

KSA 1: WATER RESOURCE MANAGEMENT



SCOPE

Fundamental global challenges affect the scope of KSA 1, such as climate change, population growth and urbanisation. The results of these drivers are clear pressure manifestations, such as demand far exceeding available freshwater resources, increased competition between sectors and deteriorating water quality.

The current situation, in which there is perpetually growing water demand and competition, is leading to deepened water insecurity in certain locations. The ability and preparedness of sectors to engage on water issues has improved with the enhanced comprehension of water shortages, yet the issue of water management is not as high as it should be on the national political agenda. Water quality remains a concern, where causes and management options are well researched but the need to implement control and/or incentive measures requires additional work. Deteriorating water quality has compromised water resource integrity and its resilience in adapting to natural as well as man-induced impacts, and to be able to support national as well as regional sustainable development.

Tensions around decisions about allocations and de-allocations, water tenure, and trade-offs in satisfying demands for food security, energy and sustained

environmental services will become much more heightened. In response, research focusing largely on understanding the barriers to policy implementation at the different levels is required. The democratisation of the management of water resources, through decentralised management, will need to amplify the developmental dimension, in order to ensure equitable access to water, its use and economic benefits.

The main aim of this KSA is to provide water resource management tools for addressing the above challenges, fundamentally driven by increasing water scarcity in the face of increasing and competing demands, all of which have social, economic and environmental consequences. This unit operates in five thrusts, ranging from institutional arrangements, reform and governance to catchment assessment and planning, water quality management, water resource protection, and water resources and climate.

Apart from the problems of water resource limitations and induced scarcity, South Africa has specific challenges relating to inequities in the physical, social, administrative and institutional access to this important resource. This applies especially to the poor and disempowered majority, whose ability to pay for water is limited.



OBJECTIVES

The strategic objectives of KSA 1 are as follows:

- To establish better freshwater governance aimed at facilitating equitable, productive and sustainable use of water resources among all users
- To develop a deeper scientific understanding of the hydrological cycle (and inter-linkages) in order to promote systematic water assessment and planning
- To consolidate the vast amount of existing water quality–related research outputs in priority domains and to transfer this knowledge whilst being alert to emerging issues
- To contribute research towards a reliable supply of good quality water for the health, and environmental, social and economic wellbeing of the country

THRUSTS AND PROGRAMMES

THRUST 1: WATER RESOURCE INSTITUTIONAL ARRANGEMENTS

Scope: This thrust focuses on articulating the thinking for the new roles and responsibilities of the various stakeholders, based on catchment and water management area boundaries. The marked shift from central management of resources to a more localised scale is critical to the main founding concepts of IWRM. The defined management boundary based on watershed boundaries is another fundamental provision in IWRM as a concept. This thrust will support the suitable

implementation of IWRM in South Africa. The further articulation of the NWA for the benefit of all South Africans and the fulfilment of the developmental role of the state within the water resource limitations will be investigated. Lessons learnt and evaluations of the IWRM applications in South Africa to date will be part of this portfolio, focusing on home-grown approaches and experiences in water resource management.

Programme 1:
Water governance and
institutional reforms

Scope: The principle of subsidiarity, or, as sometimes referred to, democratisation of water resource management, has brought about challenges, both conceptually and in terms of application. Although current reforms in South Africa are based on sound IWRM principles, to date the implementation thereof continues to break new ground, proving that institutional engineering cannot provide a one-size-fits-all solution to the new management paradigm. Further understanding and research are hence needed to learn and to decide on best practice as defined in the South African or similar socio-economic settings.

Programme 2:
Compliance and
enforcement

Scope: For the implementation of state-of-the-art legislation like the NWA, a matching enforcement and compliance regime needs to be in place to ensure effective implementation. The regulatory environment in the South African water sector is in its infancy and requires substantial support from research in creating the understanding and knowledge for informed decision making. Benchmarking and best practice are crucial here to accelerate learning.

Programme 3:
Pricing and financing
WRM

Scope: The issues of financial sustainability, affordability of charges by users, transparency and corporate governance are becoming central in the decentralisation era. The new infrastructure agency responsible for new developments and maintaining national assets provides good ground-breaking research opportunities, especially to assess if water tariffs can indeed pay for managing and sustaining water resources. Does pricing water and introducing the water resource charge exclude the poor and will it further cripple local government from delivering services? The waste discharge charge is another serious introduction to the water sector fraught with considerable challenges. This programme can project and assess such issues.

Programme 4:
Transboundary water
resources

Scope: This programme will provide tools and guidelines for resolving potential water-centred conflicts for the management of shared international rivers and transboundary aquifer systems, including development of appropriate institutional forms and functions, development and harmonisation of policy and regulation in shared river basins, strategies for knowledge-sharing and joint management of shared river basins. A need has been identified to define the roles and interrelationships between local WRM institutions and international basin organisations.

Programme 5:
Future scenarios

Scope: This activity has been assigned a separate programme to ensure that local South African expertise is qualified to explore future scenarios and answer the 'what if' questions in support of reflection and evaluation of national policy applications. Projecting the water resource management and development institutional arrangements landscape 10 or 15 years from now would be of interest to decision makers to define policy reviews and enhance decision making. This is considered as one of the tools for assisting in learning and allowing for dialogue to take place around options. Other tools exist which will also be explored in due course such as Game Theory especially in support of water allocation options.



THRUST 2: WATER RESOURCE ASSESSMENT AND PLANNING

Scope: This thrust focuses on developing a scientific understanding of the hydrological cycle (and inter-linkages) in order to promote systematic water assessment and planning. The thrust will promote better understanding of the variability of the quantity and quality of water available for use and development in South Africa. Recent changes in national water resource infrastructure management, the awareness

of the poor state of water resource infrastructure and increased knowledge of water resource planning needs are expected to receive attention, through the support of competent and sustainable solutions. Sound water resource assessment and planning can only be achieved with reasonably accurate and consistently recorded and processed data and information.

Programme 1: Catchment data and information systems

Scope: This programme will support the provisions of Chapter 14 of the National Water Act, especially Part 2: National Information Systems on Water Resources. This programme is focused on supporting the national initiative for improving the available water resource information, better management of the information and improved information dissemination to stakeholders. It will establish direct linkages to the national information systems as well as identifying and resolving water resource information gaps. In this programme researched water resource information will be integrated into the national information system that is being established by DWA. The programme will also support the process of decentralising identified water resource data and information from broader national perspectives to detailed and highly-resolved local and catchment scales.

Programme 2: Surface water / groundwater hydrology

Scope: This programme focuses on developing and utilising integrated hydrological approaches in surface water and groundwater assessments, water resource explorations, planning and management. It will take advantage of gains made in improved understanding of groundwater and surface water hydrological processes as well as the availability of better hydrological data, especially the various forms of more accurate remotely-sensed data with better coverage. Through this programme, strategic partnerships with international expertise in both groundwater and surface water hydrological research will be encouraged to flourish. Hydrological tools that have been developed in the past are expected to be upgraded, redeveloped or replaced by tools that are more suited to the current data availability, the improved knowledge and the recent technological advances in hydrological modelling. In this programme, the continued deterioration of hydrological gauging processes and other installed earth measurement devices will be addressed through the intensive use of new data sources from remote sensing coupled with the limited earth-based measurements.

Programme 3:

Water resource planning and infrastructure

Scope: This programme will address water resource planning for the purposes of improved water allocation, better management of water use activities and to ensure secure, sustainable and adequate national water resources. It is also focused on the development of tools that will address planning gaps such as the absence of reliable information in ungauged areas and the persistent record gaps which exist in present data sets. The programme will promote a deliberate shift towards the development of water system plans that will benefit from real-time, historic and stochastic data on a countrywide basis. Impacts of climate change on water resources and the planning processes will be accounted for so as to ensure a proactive approach and allow for national preparedness. Integration will also be achieved through aligning this programme to wider national water resource planning needs as expressed in the objectives of Water for Growth and Development as well as through accounting for other factors, which include poverty alleviation, economic benefit, empowerment and the importance of meeting the Millennium Development Goals. Research on the planning of water resources will also address the information gaps in the understanding and subsequent utilisation of seawater in building water resource security. Saline water, brackish water, and other water bodies that can be purified and made available for regular water uses will be investigated and included as part of future water resource plans. There is an increasing need to develop systems for the efficient maintenance of the aging water infrastructure as the demand for the development of new and expensive water resource infrastructure is increasing due to the growing economy and population growth. This programme will seek to develop strategies and priorities for water resource infrastructure development and management to address the uncertainties and risks associated with climate change. While built infrastructure development such as dams, reservoirs, irrigation and flood barriers, are important options for addressing these issues, this programme will also explore the potential use of natural infrastructure such as wetlands, floodplains, artificial recharge (to aquifers), etc., to complement built infrastructure (but with an added advantage of healthy ecosystems).

Programme 4:

Climate change and water resources

Scope: Global environmental change, including climate change, has potential deleterious effects on systems, resources and society, and will be superimposed on currently existing stressors such as unsustainable use of water, deteriorating water quality, and land use and demographic changes in time and space. Potential secondary impacts due to resultant lack of access to adequate water of acceptable quality are likely to also have undesirable impacts on economic growth, food security, health, ecosystem goods and services, as well as community livelihoods. Consequently, adaptation aimed at reducing the country's vulnerability to the currently highly variable climate, under natural conditions and due to human induced impacts, as well as to projected climate change impacts on water availability, is crucial. This thrust accordingly focuses on developing the understanding of global climate change and hydro-climatic variability impacts, crafting methodologies for vulnerability assessments and development of appropriate adaptation options and solutions at various scales. The focus is also on developing appropriate quantitative understanding, tools



and strategies for managing the impacts of climate variability and change, as well as human interventions on the hydrological cycle and related water resources, with the aim of supporting the development of policy responses, at regional, national or catchment scale, to existing and emerging problems. This includes, but is not limited to, development of tools and systems (e.g. weather forecasts, model scenario projections or early preparedness) for among others, managing floods and droughts and the effects thereof on the resources and the people who rely on those resources, with special emphasis on water quality (e.g. trophic waters) and quantity (due to increased evaporation rates and other) impacts.

Programme 5:
New water and water
security

Scope: Secure and sustainable access to water is essential for a wide range of critical uses such as human health, economic growth, food security, etc. However, in semi-arid environments such as South Africa, conventional water sources are not sufficient to meet the ever-growing demand. Therefore, the understanding and assessments of alternative sources of water such as fog water, desalination, water transfers, etc., is essential. The programme will also promote research on transboundary water issues (with respect to water quantity and quality) to ensure water security for South Africa. Other issues to be researched include cooperation on shared surface water and groundwater resources, as well as the integration of social, economic, and environmental considerations as key components of sustainable water resource development

THRUST 3: WATER QUALITY MANAGEMENT

Scope: This thrust acknowledges the significant water quality problems in our natural water resources. Water quality is generally reflected in concentrations of substances and microorganisms, physico-chemical attributes, radioactivity, as well as biological responses to these. Within each of the programmes in this thrust, research will focus on two broad fronts, namely, (1) consolidation and knowledge transfer and (2) alertness to emerging issues. Consolidation is necessary of the vast amount of existing water quality-related research outputs in priority domains. The primary aim will be to distil effective decision support for management of our water quality problems. Emphasis will be more on formulating solutions than on formulating problems. By actively sharing knowledge with decision makers, and working closely with them, the decision support must explicitly address their absorptive capacity in its broadest sense. On the one hand, solutions need to be based on a thorough holistic and realistic examination of

likely consequences of implementation of those solutions. This must create confidence that risks of unintended consequences will be minimised. However, on the other hand, solutions must cater for the inherent complexity (and hence uncertainty) of both the institutional and natural environment. Research will also be encouraged that heightens awareness, and/or recommends management approaches, specifically to important emerging issues, i.e., those potential or recognised concerns that are either not addressed, or are only partly addressed, in current water quality management practice and research. High priority issues include those of national concern, those for which the frequency or probability of adverse conditions occurring is high, and the consequences are severe, and so on. Water quality necessarily cuts across various KSAs as well as thrusts within this KSA. The scope of this particular thrust focuses primarily on water quality of inland surface waters and its management.

