

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



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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. The bulk of the research in this KSA is in support of Government Outcome 10: 'Environmental assets and natural resources that are well protected and continually enhanced'. Output 1: 'Enhanced quality and quantity of water resources' is largely supported by Thrusts 1, 2, 3 and 4. Thrust 5 supports Output 2: 'Reduced greenhouse gas emissions, climate change impacts and improved air/atmospheric quality'. Thrust 3 also addresses aspects of Output 3: 'Protected biodiversity'.

Integration, transdisciplinarity, synthesis, adaptive management, absorptive capacity and requisite level of simplicity are the principles guiding the future research approach. Emerging research areas are around water security and trade-offs between water, food, energy and the environment; the need for an equity framework and revised tenure systems for water; complete value chain assessments from water resources to raw water supply, tap water supply, wastewater treatment and finally back to freshwater systems or the coast.

OBJECTIVES

The ultimate objectives of the research in this KSA are to grow and maintain appropriate scientific capacity (i.e. the people-based knowledge pool), and to develop efficient and effective knowledge tools that meet the changing needs of water resource management in South Africa in which the human dimension is very central. This necessitates proactive, innovative, scientific, technological and institutional experientially-based solutions. A better understanding of water resources and their management requires a more holistic conceptual framework encompassing regional-scale hydrologic systems, land-atmosphere interactions and the biogeochemical cycles that control contaminant transport. Holistic approaches to water resource management are particularly pertinent in this area of research and must take account of all sources of water from quality, quantity and accessibility perspectives.

These objectives are achieved in support of the desired impacts on the lives and health of people, on the economy and on the environment, as articulated through the WRC Knowledge Tree and the Government performance outcomes.

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

Programme 3:
Water resource planning

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.

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.

Programme 4:
Water resource
infrastructure

Scope: 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,

Programme 5:
New water and
water security

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).

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).

THRUST 5: WATER RESOURCES AND CLIMATE

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 1: Predictive tools

Scope: The need to prepare the country to cope with global climate change and regional climate variability is of paramount and strategic importance. Taking the view that water is South Africa's key resource implies the need to adapt water resource management progressively as global climate change progresses,

in order to maintain optimal levels of both resource protection and beneficial use of water for society. The development of coping strategies will require the development of informed, quantitative scenarios of potential impacts, at regional and catchment level, on rainfall regimes and rainfall variability, hydrological and geohydrological regimes, water availability and reliability, water quality, ecosystem structure and functions and ecological processes. This programme will therefore focus on the following key issues: select and use GCM-generated scenarios of global climate change of appropriate confidence level as a basis for development of model projections; improve techniques for downscaling of scenarios from global (GCMs) to regional and catchment scales to enable or support management at higher resolution scale and to ensure high level of reliability and robustness; improve on detection and attribution of anthropogenic impacts of climate change in the Southern African context in order to distinguish those from natural climate variability and change-related impacts. The programme will also deal with: the choice of relevant and appropriate climate indicators and variables as well as monitoring systems that need to be in place in this regard; determination of the frequency and magnitude of resultant extreme rainfall and flow events; use of existing conceptual and numerical models to utilise global change-related, downscaled, hydro-climatic information effectively, to provide information regarding likely inter-related land-use, ecosystem, hydrological (including geohydrological), water yield and water quality changes at regional/catchment level; modification of existing management strategies and tools for adaptation purposes; determining the likely socio-economic impacts for a given structure of society in Southern Africa; and appropriate technological, social and political coping strategies. Other areas that will be attended to include: improving understanding of and forecasting of the variability of rainfall, flow and groundwater recharge, as the ability to forecast at very short time scales would greatly benefit flood management and disaster mitigation and adaptation activities; and improving the understanding of global climate change impacts and vulnerability for the purposes of better informing the nation on permanent changes of the climate which require long-term solutions and adaptation actions. Through this programme, support will be provided for weather and climate disaster mitigation programmes at various levels which will include regional, national and provincial as well as other, more localised, scales.

Programme 2:
Climate change risk,
vulnerability and
adaptation

Scope: SClimate change risk management seeks to promote sustainable development by reducing vulnerability associated with climate risks. The approach involves a range of actions including reduction of vulnerabilities or enhancement of resilience amongst people and societies, protection of ecosystem goods and services, early response systems, strategic diversification, and improved institutional capacities. Climate adaptation refers to the ability of the system to adjust to climate change, variability or extreme to moderate potential damage or to cope with the consequences. This programme is aimed at reducing vulnerabilities among communities and people through development or implementation of systems, tools, approaches and strategies (some of which would have been developed under Programme 1, such as modification of structures or implementation of early preparedness programme for extreme events). Protection or restoration of ecosystem goods and services that are vulnerable to climate variability and change as well as strengthening capacity of people and institutions are some of the techniques that will be investigated under this programme. Climate risk management strategies to be developed under this programme also aim to maximise opportunities in climate-sensitive economic sectors, even under uncertain climatic conditions of high variability. The programme could also deal with implementation of capacity building and awareness programmes including sharing of climate information as part of a broader adaptation programme.

Programme 3:
Integrated flood and
drought management

Scope: Flooding and drought are major natural hazards to human society and have important influences on social and economic development. The most vulnerable communities are often those who are poorly resourced since they barely have means to cope, and also often live in informal settlements notorious for being drought- or flood-prone with poor infrastructure. This programme focuses on research that will result in the development and implementation of integrated institutional frameworks and technological tools to reduce and combat floods and their negative effects, while enhancing positive flooding patterns that are important to the natural ecosystem. Research related to drought management will focus on integrated tools and strategies for early identification and mitigation of the social and economic impacts of drought, with the aim of supporting collaborative, multi-institutional processes and programmes.

STRATEGIC CONTEXT

In December 2010, the United Nations General Assembly declared 2013 as the United Nations International Year of Water Cooperation. There was thus a focus in 2013/14 on raising awareness, both on the potential for increased cooperation, and on the challenges facing water management in light of the increase in demand for water access, allocation and services. Successful water cooperation initiatives were highlighted, as well as ongoing challenges such as capacity building, water governance, transboundary water management, national and international legal frameworks, and infrastructure development. Particular challenges faced in South Africa include: institutional fragmentation, mainly poorly coordinated multi-level governance vertically and horizontally; limited capacity at the local level to participate in water-related decision making; and a struggling allocation reform process. Inadequate means for measuring performance have also contributed to weak transformation and reforms. These obstacles seem to be rooted in the insufficient definition of policies and regulations related to the National Water Act and the overall lack of common vision regarding water in the tri-central focus of economy, society and the environment.

It is well known that there is no one-size-fits-all answer or magic blueprint to respond to governance challenges in the water sector. Local and spatially-defined policies integrating boundary specificities and local concerns, water management institutions, catchment management agencies, water user associations, transboundary commissions, etc., are at different developmental stages but tend to face common challenges, which will need to be examined, with the benefit of hindsight, to provide adequate policy responses. In order to do so, there is a pressing need to take stock of recent experiences, identify and document good practices and develop pragmatic tools across different levels of government and other stakeholders for engaging shared, effective, and implementable water policies.

A main effort in this KSA is to continue understanding the water cycle and how it operates, how it affects land-use practices and is affected by them and other atmospheric and anthropogenic processes. Climate change and the focus on allocating scarce water resources will require strategies for managing demand, increasing efficiency, and creating new sources of water from desalination, fog harvesting, targeted recycling, reuse, artificial recharge, etc., which can be viewed as part of Outcome 6: 'An efficient, competitive and responsive economic infrastructure network' which relates directly to water resource assessments, planning and development of infrastructure. Output 4: 'Maintenance and supply availability of our bulk water infrastructure', relates to these pertinent aspects.

Water resource assessments are expected to benefit from improvements in the accuracy and detail of hydrological measurements and how these are interpreted in water resource simulations and other tools for water resource decision making. The extent to which interpolations and extrapolations can be used in modelling real water regimes can only suffice if real, reliable data are available at reasonable spatial and temporal resolutions for verification. The KSA has invested heavily in enhancing the estimates for quantifying water use and water availability. Furthermore, the need for integrating surface water and ground-water models has been highlighted. Concerted effort is being made to bridge this gap and to create a continuum, starting with improving evapotranspiration estimates, which take into account the unsaturated zone, informed by groundwater dynamics.

The marked inequities in the physical, social, as well as institutional, access to this important resource remain a challenge. At its heart, sustainable development is about giving people the opportunity to build resilience by providing them with more options in their lives and livelihoods. The focus is on the poor and the disempowered majority whose ability to pay for water is limited. Delivering water services to this majority and ensuring that there are adequate water resources for new productive users, such as emerging farmers in rural areas, is a main target of Outcome 7: 'Vibrant and sustainable rural communities and food security for all'. Output 1: 'Sustainable agrarian reform' is a major focus for the KSA dealing with Water and Agriculture, but in this KSA the main focus is from the perspectives of climate change and adaptation, resource assessment and the institutional arrangements pertaining to addressing equity aspects as well as water licensing and allocation reform.

The KSA's contribution to the national service-delivery-based outcomes is hence through conducting research that can yield impacts on sustainable development's triple bottom line, through improved water allocation and optimisation of water use between social development, economic growth and environmental sustainability.

Water and society

The National Water Act (NWA) places emphasis on stakeholder participation in water resource management, which forms a blend between decentralisation and democratisation for decision making. Vast resources have been used in ensuring that adequate consultation takes place, without necessarily reflecting much value from those investments. International literature confirms that empowerment is a long path which is progressive in nature and highly non-linear. Since the primary focus is to make an impact on the lives of people, the KSA has commissioned studies to establish the lowest appropriate level for decision making in water management in South Africa, the benefits from such engagements and their impact on the lives of women and the poor. The role of local government as the democratic representative in water-related decision making in South Africa is an area that needs further investigation.

Water and the economy

The evidence of global climate change, largely as a result of human activities, has now been documented. There is a growing consensus among global climate model projections regarding the nature and extent of the change. The main climate change consequences which are related to water resources have been identified as increases in temperature, shifts in precipitation patterns, increased frequency and intensity of floods and drought events, and sea-level rise.

The KSA has initiated a comprehensive research programme on climate-change impacts on water resources, with a view to gaining insight into the magnitude of the impacts and subsequently the consequential adaptation needs for the economy; the first steps to incorporate research on vulnerability, mitigation and adaptation have already been taken. The success of this research relies on the outcomes of considerable prior investment by the WRC in water-related climate, atmosphere and ocean-atmosphere research, as well as hydrological modelling research, done over a period of more than 15 years.

Water and the environment

A recent review of relative investments in the different impact areas revealed the need for new research in the area of environmental degradation and mitigation, especially from a water-use perspective, such as that of agriculture, mining, etc. Environmental functioning within the hydrological cycle and the integrative knowledge for ecosystem-based water resource management is another area of interest. The impact on the environment from the release of energy and the resulting impact thereof on water resources have formed part of a long-term discussion between WRC and Eskom, and an agreement has been signed between the two parties to conduct joint research into alternative energies and the international benchmarking of the latest technologies.

BUDGET FOR 2013/14

The approved funding of the research portfolio for 2013/14 led to a committed and approved funding budget, inclusive of roll-over, of R33 850 278.

| Research portfolio | Approved 2013/14 (R) |
|--------------------|----------------------|
| Current projects | 24 081 184 |
| New projects | 9 769 094 |
| Total | 33 850 278 |

RESEARCH PORTFOLIO FOR 2013/14

The primary objective of the research in this KSA continues to be to ensure that water resources of South Africa are protected, utilised, developed, conserved and managed to achieve environmental, social and economic sustainability. The research portfolio for 2013/14 addressed this primary objective through Government delivery Outcomes 6, 7, 9 and 10, and as reflected by the following secondary aims:

- Broaden the scope for policy and institutional studies to deal holistically with political, legal, economic, compliance and implementation aspects
- Improve water resource information systems and access to data
- Protection of water sources in a comprehensive and integrated manner by focusing on supporting implementers
- Mainstreaming climate change discourse to pay closer attention to water

COMPLETED PROJECTS

THRUST 3: WATER RESOURCE INSTITUTIONAL ARRANGEMENTS

Programme 1: Water governance and institutional reforms

The development of an institutional adequacy index using the multi-dimensional poverty approach

Brooks World Poverty Institute; University of the Western Cape; University of Oxford

No. 1971

There are obvious links between water and poverty, links that are implicit in the water policy legislation (National Water Act, 1998) and guiding frameworks such as the framework Water for Growth and Development, Catchment Management Strategies and Water Services Development Plans. The Act prescribes that suitable water management institutions must promote social and economic development through the use of water. The water sector operates in an epistemological framework that is predominantly positivist. The poverty frameworks and notions of human development that cannot be captured from within that frame remain underdeveloped. One of the core principles of integrated water resource management (IWRM) is that resources should be managed by users who are closest to the resource and that there should be suitable institutions put in place with multi-stakeholder representation at the lowest possible levels. The reason for multi-stakeholder representation is that the stakeholders themselves should have the opportunity to make decisions in line with ideals of social equity, financial feasibility and environmental sustainability. However, our eagerness to implement policy in the sector all too often results in what Crocker (2011) calls 'palliative remedies', where the intended good of representation and inclusivity is all too often lost, with not enough attention given to the conditions that are necessary for these institutions to be 'suitable.'

