT VAN DIE VRYSTAAT
YUNIVESITHI YA FREISTATA
UFS UV

28. Enhanced Water Footprint Guide for Crops

Innovation Description

Food production accounts for a huge percentage of freshwater use globally, with approximately 86% of all the freshwater resources in the world consumed during the production of food. As a result, the relative importance of water in food production and to human survival cannot be overlooked. A means to manage water use in various sectors is through water footprinting, and in the food production industry, this practice has not been widely used in South Africa. The proposed innovation is a guideline developed through the integration of water footprint analysis with economic and social analytical tools into a single framework for the determination of water use behaviour that is environmentally, economically and socially sustainable, thus satisfying the Triple Bottom Line.

The guideline provides a standardised method to calculate the water footprints of various irrigated field crops and forage crops in South Africa.

Technology Category

Guidelines

Technology Readiness Level

The guidelines have been fully developed and disseminated to relevant stakeholders for adoption. They are therefore at a TRL 9.

Benefits

The standardised procedure guidelines will be applied to set water use benchmarks for different agri-food industries involved in the life cycles of the selected crops in South Africa. Such benchmarks will contribute towards the sustainable use of freshwater in the production of the selected crops in South Africa. Ultimately, it is envisioned that the implementation of the proposed guidelines will result in more economic and sustainable water use behaviour.

Research Partner

University of Free State

Next Steps

The guideline has been shared with several stakeholders, including farmers unions, national departments, academics and other relevant industries. The next steps include the monitoring of the use of the guideline and the documentation of learnings.

RHODES UNIVERSITY
Where leaders learn

29. Decision Support Tool for Grassland Rehabilitation

Innovation Description

Invasive alien plants (IAPs) have a negative impact on South Africa's natural vegetation in various ways. As an example, they pose a serious threat to water supply and storage reservoirs throughout the country. As such, clearing IAPs is a top priority for the Working for Water (WfW) programme. However, the clearing of these aggressive alien plant species leaves indigenous vegetation areas requiring some form of regeneration.

The proposed innovation is a decision support tool to aid in the rehabilitation of grasslands after the eradication of alien invasive trees. The tool consists of a set of methods adapted from existing tools for estimating catchment-scale evapotranspiration (ET) driven by input from satellite-borne sensors and programmes.

Technology Category

Decision support tool

Technology Readiness Level

The proposed tool has been fully developed and adopted. It is therefore at a TRL 9.

Benefits

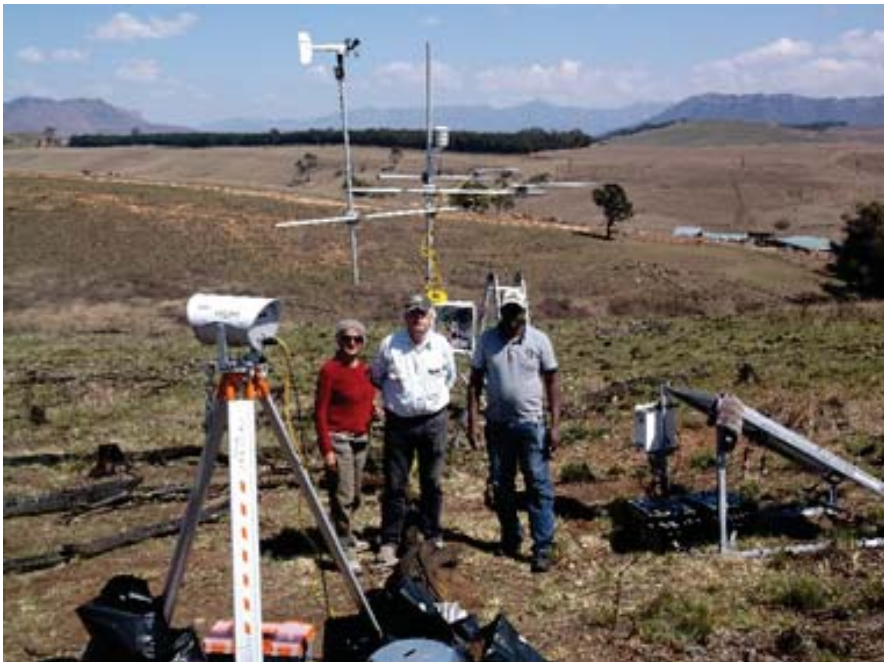
The tool comprises various existing tools which have been adapted to include the determination of factors such as evapotranspiration. These adaptions allow the proposed tool to be utilised in making more accurate decisions in the rehabilitation of indigenous vegetation areas.