Programme 1:

Water quality monitoring

Scope: Sound water quality monitoring data are crucial to sustainable management because they provide information on the current status and trends. Creative yet soundly-scientific approaches to monitoring are required that optimise information and minimise costs. All phases of monitoring design need careful consideration, from data acquisition, data storage and management, information generation and dissemination, through to realistic implementation strategies.

Programme 2:

Water quality modelling

Scope: The programme will encourage a move to open-source modelling platforms that benefit individual model developers, while allowing effective interfacing with other modelling modules in a way that provides integrated, scientifically-defensible water quality information. Business models of such platforms must be as much in the interests of users of such information (e.g. catchment management agencies) as the service providers and modellers.

Programme 3:

Impacts on and of water quality

Scope: This programme will focus on identifying, characterising, and understanding (1) the changes in the state of water quality in our water resources associated with either point or non-point pollution sources, and (2) the associated impacts of such compromised water quality.



THRUST 4: WATER RESOURCE PROTECTION

Scope: Reliable supply of good quality water is required for the health, environmental, social and economic wellbeing of the country. The National Water Act of 1998 recognises that protection in relation to a water resource means: (1) maintenance of the quality of the water resource to the extent that the water resource may be used in an ecological sustainable way; (2) prevention of the degradation of the water resource, and (3) the rehabilitation of the water resource. There are significant gaps in our knowledge on how to protect our water resources in an integrated manner. While Thrust 3 will look mainly at the quality of the water within our systems this thrust focuses on protecting the water resources,

by reducing the quantity of harmful materials reaching the water resources, within a broader framework for all uses. Broadly, research in this thrust focuses on the generation of knowledge and understanding of the catchment processes and land use activities that influence the quality and quantity, negatively or positively, of the water resources. Scientific, technological and institutional approaches that will help to characterise and address these problems include: (1) assessment, monitoring and prediction; (2) tools and control strategies; (3) innovation to assist with prediction and control; and (4) implementation and technology transfer options.

Programme 1: Source water protection

Scope: Source water protection refers to protecting source water (water from dams, wetlands, rivers, aquifers, etc.) from contamination and overuse. Specific driving forces, or a combination thereof, which have an impact on water resources will be researched. Integrated protection strategies and approaches will be researched and tested. The development of source water planning, control and response strategies, to minimise adverse impacts on source waters by reducing pollution risks and securing water availability, is a key component of this programme. The source water protection approach will look at, among others, land use (see Programme 2 below), vulnerability assessments and catchment plans and strategies (for both surface and groundwater).

Programme 2: Land-water linkages

Scope: This programme will enhance our knowledge on the interaction of water and land at various scales. This programme will focus on the driving forces (new developments, emergency spills, erosion, leaks, soil enhancements, etc.) that can impact water resources from land-based activities. The aim is also to research, evaluate and develop common regulatory tools to overcome the challenge of different technical and procedural approaches for water resource and land use management, in order to enhance our water resource protection capabilities. Techniques to delineate, protect and remediate areas, and/or the activities occurring within these areas, will be researched. Research will also be bi-directional where potential impacts on water resources from land-based activities or processes are investigated as well as the impact of water resources on land-based activities (e.g. floods and droughts).

RESEARCH PORTFOLIO FOR 2016/17

COMPLETED PROJECTS

THRUST 1: WATER RESOURCE INSTITUTIONAL ARRANGEMENTS

Programme 1:

Water governance and institutional reforms

Natural resource governance system in South Africa

Pegasys Strategy and Development (Pty) Ltd; University of the Witwatersrand (Centre for Water in the Environment); SANParks

2161

In order to strengthen governance of water resources, we need to make an array of shifts. While some of these require bold actions that impact on the overall manner in which we view development, some of the shifts involve tweaking of existing policies, institutional arrangements and legislation. The range of actions that need to be taken probably appear intimidating and politically difficult, but the recent crises in energy and water show us that it is necessary to make key changes. If changes are not made, history shows us that the broader society will stand up to force changes in the way they can. The changes envisaged in this report can be considered along the following dimensions: foundational matters – this speaks to the manner in which resources are

viewed in broader development planning, and thus how government functions in a broader sense; and legislative, policy and institutional matters – these are governance changes within the water sector that will help improve the way we manage resources. Critically, this hinges on collaboration with non-traditional actors, such as the private sector and communities. More broadly, the changes envisaged require inputs from societal actors at key points, including devising of systems, oversight, implementation, and collaborations. It is important to note that the manner in which society has been involved in governance has been somewhat organic, but in order to strategically harness this opportunity, roles, responsibilities and replicable experiences need to be documented and engaged with. Overall though, the collaborations between government and society – particularly through initiatives like the SWPN-SA – are promising, and will be a key aspect of future governance frameworks.

Cost: R1 000 000

Term: 2012 – 2016



Lessons learnt from the establishment of catchment management agencies in South Africa

Centre for Water Resources Research (CWRR); CSIR;
Australian National University

2320

Water plays a vital role in the well-being and economic activity of any society, be it within a rural or urban community, country or region. As a basic primary commodity, water contributes either directly (e.g. production of food) or indirectly (e.g. generation of electricity) to our livelihoods, lifestyles and wider economic activities. Water in a water-scarce country like South Africa is a catalyst to much societal and economic vulnerability embedded in our historical and cultural storyline. Furthermore, in a country where policy implementation is lacking in crucial areas, poverty alleviation is high on the socio-economic agenda and impacts of global change are severe. Such vulnerabilities should guide planning and decision-making. In South Africa the large number of impoverished people, a small middle class, and a limited number of wealthy result in strong inequalities. This is also true for levels of education, mobility and financial resources, and thus the population's vulnerabilities to risks are highly unequal. Therefore, water management in the sense of 'some for all forever' will need to incorporate much more localised and diverse issues with those of national economics and development. The information needed to address this is three-pronged:

- The impacts of change on the biophysical environment
- The socio-economic characteristics of the sector, group or individual
- The manner in which changes over time, in both aspects, impact on the overall growth and development of individuals, groups, catchments and the region

All three dimensions call for a wide range of data, knowledge and analyses which have to be regularly updated, incorporated and lead to specific management interventions that enable growth and development, empowerment and wellbeing of people, society and the nation. The project aimed at identifying sustainable development pathways for the establishment of CMAs in the different biophysical, social, economic, political and historical contexts of the diverse and highly unequal society of South Africa. By using conversations, workshops and other participatory tools it allowed the project team to create awareness and capacity for the different communities involved in CMA establishment. The repository as well as the guidelines will hopefully inform policy and lead to better decision making in the water sector.

Cost: R1 000 000

Term: 2014 – 2016

Water governance of groundwater and surface water resources in South Africa

Umvoto Africa (Pty) Ltd; Southern Waters Ecological Research and Consulting; IWR Water Resource (Pty) Ltd

2332

Several institutions are often responsible for groundwater management at different levels. These institutions are responsible for various activities and often require some level of inter- and intra-institutional cooperation. Ideally, multiple organisations, policies, legislation, plans, strategies and perspectives should be involved in water-related decision-making, which in turns creates complex leadership challenges. Globally, the lack of sustainable groundwater management can be ascribed to poor governance provisions. These include, but are not limited to, institutional arrangements and political will, including fragmented and overlapping jurisdictions and responsibilities, competing priorities, traditional approaches, rights and water pricing systems, diverging opinions, incomplete knowledge, data as well as uncoordinated information systems. Adding operational and maintenance issues, decision-makers often view groundwater as an unreliable resource and are hesitant to make significant investments in groundwater infrastructure and capacity. The conjunctive use and management of surface water and groundwater is a key strategy to meet the country's water demands. The project proposed here will aim to integrate groundwater governance provisions within the more established (surface) water governance provisions, as far as is possible, given the difference in current regulations,

as well as the spatial and temporal scale differences. However, the proposal aims to go beyond the defined scope of works as it is believed that current shortcomings in the implementation of integrated water resource management on national and regional level must be addressed to achieve sound groundwater and surface water governance on local level.

Cost: R1 000 000

Term: 2014–2016

When and under what conditions should a CMA become a responsible authority

Crossflow Consulting (Pty) Ltd; African Centre for a Green Economy (Africege); Vulamanzi Water Law Advisers; University of Cape Town

2334

This project assessed the role to be played by catchment management agencies (CMAs) in water resource management and the optimal methodology to progressively empower them to do so. As such, this study, among other things, specifically examines the conditions necessary for CMAs to act as a 'Responsible Authority' for specific powers and functions. The indicators assist in determining when and under what conditions a CMA must become a responsible authority for specific powers and functions.

Cost: R1 000 000

Term: 2014 – 2016



Catchment management for the evolving priority in effecting subsidiarity principles in water management

AV Munnik & Associates; Pegasys Strategy and Consulting; AWARD; North-West University; Vaal Triangle Campus

2411

Catchment management forums (CMFs) are seen as places for enthusiastic participation, communities of practice in the making, and crucial to the devolution of water management to local stakeholders. They are also seen as exhausted, toothless talk shops, unrepresentative, undemocratic, haunts of the privileged, ignored by officials and a waste of time. Caught between reality and potential, theory and practice, they remain attractive to many people who are interested in participating in the governance of South Africa's water resources. This research project was designed to accompany the DWS revitalisation of catchment management forums, which was taking place as part of the roll-out of catchment management agencies. The project aimed to ensure that CMFs are well understood, resourced and appreciated as a critical level of governance capable of addressing the reduced stakeholder participation, and to find ways of enabling equal access to participatory structures and processes. The study started by examining the number of existing CMFs in the country, in whatever form they were in. The survey identified 81 CMFs, although the number is growing with the current roll-out of CMAs. CMFs differ radically from each other in composition, focus points, effectiveness and extent to which they address historical inequities. In general, the study has found CMFs to be

vibrant spaces with keen participation from members and enjoying support from government departments, water boards, universities and non-governmental organisations. However, there are signs of participation exhaustion, ongoing conflict with and absence of local government, and frustration with a lack of compliance enforcement from government officials mandated to do so. The study also provided a model of functionality for CMFs based on five levels, i.e., logistical, communicative, community of practice, power to act and institutional resilience. Lastly the study found that a principled pragmatism is required in sustaining CMFs. Principled pragmatism retains the participatory and sustainability principles of IWRM but is pragmatic about what resources are available, and the technical and other constraints. This is a notion that was discussed in the form of forums – a structure the study also found necessary to establish in order to serve as a body bringing meta-issues to the DWS, in providing inputs on strategic matters that impact upon forums and in supporting the development of capacity across forums. The study produced ministerial and policy briefs listing all the key policy recommendations in establishing and sustaining CMFs.