Cost: R1 590 000

Term: 2010 - 2013

Change-oriented learning and water management practices: knowledge flows and mediation tools

Rhodes University; Masithethe; Mvula Trust; AWARD

No. 2074

This project has drawn on 15-20 years of research into participatory integrated water resource management and environmental learning, in an endeavour to understand the role of learning in the democratic management of natural resources, in this case water. Research into integrated water resource management in South Africa first focused on trying to understand how to implement the principles of the then new National Water Act. This included establishing decentralised institutions of water management. The assumption was that residents of catchments would be more equipped and should have the right to make important decisions about the management of their natural resources.

The emphasis was on participation, representivity and inclusion. Right from the start it became apparent that part of the process of decentralisation of power and decision making was a need to capacitate. Learning how to manage a catchment, how to work together and how to develop appropriate practices and responses did not happen automatically but needed to be mediated.

Cost: R900 000
Term: 2011 - 2014

Investigating stakeholder engagement cycles and identities within water resource management, using narrative techniques

The Narrative Lab; Nelson Mandela Metropolitan University; SANParks

No. 2076

This project investigated the social dynamics of stakeholder engagement and volunteerism, using narrative techniques at two study sites in the Western Cape, namely, the Wilderness and Swartvlei estuaries, situated on the Garden Route, close to the towns of Wilderness and Sedgefield. In particular, the study aimed to understand why citizens choose to engage with water resource challenges, how they translate that engagement into action and participation and how such engagement may be cyclical in nature. The study investigates how citizens become and remain engaged in decision making regarding the management of the natural resource, to determine: (i) if they feel they are empowered, and (ii) if they have sufficient knowledge, as well as (iii) guiding principles on how to act or start an active engagement process.

Cost: R746 108
Term: 2011 - 2013

Programme 3: Pricing and financing WRM

Approaches to engaging basin risk and the political economy of water in the Western Cape system

Pegasys International

No. 2075

Historically, water planning has focused on water resources infrastructure development and operation, supported by demand management initiatives to reconcile water requirements and availability. However, as water resources are increasingly developed and utilised, catchment quantity and quality stress tend to increase. The resulting complexity in management and use requires a shift towards improved governance and balancing of competing economic, social and ecological interests. This project investigated possible ways of assessing regional water resources in the Western Cape system (Berg and Breede-Overberg WMAs) from a political-economic and developmental perspective. This can be used to inform water management strategy processes (both the National Water Resources Strategy and

Catchment Management Strategies) as well as provide the types of information that allow effective engagement with provincial and local government planning processes.

Cost: R700 000
Term: 2011 - 2014

An analysis of water pricing instruments governed by the DWA water pricing strategy, and its potential for generating revenue for CMAs

Prime Africa Consultants (previously CIC International); Inkomati Catchment Management Agency

No. 2078

CMAs are statutory bodies with jurisdiction in defined water management areas. The mandate of the CMA has been clearly defined. The various functions required of the CMA have been spelled out in the National Water Act and various publications of the Department of Water Affairs. The foundational strategies, as defined in this report, address the core business of managing water resources and of complying with the business requirements, and with the other functions vested in the Minister. As the CMA becomes established, the Minister will progressively delegate further powers to the CMA to broaden its functioning. In the initial phase the CMA is required to develop policy and strategy and organisational and administrative support. Following this the Minister may delegate certain financial functions such as the registration of water users and the setting of water use charges. The physical implementation and information management of the WMA are then to be delegated before the CMA will become the responsible authority in the WMA. Recognising that some of the CMAs will serve areas with a relatively small water use management component, while others will serve WMAs with a large and diverse economy, the size and powers of the CMA would differ accordingly. The current raw water charge structure does not reflect the full cost of water resource management and is therefore subsidised by a substantial amount from the national fiscus. The current water use charge levels will yield a total revenue of between R223 million and R273 million by the year 2025. An increase of about 270% would be required to raise CMA revenue to the level where the cost of the CMAs could be 100% accounted for. At this tariff level, the average charge per cubic metre would be 5.86 cents and would generate revenue of approximately R828 million, which will fully cover the estimated cost of running 9 fully functional CMAs.

Cost: R610 000
Term: 2011 - 2014

Programme 5: Future scenarios

An analysis of paradigms shaping water research in South Africa: questions for future research

University of Cape Town

No. 2170

Limited historical data are available to describe water research in South Africa over the first half of the 20th century. Many authors recognise that this period was dominated by technological developments, breakthrough research and projects in water storage and transfer, and frequently characterised by a positivist approach to nature and development. A new era in water research in South Africa began with the promulgation of the Water Research Act No. 34 of 1971. The Act led to the formation of the Water Research Commission (WRC) and the Water Research Fund with the purpose of initiating, managing and financing water research. The objectives of the WRC, as stated in the Act, were to co-ordinate, promote, and encourage research in respect of a wide range of purposes and activities (Republic of South Africa, 1971). A shift in the political landscape, marked by the first democratic elections in South Africa in 1994, contributed to a major shift in the existing water resource management paradigm. Legislative reform coincided with growing concerns about the state of the country's waterways and the rising capital expenses in supply schemes, coupled with the growing environmental concerns globally. South Africa is lauded as being the first country in the world to have promulgated national water legislation which uses water to achieve societal transformation and which focuses attention on environmental and social justice. This study commenced with the identification of the prevailing paradigms that have influenced the history of water research in South Africa, by analysing the publication output over the last four decades, and identifies research questions proposed by a range of researchers active in the water sector in South Africa.

Cost: R300 000
Term: 2012 - 2013

THRUST 2: WATER RESOURCE ASSESSMENT AND PLANNING

Programme 2: Surface water / groundwater hydrology

The use of isotope hydrology to characterise and assess water resources in South(ern) Africa

University of the Western Cape; iThemba Laboratory for Accelerator-Based Sciences; Department of Water Affairs; University of Cape Town; University of KwaZulu-Natal (Pietermaritzburg); Mannie Levin; AS Talma; University of the Witwatersrand

No.1907

Environmental isotopes are routinely employed world-wide in the study of groundwater and surface water, as they provide unique information on transport and interconnectivity of water resources and reservoirs. The term environmental isotope embraces the measurement of isotope ratios of the elements making up the water molecule and of substances dissolved in water. These are subject to environmental processes and undergo changes, for example during evaporation. Water in specific environments thus obtains isotopic labels that are transported and

can be traced along the flow pathway. The sustainable development and management of groundwater resources requires an accurate assessment of their occurrence, availability, sustainability and vulnerability to deterioration. Environmental isotope studies have been shown to provide important information useful in the effective management of both groundwater resources and surface water systems.

Cost: R2 000 000
Term: 2009 - 2013

The long-term impact of *Acacia mearnsii* trees on evaporation, streamflow, low flows and groundwater resources. Phase II: Understanding the controlling environmental variables and soil water processes over a full crop rotation

Department of Water Affairs; Mondli; CSIR; University of KwaZulu-Natal (Pietermaritzburg)

No. 2022

Internationally, long-term catchment studies such as those conducted at the Two Streams research site which include actual measurements of all of the water balance components (some since 1999, and to 2013) are scarce, while locally this represents a unique study on the impact of an exotic tree plantation on catchment hydrological processes. Detailed measurements of total evaporation, streamflow, rainfall and groundwater were compiled to show a deficit in the water balance over the past seven years. Additional research was conducted on canopy and litter interception and stemflow contributions. During the most recent phase of work, isotope samples were collected using conventional automatic samplers from the stream as well as newly developed rainfall samplers. In addition, techniques to extract isotope samples from the soil profile were improved, providing information on the water pathways through the catchment. Tree water-use measurements on different slope positions showed significant differences depending on distance from the river and aspect. These detailed process studies continue to enhance our understanding of the impacts of commercial forestry on the hydrological cycle, providing invaluable information to support hydrological models and policy development within the water sector.

Cost: R2 295 872
Term: 2011 - 2015

Groundwater–surface water interaction: From theory to practice

University of the Free State; Rhodes University; University of KwaZulu-Natal (Pietermaritzburg)

No. 2054

Surface water and groundwater resources as well as atmospheric processes are all components of the larger, interconnected hydrological system and the development of either resource will affect both the quantity and quality of the other. In the past, surface water and groundwater were seen as separate water resources and dealt with individually. However, in more recent times the inter-connectedness of these two resources has become evident.

It stands to reason that understanding and quantifying the amount of groundwater feeding the surface water system at the river–aquifer interface is an essential component of understanding the whole hydrological system to ensure the responsible use of both water resources. Furthermore, in South Africa, data is segmented into purely atmospheric, surface hydrology or geohydrological data for specific areas. Commonly, no significant overlap exists between the surface and sub-surface hydrological data that could enable the establishment of a relationship between these two components of the hydrological cycle. In light of this, the current project is aimed at investigating surface water–groundwater interaction at specific test sites, where this interaction can be studied using a multi-disciplinary approach. The multi-disciplinary approach aims to include surface hydrology, evapotranspiration, vadose zone hydrology and geohydrology. The data gathered at the specific test sites will be used to identify important processes taking place, define the contributing sources to the river and the quantification of these source volumes.

Cost: R3 000 000
Term: 2011 - 2013

Investigation of groundwater potential in fractured crystalline rocks of the North West Province, South Africa

University of Venda; Council for Geoscience

No. 2055

In this study, investigation of groundwater potential in crystalline basement rocks of the North West Province was carried out. The area of study is located in the Naledi Local Municipality situated in the central part of the North West Province. It covers an area of ~7 260 km² and consists of 8 quaternary catchments. Hydrogeologically, a large part of the area falls within the Lower Vaal catchment. The average annual precipitation in the area is ~350 mm and temperature varies from very cold (below freezing point) to 35°C during the warm season. Groundwater recharge in the area is low (<10 mm) and largely depends on temperature and the seasonality and intensity of rainfall. Potential evaporation rate ranges from 1 960 mm to 2 100 mm per annum, exceeding annual rainfall. It is typically a semi-arid to arid region, and groundwater is the main source of water supply for domestic and agricultural use. The resulting map shows a number of groundwater potential zones varying from 'very good' to 'very poor'. The zone shown as 'very good' and 'good' groundwater potential covers ~17% and ~22% of the study area, respectively. The superimposed borehole yield also confirms the results derived from multivariate statistical modelling approaches, whereby high borehole yields (> 15 L/s) occur within carbonate rocks consisting of dolomite and limestone and located in the southern part of the area. In addition, follow-up geophysical surveys carried out at selected sites confirmed the presence of conductive layers varying in depth from 20 m to 35 m. The high conductivity possibly indicates the presence of water-bearing formations, in particular dolomite, located around Vryburg, and highly-fractured granite just south of Stella. The high-yielding wellfields can be attributed to dissolution of carbonate rocks by water that percolates through pre-existing fractures leading to enlarged fracture apertures, and consequently resulting in the development of large cavities that can store and supply significant amounts of water.

Cost: R1 000 000
Term: 2011 - 2013

Development of the pressure release flowing test method for artesian flow aquifers with case study in TMG

University of the Western Cape; Council for Geoscience

No. 2058

The Table Mountain Group (TMG) is a strategic aquifer system in South Africa. The sustainable utilization of groundwater resources in TMG still presents challenges, as many flowing artesian boreholes cannot be properly tested using conventional pumping test approaches. Due to the unique characteristic of flowing artesian boreholes, a free-flowing test is preferential to the conventional constant-rate pumping test approach. Discharge rate and pressure head at pumping and/or observation boreholes are required to be measured simultaneously during the test. Therefore, a test unit for capturing the data accurately is deemed to be critical for data interpretation afterwards. Two case studies in TMG are presented in this report. For the artesian borehole in Rawsonville, the test unit was installed and utilized to capture the data during the free-flowing test, which are interpreted by the program afterwards. The resultant parameters were verified by the single-packer tests conducted in 2006. For the case study in the Oudtshoorn artesian basin, data from a two-month free-flowing test in a flowing artesian borehole were manually captured from both the test borehole and observation borehole. The results from both cases indicate that the aquifers are somehow bounded by no-flow conditions, especially in the case of Rawsonville where the recorded data supported this hypothesis. Furthermore, there is a negative skin zone surrounding the test boreholes. Skin factor ranges between -3 and -2 with effective radius ranging from 0.5 to 1.58 m for the artesian borehole in Rawsonville; while the skin factor and effective radius of the artesian borehole in Oudtshoorn are approximately -2.2 and 0.92 m, respectively, as derived with the data from the observation hole. The transmissivity of the artesian aquifer in TMG ranges from 4 to 24.4 m²/d, calculated with recovery test data, while, based on the values for effective radius, it varies from 13.7 to 78.3 m²/d, derived with free-flowing test data. The storativity of the artesian aquifer in Rawsonville is about 2.0×10^{-4} to 5.5×10^{-4} , and in Oudtshoorn is approx. 1.16×10^{-3} . The transmissivity of the aquifer derived by the recovery test method is lower but more reliable than that derived by the conventional pumping test method.