Research Partner

Rhodes University

Next Steps

The grassland rehabilitation decision support tool has been fully developed is currently being adopted and implemented. The implementation of the tool will be monitored and deductions made in respect to its impact.



Centre for Water Resources Research

30. Adapted MIKE-SHE and SWAT Tools: Hydrological Modelling

Innovation Description

Soil erosion is an unavoidable phenomenon which involves the loss of fertile topsoil, effectively reducing soil productivity and resulting in crop yield reduction over time. This phenomenon causes water management problems to arise, particularly in semi-arid regions, such as South Africa. Another problem posed by soil erosion is the siltation of storage dams, which compromises water sources. From a health perspective, silt often acts as a pathogen. Better understanding of erosion and sediment yield is important in limiting challenges including siltation.

The proposed innovation involves the adaptation of existing software modelling tools to understand erosion and sediment yield events. These tools are termed the MIKE-SHE and SWAT tools. Together, these computer-based tools are used to assist in the decision-making process by allowing users to deduce differences in hydrology with differences and change in land cover.

Technology Category

Decision support tool

Technology Readiness Level

The proposed tool has been demonstrated in an operational environment. It is therefore at a TRL 8.

Benefits

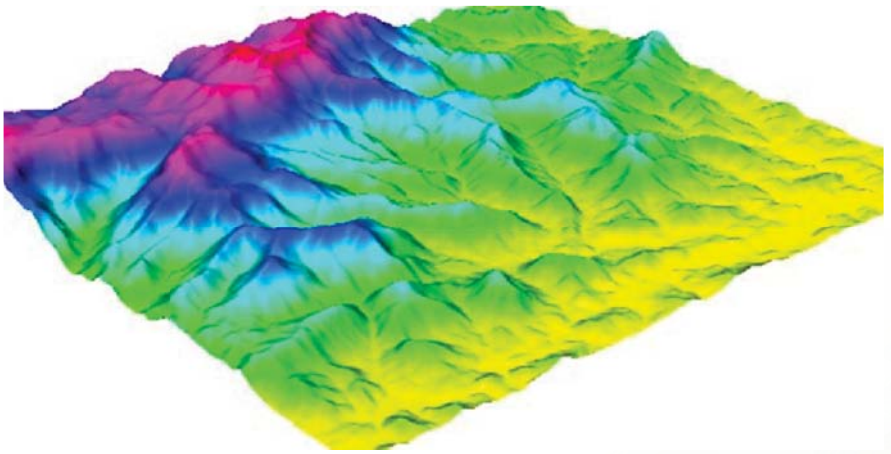
The capabilities of the MIKE-SHE software to incorporate detailed spatial and temporal datasets is a beneficial attribute in small sites such as the Two Streams sub-catchment, allowing for greater precision and heterogeneous expression of hydrological variables.

Research Partner

Centre for Water Resources Research (University of KwaZulu-Natal)

Next Steps

The proposed decision support tool has been demonstrated within an operational environment. An adoption partner for the tool is being sought.



31. Decision Support Tool to enhance adaptation and the business of farming

Innovation Description

The agricultural sector is sensitive to variations in climatic conditions and will be highly affected by long-term climate change. Adaptation is therefore critical to the success of this sector. Adaptation strategies in response to climate change are in demand, not just for the long-term but also for shorter time scales which would make agricultural systems more resilient to climate variability. In this regard, seasonal forecasts can prove valuable. As such, the proposed solution is a decision support tool to assist in achieving the seamless forecasting of rainfall and temperature for adaptation of farming practices to climate variability.

The proposed tool aims to enable hydrological forecasting to allow farmers to make more informed planting decisions so as to maximize crop yields.

Technology Category

Decision support tool

Technology Readiness Level

The tool was demonstrated within a relevant environment and therefore sits at a TRL 6.