Cost: R560 000

Term: 2014 – 2015

The path to successful water user associations in the NW dolomites

Jude Cobbing Consulting; Counterpoint Development; University of Pretoria

2429

Dolomite rocks in North West Province supply large volumes of very good quality groundwater (borehole water) for urban municipal water supply, dispersed rural water supply, irrigated agriculture, industry, and other uses. Unfortunately, these aquifers are poorly managed, and we are seeing falling groundwater levels, failing springs and the drying of wetlands. These issues in turn harm the assurance of water supply to towns such as Mahikeng, Zeerust and Lichtenburg, and can damage certain agricultural activities and other livelihoods. Groundwater supply from the dolomite aquifers has important backward and forward economic linkages to the regional economy. The Grootfontein aquifer near Mahikeng is a good example. Although it once used to be the main source of water for Mahikeng and Mmabatho, groundwater levels have now declined in the aquifer by an average of about 12 m below the level of the ground, and now the source is not reliable. This is because too much groundwater is pumped from the aquifer by irrigating farmers, and also by the boreholes supplying Mahikeng and some surrounding communities. If pumping quantities were lowered and groundwater levels were allowed to recover then the aquifer would be a much more reliable source of water. Mahikeng and DWS are currently spending a lot of money on upgrading the water treatment works at the Setumo Dam nearby, but much less attention is given to the Grootfontein aquifer. The Grootfontein aquifer can potentially hold more water than the Setumo Dam, and the water quality is much better than the dam water. The Water Users Association for Grootfontein was not approved years ago, and today there is no local organisation that is addressing the over-abstraction of groundwater at Grootfontein. If we could manage

Grootfontein better, and other aquifers that are similar, we would be able to supply more people with good quality water and at a lower price. There is a lot of work to do, but in the end it will be cheaper than dealing with problems of drought and poor water quality. If we can improve the management of groundwater at Grootfontein, then this could also be used as a model for other areas in South Africa where groundwater management is a problem.

Cost: R335 000

Term: 2015 – 2016

Programme 2: Compliance and enforcement

Citizen monitoring of the NWRS2

Environmental Monitoring Group; AV Munnik & Associates; Rhodes University

2313

This project piloted an approach that empowers community-based and other civil society organisations to participate in local water governance, using forms of knowledge and analysis appropriate to their context and experience, through monitoring and engaging on key issues from the NWRS2 and other relevant water policy. Water quality and the inclusion of spiritual water users, timber plantations and ecosystem functioning water demand management (WDM) within the context of climate change are areas in the NWRS2 which were used as case studies to develop an in-depth understanding of how South African water policy is monitored and



implemented, and what role civil society can play in these processes. Also, the study explored the potential for social learning processes to build capacity in civil society, and produce guidelines for use in strengthening civil society participation in water resource management.

Cost: R1 764 300

Term: 2014 – 2017

Programme 4:

Climate change and water resources

Validation of the variables (evaporation and soil moisture) in hydrometeorological models: Phase II, Application of cosmic ray probes for soil water measurement

Centre for Water Resources Research (CWRR); University of Pretoria; Pegram and Associates (Pty) Ltd; University of Arizona

2323

For many field and modelling applications, accurate estimates of soil water (SW) are required, but are often lacking. Modelled estimates of SW are often used without proper validation and the verification of the results is questionable. In addition, remotely-sensed (RS) products are becoming more widely used in hydrological modelling. However, RS SW measurement is faced with the difficulty of 'seeing' below the soil surface and penetrating the aerial plant canopy layer. This still presents a major source of uncertainty in many hydrological applications where SW forms the interface between the atmosphere and the

vadose zone and ultimately streamflow generation. Water resource management, crop modelling, and irrigation scheduling all require accurate, spatially distributed, daily estimates of SW and total evaporation (ET) from catchment to national scale. One of the major challenges facing providers of SW products is validation. This project was initiated to provide a spatially explicit validation procedure for the 1-km grid of SW and ET produced by the SAHG at UKZN and other global climate models. The recent development of cosmic ray probes (CRP) was timely and provided a technology previously unobtainable, which fitted perfectly with the spatial resolution of this project. The CRP is a new and innovative in-situ instrument, capable of measuring SW at an intermediate scale. The CRP estimates were used to validate modelled SW estimates and the back-calculation of SW from relative evaporation estimated from the SEBS Model. The back-calculation of SW from relative evaporation and evaporative fraction, estimated using the SEBS model, looked like a promising technique. The spatial resolution was less than the catchment area and the measurement depth was representative of the root zone of the vegetation (0.50 m). Therefore, this product would have the least horizontal and vertical scaling issues, when validated against the CRP. Although the back-calculation method results in SW estimates on a 30-m spatial grid, the temporal resolution of the imagery used is 16 days and performed poorly against the CRP validation data. It is recommended that further research is required into the measurement of SW from RS products and the CRP.

Cost: R1 000 000

Term: 2014 – 2016

Open water evaporation measurement using micrometeorological methods

University of KwaZulu-Natal (Pietermaritzburg);
Department of Water and Sanitation

2335

For Midmar Dam in KwaZulu-Natal, South Africa, a Penman-Monteith model (DPMETHS), that uses land-based meteorological data, was used to estimate daily open water evaporation. The DPMETHS model estimates, accumulated annually, exceeded 1 300 mm during El Niño years. The maximum annual evaporation for the 1963 to 2014 period exceeded 1 400 mm with a minimum of 975 mm. Statistically, there has been no significant change in annual evaporation for the 1963 to 2014 period. The agreement between Symon's pan (annual) open water evaporation (available for 1976 to 2006) and the DPMETHS model estimates was poor for the period 1976 and 1993 with the Symon's pan significantly underestimating compared to the DPMETHS estimates. For the period 1994 to 2006, the agreement was improved. In a field above-water study at Midmar Dam, in spite of the reasonable Monin-Obukhov similarity theory (MOST) vs, eddy covariance (EC) comparisons, more than 30% of the EC evaporation measurement data collected were discarded as a result of application of the data quality assurance protocols. It was therefore not possible to use the EC method to obtain continuous 30-min measurements of evaporation. Unlike vegetated surfaces, for which there is stomatal control of evaporation during the daytime and virtually no evaporation at night due to stomatal closure, open water surfaces are not constrained. MOST evaporation

measurements demonstrated that 44% of daily total evaporation occurs at night with 56% during the daytime. The MOST measurements demonstrated the significant wind control influence on the evaporation estimates. Surprisingly too, maximum wind speeds generally occurred at night with the night-time wind run comprising 42% of the total wind run. Over land, vegetation would offer more resistance to wind so wind effects on evaporation would be reduced, compared to open water surfaces. Evaporation was the greatest component of the energy balance by far, representing about 75% of the net irradiance, 12.8% for water-stored heat flux and 12.1% for sensible heat flux. This study has demonstrated the importance of above-water weather data collection for evaporation estimation. Future research should focus on collecting data above open water for an extended period of time that includes a full summer season, winter and summer rainfall areas and small and large dams.

Cost: R1 100 000

Term: 2014 – 2016

Programme 5:

New water and water security

Sustainability indicators and decision framework for sustainable groundwater use

Delta-H (Pty) Ltd; University of the Free State (Institute for Groundwater Studies); Groundwater Africa

2311

The well-documented and scientifically accepted



theoretical principles of groundwater flow theory dictate that 'water withdrawn artificially from an aquifer is derived from a decrease in storage in the aquifer, a reduction in the previous discharge from the aquifer, an increase in the recharge, or a combination of these changes' (Theis, 1940). The associated decrease in discharge or increase in recharge has been termed 'capture' of water, and it is the ability of aquifer pumping to capture discharge and enhance recharge that dictates the aquifer's yield. It follows that an assessment of the sustainability of groundwater abstraction would quantify these changes in the flow regime, and determine whether the changes and their associated impacts are considered acceptable, termed here the capture principle-based approach to groundwater sustainability. However, many current tools to support groundwater management broadly apply water balance type calculations for aquifer yield assessments, often at quaternary catchment scale,

and aquifers (or catchments) with high use compared to recharge are generally identified as 'stressed' or 'over-used'. The approach can limit groundwater development based on a perceived stress. Impeding the implementation of the capture approach to sustainability, is the fact that the approach is intertwined with adaptive management. Management must proceed on less than ideal information, and decisions must be adjusted as groundwater use continues. This is awkward to regulate. The ultimate purpose of the project was to promote the capture principle approach to sustainable groundwater use. The project proposed the development of a tool (decision framework) that could facilitate the translation of theoretical hydrogeological principles for sustainable groundwater use based on the capture approach into practice.

Cost: R700 000

Term: 2014 – 2017

THRUST 3: WATER QUALITY MANAGEMENT

Programme 1:

Water quality monitoring

Update of the Groundwater Sampling Manual

University of the Free State (Institute for Groundwater Studies)

2428

The Department of Water and Sanitation (DWS) is

custodian of water resources and responsible for coordinating investments in water infrastructure. There are about 250 water schemes in South Africa that DWS is responsible for. Other water infrastructure schemes that the state has responsibility for comprise those that are transboundary in nature, including the Lesotho Highlands Water Project (LHWP). It is estimated that the current replacement value for the water infrastructure is about R139 billion, and that South Africa requires at

least R1.4 billion investments per annum to maintain the current water infrastructure. This funding challenge has exacerbated the water management situation in the country. This study sought to develop understanding of the perceived challenges and constraints faced by the private sector, which prevents them from harnessing the opportunities of investing in the water and sanitation sector in South Africa. This was based on the premise that by unpacking these perceived challenges, a clear picture of the investment opportunities in the sector might be unveiled to make a business case for investments in the sector. The main outcome of this study reflects the fact that private sector involvement in the financing of water infrastructure is still quite poor, with the public sector still bearing the large cost

of infrastructure financing. In cases where the private sector is involved, it is on the basis of financing large infrastructure programmes that have been guaranteed by government. The lack of clarity in the regulatory framework in the financing of water infrastructure has exacerbated the perception of risk by the private sector and resulted in their participation being quite limited. The financial status of local municipalities has also hindered them from effectively using market mechanisms for fundraising for their infrastructure programmes, because of poor balance sheets.

Cost: R600 000

Term: 2015 – 2017

THRUST 4: WATER RESOURCE PROTECTION

Programme 2:

Land-water linkages

Regional water-sensitive urban design scenario planning for Cape Town using an urban (geo) hydrology model

Delta-H (Pty) Ltd; City of Cape Town; University of the Free State (Institute for Groundwater Studies); Hydrologic Consulting (Pty) Ltd; Highlands Hydrology (Pty) Ltd

2441

The study area focuses on WSD interventions for the area covered by the Cape Flats aquifer, and included

the surface water catchments to the east of the Kuils River. Available data and information on the hydrology and hydrogeology of the study area is described. In order to define the surface water contributions to the Cape Flats aquifer, it is necessary to account for the way in which effective rainfall is partitioned in the water balance, into its evaporative, runoff, storage and infiltrating components, as well as the separation of runoff into overland flow and stormwater flow through the stormwater network. The primary surface water input into the groundwater component of the Cape Flats aquifer model is infiltration, and it is through solving of the aforementioned components of the water balance



that infiltration is best estimated. Existing surface water models (in PCSWMM) were sourced, and updated, for the northern and eastern catchments, and a new model was established for the southern catchment. The models were used to quantify spatially disaggregated infiltration across the Cape Flats for normal, wet and dry years. A numerical groundwater model was established for the Cape Flats aquifer (in SPRING). Scaling the surface water model-derived infiltration to absolute recharge, a spatially disaggregated recharge dataset has been generated. This recharge dataset improved numerical model calibration, suggesting that inclusion of the urban influences on infiltration is necessary to accurately replicate observed water levels. The WSD scenarios tested illustrate that the Cape Flats aquifer could provide a significant resource for bulk abstraction (~10 million m³/a for the wellfield scenarios applied), in addition to maintaining increased dispersed abstraction

(~7 million m³/a). Although the ecological impact of reduced groundwater contribution to baseflow is not considered here, this is likely to be minimal since several rivers currently have almost no ecological functioning (canalised, degraded), particularly in comparison to abstraction in pristine areas or in areas where reduced baseflow may impact utilised surface water resources. The simulation results illustrate that the source of groundwater for bulk abstraction (protection zone) is a relatively small area around the abstraction sites. The WSD scenarios tested also illustrate that point injection does not appear to be beneficial to bulk abstraction. Aerial infiltration within the cone of dewatering is likely to provide better results.