Cost: R400 000
Term: 2011 - 2014

Validation of the forcing variables (evaporation and soil moisture) in hydrometeorological models

University of KwaZulu-Natal (Pietermaritzburg); WaterWatch; Pegram and Associates (Pty) Ltd

No. 2066

Evapotranspiration (ET) and soil moisture (SM) have only been available at isolated sites until recently, when the work carried out during two WRC research projects (Pegram et al., 2010; Sinclair and Pegram, 2013) developed a detailed spatial product of real-time estimates of SM and ET. The model has shown great promise, but still required

further development as errors in the input data streams are hampering the quality of the product. This project was commissioned to provide a spatially explicit validation procedure for the 1-km grid of ET and SM which are produced through the HYLARSMET and PyTOPKAPI models, as well as other hydrological models. The specific objectives of the project included (i) disseminating knowledge on the process of soil modelling using the distributed PyTOPKAPI model; (ii) establishing the best method for verification of modelled results (iii) identifying suitable scales and replication of field measurements required, and (iv) selecting the most suitable catchment where data networks and suitable land uses are in place. The project provided field measured ET and SM data during the two validation experiments, using the eddy covariance method and profile soil water content measurements. The SEBS model was used for ET and SM estimates for inter-comparison with the HYLARSMET model. In addition to spatial estimates of ET, the project aimed to use spatially-distributed field-based measurements of SM to verify SM sensors which were planned to be rolled out at SAWS weather stations. The spatial knowledge of land surface ET and SM is crucial for water resources management, crop modelling, optimizing irrigation water use, and flood forecasting.

Cost: R700 000
Term: 2011 - 2014

Programme 3: Water resource planning

An Investigation into the effects of atmospheric pollutants on surface water quality in the eastern regions of South Africa

Univ. of KwaZulu-Natal (Pietermaritzburg); Golder & Associates; Univ. of Stellenbosch; Umfula Wempilo Consulting
No. 1697

The aim of the project was to determine if emissions from fossil fuel burning on the Mpumalanga Highveld are likely to increase salinization of surface water and degrade soil resources. The approach was to first identify and select three catchments which fall within the area of heavy deposition of acids of atmospheric origin, then estimate deposition of acidic substances originating from gaseous emissions from fossil fuel burning, analyse streamflow, and undertake soil chemistry tests. The findings were that both acid emissions and acid deposition have been increasing exponentially, as well as loads of sulphate and base cations exported from each catchment. Soils, on the other hand, were found to have a high buffering capacity due to high organic content.

Cost: R1 435 300
Term: 2006 - 2013

Optimal utilisation of geothermal water resources

University of South Africa; Council for Geoscience; University of Pretoria
No. 1959

The aim of the project was to identify the optimal uses of thermal springs in South Africa. The objectives were three-fold, including the determination of the geological, biological, physical and chemical characteristics of the thermal springs in South Africa; their fitness for current use; and their suitability for alternative uses. Various countries around the world have recognised alternative uses for waters and heat generated from thermal springs. Currently, the South African thermal springs are underutilized. This project has explored the suitability of South African thermal springs for a variety of alternative uses as applied elsewhere in the world. Alternative uses included geothermal power generation, the bottling of thermal waters, use for agriculture, such as greenhouse heating, the production of fish and Spirulina and the extraction of minerals. It has also sought to assess the suitability of thermal springs for more unusual uses such as for cosmetic purposes and to identify springs that could possibly associated with Kieselguhr deposits.

Cost: R 2 380 655
Term: 2010 - 2013

Development of a groundwater resource assessment methodology for South Africa: towards a holistic approach

University of the Free State; GEOSS - Geohydrological and Spatial Solutions International (Pty) Ltd; Water Geosciences Consulting; IWR Water Resources

No. 2048

With growing water demand in South Africa, the limit of what surface water can supply has nearly been reached, and many experts are calling for more groundwater use and better groundwater management. However, estimating the groundwater that can be safely abstracted from an area or catchment without harming the environment and other water users is difficult. Over the years, scientists have developed various models to quantify the groundwater resources and these have been standardised in a number of countries. In South Africa there is no standardised approach with which to assess groundwater resources. The purpose of this study is to develop and test (to a limited extent) a more consistent approach to quantify groundwater resources for South African conditions. The proposed mixing cell model (MCM) takes into account both the physical flow of water in a river and the changes in natural river water chemistry that can signify groundwater baseflow. The method will be considered for incorporation into the existing methods for assessing South Africa's total water resources.

Cost: R980 000
Term: 2011 - 2013

Non-parametric multi-site stochastic rainfall generation including climate change–related non-stationarity

University of the Witwatersrand

No. 2148

The planning and operation of most of the large water resource systems in South Africa has been applying a multi-site monthly streamflow generator since the 1990s, but it has recently been recognized that the use of stochastic rainfall

generation may hold several advantages over stochastic streamflow generation. Since rainfall is the main input to the hydrological cycle, applying stochastics on rainfall rather than streamflow is naturally more inclusive. With stochastic rainfall, probabilistic analysis can be included more realistically and easily in the analysis of catchment hydrological processes and rainfall-dependent activities such as irrigation. The impacts of climate change and increasing variability on basin hydrology and water resources can also be studied with more ease with a rainfall rather than streamflow stochastic generator. Consequently, this project was proposed to develop and test a monthly non-parametric stochastic rainfall generator that would comprehensively incorporate climate change and changing variability, including information from global climate model (GCM) projections.

Cost: R417 600
Term: 2012 - 2014

Evaluation of the monthly stochastic rainfall generator in existing Department of Water Affairs risk-based water resources yield assessment processes

Hydrosol; University of Stellenbosch; University of KwaZulu-Natal (Pietermaritzburg)

No. 2155

The application of spatially-correlated time-series of monthly stochastic streamflow in South African water resources planning processes is widely considered to be world-leading technology. With the recent development of a monthly spatially-correlated stochastic rainfall generator (PEGRAIM-W), the aim of this project was to assess the impact of applying stochastic rainfall from PEGRAIM-W in yield assessments for four climatically diverse water resource systems. The use of stochastic rainfall presents significant potential advantages, including the explicit stochastic modelling of hydrological processes such as surface-groundwater interaction, irrigation requirements, the impacts of streamflow reduction activities and water quality in yield and planning scenario analyses. Other advantages are the potential for modelling climate change impacts on rainfall stochastically and contributing towards current initiatives to quantify uncertainty in hydrological and yield assessments. Based on the results of the research project it was concluded that the yield and assurance of supply characteristics resulting from analyses undertaken based on stochastic rainfall and stochastic streamflows compare remarkably well. In view of this finding, as well as the associated advantages mentioned earlier, it is strongly recommended that the stochastic-rainfall approach is implemented as an alternative option for undertaking risk-based water resource yield assessments in South Africa.

Cost: R700 000
Term: 2012 - 2014

Programme 4: Water resource infrastructure

Structural health monitoring of arch dams using dynamic and static measurements

Department of Water Affairs; University of Cape Town

No. 2025

The key objective of this project was to develop a holistic approach to structural safety assessment of concrete arch dams, while developing high level manpower in the field of dam safety. Two methodologies, the ambient vibration method (AVM) and the Westergaard method, which is the most commonly adopted approach for dynamic analysis of dams, were tested to establish their applicability in finite element model updating of arch dams based on ambient vibration testing. The project demonstrated that ambient vibration testing (AVM) is a viable methodology for surveillance and monitoring of arch dams, while the Westergaard method tends to overestimate the added mass of water for divergent and/or skewed reservoirs. A significant finding is that the Westergaard method cannot be directly applied to dams with divergent and/or skewed reservoirs. Additionally, the effect of seasonal temperature variations on arch dams was modelled and the results show that it is critical to include temperature effects for dynamic analysis of arch dams. However once the initial thermal stresses have been introduced, the influence of seasonal temperature variations on dynamic characteristics is negligible.

Cost: R1 500 000

Term: 2010 - 2013

THRUST 3: WATER QUALITY MANAGEMENT

Programme 1: Water quality monitoring

Implementation of the rule-based agent for *Microcystis* in Rietvlei Dam

Crips Environment; City of Tshwane; North-West University (Potchefstroom)

No. 1962

In a study done by Van Ginkel (2008), an early warning/prediction tool (a real-time rule-based agent) for *Microcystis aeruginosa* blooms was developed and validated by means of a merged limnological time-series dataset of hypertrophic reservoirs, Hartbeespoort, Rietvlei and Roodeplaat Dams, using hybrid evolutionary algorithms (HEA). This rule set was then tested on data from two other hypertrophic dams, Bon Accord and Klipvoor Dams, which had not been used in the training data set. The agent proved to be generic for the five warm, temperate and hypertrophic reservoirs, four of which were monomictic and one dimictic. Although this model has already been validated

conceptually, there is a need for the model to be validated operationally, and the data to be used should be statistically validated for it to be acceptable as a prediction tool. In this study the prediction tool (CEGAP), for *Microcystis aeruginosa*, was validated operationally using data obtained from the Rietvlei Dam WTW. However, due to the recent deployment of the SolarBees, data from Bronkhorstspruit Dam was also used for further validation. The prediction tool (CEGAP) has been prepared in a ready-to-use Excel (2007) format and can be used by local water resource managers to predict blooms up to 28 days in advance. With the aid of this predictive tool the proper drinking water treatment procedures can be incorporated in advance, in order to ensure the production of safe drinking water, thereby managing the risk imposed by the cyanobacterial blooms in the water resource on drinking water facilities and the health of recreational users. The following were the aims of the project:

- To compile a recent ecological overview of the water quality of the Rietvlei Dam and to describe the process configuration and advanced treatment options already employed to produce potable water
- To investigate the effect of habitat disturbance created by long-distance circulation of the SolarBees on the development of cyanobacterial blooms and water quality
- To implement the prediction tool CEGAP and evaluate its performance as an early warning/prediction tool for water treatment works' managers

Cost: R175 000
Term: 2010 - 2015

Programme 3: Impacts on and of water quality

Guideline for EDC management in water resources: Volume 1: Monitoring and Assessment

University of Pretoria; CSIR; Department of Water Affairs; Rhodes University; independent consultants

No.1915

A significant aspect of the project that was investigated related to the current data sources and data quality for EDC detection and monitoring in South Africa. This allowed for needs, capacities and capabilities to be determined for the monitoring and assessment of EDCs. These outcomes were then tested in practical site-specific case studies in which monitoring and assessment of EDCs was conducted. The objective was to not only provide an example of how to proceed with the monitoring and assessment of EDCs but to also evaluate the methods presented in the various Volumes of the Manual. The case studies also included, for the first time in the WRC EDC programme, the investigation and presentation of thyroid dysfunction due to potential EDC exposure via drinking-water in a sentinel livestock species. A robust, cost-effective method for investigating several EDC endpoints in a sentinel livestock species was tested and, based on the results, proposed as a viable addition to EDC monitoring and assessment. Analytical procedures required to routinely assess inorganic EDCs were also developed and tested for the case studies. Whilst conducting the case studies the project engaged with several Government departments, notably the Department

of Mineral Resources, the Department of Environmental Affairs, the Department of Agriculture, and the Department of Water Affairs. It was established that in order for the monitoring and assessment of EDCs to have any significant impact legal compliance with the relevant sections of several Acts and Government Notices was essential. Although this related primarily to the manner in which current monitoring requirements were being formulated within the directions and intentions of existing legislation, stakeholder consultation and comments submitted for various reviews and Government Notices, resulted in an invitation to submit proposals for best-practice guidelines. Since this was not accommodated in the scope of this Volume, nor the Manual, it remains a recommendation to develop a single guideline document for the Directorate of Water Resource Protection and Waste at the Department of Water Affairs. The fundamental objective of the project was thus to highlight the approach required for the regulator/health authorities to make informed decisions based on acceptable scientific data within the context of the challenges posed by the monitoring and assessment of EDCs. As with other the Volumes the approach adopted remains based on the precautionary principle, as many of the EDC potential hazards posed are new and not yet fully described.