Benefits

The tool aims to assist farmers and advisers in making better decisions and thus helping them to alter their production systems accordingly to ensure optimum production and reduction of production costs. In events of unfavourable farming conditions, the proposed system should be able to assist farmers by minimising losses. The tool is a user-friendly system with ease of configuration, and is able to handle the large amounts of data required for hydrological forecasting.

Research Partner

University of Cape Town

Next Steps

The testing and demonstration of the proposed solution has revealed a need for further development and refinement of the tool. A follow-up project is currently underway to address these needs.

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

32. Computer-based Decision Support Tool: agricultural nitrogen and phosphorus pollution from field to catchment

Innovation Description

Elevated nitrogen (N) and phosphorus (P) concentrations in surface and sub-surface waters leads to eutrophication, which is a major challenge in South Africa. Agricultural N and P pollution is difficult to quantify because of challenges in measuring nutrient losses via runoff and drainage at the plot scale, and the complications to upscale field measurements to a catchment scale.

The proposed solution is a computer-based decision support tool for the quantification and management of agricultural nitrogen and phosphorous pollution from field to catchment scale. The adapted tools Hydrus, APSIM and SWAT are models commonly used internationally to investigate non-point source pollution from agriculture. Hydrus investigates complex hydrological systems, APSIM explores in-field best management practices to reduce N and P pollution, while SWAT is best applied at the sub-catchment to basin scale. These tools were adapted through the addition of various parameters such as temperature, humidity and crop coefficients.

Technology Category

Decision support tool

Technology Readiness Level

The tool has been tested within the relevant environment. It is therefore at a TRL 6.

Benefits

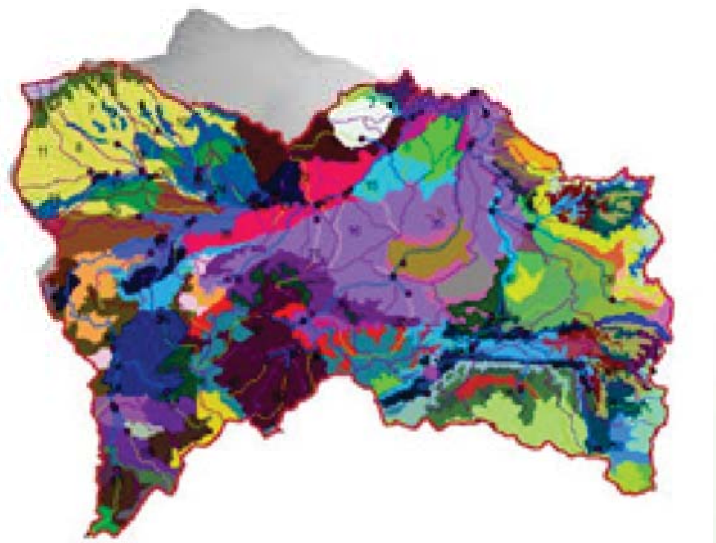
With agricultural non-point source pollution being identified as an important contributor to eutrophication, the proposed tool brings together international best-practice tools, which will assist in the management and reduction of pollution caused by agricultural nitrogen and phosphorus.

Research Partner

University of Pretoria

Next Steps

The tool has been fully developed and tested, but requires adaptation. A recommendation has been made that a workshop be held for the relevant stakeholders within the agricultural sector to market the tool for adoption.



UNIVERSITEIT STELLENBOSCH UNIVERSITY

33. Salt Accumulation and Waterlogging Monitoring System (SAWMS)

Innovation Description

Salt accumulation and waterlogging often pose a challenge during crop production in irrigated areas. The accumulation of salt in the plant root zone deteriorates vegetation growth, resulting in low crop yields and barren soil. Furthermore, it has been estimated that 18% of South Africa's irrigated land is either moderately or severely salt-affected or waterlogged. These two events, salt accumulation and waterlogging, are closely linked as rising water tables prevent salts from being leached.

The proposed solution is a decision support tool which provides a method for monitoring salt accumulation and waterlogging in agricultural land. More specifically, the proposed tool aims to manage these undesirable events by identifying the zones within fields and orchards which are likely to be affected by salt accumulation and/or waterlogging, allowing for more efficient and relevant mitigation measures to be deployed.

Technology Category

Decision support tool.