Cost: R1 000 000

Term: 2015 – 2016

CURRENT PROJECTS

THRUST 1: WATER RESOURCE INSTITUTIONAL ARRANGEMENTS

Programme 1:

Water governance and institutional reforms

Institutional arrangements for implementing water equity mechanisms in South Africa

Prime Africa Consultants (previously CIC International)

2255

Project aims:

- Investigate the potential benefits of two water equity enforcing mechanisms: domestic water supply and the General Authorisation (Government Gazette No. 20526 8 October 1999)
- Design the institutional requirements for implementing these water-equity enforcing mechanisms
- Determine the costs and risks to the fiscus of these institutional requirements
- Develop a case (in National Treasury format) for implementing these mechanisms.

Cost: R 1 162 600

Terms: 2013 – 2016

Assessment of implementation of all national water-related policies and the development of the framework for monitoring the extent of the implementation of the NWA

Prime Africa Consultants cc

2417

Project aims:

- To conduct a comprehensive performance assessment of the nature and extent of implementation of the water policies and the NWA in South Africa. This performance assessment will include assessment of progress in implementation of water policies and the NWA against policy/legislative objectives, targets and recommendations
- To identify the gaps and lessons learnt from the implementation of these water policies and the NWA
- To inform the amalgamating of the NWP and NWA, based on a consultative process of assessment
- To develop a framework for the assessment of the resources required for the implementation of the amended/new and amalgamated NWP and NWA
- To apply the framework to formulate different resource dimensions required to implement, and monitor progress of, the reviewed/amalgamated NWP and NWA



- To establish the means of determining the obstacles and/or contradictions that may hamper implementation of the NWA and NWP.
- Using scenarios, identify the kinds of investments that are needed

Cost: R1 000 000

Term: 2015 – 2016

Programme 3:

Pricing and financing WRM

Approaches for emerging farmer participation in water resource management: The case of the Breede-Overberg Catchment Management Agency (BOCMA), Western Cape

Cape Peninsula University of Technology

2310

Project aims:

- Review progress in accessing water resources by emerging farmers in two selected areas in the Breede-Overberg Catchment Management Agency
- Explore the role and challenges faced by emerging farmers in participating in water user associations
- Explore opportunities for engaging emerging farmers to participate in water user associations and water allocation processes
- Develop a general approach for engaging emerging farmers to participate in water user associations in the Western Cape (and South Africa)

Cost: R1 303 000

Term: 2014 – 2017

Towards sustainable economic development in water constrained catchments: tools to empower decision making

GreenCape; University of Cape Town

2453

Project aims:

- To develop a guideline for a planning approach that recognizes the cyclic interdependency of economics and water resources
- To conduct an economic, social and environmental cost-benefit analysis (CBA) and cost-effective analysis (CEA) of economic developments and water resource interventions
- To build a spatial hydro-economic model (HEM) for use as a tool to manage regional allocations in constrained catchments, which can be customized for use in other regions/contexts
- To develop research products in close collaboration with decision-makers, and implement research outcomes to address current development challenges

Cost: R2 059 672

Term: 2015 – 2018

THRUST 2: WATER RESOURCE ASSESSMENT AND PLANNING

Programme 1:

Catchment data and information systems

Implementation of Adaptive Operational Governance Dashboard (AOGD) for the Inkomati-Usuthu CMA

University of KwaZulu-Natal (Pietermaritzburg); DHI (SA); Hydrologic Consulting (Pty) Ltd; Jeffares & Green (Pty) Ltd; Inkomati-Usuthu Catchment Management Agency

2418

Project aims:

- Conform operational setup, automation and information sharing needs of the AOGD
- Add the Technical & Economic components of STEEP to the AOGD
- Add the Social & Political components of STEEP to the AOGD
- Train ICMA Board and staff as well as key stakeholders on the use of the AOGD

Cost: R1 788 000

Trm: 2015 – 2017

Water accounts for South Africa

Prime Africa Consultants cc; United Nations Environment Programme; University of Pretoria

2419

Project aims:

- Phase 1
 - » Provide a methodological framework for the water accounts according to international best practices
 - » Consultation through engagement with all relevant role-players
 - » Create a framework, structure and knowledge base for these accounts to enable more frequent updates and potentially more detailed accounts in the future
- Phase 2
 - » Provide a research document containing an overview of the methodology, water tables and water accounts that can be published in collaboration with Stats SA
 - » Provide water tables and accounts in Excel to enable ease of use for integrated impact and policy analysis

Cost: R1 800 000

Term: 2015 – 2017

Constructing a baseline of environmental, agricultural and socio-economic intersections for the Mzimvubu Water Project

University of Fort Hare; Rhodes University

2433

The objective of this project is to construct and develop a detailed baseline database of environmental, agricultural and socio-economic aspects which might be influenced by



the Mzimvubu Water Project. Specific aims and objectives include:

- To construct and develop a database of the water quality and streamflow regimes at representative sites in the Tsitsa River prior to the Mzimvubu Water Project
- To construct and develop a database of groundwater levels and quality at representative sites prior to the Mzimvubu Water Project
- To quantify suspended sediment loads in the Tsitsa River during selected flood events prior to the Mzimvubu Water Project
- To characterise stream geomorphology of the Tsitsa River below the Ntabelanga Dam up to the confluence with the Mzimvubu River prior to the Mzimvubu Water Project
- To construct a database of riparian vegetation at selected sites prior to the Mzimvubu Water Project

Cost: R2 000 000

Term: 2015 – 2018

The impacts of commercial plantation forests on groundwater recharge and streamflow

CSIR

2443

Project aims:

- To quantify the long-term (at least annual) water use of key commercial plantation forests, e.g. pine and eucalyptus species, and co-occurring indigenous vegetation in the catchment

- To monitor and compare the groundwater levels in the vicinity of the plantation forest and in the area occupied by the indigenous vegetation
- To identify the sources of water used by the plantation forests and to quantify the proportion of total water use that is derived from groundwater
- To quantify groundwater recharge variations between commercial forest and indigenous vegetation ecosystems using a suitable unsaturated zone model
- To extrapolate the results and findings to the quaternary catchment scale using a coupled groundwater–surface water model
- To validate remote-sensing products utilizing the data generated during this study

Cost: R1 605 960

Term: 2015 – 2018

The hydrogeology of Groundwater Region 39

North-West University (Potchefstroom); University of KwaZulu-Natal (Westville)

2456

Project aims:

- Analyse and present the related groundwater data in a concise manner
- Estimate how much water is available for use and how much is currently being used
- Quantify possible pollution sources and associated impacts
- Provide guidelines for the future development and management of groundwater resources

- Provide a document (standard format for the groundwater regions as set out by Vegter), a database and tools to assist in the management of groundwater resources within the study area

Cost: R400 000

Term: 2015 – 2017

Programme 2:

Surface water / groundwater hydrology

Sustainability of shallow groundwater utilization for small-holder irrigation in the Limpopo Province

CSIR; University of Limpopo

2426

Project aims:

- To determine the extent of shallow groundwater in the area of the Mopani District
- To determine the sustainability of large-scale groundwater use in the Mopani District
- To investigate the environmental sustainability of irrigating selected alternative and indigenous crops on emerging farms
- To investigate the potential and quantify the effects of riparian vegetation strips in mitigating the impacts of agricultural activities on shallow groundwater

Cost: R2 727 800

Term: 2015 – 2018

Optimising the use of updated and additional products from the Nowcasting Satellite Application Facility to improve the Rapidly Developing Thunderstorms and Convective Rainfall Rate products

South African Weather Service; EUMETSAT

2430

Project aims:

- To use and test the latest version of the Nowcasting software (v2013) for the RDT and CRR products on a dedicated server at SAWS using information from the MSG satellite, and model input from the local version of the Unified Model
- To include lightning data from the South African Lightning Detection Network as auxiliary data to further enhance the accuracy of the products
- To transfer skills to forecasters from South Africa as well as southern Africa, in order to understand the improvements to the products and its usefulness (through training sessions and/or workshop presentations)
- To make the improved RDT and CRR products operationally available to all forecasters in SA as well as SADC via the Internet

Cost: R250 000

Term: 2015 – 2017



Enhancement of the method to identify and delineate South Africa's water source areas, water towers, with specific focus on mountain groundwater systems

CSIR; Dirk Versfeld cc; DELTA-H (Pty) Ltd

2431

Project aims:

- Review and refine the understanding of the hydrological processes that lead to the generation of runoff and groundwater recharge in South Africa's water source areas, and especially in groundwater systems
- Develop an integrated method to identify and delineate Water Source Areas that include run-off generation and groundwater recharge
- Identify additional management/protection requirements for Water Source Areas

Cost: R3 500 000

Term: 2015 – 2018

Resetting the baseline land cover against which streamflow reduction activities and the hydrological impacts of land use change are assessed

University of KwaZulu-Natal (Pietermaritzburg); SAEON

2437

Project aims:

- To classify Mucina & Rutherford (2006) vegetation types into hydrologically relevant vegetation groups

- To estimate spatial baseline (natural) vegetation water use using remote sensing (SEBS)
- To derive vegetation and water use input parameters for each vegetation grouping for hydrological modelling
- Determine the hydrological response under the Mucina and Rutherford (2006) baseline
- Determine the potential implications of using Mucina and Rutherford (2006) as the baseline vegetation in determining water use of streamflow reduction activities

Cost: R2 500 000

Term: 2015 – 2018

Upstream–downstream hydrological linkages in the Limpopo River Basin

CSIR; Rhodes University (IWR)

2439

The main objective of this research is to establish and quantify upstream–downstream hydrological linkages in the Limpopo River Basin in order to promote transparent and well-informed cooperation between various stakeholders and provide information that will be used to increase resilience to climate change and extreme weather events. The work will provide improved estimates of the water resources of the whole of the Limpopo basin, building on the work previously undertaken. The intention is therefore to also increase the confidence that can be expressed

in these estimates for purposes of water sharing, current and future socio-economic development and maintaining ecological integrity of the basin for sustainable development. This is necessary if the water and food security in the basin, and mitigation of flood and drought disasters, are to be achieved. The aims of the project are:

- To identify and delineate the water sources (water towers and recharge areas) in the LRB
- To develop a conceptual model of the flow paths of water in the LRB
- To set up a hydrological model to provide estimates of the water resources of the LRB, that can be used as a basis for planning and management of the basin both for the present and future
- To estimate the impacts of climate change on the hydrology and water resources of the basin

Cost: R1 700 000

Term: 2015 – 2018

Integrated use of isotope tracers to understand the role of surface water-groundwater interaction in salinisation of groundwater resources in arid and semi-arid environments in Southern Africa

Stellenbosch University; Australian National University; University of Kansas; University of Cape Town; GWI Consulting cc

2442

Project aims:

- To develop the methodology for B and Mg isotope

analysis in waters and establish this as a standard analytical tool in water research

- To determine the Chlorine 36, Iodine 129, Tritium, Carbon 14 (and possibly tritogenic helium) isotope systematics in saline groundwaters in South Africa in comparison to non-saline groundwaters
- To clarify the origin of salts in various catchments within the Western Cape and Northern Cape using the above isotopes and with conventional geochemistry including stable isotopes of O, H and C as well as radiogenic Sr
- To establish the usefulness of novel isotope tracers (as indicated for Aims 1 and 2 but including stable isotopes of chlorine) for understanding the interaction between surface water and groundwater in areas of salinization
- To build capacity in isotope hydrology within South Africa
- To develop management tools to assist in the management and mitigation of saline groundwater

Cost: R1 400 000

Term: 2015 – 2018

Programme 3:

Water resource planning and infrastructure

Enhancements to WR2005 study (completed for the WRC in December 2008)

SSI

2019



The main objective of this study is to enhance the Pitman Model in order to generate patched observed streamflows for areas where rainfall gauging stations have unreliable records (or records are non-existent). It is envisaged to create a complete database of the actual monthly patched observed monthly flow volume for each streamflow gauge.