Cost: R1 500 000
Term: 2009 - 2013

THRUST 4: WATER RESOURCE PROTECTION

Programme 1: Source water protection

Vadose zone hydrology: Spatial and temporal influences, assessment techniques and aquifer susceptibility

WSM Leshika Consulting (Pty) Ltd; University of Pretoria; independent consultant

No. 2052

The vadose zone can also be considered as 'the zone between the land surface and the water table', which includes the plant root and intermediate zones and the capillary fringe, representing that portion of the crust where the pore spaces contain water at pressures below atmospheric, air and other gases. The vadose zone falls within a framework overlapping between and combining the specialisation of many different disciplines. Vadose zone hydrology includes the specialist input of, notably, soil scientists, surface water hydrologists, hydrogeologists and engineering geologists, but such collaborative efforts are still mostly limited to the implications of soil water on biodiversity or the protection offered to the aquifer by the overlying unsaturated media, and hence closely linked with studies in geotechnical engineering and ecology. The safe locating of such potential sources of contamination and the mitigation and rehabilitation of contamination can be better assessed based on an improved understanding of the spatial (or lateral), vertical (or horizon-based) and temporal (or time-dependent) influences on vadose zone seepage. The project had the following aims:

- Evaluate by means of a thorough literature survey and intensive, long-term testing, the most common methods applied to assess unsaturated flow in the field, laboratory, or based on empirical approaches
- Evaluate some new parameters and refine the determination of porosity, effective grain size and hydraulic conductivity or permeability
- Assess the movement of ions and fine material through leaching processes which may, over fairly short periods, alter the subsurface hydraulic properties permanently, as well as the leaching processes changing the subsurface hydrology and the influences on these processes
- Evaluate the spatial and temporal influences on unsaturated flow and apply the results to conceptual issues such as sanitation systems, cemeteries, underground storage tanks, waste disposal sites, sludge dams, tailings, etc.
- Clarify the concepts and approaches applying to unsaturated flow in a multi-disciplinary approach (including hydrogeology, geotechnical engineering and soil science) in a vadose zone handbook and glossary
- Apply and evaluate the preliminary vadose zone classification methodology, followed by refining of the method and finalising the methodology
- Create awareness regarding the unsaturated zone by means of workshops, thus accentuating the importance of the vadose zone in terms of contamination, recharge and sustainable development

Cost: R1 000 000

Term: 2011 - 2014

Towards an integrated framework for the assessment and management of sediment-related impacts on water resources in South Africa: A dam performance case

Muondli Consulting and Projects; University of South Africa; University of Venda

No. 2064

South Africa does not have a sediment management framework in place; nevertheless, a number of studies have been and or are being undertaken around sedimentation. These studies have dealt with site(problem)-specific cases regarding sedimentation; however, with the movement towards integrated management of water resources, it is necessary to collate the results of these studies to come up with a holistic understanding of the impacts. This requires an integrated framework which will ensure that the assessment and management methodologies for each site-specific case are consistent with each other, and can therefore be easily integrated. Hence, the purpose of this project was to develop an integrated framework for the assessment and management of sediment-related impacts on water resources in South Africa. The framework incorporates source-specific interventions, particularly aimed at regulating the activities responsible for sediment production, coupled with strict monitoring.

Cost: R1 000 000

Term: 2011 - 2013

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

Groundwater Consulting Services; University of the Western Cape

No. 2288

Choosing the appropriate protection zoning method requires specific procedures that consider the amount of hydrogeological data that is necessary, the hydrogeological complexity, the required accuracy of the results, time, human resources, the capabilities of the groundwater management agency, and available funding. In the South African context it should be recognised that the data and resources to protect the critical water resources will probably not be available and that a phased protection approach needs to be adopted. The phased protection approach has been adopted in developing countries like Argentina, where a basic protection zoning scheme is implemented and improved over time as more data becomes available. Monitoring and periodic revision of the protection zones is therefore an important component in the iterative process to ensure the protection of drinking water quality. High borehole yields in hard rock aquifers – typical South African aquifers – are associated with fractures, faults and bedding planes, complicating the flow of water and contaminants to the boreholes. Protection zones will have to be determined for these types of complex aquifer settings, especially in aquifers like the Table Mountain Group (TMG) and Karoo, where faults and dykes are targeted for water supply. The establishment of protection zones will generally be a compromise between what is desirable and what is feasible. Zoning regulations could have adverse economic effects on a community if an inappropriate amount of land were to be placed in an area zoned for stringent protection. When considering public health, however, the delineated area should not result in under-protection. The implementation of resource protection strategies like protection zoning is not visible and benefits are difficult to measure, but provide benefits to communities, water supply companies, ecosystems and policy makers. These benefits must be communicated to the stakeholders to initiate implementation at all management levels.

Cost: R510 000

Term: 2013 - 2014

Hydrogeological heritage overview: Upper and Lower Fountains, Pretoria, City of Tshwane

University of Pretoria; independent consultant

No. 2150

Despite the majority of the terrestrial freshwater resources being groundwater, there still exists a public perception that the only source of potable water is from surface water bodies. Due to this misperception, the general public often forgets the importance of groundwater as a resource. This is evident in the lack of knowledge regarding the Upper and Lower Fountains in Pretoria, as the main reason for various historical events in and around the city, leading to it eventually becoming the capital of South Africa. This project, which introduces a broader Hydrogeological Heritage Overview programme, is intended to create awareness regarding the history and importance of water in the development of South Africa, and to improve public understanding of the important role that hydrology and hydrogeology is playing in our day-to-day lives. Such an awareness programme will be beneficial in terms

of community engagement and education in the long run, creating an opportunity for educators and the general public to appreciate the importance of hydrogeology in South Africa. Public awareness is also essential in the long-term conservation of water resources. For this reason, the focus is more on the awareness of hydrogeology and, to a lesser extent, surface hydrology, than the detailed history behind the founding of Pretoria, and additionally on making the available data (trends and quality) available to the scientific community where possible.

Cost: R100 000

Term: 2012 - 2013

The economics of sustainable aquifer ecosystem services: a guideline for the comprehensive valuation of aquifers and groundwater

Prime Africa Consultants (previously CIC International); Umvoto Africa

No. 2165

As groundwater gains increasing recognition in South Africa, so efforts have been bolstered to detail the extent to which the unseen resource is utilized and consumed. As the emphasis for water resource development shifts away from surface water resources towards alternative supplies, there is an increasing need to understand the economic incentives/arguments for groundwater use. In order to understand these incentives/arguments, it is necessary to consider groundwater resources and aquifer systems holistically, looking at their role in the freshwater supply value chain, and within the larger economic framework. Herein lays the challenge, and the objective of this study, which is to begin to construct a comprehensive and integrated framework for the economic assessment of groundwater resources and aquifer systems. However, in order to understand the economic contribution of a given groundwater resource to the water supply system, and to the economy as a whole, it is first necessary to identify and isolate the particular sources of value attributable to groundwater resources, after which consideration needs to be given to their quantification. Using this framework, in combination with a workshopping method known as a Comparative Risk Assessment (CRA), this study investigated the ecosystem services of groundwater resources through the expert analysis of three case studies, specifically, the fractured rock aquifer systems being utilized in the Hermanus area, the dolomitic aquifer systems in the Krugersdorp area, and the primary aquifer in the Sandveld region. The exercise identified the following priority ecosystem services, including: (i) provisioning services: provisioning of fresh water, provisioning of biodiversity and genetic resources; (ii) regulating services: water regulation, storage and retention, water purification and waste treatment; (iii) cultural services: recreation and tourism. Key findings of the study are as follows: firstly, the findings support the notion that the regulation, storage and retention ecosystem services provided by groundwater resources improve the efficiency profile of a water supply system. Secondly, water allocation and restriction controls that are compiled in relation to the status of both groundwater and surface water resources, as opposed to just surface water resource, are a more efficient means of systems control, benefiting from consideration of a wider pool of information. The controls that guide/manage the allocation of water resources within a given entity (i.e. community, municipality, etc.) are designed based on the constraints of surface water resources, and do not, as yet, factor in the constraints associated with groundwater resources and aquifer assets. Allocation/restriction control

within a conjunctive use water supply system should be designed around the availability of both surface water and groundwater resources.

Cost: R827 350
Term: 2012 - 2014

Programme 2: Land-water linkages

Water Sensitive Urban Design (WSUD) or Low Impact Design (LID) for improving water resource protection/conservation and reuse in urban landscapes

University of Cape Town; University of the Witwatersrand; University of Stellenbosch; City of Cape Town; eThekweni Municipality; Johannesburg Municipality; City of Tshwane; University of the Western Cape

No. 2071

South Africa (RSA) is a water scarce country challenged with transforming its unsustainably resource-intensive economy whilst also addressing the legacy of Apartheid. The adequate provision of water to RSA's citizens is one of the most significant challenges facing the country. This is particularly relevant in the rapidly-urbanising areas, owing to the fact that they are hubs of economic growth, and could without proper management become major drivers for increased water demand. It is evident that alternative, systems-based approaches to conventional water management of water supply and modes of ensuring water quality are required. A systems approach with multiple objectives is called for; one that takes into account community values and aspirations when dealing with water supply, wet and dry sanitation, biological and chemical treatment of associated contaminants, drainage and the management of industrial effluents, whilst also acknowledging the range of users, including residential, institutional, commercial and industrial. An integrated systems-based approach such as this has the potential to facilitate a change in urban areas, from 'water-wasteful' to 'water-sensitive' settlements, where a 'settlement' is to be broadly understood as comprising a concentration of people within a specific area and serviced by some public infrastructure and services. This study was thus aimed at providing strategic guidance to urban water management decision-makers (primarily city managers and other local authority officials) on the use of WSUD in a South African context. It introduces the philosophy of WSUD – a new paradigm in urban water management – and starts to build the case for its adoption in a water-scarce country such as RSA, as well as providing a base for future studies. It is aimed at defining what 'water sensitivity' might mean within the RSA context – including expanding the definition of 'city' in WSC to include a broader range of settlement types – so as to motivate for adopting a context-specific vision for water sensitivity. In this regard it suggests a strategic framework with four different components to enable the transformation to Water Sensitive Settlements (WSS) in RSA, and provides guidance on the various WSUD strategies that could be adopted to achieve this, as well as giving an indication of appropriate modelling tools. A policy review (including institutional and legal issues) was also carried out in order to identify obstacles to WSUD and to provide recommendations on how they may be overcome.

Cost: R2 000 000
Term: 2011 - 2014

THRUST 5: WATER RESOURCES AND CLIMATE

Programme 1: Predictive tools

Developing climate change adaptation measures and decision-support system for selected South African water boards

Rhodes University; Amatola Water; Bloem Water Board

No. 2018

The project aimed to identify potential impacts and threats of climate change to sustainable water services delivery, as well as the uncertainties associated with these, with regards to changes in water quantity, water quality and socio-economic developments. The methodology was developed for assessing risks and vulnerabilities (including uncertainties in predictions) to climate change. A strategy and monitoring network for water audits in order to monitor indicators of change were also developed; and the Thresholds of Potential Concern (TPCs) for water quality and quantity issues derived for Water Boards related to raw and potable water, discharges, pricing effects, etc., based on the outputs of the climate models. Lastly, a decision-support framework for an adaptive management strategy was developed to assess and modify water services delivery and development plans of the Water Boards in terms of infrastructure repair and developments, water conservation and demand management, water pricing changes and other associated issues. The results show that the minimum monthly storage expected under the near-future climate scenarios for reservoirs is higher than with that simulated for the current-day climate situations, probably due to an increase in expected rainfall under the near-future climate scenarios for the Amathole area. The report's results are also relevant to water services delivery and water resources management.

Cost: R1 000 000
Term: 2010 - 2013

Projected impacts of climate change on water quantity and quality in the uMngeni Catchment

University of KwaZulu-Natal (Pietermaritzburg); Umgeni Water; University of Cape Town; Swedish Meteorological and Hydrological Institute (SMHI)

No. 1961

The ability of the ACRU agro-hydrological model to assess the interactions between land-use change, climate change and hydrological responses was confirmed by comparing its output with observed streamflow data sets from the uMngeni catchment. Then the Water Management Units of the uMngeni were delineated into 145 relatively homogeneous WMUs. Each subcatchment was further divided into major land-use units for modelling purposes. Daily rainfall and evaporation as input to the model streamflow of the catchment was simulated to assess hydrological responses, climate change and land-use impacts. Then the potential impact of climate change on the yield of dams was determined based on various scenarios. The results reflected uncertainties in model projections, hence, unpredictable futures, though most scenarios projected increased mean annual precipitation. The results also show that climate-change impacts may either amplify or dampen the impact of land-use change, and the impacts of land-use change will have feedbacks on the climate.