Technology Readiness Level

The proposed tool has been tested within the relevant environment. It is therefore at a TRL 6.

Benefits

On-farm decisions which are made through the use of the proposed tool are likely to result in the reduction of input costs as well as an increase in agricultural outputs. Furthermore, the tool is capable of servicing a very large area (i.e. on a national level) and can therefore contribute towards economic development.

Research Partner

Stellenbosch University

Next Steps

The proposed tool has been developed and tested form a developmental point of view. Resources have been allocated towards the operationalisation of the tool. This project is underway.

34. Communication Guide: Knowledge Uptake in the Agricultural Sector

Innovation Description

Research organisations such as the WRC play a key role in the agricultural ecosystem in South African through the generation of research and development knowledge. It is imperative that public research organisations demonstrate not only that they can produce scientific knowledge, but also that produced knowledge is adopted and yields impact.

As such, the proposed solution is guideline which provides a communication strategy to support the uptake of WRC research-based knowledge by irrigation schemes and commercial irrigated agriculture. The guideline outlines a communication strategy to improve the uptake and impact of research-based knowledge in the digital age. The communication focuses on a specific case, namely water measuring and metering in commercial irrigated agriculture.

Technology Category

Guideline

Technology Readiness Level

The proposed guideline has been developed and disseminated through an online application. It is therefore at a TRL 9.

Benefits

The guideline provides a means to ensure that research outputs do not end in publications, but rather reach intended communities through communicating research outputs to the public. Additionally, the fact that the guideline is in digital form makes it not only easier to disseminate, but easier for users to find required information easily.

Research Partner

Bunker Hills Investment - BHI 32 (Pty) Ltd

Next Steps

The developed guideline has been developed into an online tool through the development of a website as a communication strategy. The use of this website will be monitored and learnings documented.

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

35. A training manual for the assessment of the nutritional status of rural communities

Innovation Description

This is an innovative approach to teaching nutritional evaluation with a focus on rural populations, which aids the social net to learn and retain complex information and understand how nutrition relates to human health and wellbeing.

The role of water in achieving food and nutrition security for improved nutrition and human health cannot be understated. Water is essential for food and nutrition security through its linkages with all aspects related to economic access to food. Any discussion on food and nutrition security is incomplete without first establishing the linkages with water. As such, previous WRC-supported research highlighted and strengthened the linkages between water, agriculture, nutrition and human health, with a particular focus on poor rural households. The proposed innovation built on this study to develop a training manual for the assessment of the nutritional status of rural communities. The manual is important for promoting nutrition security for poor rural communities, among others.

Technology Category

Guideline

Technology Readiness Level

The proposed innovation has been partially demonstrated in its relevant environment and therefore sits as a TRL 6.

Benefits/Impacts

The innovation has potential to aid in educating rural communities on better accessible dietary intake which could be made available by agriculture. This could be achieved through the promotion of household and community food gardens, and the use of nutrient dense crops with low levels of water use.

Research Partner

University of Kwazulu-Natal

Next Steps

Stakeholder workshops will be held to disseminate the tool at a national level.

36. Enhancing food security, nutrition and production efficiency of high-yielding grain legumes in rural communities

Innovation Description

This innovation relates to the development and cultivation of high yielding, pest resistant, good quality and resource-use efficient crop varieties. In particular, the innovation is the identification of pigeonpea-maize and cowpea-maize varieties most suitable for the Limpopo Province.

Agriculture is the main determinant of food and nutritional security for many communities in Africa, especially rural communities. It also contributes to employment and income creation, as well as national economic growth. However, agricultural productivity in Africa is lagging behind due to a variety of reasons that include poor farming practices and reliance on rainfed agriculture. In addition, the projected population increase in Africa to about 2 billion people by 2050 will exert pressure on water, food and energy resources. To enhance food and nutritional security, food production must match population growth which must be driven by innovation. As part of the innovation, a cropping calendar has been developed to guide farmers on timely seasons for crop production.

Technology Category

New method

Technology Readiness Level

Farmers successfully planted and managed the selected and adopted varieties of cowpea and pigeonpea in their demonstration plots, therefore the innovation is at a TRL 6.