Cost: R450 000

Term: 2010 – 2011

Programme 4:

Climate change and water resources

Managing limits in skill for seasonal climate forecasting

University of Cape Town

2249

Project aims:

- Identify the signal to noise ratio over southern Africa using observations and GCM datasets in response to the forcing of global modes of variability
- Identify the spatial and temporal time scales of robust regional response to global modes of variability
- Develop a new methodological approach to explore the climate system on seasonal and sub-seasonal timescales using the phase space of the daily evolution weather states
- The integration of regional responses using a hydrological model forced by daily (or finer) meteorological variables (temperature, humidity,

wind speed, radiation and precipitation) derived from regional climate signals

- An understanding of the theoretical limits to predictability from seasonal forecast models, utilizing ensemble-based prediction techniques in the perfect model scenario
- Explore which physical parameters of the regional climate system best reflect a deterministic response signal
- Test emergent understanding of how models may be developed to improve forecasts

Cost: R2 025 640

Term: 2013 – 2017

Quantification of uncertainty in weather and climate prediction and its effective communication for better decision making

CSIR

2325

Project aims:

- To quantify (through estimation of the reliability of weather and climate forecasts) and reduce (through ultrahigh horizontal resolution simulations for cloud-resolving purposes) the uncertainties associated with predicting and projecting future weather and climate variability as well as change over the southern African region, with an emphasis on extreme events
- To optimize the configuration of the variable-resolution atmospheric model CCAM, applied at various time scales for equivalent horizontal resolutions and domains, as part

of the endeavour to build an Earth System Model (ESM), since the generation of simulations on these time scales provides a test-bed for the atmospheric model that will form an integral part of the ESM

- To develop plausible scenarios of future changes in the attributes of extreme weather events over the continent, of sufficient reliability to be actionable
- To construct large ensembles of predictions/projections at the short-range, medium-range, long-range and decadal time scales over southern Africa, by considering initialization techniques, vertical resolutions, cloud schemes, and dynamical land-surface coupling in the model

Cost: R600 000

Term: 2014 – 2016

Towards gender-sensitive strategies for responding to challenges posed by climate-related impacts

University of the Western Cape

2314

Project aims:

- Investigate enabling factors and constraints for women's participation in decision-making processes within the water sector
- Undertake a pilot study on vulnerability assessment of rural women under changing climatic conditions
- Investigate the challenges that women encounter around water security
- Evaluate the extent to which policy frameworks and strategies that address access to resources are gender sensitive

- Identify barriers to women's access to resources such as land, water and finance and recommend how these could be addressed
- Recommendation and institutionalisation of good practice in policy practice and design a framework for mainstreaming gender into climate change adaptation

Cost: R1 200 000

Term: 2014 – 2017

Future climate change impacts on flood and drought hazards in South Africa for planning and decision-making

South African Weather Service

2247

Project aims:

- Evaluate the performance of the combined GCM/ downscaling technique/hydrological model's skill in simulating observed droughts and floods in the present/control climate
- Analyse changes in drought and flood hazards in South Africa by examining extreme discharge levels simulated by a hydrological model
- Investigate the main physical mechanisms likely to result in changes in the hazards found above
- Compare the uncertainty sources for climate change impacts on future droughts and floods
- Develop information for decision makers on future drought and flood hazards that is insensitive to the various sources of uncertainty involved in the modelling process



Cost: R1 113 000
Term: 2013 – 2017

Regionally-extensive droughts and climate change in Southern Africa: mechanisms, model reliability and projections

University of Cape Town

2317

Project aims:

- Incorporate evapotranspiration (ET) into drought indices to obtain a better characterisation of agricultural and hydrological droughts over Southern Africa
- Understand the mechanisms by which remote and local forcing of drought are translated into surface moisture deficits (P-ET)
- Evaluate climate model's abilities to represent regionally extensive droughts and the associated mechanisms
- Understand the potential impacts of climate change on regionally-extensive droughts in Southern Africa

Cost: R1 150 000
Term: 2014 – 2017

Soil moisture–climate interactions under climate change: Implications for droughts, heat waves and desertification over Southern Africa

South African Weather Service

2309

Project aims:

- Identify CMIP5 simulated hotspots of soil moisture–climate interactions in the historical runs
- Investigate future changes in soil moisture regimes and the possible impacts on the locations of the hotspots identified
- Investigate the contribution of changes in soil moisture to the accelerated warming rates over south-western Africa (Northern Cape, Namibia and Botswana)
- Understand the implication of the higher warming rates for the frequency and intensity of 21st Century heat waves
- Establish the effects of changes in soil moisture regimes on the pattern and intensity of meteorological droughts
- Investigate the likely change in the spatial extent of semi-arid regions

Cost: R1 080 000
Term: 2014 – 2017

Ocean impact on southern African climate variability and water resources

University of Cape Town; University of Dijon; South African Weather Service

2425

Project aims:

- To provide an improved conceptual understanding of ocean–atmosphere linkages to hydroclimatic variability in Southern Africa at relevant spatial and temporal scales with a focus on flood and drought
- To better characterize the role of La Niña on floods in Southern Africa
- To understand the role of adjacent ocean in moisture transport, rainfall and extreme weather and climate of South Africa
- To understand the role of equatorial rainfall variability on Southern African rainfall
- To better characterise the role of ENSO on streamflows in South Africa
- To understand the origin of sea surface temperature bias in the CMIP5 coupled model used by IPCC and their adequacy to reproduce inter-annual and decadal climate variability in Southern Africa
- To understand the role of the ocean on decadal variability of the Southern African climate and explore potential decadal forecasting of Southern African climate

Cost: R1 540 000

Term: 2015 – 2018

Use of Land Surface Models for seasonal hydrological forecasting in South Africa

University of Cape Town; CSIR

2436

The general objective of this project is to combine existing models and resources, as well as institutional strengths and capabilities, in order to further seasonal hydrological forecasting systems for South Africa, by expanding and consolidating the landscape of available products, tools and knowledge and their capabilities and limitations, for improved confidence and uptake of the seasonal forecast products.

Specific aims are:

- To create a knowledge basis for an operational system comprising a land surface model linked to regular seasonal climate forecast, enabling regular forecasts of runoff, streamflow, shallow groundwater and soil moisture, addressing aspects such as frequency and intensity of events, as well as mean conditions, and thus enabling generation of a range of user-relevant indices
- To quantify value to hydrological applications of using regionally downscaled seasonal forecasts with an LSM hydrology compared to the forecast based on optimal statistical downscaling of GCM data
- To quantify relative importance of uncertainty in initial conditions (soil moisture, rainfall) compared to that in forecast climate fields, on the skill of seasonal hydrological forecast, and thus to assess the value of hydrological model initialization from observed conditions on the quality of the forecast, and determine spatial and temporal



differentiation of sources of forecast skill between the initial hydrological conditions and boundary (meteorological) forcing

- To determine which aspects of forecast processes are robust with respect to the choice of hydrological model and the choice of climate model
- To quantify propagation of uncertainty along the possible data-processing paths, considering possible downscaling pathways: GCM → statistical downscaling → hydrological model → forecast - GCM → RCM → integrated hydrological model → forecast - GCM → RCM → statistical downscaling → off-line hydrological model → forecast - GCM → RCM → off-line hydrological model → forecast
- To consolidate, with user community, a range of application-relevant metrics from the forecast product which are at the intersection of forecast skill and usability within the current decision space and current decision-making paradigms in the water sector and present these in an easy-to-use online platform

Cost: R1 271 360

Term: 2015–2018

Predictability of hydroclimatic variability over eastern South Africa under climate change

CSIR
2457

Project aims:

- Estimate changes in climate variability over the summer rainfall region of eastern South Africa under enhanced anthropogenic forcing

- Determine how seasonal predictability may change over the summer rainfall region of eastern South Africa under climate change
- Generate detailed projections of changes in streamflow and dam levels over Lesotho and the mega-dam area of eastern South Africa, including changes in variability, under climate change
- Quantify the seasonal predictability of stream low and dam levels over the Lesotho and mega-dam area of South Africa under present-day climate
- Determine how climate change may alter the seasonal predictability of streamflow and dam levels over Lesotho and the mega-dam area of eastern South Africa
- Describe the consequence of future changes in the hydrological cycle and its variability over Lesotho and the mega-dam area of eastern South Africa for water security in southern Africa

Cost: R1 257 000

Term: 2015 – 2018

Programme 5:

New water and water security

EXSMET: Exporting PyTOPKAPI and HYLARSMET over SADC including RSA with extended spatial and computational capacity of soil moisture and evapotranspiration for flood and drought monitoring

Pegram and Associates (Pty) Ltd

2312

Project aims:

- To ascertain what rainfall data are available in the SADC countries outside our borders and perform checks on their suitability for modelling
- To obtain suitable ground cover and soil maps over the whole SADC region (e.g. FAO and others), for comparison with those already available in SA
- To exploit the sensitivity calculations performed on the SA dataset under HYLARSMET
- To determine the best way to compare FAO datasets with our SA sets of ground-based data
- To determine if there are better alternative rainfall inputs to TRMM, for near real-time precipitation data input; if not, exploit bias adjustment of the TRMM product
- To exploit the soil moisture estimates of the European Space Agency's SMOS mission when they are ready for using in model inter-comparisons
- To determine how best to cope with the uncertainties associated with input parameters and forcing variables (TRMM in particular) when computing ensembles of historical and forecast data streams
- To devise means of increasing computing capacity and the speed of calculations by improving key parts of the code and employing parallel (or high performance) computing power
- To determine the best ways of cold-starting calculations (model initialization) for both gauged and ungauged catchments

Cost: R1 980 000

Term: 2014 – 2018

Finding 'new' water in an 'old' catchment: the case of the Heuningnes Catchment, Breede-Overberg Water Management Area

University of the Western Cape

2324

Project aims:

- To determine the contributions of sub-catchments of the Heuningnes River to inflows into the Soetendalsvlei and Heuningnes Estuary
- To establish the effects of land uses and water uses on quantity and quality of inflows into the Soetendalsvlei and Heuningnes Estuary
- To establish the extent to which marshes occurring along stretches of the Nuwejaars River and tributaries modify inflows into the Soetendalsvlei
- To determine how river inflows, the interactions between surface water and groundwater affect the water balance dynamics of Soetendalsvlei, and outflows into the Heuningnes Estuary

Cost: R1 400 000

Term: 2014 – 2017



THRUST 3: WATER QUALITY MANAGEMENT

Programme 1: Water quality monitoring

Encouraging citizens' water quality management through subcatchment forums

Mvula Trust

2151

Project aims:

- To bring together existing literature on catchment forums in South Africa that is relevant to dealing with water quality issues in a comprehensive overview
- To survey and understand the workings of existing catchment forums, and the factors influencing their sustainability, inclusivity, effectiveness and legitimacy
- To develop recommendations and guidelines for the functioning of catchment forums that are sustainable, inclusive, legitimate and effective
- To discuss the findings and recommendations with stakeholders involved in catchment forums
- To test the guidelines by piloting them in selected forums

Cost: R600 000

Term: 2012–2014

Water resources management in South Africa: towards a new paradigm

Rhodes University

2248

Project aims:

- To write a starter discussion document that elaborates the framework and process for the project
- To build a transdisciplinary team to undertake the project
- To develop a systems-based project design that integrates the case study focus areas (resource protection, eutrophication and microbial pollution); place-based case studies at different scales; and overarching concepts including complexity, complex social ecological systems, transdisciplinarity, resilience, social learning and strategic adaptive management
- To develop, workshop and finalise the detailed aims, methods, and outcomes at each site, for each case focus, and the whole project
- To undertake and clearly link the theoretical, conceptual framework to a specific set of methodologies, to lay a foundation for the development of robust transdisciplinary scholarship and practice; and to explore a richer understanding of 'integration'
- To provide a rich and clear understanding of the 'new paradigm' together with inherent implications (intended and unintended consequences)