Cost: R 1492000
Term: 2010 - 2013

Modelling daily rain-gauge network measurement responses under changing climate scenarios

Pegram and Associates (Pty) Ltd; University of Kwazulu-Natal (Westville); University of Cape Town; University of Melbourne; University of Stuttgart

No. 1964

This project was aimed at modelling the daily rain-gauge measurement responses under the changing climate. Two periods of recorded daily rainfall which are matched by contemporaneous RCM estimates were used. One period was used to find the statistical and stochastic links between them; while the second period was used for calibration. The other task was to check the downscaled estimates against the observed gauge rainfall during the second period in order to validate them. In addition, the characteristics required of a stochastic multisite rainfall model were determined and the model is currently being used by DWA for its water resource planning.

Cost: R1 000 000
Term: 2010 - 2013

South African climate multidisciplinary analysis

University of Cape Town; South African Weather Service; University of Kwazulu-Natal (Westville); University of Bourgogne; IRD; Joseph Fourier University of Grenoble; IFREMER; Eduardo Mondlane University; CSIR; Africa Centre for Climate and Earth Systems Science

No. 2060

The aim of the project was to create a synergy between various research groups or individuals interested in ocean and atmosphere climate variability and its impact on society and water resources of Southern Africa. It also established the impact of the El Niño Southern Oscillation on the Western Cape winter rainfall. Findings were that ENSO

impacted coastal wind and sea surface temperature in summer. The impact on streamflows and rainfall of the Water Management Areas was estimated using WR2005 data. Reasons for warming of the Agulhas Current system were explained through this project. The origin of Benguela Niño, a local phenomenon that is linked to rainfall variability in South Africa, was also unravelled.

Cost: R1 200 000
Term: 2011 - 2014

Programme 2: Climate change risk, vulnerability and adaptation

Developing water related climate change adaptation options to support implementation of policy and strategies for Water for Growth and Development

University of KwaZulu-Natal (Pietermaritzburg); University of the Witwatersrand; Department of Water Affairs; German Development Institute; Khanya-African Institute for Community-Driven Development

No. 1965

This objective of the project was to develop methodologies that would provide support to the South African water sector in mainstreaming climate-change adaptation measures into water resources management. The main report is a comprehensive reference guide on adaptation in the water sector, while the other two shorter versions are more user-oriented handbooks on adaptation. A core feature of the narrative structure of the reference guides is a focus on 'framing', since framing matters in climate-change adaptation for various reasons.

Cost: R3 000 000
Term: 2010 - 2014

Development of decision-support guidelines for vulnerability assessments and adaptation requirements among rural economies and communities, including gender issues (Phase 1)

North-West University (Potchefstroom); North-West University, Potchefstroom Campus

No. 2282

Access to safe potable water is normally one of the greatest challenges for rural communities. This project was aimed at developing decision-support guidelines for vulnerability assessments and adaptation requirements among rural economies and communities including gender issues. The approach used entailed development of a framework that consists of a series of steps required for identifying and prioritizing key vulnerabilities as well as adaptation requirements for rural communities. A two-tiered approach was followed to evaluate potential impacts of climate change on the rural communities. A decision support tool (an Excel spreadsheet) was developed to determine vulnerability, by accessing data from the groundwater resource assessment database and the WR2005 database and

then using the information to determine sensitivity to projected change in climate as well as adaptation requirements.

Cost: R350 000
Term: 2013 - 2013

The role of local community institutions in the adaptation of rural and urban communities to the impacts of climate change on water access and use

University of South Africa; Department of Water Affairs; HSRC; CSIR (NRE); University of Cape Town; University of Birmingham; Hydrosoft Institute

No. 1963

The purpose of this project was to investigate the capacity and role of community institutions in the adaptation of communities to climate change impacts on water access and use, and accordingly to develop a generic framework for institutional support. However, vulnerabilities of both rural and urban communities to climate change vary widely, while local institutions are often under-capacitated and not adequately equipped to take on the additional burden of providing climate-change adaptation support measures. The methodology entailed a literature study, engaging stakeholders and experts through workshop sessions, community vulnerability assessments and mapping, capturing data and information on water provision, access, and use, evaluating adaptive capacity of local institutions and developing a Climate Change Adaptation Framework (CCAF) for local institutions. Then a pilot study was undertaken in both rural and urban community settings to assess climate-change impacts for the different communities through case studies. The research results and products include comprehensive maps of climate change vulnerability at community level; toolboxes of possible adaptation, proposed policy and legal frameworks for supporting climate change adaptation; and the Climate Change Adaptation Framework.

Cost: R3 000 000
Term: 2010 - 2013

CURRENT PROJECTS

THRUST 1: WATER RESOURCE INSTITUTIONAL ARRANGEMENTS

Programme 1: Water governance and institutional reforms

Water governance decentralisation in Africa: a framework for reform process and performance analysis

University of Pretoria

No. 1969

The aim of this project in partnership with the World Bank is to provide knowledge about water decentralisation processes in Africa, in particular to understand which variables have a positive or a negative impact on the implementation of decentralisation processes in the African water sector, and which variables could be affected by policy interventions and how. It is also aimed to enable water sector decision-makers to identify and treat properly those hurdles hampering a transfer of water management actions to the lowest appropriate level.

Estimated cost: R1 000 000
Expected term: 2010 - 2013

IWRM – from theory to practice

University of the Western Cape

No. 1975

The aim of this analytical project is to investigate to what extent the different ways of knowing water is influencing the implementation of the 1997 water policy in South Africa.

Estimated cost: R1 005 000
Expected term: 2010 - 2013

Advancing Strategic Adaptive Management (SAM) as a framework for implementation of IWRM by catchment management agencies

University of the Witwatersrand

No. 2072

The overall aim is to advance the understanding and practice of SAM as a framework for IWRM in complex social-ecological systems. This will be achieved by:

- Actively partnering with the ICMA to implement the Inkomati CMS in a participatory and adaptive manner that is

- cognisant of the demands of complex system management
- Develop sustainable and independently functioning participatory decision-making systems in the Inkomati catchment
 - Develop a sound working relationship with DWA to integrate planning and decision systems to make the most of commonalities and differences in mandate and operating procedures between DWA (the regulator) and ICMA (the implementer)
 - Gain broader international experience and understanding of IWRM and adaptive management practices, thereby further advancing SAM and IWRM in South Africa
 - Undertake a programme of knowledge and skills transfer within South African water sector

Estimated cost: R1 637 975
 Expected term: 2011 - 2014

Natural resource governance system in South Africa

Pegasys Strategy and Development (Pty) Ltd

No. 2161

- To conduct an analysis of the advances made and the challenges being faced in the international arena regarding governance frameworks, and how these inform the local/national level discourse
- To review the current governance framework (at both policy and implementation levels) highlighting opportunities and constraints in the current institutional, strategic and regulatory frameworks for sustainably managing water resources
- To explore the priority issues highlighted in the document, 'Current and emerging governance systems in terms of water governance' (1514/1/06), which require further elaboration
- To review and update the above-mentioned Water Research Commission (WRC) document
- To recommend strategies and action plans on enhancing the knowledge base and addressing current challenges to improve and ensure good water governance
- To conduct information-sharing sessions and workshops to build capacity as well as create an aligned understanding of the governance framework and its implementation

Estimated cost: R1 000 000
 Expected term: 2012 - 2014

Programme 2: Compliance and enforcement

Development of the AWARE model for the Inkomati CMA

University of KwaZulu-Natal

No. 1935

RISKOMAN, a joint project with UNESCO-IHE, aims to develop a policy tool that: (i) can optimise water allocation in multi-purpose multi-reservoir systems in water scarce environments, based on economic values and socio-political preferences; that (ii) can continuously adjust these allocation policies based on seasonal flow forecasts and knowledge of their uncertainties; and that (iii) can hedge against inflow risks using adaptive, risk dynamic, management and operation strategies. This project adds two extra components to the RISKOMAN research: i.e. (i) The development of an interactive multi-level information system in which information will be provided to different levels of basin water resources stakeholders, with an emphasis on providing the integrated information from RISKOMAN to the level of CMA Board members; (ii) improved understanding of the hydrological functioning of the Inkomati Basin through focused research on the spatial and temporal variability of hydrological drivers in the catchment with the use of remote-sensing methodologies and the application of these within the RISKOMAN project as a whole.

Estimated cost: R1 800 000

Expected term: 2009 - 2013

Considering alternative dispute settlement practices for water resources management In South Africa

University of Stellenbosch

No. 2077

This project is aimed at evaluating the need and possibilities for alternative dispute settlement in water resource management, in view of current mechanisms and laws. It intends to ultimately propose alternative dispute settlement mechanisms to complement develop and implement provisions for dispute resolution in water law for South Africa.

Estimated cost: R1 400 000

Expected term: 2011 - 2014

Programme 5: Future scenarios

Insights towards an improved governance model and practical implementation of rural development and community upliftment projects, centred around the productive use of water

Pegasys Strategy and Development (Pty) Ltd

No. 2166

- To conduct information sharing sessions and workshops to build capacity as well as create an aligned understanding of the governance framework and its implementation
- To generate an understanding of the challenges and problems that these communities face in terms of using water productively
- To map out the difficulties that Government departments have faced in terms of supporting community upliftment projects linked to water and productive use, as well current plans for future support

- To develop an overarching governance framework and guidelines to assist Government in providing the necessary support to communities

Estimated cost: R580 000

Expected term: 2012 - 2014

THRUST 2: WATER RESOURCE ASSESSMENT AND PLANNING

Programme 1: Catchment data and information systems

The hydrogeology of Groundwater Region 17: Central Highveld

Council for Geoscience

No. 2049

The main objective of this study is to produce a report that summarises and synthesises the fragmental present-day knowledge about the occurrence of groundwater in the Karst Region. The report will serve as a guide in the exploration and further development of groundwater supplies.

Estimated cost: R700 000

Expected term: 2011 - 2013

Developing a citizen-based rainfall monitoring system

Pegasys Strategy and Development (Pty) Ltd

No. 2057

This project aims:

- To synthesise experiences, both locally and internationally, with regards to supplementing rainfall data with differing data sources, particularly citizen-based gauging
- To source and collect citizen-based rainfall data, bearing in mind the need to develop a more systematised manner for submission of this information
- To evaluate citizen-based data against other data sources such SAWS and satellite data as well as broadly assessing the uncertainties related to the various data sources
- To model the impacts of the various rainfall data sources upon the understanding of water resources within the Breede Water Management Area and from this to generate key lessons

- To provide insights into systems issues and requirements together with key role players such as DWA, BOCMA, and SAWS
- To develop some practical steps to improve the rainfall monitoring networks supported by citizen-based networks, bearing in mind the various institutional roles and responsibilities

Estimated cost: R400 000

Expected term: 2011 - 2013

The establishment of rain gauge networks for rainfall estimation calibration of the South African new weather radar network

University of the Witwatersrand

No. 2062

Overall, this project aims:

- To develop a rainfall estimation algorithm using rainfall data from the new S-band dual-polarised Doppler radar at Bethlehem and validated against a dense rain gauge network.
- To achieve the re-establishment of the Liebenbergsvlei catchment rain gauge network, near Bethlehem, as a ground-based validation/calibration tool.
- To achieve the establishment of a rain gauge network in the Cape Town area, so as to create a validation tool for comparisons between convective rainfall (in the Bethlehem area) and stratiform rainfall (in the Cape Town area).

The aim of re-establishing a network of rain gauges is not only for the validation purposes of this project, but to provide a long-term sustainable network for the validation and calibration of future radar/satellite studies. Such a network is also a good platform to provide a long term record of rainfall data over central South Africa.

Estimated cost: R1 100 000

Expected term: 2011 - 2015

WRF rainfall parameterisation and verification

EScience Associates (Pty) Ltd

No. 2162

The aims of this project are to:

- Determine the best parameterisation and model set-up for WRF in terms of modelling rainfall
- Install rain gauge network for model verification in case study areas
- Input WRF into a hydrological model and verify against stream discharge measurements

- Forecast rain events based on parameterisation in the first aim

Estimated cost: R748 651

Expected term: 2012 - 2014

A methodology to create a South African river network with hydraulic intelligence

ARC (Institute for Soil, Climate and Water)

No. 2164

The aim of this project is to develop a semi-automatic methodology to create a robust, co-extensive (countrywide) and accurate river network coverage for use in GIS projects and other planning initiatives.