Benefits/Impacts

The identification of maize varieties most suitable for rural areas is important in ensuring food and nutrition security for communities. The results have potential to enhance maize production efficiency mainly in the rainfed areas and is a pathway towards building resiliency. Also, the innovation provides information to policymakers and farmers on high yielding, pest resistant, good quality maize varieties. This is important in ensuring food and nutrition security for smallholder farmers who usually struggle to adapt.

Research Partner

University of Limpopo

Next Steps

Smallholder farmers will be trained on the cultivation of the new crop varieties according to the cropping calendar. In addition, a brochure will be developed for dissemination to stakeholders.

37. The Use of Role Playing Game (RPG) to train smallholder farmers on entrepreneurial development paths

Innovation Description

The innovation is a Role Playing Game (RPG) technique used to simulate reality by creating an abstracted version of the region, its dynamics and stakeholder interactions. The notion of role playing takes participants out of their comfort zone by enabling them to openly play out their role in reality to view their influences and effects on the system. Therefore, a RPG is used as an interactive participatory, training and planning tool with the aim of enabling participants to self-analyse their situation and develop their integrated thinking and planning abilities.

A number of studies have been conducted on behalf of the WRC in KwaZulu-Natal, Eastern Cape and Limpopo that have sought to understand the challenges that smallholder irrigation farmers face, and to identify mechanisms to improve their water use efficiency as well as their participation in value chains. The various studies have identified development pathways that can be used by farmers to progress from being homestead gardeners with a focus on subsistence production, to more market-oriented production within irrigation schemes. The proposed innovation resulted from a consultative review of the studies aimed at sharing research findings with relevant stakeholders and devising practical means of implementing recommendations.

Technology Category

Guideline

Technology Readiness Level

Stakeholder workshops have been conducted in three provinces, involving government officials, famers and representatives of different private sector entities. Therefore, the innovation is at a TRL 6.

Benefits/Impacts

The benefits of the innovation include the ability to unpack complex dynamics, relationships, interactions, issues and conflicts, the ability for stakeholder interaction without the conflict and tension associated in reality, the ability to eliminate the time lag of natural systems by speeding up the process to predict future conditions and circumstances, and the ability to test various scenarios and plans to understand probability outcomes and consequences of actions. In addition, the RPG technique enables stakeholders to not only see but understand the implications of their actions on the environment and how such actions can affect their livelihoods, it is useful in explaining and understanding multi-agent (stakeholder) systems and presents fewer side effects as learning is conducted through simulation rather than by doing.

Research Partner

Institute of Natural Resources NPC

Next Steps

Partnerships are sought to disseminate research finding to farmers through the RPG approach. The WRC will seek additional funds to rollout the game to more communities to strengthen entrepreneurship.

Institute of Natural Resources

38. A method of agro-forestry to maximize yield for livestock feed production

Innovation Description

This is a novel and sustainable forage livestock management system. The South African agricultural sector is currently facing many challenges. Among others, climate change is a major constraint to the productivity of farmers. Its direct effects include disruption in food availability, reduction of access to food, and compromised food quality for human and livestock consumption. The proposed innovation is a new type of agro-forestry which combines Panicum maximum and pigeon pea for cattle feed; i.e. the Panicum maximum / pigeon pea silvopastoral system.

The system integrates shade-tolerant Panicum maximum with the drought-resistant pigeon pea plant to produce cattle feed. The Panicum maximum /pigeon pea is an effective way of increasing the amount of fodder produced per unit area and it is also a high-quality source of fodder.

Technology Category

Guideline

Technology Readiness Level

The proposed innovation has been applied in a relevant environment, which places it at a TRL 7.

Benefits/Impacts

The benefits of this innovation include the diversification of agroforestry practices and farming systems, increasing agro-biodiversity, and the inclusion of drought tolerant woody species to make farming systems more resilient and better suited to the anticipated effects of climate change (specifically erratic rainfall and higher temperatures). In addition, since most smallholders would not plant a crop only for feeding livestock, this system also provides pigeon pea grain which can be used to improve household nutrition or sold to provide a source of income.

Research Partner

Institute of Natural Resources NPC

Next Steps

A guideline for dissemination to farmers is underway. Also, a ministerial brief has been developed.