- To develop a set of guiding principles for IWRM in South Africa
- To undertake relevant research in place-based case study areas in respect of each case focus area (eutrophication, microbial pollution, water resource protection)
- To have facilitated the development of appropriate software and data curation to support ‘new paradigm’ thinking and practice
- To have proposed and selectively practised the ‘new paradigm’ of water resource management in South Africa
- To have contributed to the scholarship and practice of transdisciplinarity, particularly in the linked development of concept, theory and method
- To recommend a principle-based and adaptive contribution to the ongoing review and writing of the National Water Resource Strategy

Cost: R5 000 000

Term: 2013 – 2017

Pilot study and technology transfer of the Integrated Water Quality Management System (IWQMS) in the Breede-Overberg and an assessment of early warning systems for source water protection

Golder Associates Africa (Pty) Ltd; MHP GeoSpace (Pty) Ltd; University of the Western Cape

2427

Project aims:

- To have the DWA regional office/CMA drawing

reports from the system and utilizing these for quarterly and annual reporting

- To unlock the reporting bottlenecks in governance to ensure there is a swift flow of information
- To refine the glitches in the IWQMS based on implementation of the system by various water users
- To report on the progress by the water users, DWA regional office, CMA, municipality and province
- To review and assess EWSs to aid in protecting our source water from over-abstraction and contamination
- To develop response scenarios and conceptual tools and frameworks based on different water management levels
- To develop ideas on how to effectively manage ongoing operation and maintenance of the EWS

Cost: R1 500 000

Term: 2015 – 2017

Revision of the 1996 South African Water Quality Guidelines – development of risk-based approach for recreational water use

CSIR; Department of Water and Sanitation; Umgeni Water; University of KwaZulu-Natal (Westville)

2435

Project aims:

- To develop a technology demonstrator that will demonstrate the features of recreational water quality guidelines
- To engage with various stakeholders to elicit comment and recommendations



- To maximise synergy with parallel projects on the development of water quality guidelines for other water users, for example, the agricultural irrigation water quality guideline project initiated this current financial year
- To develop a fully-functioning decision support system for selected specific recreational water users

Cost: R2 000 000

Term: 2015 – 2018

Development of novel fluorescent sensors for the screening of emerging chemical pollutants in water

University of Pretoria; CSIR; Department of Water and Sanitation

2438

Project aims:

- To prioritise emerging chemical pollutants in water in order to define target analytes for fluorescence screening (based on, e.g., toxicity, projected concentrations, fluorescence characteristics, etc.) and to identify potential water sampling sites in Gauteng and surrounds
- To synthesise and characterize suitable novel quantum dots (QDs) and QD nanocomposites for use in the proposed fluorescence sensor
- To immobilize the QDs and QD nanocomposites in suitable polymers (such as siloxanes) in order to generate fluorescence sensor prototypes
- To test and optimize the fluorescence sensor prototypes using synthetic standard solutions of the target compound(s) in water

- To determine the hormone mimicking activity of the synthetic standard solutions by means of suitable bioassays
- To test the fluorescence sensor prototypes which performed best with respect to synthetic solution testing in the screening of real (environmental) water samples for the target ECPs
- To determine the hormone mimicking activity of selected real (environmental) water samples (primarily those which screened positive by fluorescence screening)
- To screen additional water samples and extracts from other research projects which tested positive for hormone mimicking activity using the fluorescence sensor

Cost: R438 600

Term: 2015 – 2016

Geophysical delineation and monitoring of AMD in COH

CSIR; Tshwane University of Technology

2440

Project aims:

- Establish relationships between geophysical field parameters (resistivity magnitude and phase angle) and the site-specific physicochemical properties associated with AMD contamination such as elevated salinity (electrical conductivity / total dissolved solids) and SO₄ levels in a karst hydrosystem

- Determine the optimum survey approach and parameters for different anticipated field scenarios, depending on factors such as the required depth of investigation, the desired resolution and the geo-electric structure of the epikarst and underlying karst aquifer
- Conduct field measurements designed to derive a base-line geophysical image of the AMD plume footprint in the study area
- Repeat field measurements after 12 months to enable the monitoring of changes in plume characteristics over time
- Definition of a geophysical monitoring methodology/strategy that can be applied on an ongoing basis, if required

Cost: R720 240

Term: 2015 – 2017

Development and benchmarking of decision support for aquatic toxicity testing: technology transfer and implementation of the toxicity testing guideline/technology

Rhodes University

2445

Project aims:

- To develop and implement a technology-based decision support system for the use of aquatic toxicity testing guidelines as a screening and detailed water quality monitoring tool and demonstrate its application in a series of catchments (showing clear

relevance to the municipal, mining, agricultural and industrial sectors)

- To develop and build capacity in relevant Department of Water and Sanitation directorate on the use of the developed system and aquatic toxicity testing in general
- To collect toxicological data over one hydrological year and to prepare the reports that will enhance the work of the regulator in assessing compliance/non-compliance
- To highlight quality assurance practices associated with aquatic toxicity testing
- To set relevant catchment-based limits through stakeholder engagements and dialogue
- To develop a decision support system ready for use in the Department of Water and Sanitation
- To benchmark with international compliance monitoring programmes

Cost: R2 000 000

Term: 2015 – 2018

The development of portable Immunoassays for the detection of enteric pathogen species for water quality monitoring

University of Johannesburg; Medical Research Council

2446

Project aims:

- Re-design and modify the current proof-of-concept lateral flow immunoassay (LFIA) test strips for *Salmonella*, *Shigella* and *Vibrio* spp. and *E. coli*



- Manufacture of lateral flow immunoassay test strips and testing with reference bacterial strains
- Validation and environmental testing of the four LFIA kits

Cost: R780 000

Term: 2015 – 2017

Multi-Array sensor technology for polycyclic aromatic hydrocarbons screening in wastewater

University of the Western Cape; City of Cape Town

2454

Project aims:

- Study redox behaviour of PAHs in aqueous solutions
- Develop electrocatalysts for individual PAHs
- Develop multi-array analytical protocol for reference system
- Develop multi-array analytical protocol for multiple PAHs
- Analyse composite samples using multi-array sensor technology
- Validate composite sample analysis by HPLC

Cost: R730 000

Term: 2015 – 2017

EONEMP: The integration of earth observation into the National Eutrophication Monitoring Programme

CyanoLakes; SANSA; University of the Western Cape; DH Environmental Consulting cc; University of KwaZulu-Natal (Pietermaritzburg); Centre for High Performance

Computing (CHPC); Department of Water and Sanitation; CSIR; University of Cape Town

2458

Project aims:

- To use MERIS satellite data acquired between 2002 and 2012, and an updated version of the MPH algorithm, to produce information products for chlorophyll *a*, cyanobacteria blooms and invasive aquatic macrophytes for more than 100 South African water bodies
- Use time-series analysis methods and the data products from Aim 1 to determine the spatial extent, severity and change in eutrophication levels, cyanobacteria blooms and invasive aquatic macrophytes between 2002 and 2012 for more than 100 South African water bodies
- To integrate re-formatted and summarised data from Aim 1 into the NEMP Water Management System online database, producing time-series plots and making data available online
- To perform an inter-comparison between retrospective NEMP in-situ data and satellite data products to facilitate validation and calibration of the MPH algorithm
- To develop an operational system using Sentinel-3 OLCI satellite data for near-real-time monitoring of chlorophyll *a*, cyanobacteria blooms and invasive aquatic macrophytes in more than 100 water bodies from 2016 onwards
- To develop an algorithm for Sentinel-3 OLCI using in-situ data collected through fieldwork and ongoing NEMP sampling

- To validate products from Sentinel-3 using in-situ data collected through fieldwork and ongoing NEMP sampling
- To integrate satellite-based information from the Sentinel-3 near-real-time monitoring system into the NEMP website and WMS data archive
- To assess the whereabouts, extent, severity and change in eutrophication, cyanobacteria blooms and invasive aquatic macrophytes between 2016 and 2018 using Sentinel-3 OLCI products
- To develop an online subscription-based public warning service and mobile application for water quality information and cyanobacterial bloom warnings

Cost: R3 000 000

Term: 2015 – 2018

Programme 2:

Water quality modelling

Simulation of pollutant transport, sediment concentration and nutrient budget for uMngeni river

University of KwaZulu-Natal (Howard College Campus)

2328

Project aims:

- To analyse the existing water quality data
- To investigate the main drivers for the river water quality issues
- To understand pollutant transport processes for the river environment under various flow conditions

- To develop a mathematical hybrid model for simulation of pollutant concentrations with sediment flux and nutrient budget
- To test and calibrate the developed model using the dataset
- To develop a user-friendly software package

Cost: R667 000

Term: 2014 – 2017

Cholera monitoring and response guideline

University of Fort Hare; Department of Water and Sanitation (Eastern Cape)

2432

The overall aim of this research is the development of a cholera monitoring programme for inclusion in the water resource monitoring programme. Specific aims are:

- To assess the various types of wastewater treatment processes that are used in the Eastern Cape Province (ECP)
- To evaluate the laboratories used for sample analyses and whether these are accredited or not
- To verify the analytical methods used in the laboratories in line with the Green Drop reporting system
- To monitor the compliance of the wastewater treatment plants (WWTP) in the Eastern Cape Province to operational standards and determine the rate of and reason(s) for failure of the treatment technologies



- To evaluate the implemented measures put in place to ensure that wastewater treatment occurs during failure
- To assess the prevalence of *Vibrio* pathogens in discharged final effluents of WWTP and rural waters in the ECP and make recommendations on the factor(s) contributing to the prevalence of these pathogens in rural waters
- To ascertain the strains of *Vibrio* pathotypes that are common in the aquatic milieu of the Eastern Cape Province as well as their epidemiology, with a view to tackling the recurring scourge of cholera (and cholera-like diarrhoea) outbreaks in South Africa
- To evaluate aquatic animals (including shrimp, fish, crab, crayfish) and vegetables as potential reservoirs of *Vibrio* pathogens

Cost: R1 260 000
Term: 2015 – 2018

Extending functionality and knowledge transfer of the Water Quality Systems Assessment Model

Rhodes University; Amatola Water

2448

Project aims:

- The development and testing of a diffuse source nutrient input model linked to land cover, to be integrated within WQSAM
- Validation of algal and hyacinth growth processes within WQSAM using remote-sensing estimates of primary production for selected eutrophic reservoirs

- Extension of water quality variables simulated within WQSAM to include acid mine drainage and microbial water quality, and the application of WQSAM to selected catchments for historical conditions
- The simplification, further testing and consolidation into WQSAM of the sediment transport model, and application to selected catchments for historical conditions
- The incorporation of a cholera prediction model within WQSAM, with application to selected catchments for historical conditions
- WQSAM documentation and knowledge dissemination

Cost: R898 737
Term: 2015 – 2018

Programme 3:

Impacts on and of water quality

Combined effect of urbanisation, industrialisation and population growth on water quality of the Palmiet River and its tributaries in the Overberg West sub-catchment of the Breede Water Management Area: An integrated catchment risk assessment

Cape Peninsula University of Technology

2329

Project aims:

- The overall aim of the study is to conduct an integrated catchment risk assessment to determine the impacts of the combined effects of urbanisation,

industrialisation and population growth on water quality in the Palmiet River and its tributaries in the Overberg West sub-catchment of the Breede Water Management Area

- Conduct an environmental hazard assessment to identify and quantify the sources of selected micro-pollutants (organic waste, nutrients and pathogens) in the sub-catchment; this assessment will culminate in a conceptual site model for the Overberg West sub-catchment
- Characterise the hazards by gathering, generating and evaluating data on the pollutants and conclude on their toxicological effect and environmental fate; this will allow for the evaluation of the nature of the adverse effects associated with biological, chemical and physical agents