Estimated cost: R1 000 000

Expected term: 2012 - 2015

Programme 2: Surface water / groundwater hydrology

Hydrology of South African soils and hillslopes (HOSASH)

University of the Free State

No. 2021

It has been recognised that there is an intrinsic and interactive relationship between soil and hydrology; thus hydrologists acknowledge that spatial variations of soil properties significantly influence hydrological processes. Attempts have been made previously to link different hydrological behaviour of different soils at a pedon (or small) scale. This study focuses on upscaling this pedon classification system towards hillslope hydrology then to catchment scale and thereby improving our understanding of hillslope hydrology. The main aim of the study will be develop a hydrologically-based classification system of South African soils and hillslopes which will assist in hydrological modelling especially in un-gauged basins.

Estimated cost: R 5 000 000

Expected term: 2010 - 2015

Surface water, groundwater and vadose zone interactions in selected pristine catchments in the Kruger National Park

University of KwaZulu-Natal (Pietermaritzburg)

No. 2051

This project seeks to define the interactions of groundwater, surface water and the vadose zone within a pristine catchment (within the Kruger National Park). This will form a sound base upon which to facilitate further multi-disciplinary environmental research for extrapolation elsewhere; it will also enable the determination and quantification of scale-dependent hydrological processes in clearly organised landscape sequences in a pristine setting.

Estimated cost: R1 800 000
Expected term: 2011 - 2014

Impact of fault structures on the occurrence of groundwater in fractured rock aquifers

Council for Geoscience

No. 2053

Amongst geological features in fractured rocks, faults are one of the most important geological structures that control the occurrence of groundwater in fractured rock aquifers. Fault-controlled aquifers have been one of the most important wellfield development targets for water supply. Problems often arise from the application of current conceptual models on the evaluation of fault-related aquifers. This is mainly due to many unknown parameters of faults that are often required as input to both qualitative and quantitative models. This study aims to (a) develop multiply approaches to the delineation and characterisation of fault-controlled fractured aquifers; (b) develop sound methods for the establishment of conceptual models of fault-controlled aquifer types which will produce both 2-D and 3-D models; and (c) estimate aquifer properties and groundwater flow based on established conceptual models, using well-calibrated numerical models.

Estimated cost: R600 000
Expected term: 2011 - 2014

Favourable zone identification for groundwater development: Options analysis for local municipalities

Metago Water Geosciences (Pty) Ltd

No. 2158

The aims of this project are to:

- Mainly, develop a methodology and atlas of favourable target zones for groundwater development for priority municipal areas
- Prioritise areas based on aquifer characteristics and socio-economic factors
- Develop indicators for groundwater options analysis
- Delineate and map the potential target zones (based on desktop analyses and fieldwork)
- Prioritise the target zones based on aquifer yield, infrastructure costs and treatment costs

- Develop conceptual models for all the selected sites
- Develop protection zone strategies for the selected target zones
- Repackaging of existing management plans for local municipalities
- Identify new or improved research and educational opportunities

Estimated cost: R2 000 000
 Expected term: 2012 - 2014

Programme 3: Water resource planning

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

SSI

No. 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.

Estimated cost: R450 000
 Expected term: 2010 - 2011

Implementing uncertainty analysis in water resource assessment and planning

Rhodes University

No. 2056

Project aims:

- To utilise newly emerging field-based information on the various processes involved in surface-groundwater interactions (recharge, storage, evaporation losses, discharge to rivers, etc.) to test and, where appropriate, improve the algorithms of the Pitman model as well as improving the quantification of the relevant parameters, thereby reducing the overall uncertainty in the use of this part of the model
- To further assess rainfall input uncertainties and the possibilities of reducing the uncertainty through the use of different sources of information
- To ensure that the climate change uncertainty assessments are integrated with other approaches designed to reduce uncertainty
- Facilitation to ensure that water resource engineers understand and appreciate the value of including uncertainty and are comfortable with the use of new modelling approaches that include uncertainty

- To determine suitable uncertainty bounds around the existing regional parameters (part of WR2005) of the Pitman model
- To further develop practical procedures for constraining the uncertain outputs from hydrological models using either regional indices of hydrological behaviour and/or observed streamflow data (that may themselves be uncertain)

Estimated cost: R600 000

Expected term: 2011 - 2014

Update of water resources of South Africa (WR2005): Phase 1

SSI Engineers and Environmental Consultants (Pty) Ltd

No. 2143

The aims of this project are to:

- Critically evaluate the outcomes of the WR2005 study in terms of uses, users, impact and knowledge gaps
- Enhance the groundwater data and provide a review of catchments where groundwater is a significant resource
- Incorporate the WRC unified assessment of groundwater methodology
- Develop a folder system based on WMA of all major land uses that have impact on water availability
- Develop simulated, present-day analyses of key gauges (of the order of 100) throughout the country
- Develop a web-based database for WR2012 study for the purpose of national water resource planning which can be continually updated
- Enhance the WRSM2000 model to suit user requirements; develop the Pitman daily time-step and daily calibration facility
- Provide extended training to 8 universities and 2-week training to the Department of Water Affairs on WR2012 and the WRSM2000 model thereby enhancing the user-support system for WR2012 products
- Recommend the optimal monitoring requirements and strategic monitoring points for South Africa in respect of rainfall, streamflow gauging, groundwater and water quality for the efficient assessment of the country's water resources
- Develop a rating system for quaternary catchments that will give users a measure of the confidence they should have in using naturalised and simulated streamflow in that quaternary catchment. Climate change sensitivity analysis.

Estimated cost: R4 000 000

Expected term: 2012 - 2016

Implementation of a South African National Standard for Water Retaining Structures

University of Stellenbosch

No. 2154

The overall aim of this project is to provide the South African engineering community with their own South African standard for the design of water retaining structures, by supporting the development of this standard up to the stage of a voted SABS committee draft (CD), which is ready to be converted by SABS into a Draft South African Standard (DSS) for public comment and subsequent publication through normal SABS procedures as a National Standard (SANS). The standard will take account of local conditions and materials and be calibrated to our corresponding loading code SANS10160:2010 and concrete design code SANS10100-1/SANS EN 1992-1-1.

Estimated cost: R790 000
Expected term: 2012 - 2015

Integrated water use quantification methodology for South Africa

University of KwaZulu-Natal
No. 2205

The aims of this project are to:

- Critically assess approaches and methodologies of quantifying water use directly and indirectly and carefully assess the accuracy levels of these methods
- Integrate appropriate sources of data, information and methodologies into a single internally-consistent water use quantification and accounting system
- Apply the system to assess sectoral water use and all components of the hydrological cycle in selected study areas in South Africa
- Using available observed/measured and simulated fluxes of the components of the hydrological cycle, assess the impact of errors on the water balance, quantify the uncertainties associated with poor and/or unavailable data

Estimated cost: R2 500 000
Expected term: 2012 - 2013

Programme 5: New water and water security

Optimising fog water harvesting

UNISA
No. 2059

Project aims:

- Understanding the physical and chemical complexities of fog and its formation: a) to determine the physical and

chemical characteristics of East and West Coast fogs (drop size, density, moisture content, biological and chemical characteristics; b) to determine the factors affecting the occurrence and moisture content of fog (including the relationship between fog occurrence and rainfall, wind speed, sea surface temperature, upwelling extent (west coast), synoptic conditions (west coast); c) to determine the possible influence of climate change on the fog phenomenon and associated environmental and social impacts

- Optimising the fog water harvesting processes: a) to delineate optimal sites for fog water collection; b) to evaluate different materials so as to identify the most effective fog water collector; c) to assess the impact of the erection of fog water collection systems on the environment; d) to investigate possible alternative uses for fog water

- The development of novel products: a) to design and build a water flow meter for low-flow conditions; b) to design and develop fog water harvesting systems for unique/specific environmental conditions; c) to develop a low-cost optical fog detector with LWC potential; d) to develop new materials for fog water harvesting

Estimated cost: R2 500 000

Expected term: 2011 - 2015

THRUST 3: WATER QUALITY MANAGEMENT

Programme 1: Water quality monitoring

Presence, levels, and potential implications of HIV anti-retrovirals in drinking, treated, and natural waters

North-West University

No. 2144

The aims of this project are:

- To conduct a literature survey on HIV-ARV presence in the environment. A first screening shows no reports whatsoever. The literature review will therefore expand to generic pharmaceuticals as well as other ARVs.
- To determine the major HIV-ARV compounds used in SA. This will be done in collaboration with role players such as the pharmaceutical industry and Departments of Health. If there are too many compounds of concern, we will select a cross-section based on modes of action.
- To develop extraction and analytical procedures for selected HIV-ARVs from water and fish. We will use our newly-acquired HPLC-MS for this purpose, as well as extraction equipment used in other WRC projects looking at POPs.
- To collect treated wastewater from four different wastewater treatment works, at least three rivers, and at least three impoundments. The localities will be determined after the literature survey and in consultation with the project reference group.

Estimated cost: R471 000
Expected term: 2012 - 2015

Surveillance of viral, faecal indicator bacteria and *Vibrio* pathogens in the final effluents of wastewater treatment facilities in the Eastern Cape Province: a vehicle for capacity development in microbial water quality science in the Province

University of Fort Hare

No. 2145

The aims of this project are:

- To carry out a survey of existing wastewater treatment facilities in the entire Eastern Cape Province, noting their dates of establishment, working capacity and current statuses
- To assess the occurrence and distribution of human viral pathogens and faecal indicator bacteria and their pathogenic strains in the selected wastewater treatment plant effluents
- To assess the occurrence, distribution and antibiogram characteristics of *Vibrio* bacteria pathogens and faecal indicator bacteria including their pathogenic and toxic strains (*E. coli* and *Enterococcus*) in the selected wastewater treatment plant effluents
- To determine the physico-chemical qualities of the selected wastewater treatment plant effluents
- To correlate viral and bacterial pathogen occurrence with seasons and the physicochemical qualities of the selected wastewater treatment plant effluents
- To compare data obtained from typical urban, semi-urban and rural communities of the seven main districts and metro's that make up the province
- To submit a report of these findings to the WRC and Eastern Cape Provincial Government

Estimated cost: R900 000
Expected term: 2012 - 2014

Encouraging citizens' water quality management through subcatchment forums

Mvula Trust

No. 2151

The aims of this project are:

- 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

Estimated cost: R600 000

Expected term: 2012 - 2014

Screening study to determine the distribution of common brominated flame retardants in water systems in Gauteng

Tshwane University of Technology

No. 2153

The aims of this project are to:

- Characterize exposure to BFRs using common aquatic organisms found within the water systems
- Investigate seasonal trends of those BFRs found within the water systems
- Develop an environmental contamination profile of landfills, surface water, wetlands, groundwater, sediment, landfill and biota within the study area with respect to BFRs
- Employ derivatisation techniques to develop a treatment kit that can be used to analyse high molecular weight BFRs
- Attempt to identify the sources of BFRs if found present in relation to land use

Estimated cost: R900 000

Expected term: 2012 - 2016

Investigating the occurrence and survival of *Vibrio cholerae* in surface water sources in KwaZulu-Natal province of South Africa

University of Johannesburg

No. 2168

The aims of this project are:

- Detection of *V. cholerae* using optimised culture-based real-time PCR method
- Detection of *V. cholerae* using culture-independent real-time PCR method
- Implementation of an internal process control to monitor the performance of *V. cholerae* real-time PCR assays
- Using the newly validated methods, determine the occurrence and distribution of *V. cholerae* from zooplankton, phytoplankton, amoeba, animal stools, sediments and water from rivers in KwaZulu-Natal Province

Estimated cost: R555 000
Expected term: 2012 - 2014

Programme 2: Water quality modelling

Implementation of salinity and water management tools for the Berg and Breede catchments in the Western Cape

University of Stellenbosch

No. 2063

The general aim of the project is to implement salinity management tools at pilot catchment(s) in the Western Cape. The specific aims of the research are: to identify specific salinity-related problems and potential solutions in selected pilot catchment(s) in the Western Cape and to collect baseline data and set up catchment management tools (to populate informational databases, design an ideal monitoring network and set up spatial hydrological models). Activities will also include the following: to assess historic and current impacts of climate and land uses on water resources in multi-functional landscapes with particular focus on specific regional problems (e.g. salinity) and to refine and apply existing catchment management tools to the selected pilot catchment(s); and to run scenarios/forecasts and recommend land uses to minimise impacts on water resources in multifunctional landscapes with particular focus on specific regional problems (e.g. salinity), taking into account institutional arrangements and socio-economic implications.