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

39. A framework for facilitating the representation of female small-holder farmers in the agricultural value chain

Innovation Description

This is a gender participation agricultural framework. As it currently stands, the rural value-chain is a buyers-market as farmers are passive price recipients. This needs to change to ensure that farmers gain greater influence on the market. A new approach that ensures the formation of local market institutions is needed to facilitate effective participation in the market. This demands that development agents use creative ways of training farmers on how to enhance market access and control. In particular, training female small-holder farmers must take priority as women constitute the largest proportion of smallholder farmers and yet are amongst the poorest in South Africa, as they are less empowered in various ways. Therefore, the involvement of women in smallholder farming plays a significant role in sustaining livelihoods and food security as about 60-80% of women in South Africa engage in smallholder farming.

Thus, the proposed innovation is a framework for facilitating the representation of female small-holder farmers through the creation of new platforms, ideas and opportunities to enhance market access and control for female farmers and, consequently, their role in the agricultural value chain.

Technology Category

Guideline

Technology Readiness Level

The framework has been tested in three provinces, and therefore is at a TRL 7.

Benefits/Impacts

The framework presents a new way for facilitation of market access, particularly for female farmers. Through this framework, multiple stakeholders are involved in making female farmers aware of market requirements in terms of quality, commodities and timing.

Research Partner

University of KwaZulu-Natal (PMB)

Next Steps

The framework will be disseminated to stakeholders in the agriculture sector. In addition, a ministerial brief proposing the framework for all female small-holder farmers country-wide is underway.

ARC • LNR
Excellence in Research and Development

40. An irrigation scheduling tool for water use efficiency of pomegranate orchards

Innovation Description

A pomegranate irrigation scheduling tool. Water resource constraints makes maximising net income per unit water used a prerequisite for sustainable farming. For efficient in-field water management, correct irrigation system selection, design and maintenance are very important, but efficient irrigation scheduling is the main key to achieving high irrigation water use efficiency. Although there are general guidelines with regard to the irrigation of pomegranates, there are no local solutions available to guide producers with regard to the effect of different levels of soil water depletion on pomegranate tree growth, yield, and fruit quality under local conditions. Therefore, a solution is required to guide the water use (transpiration and evapotranspiration) of a range of pomegranate orchards with the objective to develop a model that will enable practical estimation of water use for individual orchards on-farm.

Thus, the proposed innovation is an efficient irrigation scheduling which can be used by various farmers in achieving high irrigation water use efficiency for pomegranate orchards. The innovation aims to aid producers to schedule irrigation according to tree water requirements and prevent over- or under-irrigation which impacts the environment.

Technology Category

New method/device.

Technology Readiness Level

The proposed innovation has been shared with various stakeholders. It is thus at TRL 6.

Benefits/Impacts

Skillful management of limited water resources is a necessity for optimal production and fruit quality to be retained for a total farm unit. This innovation is a solution to optimize growth, yield and fruit quality for commercial production, thus empowering South African producers to achieve high economic water use productivity.

Research Partner

ARC Infruitec-Nietvoorbij

Next Steps

The irrigation scheduling tool will be shared with farmers and various other stakeholders.

41. A tool for assessing the water footprint of table and wine grapes

Innovation Description

This is a tool for assessing the water usage of table and wine grapes. South African water resources are constrained due to below average rainfall, droughts, and other factors. The past and ongoing pressure on available water resources for agricultural production initiated renewed discussions on the sustainable and efficient use of water for crop production, as well as the crop water footprint as an indicator of sustainable water use. The proposed innovation provides a measure of the amount of water used to produce grape table and wine crops.

The water footprint can be expressed in different ways, for example, a litre of water used per kg of crop produced (L/kg), or the litre of water used to produce a litre of wine (L/L).

Technology Category

Tool/Guideline

Technology Readiness Level

The proof of concept has been validated in table and wine grape industries and therefore is at a TRL 6.

Benefits/Impacts

This innovation is an important tool for promoting the water sustainability of grape crops in the country. It promotes the benefits of water footprint assessment to industries and assists policy and decision makers in paving the way forward in regard to grape production in the country.

Research Partner

C Jarmain (Independent researcher)

Next Steps

Partnerships are sought to disseminate the tool to wine farmers nationwide. The WRC will consult with provincial partners like GreenCape in the Western Cape to support water efficiency in the wine industry.