- Develop an integrated fate and transport model by identifying the principal/dominant flow pathways, determining the dominant hydro-chemical processes controlling the fate and transport of the contaminants, and the potential for polluting
- Develop a quantitative microbial risk assessment and chemical risk assessment model to predict and evaluate the risks emanating from contamination and pollution
- Determine best management options and translate these into management and policy recommendations

Cost: R850 000

Term: 2014 – 2017



THRUST 4: WATER RESOURCE PROTECTION

Programme 1: Source water protection

The selection and validation of sediment toxicity test methods to be included in the National Toxicity Monitoring Programme

Golder Associates Research Laboratory

2160

Project aims:

- To conduct an extensive survey on national and international toxicity methods utilised as well as new methods to evaluate sediment contamination
- To test and validate the sediment toxicity tests using the in-house cultures according to international methodologies
- To test and validate available sediment toxicity test kits available in order to identify the most cost- and time-effective methods to screen sediment samples
- To provide final method and validation documentation
- Training and implementation of the method

Cost: R1 715 150

Term: 2012 – 2015

Groundwater remediation technologies manual for South Africa – a theoretical treatise and practical guide

Hydro Aqua Earth

2167

Project aims:

- The principal aim or objective of this proposed project is to provide a source of reference documentation for improved knowledge on technologies to remediate contaminated groundwater for the use of stakeholders
- Subsidiary objective 1 – to provide guidelines for characterisation of sites of groundwater contamination
- Subsidiary objective 2 – to provide a compilation of an inventory of available technologies for the remediation of contaminated groundwater
- Subsidiary objective 3 – to provide technical manuals relating to specific technologies that apply to the field of groundwater remediation (including the scientific basis, processes involved, and design systems)
- Subsidiary objective 4 – to develop guidelines for choosing appropriate and effective technologies for the remediation of contaminated groundwater, taking into account the particular contaminant (or contaminant mix), and the geological and biophysical environment of the impacted site or location

Cost: R1 000 000

Term: 2012 – 2015

Guidelines for the delineation of protection zones in a complex aquifer setting

GCS; University of the Western Cape

2288

Project aims:

- Build on DWA project by including international best practice regarding complex aquifer settings
- Evaluate fractured rock aquifer data collection methodologies
- Develop initial guideline for complex aquifer systems
- Test initial guideline at Rawsonville TMG research site
- Investigate data needs and application of risk analysis modelling software
- Effect of seasonal variation on protection zones
- Minimum requirements to establish protection zones in complex aquifer settings
- Finalise guideline for protection zoning strategy in complex aquifer settings

Cost: R510 000

Term: 2013 – 2014

Modelling studies and analytical methods for monitoring organic pollutants in selected surface water and treated water systems in Gauteng Province

University of Johannesburg

2321

Project aims:

- To prepare a database of chlorinated organic compounds found in South Africa water systems. This database will include the factors that determine the levels of chlorinated organic compounds (COCs) in water

- Use the determined factors that influence the amounts of COCs to predict levels of COCs in a given water system
- To analyse real water samples so as to determine the levels of various COC pollutants in selected water systems found in Gauteng Province
- To develop a computer model that would predict the contamination level of COC pollutants in selected water systems found in the Gauteng Province
- To generate various predictions of organic pollutants using various water system scenarios. Compare the predicted levels with the analysed values.
- To determine the prediction efficiency of the model by testing real water samples through analysis for COCs and compare the experimental data with the predicted model values

Cost: R665 000

Term: 2014 – 2017

Training manual for groundwater resource management and groundwater governance for municipalities in South Africa

University of the Free State (IGS); Central University of Technology

2447

Project aims:

- Training needs assessment for municipalities
- Development of a draft training manual on groundwater resource management and groundwater governance for municipalities in South Africa
- Pilot testing and evaluation of the draft training manual on groundwater resource management and groundwater governance for municipalities in South Africa



- Production of final training manual on groundwater resource management and groundwater governance for municipalities in South Africa

Cost: R500 000

Term: 2015 – 2017

Development of a web-enabled mine water management vulnerability assessment tool to facilitate resource protection

Emanti Management (Pty) Ltd; SHE Legal

2451

The project aims to:

- Develop a web-based mine water management vulnerability assessment tool to determine areas of vulnerability and adherence to water use licence requirements
- -Develop an associated and supportive web-based mine water management priority action plan tool to check implementation/progress with required actions
- Evaluate the tools at selected mines via pilot studies
- Support improved efficiency and effectiveness in mine water management
- Encourage stewardship of mine water management by mines through ownership of vulnerability assessment and priority action plan development and in-house implementation of associated required improvement processes
- Conduct workshops to:
 - » Train users in the use of the tools
 - » Build communities of practice/shared learning within and between mines
 - » Share experiences and associated challenges in mine water management

- » Obtain feedback regarding tool refinements/improvements
- » Forge relationships between mines and the project team to strengthen the ongoing refinement and development of the tools
- Support ongoing knowledge dissemination and promotion of tool use
- Develop a guideline for use of the tools

Cost: R854 160

Term: 2015 – 2017

Programme 2: Land-water linkages

Unconventional gas exploration and mining and its impact on South Africa's water resources

SLR Consulting (South Africa) (Pty) Ltd

2322

Project aims:

- Update the WRC state-of-the-art report (KV294/11) to include all unconventional gas sources and other available reports focusing on among others, hydrogeology of areas where unconventional gas mining is being considered, water use, contamination and remediation
- Do a gap (and barrier) analysis of the technical, policy and regulatory requirements related to unconventional gas mining
- Perform a risk-based assessment of selected aquifers, recharge areas and surface water bodies to enable adequate protection of these systems
- Develop a water resource early warning monitoring

system that could inform regulatory policies, strategies and responses

- Develop best-practice guidelines and regulatory responses based on a variety of approved and workshopped scenarios
- Develop the best-practice framework in a manner that accounts for the technical and socio-economic considerations

Cost: R2 500 000

Term: 2014 – 2017

Characterisation and protection of potential deep aquifers in South Africa

University of the Free State (IGS); University of the Western Cape; DELTA-H (Pty) Ltd; Parsons & Associates

2434

Project aims:

- Provide a state-of-the-science overview of deep groundwater hydrogeology in South Africa
- Consolidate all available and new data on deep aquifers
- Assess the potential of deep groundwater resources in South Africa
- Characterise the deep groundwater systems in South Africa from a geohydrological perspective
- Design pre-emptive protection procedures and policies for deep aquifers
- Create a publicly accessible access point for all deep groundwater data

Cost: R1 000 000

Term: 2015 – 2017

State-of-the-art cemetery guidelines: impacts of interments on water resources

University of Pretoria; University of KwaZulu-Natal (Pietermaritzburg); CSIR

2449

Project aims:

- Investigate the risks posed by cemeteries due to decomposition of bodies, mobilization of metals from coffins and so forth, including risk to human health, ecosystems and groundwater quality
- Assess the impact of interments and grave backfill on soil hydrology and vadose zone hydrology
- Assess hydrology and vulnerability of water sources from cemetery sites through soil and water analyses at three case study sites
- Evaluate the suitability of siting of existing cemeteries and their potential for contamination of soil and groundwater using GIS for different municipalities
- Establish minimum requirements document for safe interment practice and cemetery siting

Cost: R1 000 000

Term: 2015 – 2018



NEW PROJECTS

THRUST 1: WATER RESOURCE INSTITUTIONAL ARRANGEMENTS

Programme 1:

Water governance and institutional reforms

Historical and status quo evaluation and proposed policy considerations for judicial revision (appeal and review) of administrative actions under statutory water resources management in South Africa

Vulamanzi Water Law Advisers

2513

Project aims:

- To develop an understanding of the current status quo of judicial review (revision and appeal) of water management actions, and understand the shortcomings, both legally and operationally, of the current system
- To understand the legal and operational requirements for judicial review in water management
- To consider possible alternatives for a legally and operationally functional statutory review mechanism, in view of international best practice
- To propose a model for a suitable judicial review system for water management, which is both legally and operationally functional, to address the current non-functioning mechanism

Cost: R300 000

Term: 2016–2017

Water allocation for productive use – policy and implementation: A case study of the Black emerging farmers in the Breede-Gouritz Catchment Management Area, Western Cape, South Africa

Cape Peninsula University of Technology; University of the Western Cape; Breede-Gouritz Catchment Management Agency; Wageningen University (The Netherlands)

2530

Project aims:

- To explore the case of Black emerging farmers in the Breede-Gouritz Catchment Management Agency in the Western Cape, South Africa, between 2005 and 2015, by identifying and analysing the legal and institutional difficulties experienced by Black emerging farmers (BEF) accessing water use for productive purposes
- To define the role and influence of the bureaucracy as experienced by Black emerging farmers (BEF) in accessing water use for productive purposes compared to that of successful White farmers
- To plot and interrogate the role and effect of the intersection of bureaucracy and law impacting access to productive water and reform
- To contrast the experience of Black emerging farmers with those of commercial White farmers in accessing

water use for productive purposes to determine whether the new dispensation had brought about the expected redress

- To develop a means to contribute to the development and improvement of the status quo as experienced by the BEF
- To contribute to the ongoing cycle of review of the national water dispensation

Cost: R700 000

Term: 2016 – 2018

The challenge of inclusive growth in South Africa: Determinants and outcomes

University of Cape Town

2601

Project aims:

- Describe the nature of South Africa's growth-poverty-inequality trajectory since 1994
- Understand and estimate changes in asset and service poverty amongst households since 1994

Cost: R299 942

Term: 2016 – 2017

THRUST 2: WATER RESOURCE ASSESSMENT AND PLANNING

Programme 1:

Catchment data and information systems

Integrated land use and water use in water management areas, with a view on future climate and land use changes

CSIR; Stellenbosch University

2520

Project aims:

- To identify and quantify the current relationships between water use and land use at national and WMA/provincial/municipal scales
- To relate historic (15 years or longer) changes in water use to climate variability and land use changes
- To develop scenarios of future land use changes and model their likely effects on water use

Cost: R2 160 000

Term: 2016 – 2019

The hydrogeology of Groundwater Region 41: Eastern Great Karoo

Geowater IQ (Pty) Ltd

2525

Project aims:

- Contribute to the current knowledge of groundwater occurrence in the Karoo Basin



- Develop a guide for future groundwater development and regulation

Cost: R270 000

Term: 2016 – 2018

Continued hydrometeorological monitoring at the Two Streams experimental catchment for clear felling of the Acacia mearnsii stand

SAEON; University of KwaZulu-Natal (Pietermaritzburg)

2780

Project aims:

- Maintain and install monitoring equipment needed to estimate the water budget of Acacia mearnsii, and prepare for clear-felling in October
- Continue monitoring and data quality control activities until clear felling of Acacia mearnsii
- Determine the impacts of mature Acacia mearnsii on the water balance

Cost: R600 000

Term: 2017

Programme 2:

Surface water / groundwater hydrology

Ideas toward water-sensitive settlements

Envirosource; University of the Witwatersrand; University of Cape Town; University of Johannesburg

2519

Project aim:

- A water-sensitive approach to planning and design defines a new paradigm in integrated water cycle management, which aims to ensure that water is given prominence within the settlement design processes
- Assess the potential of settlements as their own potential water supply catchments, meaning access to a range of different water sources at a diversity of supply scales
- Assess the potential for the built environment (settlement) to supplement and potentially support the functions of the natural environment and human activities, e.g., agriculture
- Enable ideas of socio-political capital towards sustainability and the community's decision-making behaviour toward water-sensitive design