Estimated cost: R1 000 000
Expected term: 2011 - 2013

Nutritional factors influencing the biosynthesis of the neurotoxin Beta-N-methylamino-L-alanine by cyanobacteria

Nelson Mandela Metropolitan University

No. 2065

The aim of the research is to determine the role of environmental nitrogen, phosphorus and light quantity and quality on BMAA production by cyanobacteria, and to determine whether BMAA is produced differentially as a function of growth rate or growth phase. The purpose is also to evaluate a range of easily measured metabolites to find those that correlate with BMAA so as to facilitate easy BMAA measurement without expensive equipment and to establish the mechanism of BMAA biosynthesis in cyanobacteria.

Estimated cost: R500 000
Expected term: 2011 - 2013

Using an integrated water quality management model to support the implementation of National Water Act water use authorisations.

Golder Associates Africa (Pty) Ltd

No. 2159

The aims of this project are:

- To use the refined model developed and to demonstrate how it can support the implementation of integrated water use licences and other water use authorisations, by setting up management units with the relevant stakeholders such as water use licence holders and catchment stakeholders
- To produce a web-based system that will ultimately link to existing tools such as WMS and eWQMS, the stakeholder database and geographical areas, and be available for use by other water users at various levels
- To present the system at a minimum of two relevant conferences over the proposed two years of the project.

Estimated cost: R555 000

Expected term: 2012 - 2015

Programme 3: Impacts on and of water quality

Microbial pathogens in water resource sediments: their dynamics, risks and management

CSIR

No. 2169

The aims of this project are to:

- Characterise and model the pathogen loads from point, non-point and land use practices in two selected areas (this will be undertaken in close cooperation with WRC project K5/1984)
- Develop simulation model/s based on the outcome of the hypothetical models and the processes that drive the remobilisation of pathogens from sediments to ultimately predict pathogen loads under different climatic conditions (above- and below-normal rainfall events) and seasons (dry versus wet) of the year
- Develop a tool that links derived turbidity measurements obtained from remote sensing data with microbial contamination levels under different climatic conditions
- Use the Basins-4 framework to make the models' availability and outcomes standardised within the research community
- Build capacity in relevant stakeholders with regard to the use of the developed models to improve decision making

Estimated cost: R1 300 000
Expected term: 2012 - 2015

THRUST 4: WATER RESOURCE PROTECTION

Programme 1: Source water protection

Preventing production borehole clogging by in situ iron removal in South African aquifer systems

Council for Geoscience

No. 2070

This project will test local applicability of the in-situ iron removal technique for prevention of clogging in a primary aquifer and associated boreholes as well as a borehole(s) situated in fractured rock aquifer(s). This project aims to eliminate iron-related clogging problems experienced in SA by eliminating the underlying source. This would be done through preventing high Fe (II) concentrations developing in and mobilising from the aquifer. Studies have been done since the 1970s into prevention of iron dissolution from the aquifer matrix and implemented abroad. To date, a practical rather than a pure theoretical approach into Fe (II) fixation in SA aquifers has not been found and this knowledge gap is what this project aims to address through the proposed research. Based on experiences abroad, the most viable option at the moment to research and apply to fixation of Fe (II) in SA aquifers would be through the in situ iron removal treatment.

Estimated cost: R600 000
Expected term: 2011 - 2014

Development of an interactive vulnerability map and preliminary screening level monitoring protocol to assess the potential environmental impact of hydraulic fracturing

University of the Free State

No. 2149

The aims of this project are to:

- Carry out a background review in order to understand the issues related to hydraulic fracturing and to identify possible risks to the resources (biodiversity and water) of South Africa.
- Produce an interactive map that should mainly assist in aiding decision-makers in determining whether hydraulic fracturing should be allowed in certain sensitive areas of South Africa
- Develop a provisional screening-level monitoring protocol for a typical hydraulic fracturing site (this protocol should

be applied by the regulators to regulate hydraulic fracturing and should monitor, with minimal costs, whether hydraulic fracturing has major potential impacts on any sites where hydraulic fracturing might be allowed and implemented

Estimated cost: R900 000
Expected term: 2012 - 2014

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

Golder Associates Research Laboratory

No. 2160

The aims of this project are:

- 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

Estimated cost: R1 715 150
Expected term: 2012 - 2015

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

Hydro Aqua Earth

No. 2167

The aims of this project are as follows:

- 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

Estimated cost: R1 000 000

Expected term: 2012 - 2015

Programme 2: Land-water linkages

The effect of long-term fire frequency and season treatments on the soil hydraulic properties and soil water balance within semi-arid savannas in the Kruger National Park

SANParks

No. 2146

The aims of this project are as follows:

- The key question of this research is to understand the long-term effects of fire frequency, season and intensity on the soil hydraulic properties and the consequent impacts on the soil water balance on two different soil geologies in the Kruger National Park
- To determine the effect of long-term fire and no-fire treatments within basalt and granite geologies on soil hydraulic properties and soil water balance. In order to determine the variation of this effect across these geologies, as a result of a decrease in soil surface crusting and water repellency associated with fire
- To determine the effect of long-term fire regime on the soil hydraulic properties, in order to determine if an increase in fire frequency, season and intensity may alter those soil hydraulic properties associated with infiltration and redistribution across the two geologies

Estimated cost: R320 000

Expected term: 2012 - 2014

Groundwater yield-reliability analysis and operating rules for rural areas

University of Venda

No. 2157

The aims of this project are:

- To review literature on existing methods for yield-reliability analysis and deriving operating rules
- To select and delineate a water-scarce rural area on a fractured aquifer with no groundwater yield time series data as a groundwater resource unit (GRU)

- To monitor soil moisture, groundwater abstractions and groundwater yield, and compute runoff for the GRU
- To compute groundwater recharge for the GRU
- To assess groundwater resource availability for the GRU
- To perform yield-reliability analysis and derive groundwater supply operating rules for the case study village
- To generalise the groundwater operating rules for rural areas with fractured aquifers in South Africa

Estimated cost: R700 000
 Expected term: 2012 - 2015

THRUST 5: WATER RESOURCES AND CLIMATE

Programme 1: Predictive tools

Unifying weather and climate variability predictions - An operational seamless forecasting system for Southern Africa at time scales from days to seasons

CSIR

No. 2050

This research project aims to analyse a set of regional projections of climate change in extreme events, particularly CCAM over Southern Africa, within the context of anthropogenic forcing. This will be done in order to develop an optimal operational forecasting system for extreme events over Southern Africa that has the potential to bridge the gap between weather and seasonal forecasts, i.e., a seamless forecasting system. The project also aims to develop an operational seamless streamflow forecasting system for South Africa, and an operational seamless tropical cyclone prediction system for the south-western Indian Ocean, as well as to improve communication between forecast providers and forecast users.

Estimated cost: R950 000
 Expected term: 2011 -2014

Development of defensible regional climate change projections for adaptation and policy

University of Cape Town

No. 2061

This research project aims to explore the changes in regional rainfall in relation to climate processes on multiple scales, and so develop more confident understanding of the regional expression of anthropogenic climate change in relation

to natural variability. Methodologies include the following:

- Assess techniques in probability/uncertainty analysis for application to South African climate change projections, drawing on existing literature, perturbed physics simulation techniques, and contextualised by understanding of natural variability
- Integrate emerging data sources, especially from multiple models of CMIP5 and CORDEX, along with local institutional climate modelling activities, to support the development of regional climate change projections with associated measures of the envelope of possibilities and uncertainty.
- Develop region-relevant skill assessment of model and downscaled climate change projections, and apply appropriate measures for evaluating the quality and value of the different data sources so as to maximise the development of robust interpretations and probability measures.
- Develop and test a framework for incorporating the advances of the above aims into a robust approach to developing regional climate change projections, with appropriate support information on probability and confidence.
- Leverage the value of existing perturbed physics model simulations for South Africa (from the UCT/Hadley centre collaboration) to strengthen the assessment of possible attribution of regional climate change.
- Incorporate new knowledge into existing climate service activities for the dissemination and communication of regional climate change and incorporate the regional projections into a hydrological model and/or collaborate with external partners to assess the consequences in relation to the existing literature.

Estimated cost: R1 317 750

Expected term: 2011 - 2014

The limits of predictability of the South African seasonal climate

University of Cape Town

No. 2067

The research project seeks to determine the limits of the predictability of the South African seasonal climate state and how these limits depend on the season and on ocean and land surface forcing, to determine the robustness of the estimated predictability properties to choice of atmospheric model structure, estimate the contribution of anthropogenic emissions to forecast predictability, estimate the attribution of the risk of extreme weather events to anthropogenic emissions and to characterise the relevance of the limits of predictability in the operational forecast setting.

Estimated cost: R1 200 000

Expected term: 2011 - 2014

Investigating climate change effects under altered land uses on water yield and downstream ecosystem services

Golder Associates Africa (Pty) Ltd

No. 2156

The aims of this project are:

- To investigate the impacts of invasive plant species and degraded land on hydrological responses, particularly on sustained water yields, under present and projected future climatic conditions through the refinement of hydrological modelling methods at appropriately fine spatial scales
- To investigate the effects of projected climate changes on downstream ecosystem services and their economic values, and ascertain how these could affect human wellbeing and the resilience of natural systems
- To develop a strategy and guideline for adaptive catchment management towards improved water yield, based on the modelling results

Estimated cost: R900 000

Expected term: 2012 - 2015

Stratospheric and tropospheric radiative forcing of Southern African climate variability and change

CSIR

No. 2163

The aims of this project are:

- To test if the inclusion of realistically varying GHG as well as stratospheric sulphur dioxide and ozone concentrations in an AGCM will improve on seasonal forecasts of rainfall and temperature over Southern Africa
- To quantify the improvement in terms of season (spring, summer, autumn and winter), variable (rainfall and temperatures) and lead-time (up to 6 months' lead)
- To investigate to what extent stratospheric ozone depletion interacts with the enhanced greenhouse effect to impact on Southern African circulation and rainfall patterns
- To investigate the circulation dynamics by which the effects of stratospheric cooling are communicated to the subtropics, and Southern Africa in particular
- To obtain plausible projections of how ozone recovery and increased greenhouse gas concentrations will interact over the coming century to cause climate change over Southern Africa

Estimated cost: R1 008 100

Expected term: 2012 - 2015

Programme 2: Climate change risk, vulnerability and adaptation

Pinpointing human infectious disease risks and climate vulnerability: An integrative approach using cholera as a model

CSIR

No. 2147

The aims of this project are:

- To develop an early warning system for waterborne infectious disease outbreaks using *Vibrio cholerae* as a model organism
- To delineate areas and populations at risk under future climate scenarios
- To develop risk maps indicating the possible extent of infectious disease outbreaks under different climate scenarios
- To develop a generic guidebook for adaptive management and preparedness
- To demonstrate water use, access, storage and collection technology adaptation on a small scale in one area

Estimated cost: R1 500 000

Expected term: 2012 - 2015

Planning for adaptation: Applying scientific climate change projections to local social realities

Umphilo waManzi

No. 2152

The aims of this project are:

- To develop and test a process of translating scientific climate and hydrological model output into community accessible, local-level scenarios of future climate and water resources to allow for community-led development of adaptation strategies
- To understand socio-political and institutional issues that arise at the community level in planning for climate change and water resource adaptation with local communities
- To pilot, test, and improve an approach and methods, for application to other catchment areas in South Africa
- To engage national Government and water resource stakeholders in dialogue about climate change and water resource adaptation at the local level

Estimated cost: R1 100 000

Expected term: 2012 - 2015

Programme 3: Integrated flood and drought management

Improvement of early preparedness and early warning systems for extreme climatic events flood warning

South African Weather Service

No. 2068

Enhancement of the early warning systems of extreme flood events, particularly the SAFFG system, based on in situ observation and remotely-sensed hydro-meteorological information as well as the prediction tool, to support water resource and disaster managers in flash-flood risk evaluation and analyses, river flow forecasting as well as precipitation estimation, is in the aim of this project. Methodologies will include reviewing of international best practices of early warning and preparedness for flash-flood events, and comparison of available technology such as the SAFFG, TOPKAPI and others. Other activities will entail the following:

- Improve rainfall estimation (from radar and satellite) and nowcasting input into the flash flood guidance modelling system
- Improve the hydrological input and products of t-flood guidance warning system, including soil moisture estimation products
- Enhance the integration of system components to enable seamless application of flash-flood warnings down to end-users such as disaster management and water managers

Estimated cost: R813 000

Expected term: 2011 - 2014

NEW PROJECTS

THRUST 1: WATER RESOURCE INSTITUTIONAL ARRANGEMENTS

Programme 1: Water governance and institutional reforms

Key Interventions to improve local groundwater governance

University of the Western Cape

No. 2238

The aims of this project are:

- To identify the key components of good local groundwater governance

- To identify the components lacking in good local groundwater governance in South Africa
- To identify key interventions needed to improve local groundwater governance
- To test the implementability of the key interventions
- To disseminate the findings to key role-players

Estimated cost: R300 000

Expected term: 2013 - 2015

A compendium of the legal narrative of the South African White Paper and National Water Act of 1998

GHT - Southern Africa

No. 2250

The aims of this project are:

- To document all information (oral and written) in the public domain and state archives related to the water law review which led to the development of the White Paper on a National Water Policy (1997) and the National Water Act (1998) in South Africa
- To review all available sources of information related to water law in South Africa
- To identify major departure points from the previous law of 1956 and document how the different elements were debated and in the process, analyse and profile the main driving factors for the water reforms
- To source and document all major discussion documents prepared for the above purpose including oral knowledge
- To identify major deviations of interpretation, implementation and debates and identify gaps
- Based on results from the documentation process and critical assessments, recommend appropriate policy options, strategies and institutional steps that may enhance the water reform implementation process for better impact on the ground.