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

42. Alternative Land Use Guideline

Innovation Description
The proposed solution is a guideline for alternative use of the Vasi Pan Wetland as part of a silvopasture framework based on the findings of the water-use of trees and surface/groundwater modelling.

It is widely accepted that the expansion of commercial forestry using fast growing alien tree species may have negative hydrological consequences. However, it is acknowledged that some alien plants are important contributors to the South African economy. In water-stressed catchments where there is a high demand for the expansion of commercial forestry (new licence applications) there is an urgent need for alternative land-use activities that will provide viable economic and resource outputs while simultaneously achieving an equitable balance in water resource demand.

Technology Category
Guideline

Technology Readiness Level
The proposed tool has been disseminated to various stakeholders including municipalities and national departments, and therefore sits at a TRL 9.

Benefits
The guideline provides a way to understand and quantify the alternative land use of the Vasi Pan Wetland. Its application could potentially lead to an integrated, multiple-use agroforestry system(s), as an alternative to commercial plantation forestry in water stressed catchments.

Research Partner
University of Pretoria

Next Steps
The impact of the guideline will be monitored and learnings documented.

APPENDICES

Appendix A: Technology Readiness Levels

Technology Readiness Levels		
TRL 1	Basic research	An innovative principle was observed and reported on. The innovation is an idea. The observation cannot be reproduced or applied as yet.
TRL 2	Proof of principle	The innovation concept and/ or application has been formulated and it is possible to demonstrate parts of or the entire innovation.
TRL 3	Early lab scale demonstration	Partial proof of concept achieved. A laboratory-scale demonstration was possible. May not be reproducible yet.
TRL 4	Late lab scale	Lab scale validation of proof-of-concept through a trial, and/or input received from an external source. Innovation is reproducible.
TRL 5	Validation	Broader trial or validation of the proof of concept is achieved. Can include early stage commercial demonstration or application in relevant institutional environment
TRL 6	Early prototype	The early stage prototype can be fully or partially demonstrated in its relevant environment of use (possibly in a commercial or institutional setting). It is not a complete prototype. Learnings and iterations still ongoing.
TRL 7	Late prototype	The prototype can be demonstrated in its relevant environment of use (possibly in a commercial or institutional setting). The prototype is nearer to completion. Fewer learnings and iterations are needed.
TRL 8	Early stage commercial environment application	Innovation being tested or has been completed in its commercial or institutional environment. Learnings and iterations applicable to its commercial use are still generated.
TRL 9	Market ready application	Innovation is being used in its intended commercial setting. There is proven commercial use or proven institutional application. Fewer iterations are being done, if so then they are minor.

Appendix B: Innovation Categories

Category	Definition	
Guidelines	Knowledge products developed to assist in various areas of water challenges	Non-technological
Decision Support Tools	Information systems which enable and support various water-related decision-making activities	Can be both technological and non-technological
New Method/ Device	Novel methods or devices used for the purpose of monitoring water quality in different environments	Non-technological (new method) – new method converted into an analysis machine is technological
Technology	Process innovations Product innovations Apps and ICT innovation Devices	Technological
Tools/ Models	Mathematical models, software or tool-based systems used to perform various actions, or measure/ calculate certain parameters	Technological
Databases	Datasets which are developed to feed into a separate application such as a tool or model	Non-technological

REFERENCES

- Baghai, M, Coley, S, and White, D (2000) The Alchemy of Growth, Practical Insights For Building The Enduring Enterprise, Basic Books; New edition (July 2000)

- Enduring Ideas: The three horizons of growth (2009) https://www.mckinsey.com/business-functions/strategy-and-corporate-finance/our-insights/enduring-ideas-the-three-horizons-of-growth, July 2009 article

WRC TECHNOLOGY TRANSFER OFFICE

Title	Name	Position	Phone No.	Email
Mr	Thabo Mthombeni	Manager	(012) 761 9326	thabom@wrc.org.za
Ms	Thembela Ntlemeza	Officer	(012) 761 9376	thembin@wrc.org.za

wader

For more info on WADER, contact
Dr Manjusha Sunil at manjushas@wrc.org.za.

SASTEP

For more info on SASTEP, contact
Mr Akin Akinsete at akina@wrc.org.za.

WATER RESEARCH COMMISSION