Cost: R380 000

Term: 2016 – 2018

An integrated early warning forecast system for wet seasons and their relationship to flooding events: A predictability study in support of hydrological applications

CSIR

2522

Project aims:

- To expand on the current CCAM seasonal forecasting capability of the CSIR through coupling with the Coupled Atmosphere-Biosphere Land Exchange

(CABLE) dynamic land surface model and the utilization of its river routing scheme; the horizontal resolution of the CCAM in seasonal forecasting mode will be 200 km

- To expand the 15-km resolution 7-day forecasts of CCAM to the medium-range of 14 days; CABLE coupling and river routing for 14-day forecasts to be implemented
- To further enhance the high resolution (4 km) weather forecasting capability of the CCAM by producing flow forecasts through the river routing scheme of CABLE; area of interest is the north-eastern interior of South Africa and adjacent countries
- To develop statistical downscaling schemes for seasonal, medium-range and 48-hour forecasts of river flows over the north-eastern interior of South Africa by making use of the daily flow data hosted by the Department of Water and Sanitation

Cost: R900 000

Term: 2016 – 2018

Nanosensors for oceans and atmospheric research

University of the Western Cape; Department of Environment Affairs (Marine and Coastal Management)

2533

Project aims:

- Development of novel polyamic acid nanocomposites modified with graphene: unique reactivity of polyamic acid (PAA) is induced by prevention of the cyclization of the reactive soluble intermediate into polyimides at low temperature to design polymer-assisted nanostructured materials; a new class of

conductive polymers that may be functionalised by incorporation of metal nanoparticles, quantum dots or copolymerisation (using polypyrrole) will be produced for selective electrochemistry

- Development of a Cyt C nanosensor, the detection of NO using the graphene-modified polymeric composites as well and those infused with metal nanoparticles
- Evaluation of the partition coefficients of CO₂, NH₃ and S_xO_y species at individual polymer/graphene nanocomposite interfaces; the gas(air) partition coefficients for CO₂, CH₄OH, CH₃CH₂OH will be determined using the shake flask method and UV/vis analysis and construction of calibration curve for quantification; the sensitivity of the polymer metal nanocomposites for these analytes in solution will be determined electrochemically and the sensor response for CO₂, CH₄OH, CH₃CH₂OH will be determined using potentiometric response protocols
- Evaluation of sensor array sensing formats for multicomponent analysis of the chemical species for which the electrochemical analysis protocol will be established
- Evaluation of array sensing in real sample analysis, in partnership with the scientists at Department of Environmental Affairs research laboratories, sensor array technologies will be applied to the determination of concentration profiles for CO₂, NH₃, NO_y and S_xO_y species, in and above ground and in seawater

Cost: R300 000

Term: 2016 – 2018



Programme 3:

Water resource planning and infrastructure

Developing practical documents to aid design and construction of liquid-retaining structures and making research provision for the next revision of SANS 10100-3

Stellenbosch University (Civil Engineering); University of KwaZulu-Natal (Howard College)

2514

Project aims:

- To provide guidance documents to clients, design engineers and contractors that would assist them in delivering economic, safe, watertight and durable structures, avoiding the common pitfalls in design and construction
- To conduct focused training seminars to disseminate the content of the guidance documents to clients, design engineers and contractors
- To identify outstanding issues influencing the effective procurement, design, construction and operation of liquid retaining structures, related water supply structures and infrastructure and to develop a framework for future initiatives required to address these
- To conduct the necessary research required to allow an informed decision regarding which crack width prediction models and limits for load-induced and restraint cracking, respectively, should be included in the next revision of SANS 10100-3, due in 2020 (these have a direct and significant influence on the economy of the structural design)
- To conduct the necessary research required to allow

the provision of better design guidance on the T1 (heat of hydration) and T2 (seasonal variation) values used in design for early age and long-term thermal cracking (thermal cracking is often problematic, necessitating unexpected and costly repair work).

- Contribute to capacity building by supporting one PhD student, two MEng students and several final-year student projects, who will be involved in related research
- Development of specialisation amongst staff members at Stellenbosch University (three members) and the University of KwaZulu-Natal (one member)

Cost: R1 500 000

Term: 2016 – 2019

Programme 4:

Climate change and water resources

Impact of the predictability of continental tropical lows on hydrological modelling: current state and future projections

University of Pretoria; University of Limpopo; South African Weather Service; CSIR

2510

Project aims:

- Develop an objective identification system for continental tropical low-pressure systems based on their circulation criteria and dynamical characteristics using re-analysis data
- Describe the temporal and geographical variability

of continental tropical low-pressure systems over subtropical southern Africa within the broader climate variability in the region

- Determine the contribution of CTL to rainfall over South Africa
- Provide case study examples of extreme rainfall producing CTLs
- Investigate the forecast uncertainty associated with CTLs using atmospheric flow fields from ensemble predictions and compare these results to forecast uncertainty associated with heavy rainfall producing cut-off lows
- Investigate the impact of forecast uncertainty on stream flow in the Limpopo River basin by using rainfall prognosis from ensemble predictions
- Determine the projected changes in frequency of occurrence and location of CTLs and the associated rainfall in a future climate

Cost: R719 800

Term: 2016 – 2019

Economic study of assurance of supply requirements for water resource management

WRP Consulting Engineers (Pty) Ltd; Conningarth Economists

2517

Project aims:

- To develop a methodology for assessing the assurance of supply requirements of various water user sectors based on economic grounds; case studies will be used, with particular reference to the agricultural sector
- Results will be used to develop assurance of supply criteria to enable the economically optimal management of water resources (local, regional and national)

Cost: R760 000

Term: 2016 – 2018



THRUST 3: WATER RESOURCE ASSESSMENT AND PLANNING

Programme 1:

Water quality monitoring

Assessment of potentially toxic elements and their species in selected water systems in Limpopo Province

University of Limpopo; Tshwane University of Technology; University of Johannesburg

2515

This project aims to assess the levels of potentially toxic elements (V, Mn, Pb, Cd, Ni, Cu, Fe, Zn, Cr, As and Se) and their species in wastewater, water and sediment samples collected from selected rivers in Limpopo Province, South Africa. The specific objectives are:

- To collect water and sediment samples from selected sites
- To develop a sample mineralisation method for digestion of wastewater and sediment samples using microwave-assisted digestion system for the determination of total concentrations of potentially toxic elements
- To develop sample preparation procedures, solid phase extraction (SPE) and supported liquid membrane (SLM) using chemical and biological adsorbents for sample pre-concentration and speciation of potentially toxic elements
- To apply the sequential extraction procedure proposed by the European Standard, Measurements and Testing (SM & T) program, formerly the Community Bureau of Reference (BCR), for

fractionation of potentially toxic elements in river sediments

- To develop microwave-assisted sequential extraction procedure for fractionation of the elements in sediments in less time, while using smaller volume of reagents
- To validate the developed/improved analytical methods by using standard reference materials (SRMs)
- To determine the levels of potentially toxic elements and their species in water and sediment samples using F-AAS, ICP-MS and HPLC-ICP-MS
- To evaluate the potential health risks that arise from the consumption of contaminated water

Cost: R1 037 000

Term: 2016 – 2019

Emerging and persistent contaminants/pathogens: monitoring methods development

University of the Western Cape; Chris Swartz Water Utilisation Engineers; Cape Peninsula University of Technology

2521

The aim of the project is to investigate and develop detection/monitoring methods for a large range of emerging and persistent contaminants:

- To scan the literature for possible emerging micropollutants identified in other provinces in South Africa

- To develop clear, concise and suitable effluent sampling procedures
- To develop suitable extraction procedures for the detection of a variety of emerging micropollutants
- To develop a new analytical method based on nanosilver-coated track-etched membranes that can be used for the identification of the emerging micropollutants in water samples by surface enhanced Raman spectroscopy (SERS)
- To determine the effect of different matrices upon detection and quantification of emerging micropollutants
- To determine the limitation of sampling, extraction and analytical techniques for detecting different categories of emerging micropollutants in water samples
- To compare the new analytical method with the existing ones in order to determine the advantage of the new method over the existing ones

Cost: R1 635 000
Term: 2016 – 2019

Improving drought and flood early warning, forecasting and mitigation using real-time hydroclimatic indicators

University of Cape Town
2618

The central and innovative hypothesis of the project is that new hydro-climatic observational networks, such as agro-meteorological and weather radar networks, can be integrated with conventional observational networks and models, thus allowing for better spatio-temporal estimation

of the severity of droughts and floods, facilitating their management. The main objective of IMDROFLOOD is to enhance flood and drought risk management at the catchment level through the development of novel flood and drought information tools.

Cost: R754 491
Term: 2016 – 2019

Scoping study: development of an inclusive terms of reference to improve licensing conditions by better understanding and application of RQOs used to improve resource class, under its current application in the Vaal Catchment

Rhodes University
2782

Project aims:

- To consult with all relevant stakeholders including: DWS (all relevant units), the Upper Vaal CMF, small industries, and Sasol
- To frame the scope of the case study that will investigate the methods and scientific defensibility for setting standards so as to meet RQOs
- To ensure buy-in by DWS (all relevant units) and stakeholders concerning the case study river reach/es
- To produce a TOR for an Upper Vaal Case study with agreed objectives, timelines and deliverables

Cost: R100 000
Term: 2017



THRUST 4: WATER RESOURCE PROTECTION

Programme 1:

Source water protection

Sentinel-3 validation for water resources protection (S3VAL)

CyanoLakes; CSIR; University of Cape Town

2518

Project aims:

- To validate measurements of water colour (radiometry) and geophysical variables from the Sentinel-3 Ocean and Land Colour Instrument during instrument commissioning and afterwards
- To collect high-quality datasets from locally developed, autonomous moored platforms to be used for validation of satellite-based measurements and development and testing of geophysical retrieval algorithms
- To build human capacity/expertise in water remote sensing to meet the demands of the private, public and research sectors
- To assess the data quality, absolute radiometric errors and the performance of standard atmospheric correction procedures of Sentinel-3 OLCI

Cost: R430 500

Term: 2016 – 2018

Incorporating environmental fate models into risk assessment for pesticide registration in South Africa

CSIR; University of Pretoria

2524

Project aims:

- Evaluate current registration process used in South Africa and identify gaps in current risk assessment framework
- Evaluate international best practice risk assessment approaches in pesticide registration
- Evaluation of data requirements, data availability and data sensitivity of environmental fate and transport models used in risk assessment for pesticide registration
- Development of standardized exposure assessment scenarios for higher tier exposure assessments in SA risk assessment
- Propose an improved/revised risk assessment framework for pesticide registration in South Africa that adequately addresses fate and transport of pesticides in the environment

Cost: R1 000 000

Term: 2016 – 2019

Water resources protection: a review of the state-of-the-art and research and development needs for South Africa

Umvoto Africa (Pty) Ltd

2532

Project aims:

- Review current legislation and regulations to identify research gaps
- Review current governance to identify research gaps
- Identify knowledge gaps
- Research into the current land–water nexus

Cost: R400 000

Term: 2016–2017

Hybrid water supply systems and conjunctive use in the context of water-sensitive settlements: a case study of Sekhukhune District Municipality, Limpopo Province

Vaal University of Technology

2534

Project aims:

- Assess and determine the status of physical and hydrological attributes of surface and groundwater resources in this area
- Quantify and map the stormwater and rainwater harvesting potential of the area as an alternative water source
- Characterise the quality of rainwater and stormwater harvested
- Profile the existing and potential new water users with a view to determine their water use characteristics (vis-a-vis quality and quantity) so as to determine

the probable alternative source(s) that is fit for the identified purpose

- Develop a framework/scheme for cascaded/stepped/ staged development of alternative water sources for the area
- Develop a model for conjunctive use of surface and groundwater for SDM

Cost: R1 000 000

Term: 2016 – 2019

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