Estimated cost: R1 500 000

Expected term: 2013 - 2016

Institutional arrangements for implementing water equity mechanisms in South Africa

Prime Africa Consultants (previously CIC International)

No. 2255

The aims of this project are:

- 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.

Estimated cost: R 1 162 600

Expected term: 2013 - 2016

Programme 4: Transboundary water resources

Water's role in driving regional economic integration in Southern Africa

GHT - Southern Africa

No. 2252

The aims of this project are:

- To support more effective and sustainable use of shared water in transboundary river basins and drive regional economic integration in Southern Africa
- To review the current state-of-the-art literature on transboundary water governance and regional economic integration and draw relevant lessons for best-practice
- To analyse the role of different actors, institutions, and processes of regional economic integration and their interface with water with a view to strengthening their capacity
- To assess the challenges and opportunities faced by current regional economic institutional arrangements that support transboundary water governance and regional economic integration in the SADC
- To analyse the emerging economic regionalism in the form of commodity regions and clearly highlight the role of water in this landscape.
- Based on results from the critical assessments, identify the key pillars for sustainable regional cooperation over water leading to better economic integration and recommend appropriate policy options, strategies and institutional steps that may enable African TRBOs and riparian countries to move towards best-practice

Estimated cost: R1 000 000

Expected term: 2013 - 2015

THRUST 2: WATER RESOURCE ASSESSMENT AND PLANNING

Programme 1: Catchment data and information systems

Establishment of an observation network to improve understanding of global change in the sensitive and critical water supply area of the Drakensberg

University of KwaZulu-Natal

No. 2236

The aims of this project are:

- To classify land cover/use in the area
- To develop a drainage-system model for the Mooi River
- To determine the diurnal and seasonal variation in the chemical characteristics of the surface water of the system
- To determine the diurnal and seasonal variation in the chemical characteristics of the sediment of the system
- To compile a survey regarding the presence/absence of microbial and diatom indicators or extreme species

Estimated cost: R900 000

Expected term: 2013 - 2016

Revision of the mean annual precipitation (MAP) estimates over Southern Africa

Pegram and Associates (Pty) Ltd

No. 2241

The aims of this project are:

- To first assess the quality of the rain-gauge data and, where necessary, clean it, mindful that CSAG have already given the set a careful screening using NOAAs Quality Control, Homogeneity Testing, and Adjustment Procedures
- To temporally infill CSAG rainfall database and provide Confidence Limits (CLs) since 1950 using copula-based methods
- To interpolate daily rainfall on a 1-minute grid over RSA and provide CLs since 1950
- To derive a new Mean Annual Precipitation map over RSA, with accompanying map of CLs augmented by monthly and seasonal breakdowns, and decadal shifts

Estimated cost: R1 800 000

Expected term: 2013 - 2016

Sediment yield modelling in the uMzimvubu River catchment

ARC

No. 2243

The aim of this project is to assess the sediment yield in the uMzimvubu Catchment by means of a distributed modelling and remote sensing approach.

Estimated cost: R500 000

Expected term: 2013 - 2015

The use of GIS and remote sensing techniques to evaluate the impact of land-use and land cover change on the hydrology and water resources of Luvuvhu River Catchment in Limpopo Province

University of Venda

No. 2246

The aims of this project are:

- To review literature on existing methods for assessing land-use and land cover changes and their impacts on hydrology and water resources
- To classify and quantify the land-use and land cover changes in the LRC between 1970 and 2010
- To determine the present and potential water resources of the LRC
- To extract the geomorphologic and hydrologic properties of the study area from digital elevation models (DEMs)
- To model the impact of land-use and land cover changes on water resources in the LRC

Estimated cost: R555 000

Expected term: 2013 - 2015

Programme 2: Surface water / groundwater hydrology

Investigating projected changes in the nature of extreme rainfall over South Africa during the 21st century

University of Cape Town

No. 2240

The aims of this project are:

- Identify extreme rainfall regimes across South Africa using synoptic circulation data and station-based ETCCDMI indices

- Downscale projection data to the station scale and identify changes in these over different regions of the country
- Use native resolution GCM projection data as well as dynamically downscaled projection data from the CORDEX project to identify changes in the frequency of occurrence of synoptic circulations associated with extreme rainfall
- Explicitly examine known circulation features that are associated with extreme rainfall such as cut-off lows and tropical temperate troughs and identify trends in these systems

Estimated cost: R418 000

Expected term: 2013 - 2016

Programme 3: Water resource planning

Dam surveillance and monitoring using dynamic and static measurements

University of the Western Cape

No. 2244

The aims of this project are:

- Develop best practices in ambient vibration testing of dams
- Best practice procedure for finite element model calibration of arch dams
- Develop framework for long-term structural monitoring of dams
- Transfer of experience gained to DWA and industry

Estimated cost: R890 000

Expected term: 2013 - 2016

Extending the Ogee spillway relationship to accommodate the unsymmetrical upstream cross sectional details, the relative orientation of the wall structure and the influence of the curvature of the dam structure

University of Pretoria

No. 2253

The aims of this project are:

- Determine the influence of un-symmetric upstream channels on the required form of the Ogee spillway relationship
- Determine the influence of relative orientation of the spillway relative to the upstream approaching flow direction
- Determine the influence of curvature of the wall in relationship to the total upstream energy on the required form of the Ogee spillway relationship
- Develop guidelines to assess if it is required to review other parameters in the design of uncontrolled spillway

Estimated cost: R300 000
Expected term: 2013 - 2015

THRUST 3: WATER QUALITY MANAGEMENT

Programme 1: Water quality monitoring

Polycyclic aromatic hydrocarbons (PAHs) in the aquatic ecosystems of Soweto/Lenasia

North-West University (Potchefstroom)

No. 2242

The aims of this project are:

- To determine the nature and extent of 16 priority PAHs at a site previously found to exhibit high levels of PAHs
- To assess the possible sources using PAH fingerprinting
- To perform a preliminary assessment of possible associated risks to local fish and human health

Estimated cost: R375 000
Expected term: 2013 - 2016

Water resources management in South Africa: towards a new paradigm

Rhodes University

No. 2248

The aims of this project are:

- 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

Estimated cost: R5 000 000

Expected term: 2013 - 2017

Programme 2: Water quality modelling

Development and application of a simple South African water quality model for management of rivers and reservoirs under current and future development and climate change scenarios

Rhodes University (Institute for Water Research)

No. 2237

The aims of this project are:

- The construction of a water quality systems assessment model (WQSAM) to work in conjunction with both the WReMP or WRYM yield models and the Pitman model, to simulate the frequency of certain water quality concentration thresholds being exceeded, using predominantly available observed data, and a simplified conceptual framework
- Investigation of freely available remote-sensing data for parameterization and calibration of WQSAM
- The application of WQSAM to various catchments in South Africa, for comparison of model simulations to historical data, so as to assess the model's performance
- The assessment of various future development and climate change scenarios using WQSAM within the case study catchments, so as to assess the possible future impacts of development and climate change on water quality, and for comparison with results from previous studies

Estimated cost: R500 582
Expected term: 2013 - 2015

A feasibility evaluation of the total maximum daily (pollutant) load (TMDL) approach for managing eutrophication in South African dams

DH Environmental Consulting cc

No. 2245

The aims of this project are:

- Literature survey of the TMDL approach and its values for the strategic management of surfaces, in particular, reservoirs
- Formulation of a short-list of priority-need reservoirs for further analysis; this list would be developed in conjunction with the DWA and relevant stakeholders
- Selection of three to four dams for TMDL analysis; selection of the reservoirs will be based on the criteria of flow, data, types of sources (one each from the TMAPL study groups), data for point sources (WWTWs)

Estimated cost: R638 250
Expected term: 2013 - 2015

THRUST 4: WATER RESOURCE PROTECTION

Programme 1: Source water protection

The hydrogeology of Groundwater Region 65: Northern Zululand Coastal Plain

North-West University: Potchefstroom Campus

No. 2251

The aims of this project are:

- 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 (in the 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

Estimated cost: R550 000
Expected term: 2013 - 2015

Characterising the chemical composition of deep and shallow groundwater in an area considered for shale-gas exploration in the Main Karoo Basin

Groundwater Africa

No. 2254

The aims of this project are:

- In a selected area in the Main Karoo Basin where shale-gas exploration is envisaged, characterise shallow (cold) and deep (warm) groundwater by analysing the waters (borehole and spring) for chemistry including trace elements, heavy metals, rare earth elements, isotopes and possibly noble gases
- Identify specific determinants (out of the above) that distinguish shallow from deep groundwater and whether specific areas associated with shallow water samples contain traces of deep groundwater
- For regulatory purposes, develop a list of determinants that should be analysed in both shallow and deep boreholes in future shale-gas exploration and development areas

Estimated cost: R1 000 000
Expected term: 2013 - 2015

Groundwater use by alien invasive plants: assessing the impact of *Prosopis* spp. invasions on water supply to groundwater-dependent communities

Council for Scientific and Industrial Research

No. 2256

The aims of this project are:

- To establish the long-term water use trends by *Prosopis* invasions and co-occurring deep-rooted indigenous vegetation in order to determine impacts on groundwater
- To characterize the hydrogeology of a *Prosopis*-invaded aquifer
- To determine the sources of water used by the vegetation and to quantify the proportion of the total water use that is derived from groundwater
- To quantify potential increases in groundwater recharge as a result of clearing *Prosopis* invasions
- To evaluate a physically-based model for predicting water use by *Prosopis* invasions integrating in situ and remote-sensing data
- To apply the model to scale up estimates of groundwater use by *Prosopis* to selected invaded sites in the country

Estimated cost: R1 324 700
Expected term: 2013 - 2016

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

GCS; University of the Western Cape

No. 2288

The aims of this project are:

- 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

Estimated cost: R510 000

Expected term: 2013 - 2014

THRUST 5: WATER RESOURCES AND CLIMATE

Programme 1: Predictive tools

Using satellite data to identify and track convection over southern Africa

South African Weather Service

No. 2235

The aims of this project are:

- To install the code for the RDT on a dedicated server in SAWS using information from the MSG satellite as well as model input from the local version of the Unified Model input instead of ECMWF
- To create a two-fold system – one for operational runs using operationally updated data and one for case studies, in 'archive' mode
- To test and validate the system on South African and southern African case studies and validate the results against the occurrence of lightning data in order to provide evidence of the usefulness of the system

- To transfer skill to forecasters from South Africa as well as southern Africa to understand the RDT product and its usefulness (through workshop)
- To make the RDT operationally available to all forecasters in southern Africa

Estimated cost: R400 000

Expected term: 2013 - 2015

Managing limits in skill for seasonal climate forecasting

University of Cape Town

No. 2249

The aims of this project are:

- 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

Estimated cost: R2 025 640

Expected term: 2013 - 2017

Dynamics of climate variability over the all-year rainfall region of South Africa

ARC

No. 2257

The aims of this project are:

- Determine the relative contribution of the various rain-producing weather systems to monthly and seasonal rainfall totals over the all-year rainfall region; the relative contribution during spring and autumn is of particular interest
- Determine whether the occurrence of the bi-modal rainfall distribution is consistent at inter-annual time scales

Estimated cost: R312 000
Expected term: 2013 - 2016

Programme 2: Climate change risk, vulnerability and adaptation

Water–energy nexus in the context of climate change: investigating trade-offs between water use efficiency and renewable energy options for South Africa

Pegasys Strategy and Development (Pty) Ltd

No. 2239

The aims of this project are to investigate renewable energy choices for SA and their water requirements (consumption).

Estimated cost: R1 500 000
Expected term: 2013 - 2016

Programme 3: Integrated flood and drought management

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

South African Weather Service

No. 2247

The aims of this project are:

- 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

Estimated cost: R1 113 000
Expected term: 2013 - 2017

CONTACT PERSONS

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