



KSA 2: Water-Linked Ecosystems

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SCOPE

The glossary of the Environmental Health Centre of the National Safety Council defines an ecosystem as: The interacting synergism of all living organisms in a particular environment; every plant, insect, aquatic animal, bird, or land species that forms a complex web of interdependency. An action taken at any level in the food chain, use of a pesticide for example, has a potential domino effect on every other occupant of that system. Note that the term 'all living organisms' does include people.

Water-linked ecosystems are defined as instream (fully aquatic), riparian (dependent on water stored in the river banks and linked to the river), groundwater and water table-dependent (dependent on a water table, but not on surface water). This KSA will continue to focus on the protection and sustainable utilisation and management of the aquatic environment and biota (instream, riparian and ground-water). This includes the research needs around the international conventions on environmental management (e.g. biodiversity) as well as human needs from the aquatic environment (e.g. sustainable management for equitable ecosystem resource utilisation, recreation and ecotourism by rural communities).

In the light of local needs and international trends in research, the portfolio of research by which the scope of this KSA is addressed will be adjusted when deemed necessary. However, the primary objective remains the provision of knowledge to enable good environmental governance so as to ensure the utilisation and sustainable management of water-linked ecosystems in a water-scarce country, taking into consideration demographic dynamics and threats

due to climate change, alien and invasive species. This will be achieved through the following:

- Development of an understanding of the ecological processes underlying the delivery of goods and services.
- Development of the knowledge to sustainably manage, protect, utilise and rehabilitate the aquatic ecosystem.
- Transfer of the knowledge to appropriate end-users. A part of this will be the development of innovative tools and methods for effective knowledge dissemination.
- Strategically align research with WRC impact areas and Government, with a focus on the DWA National Water Resource Strategy (NWRS) and Government outcomes. Special attention will also be given to emerging strategies and plans of Government departments such as Human Settlement, Planning Commission, Rural Development and Land Reform, Science and Technology, and Agriculture, Forestry and Fisheries.
- Building of capacity in both research and management to sustainably manage aquatic ecosystems.
- Bridging societal needs (livelihoods) and resource protection.
- This KSA will work closely with KSA 5 in developing a KSA2-specific knowledge dissemination and uptake plan to ensure that the research knowledge produced under this KSA is broadly utilised in South Africa and Africa.

OBJECTIVES

In the light of international trends in research, the portfolio of research falling within the scope of and addressing this KSA will not change. The primary and secondary objectives

of this KSA have been found to address future research need scenarios appropriately. The main objective is the provision of knowledge to enable good environmental governance so as to ensure the utilisation and sustainable management of water; and to develop an understanding of the ecological processes underlying the delivery of goods and services from the water-linked ecosystems in a water-scarce country during a time of demographic and climate change.

This will be achieved through the following (secondary) objectives which aim to:

- Develop an understanding of the ecological processes underlying the delivery of goods and services.
- Develop the knowledge to sustainably manage, protect and utilise aquatic ecosystems.
- Transfer the knowledge to appropriate end-users through the development of innovative tools and methods for effective knowledge dissemination. These will be developed in conjunction with other KSAs within the WRC.
- Strategically align research with the WRC mandate and government priority areas/projects and the Water for Growth and Development framework, where relevant.
- Promote good science and build capacity in both research and management to sustainably manage aquatic ecosystems.

THRUSTS AND PROGRAMMES

As indicated above, the research portfolio presented here does not deviate materially from that presented in the previous year's plan. The thrust addressing Ecosystem Processes is progressing well. A general description of thrust and programme structure is presented below. New initiatives and current projects have been grouped into strategic thrusts and programmes which directly address the above-mentioned objectives and are summarised as follows:

THRUST 1: ECOSYSTEM PROCESSES

Scope: This thrust includes research addressing the biophysical processes, form and function of ecosystems. This understanding will assist those managing the resource (water services, crop and aquaculture, biodiversity, etc.) to maximise socio-economic benefits in a sustainable manner. The aim is to generate knowledge to inform policy and management. Current programmes are:

- Estuarine processes
- Riverine processes
- Wetland processes
- Groundwater-dependent ecosystems
- Impoundments

THRUST 2: ECOSYSTEM MANAGEMENT AND UTILISATION

Scope: This thrust includes research which specifically addresses the management of ecosystems for sustainable utilisation for the provision of the ecosystem benefits that people depend on. Central to this is the need to manage the social and economic requirements of society from ecosystems and the implementation of policy and legislation. Capacity will be built to implement the research findings. The following programmes are addressed:

- Ecological Reserve
- Estuary management
- Ecosystem health
- Environmental water quality
- Endocrine disrupting compounds in water resources
- Socio-economic considerations
- Ecosystem governance

THRUST 3: ECOSYSTEM REHABILITATION

Scope: This thrust addresses the rehabilitation of aquatic ecosystems (including both the abiotic and the biotic components) which have been degraded through anthropogenic activities, with the view to restoring, as far as possible, process, form and function in order to provide the stream of goods and services that a healthy aquatic ecosystem should provide. This will be done in terms of both relevant international conventions and national legislation, and seeks to restore biodiversity where possible. Capacity will be built to implement the research findings. Programmes include:

- Wetland rehabilitation
- River and impoundment rehabilitation
- Influence of instream-constructed barriers

RESEARCH PORTFOLIO FOR 2010/11

This KSA focuses on the protection and sustainable utilisation of the aquatic ecosystems (abiotic and biotic) and the economic (livelihoods) and social benefits related to their use. It addresses national research needs (strategically of long-, medium- and shorter terms) as well as those of international conventions on environmental management (e.g. wetland conservation (Ramsar) and the Convention on Biodiversity). Work done within this KSA has contributed to the development of the National Water Act (NWA) and associated policies, an example being the ecological Reserve. This has meant that work within this field has not only addressed the strategic needs of the country, which have increased in line with the increased global recognition of the importance of the role of sustainable environmental management, but has also addressed some of

the immediate research needs related to the NWA and its implementation. What people require of the environment is an area of increasing importance, and the building of capacity amongst the country's citizens (managers and the various user groups) to manage the environment sustainably is of cardinal importance.

Research was solicited in the following areas during 2010/11:

Impact of sediments as a physical water quality variable on macro invertebrates: South Africa, like many semi-arid countries, transports large amounts of sediment into the oceans via rivers. This is due to high erosivity of our soils and unpredictable storms following long periods of droughts or dry seasons. The sediment eroded from the catchments and within river courses is transported downstream with serious potential impacts on the biota, clogging/abrasion of fish gills leading to fish mortality, loss of habitats, and consequently loss of biodiversity. Eroded sediments also affect siltation of dams, temperature and light penetration changes in the systems, primary production, transportation of sediment-adsorbed toxicants, closure of usually open-mouth estuaries, and many other factors. Although the extent and quantification of sediments and related hydraulics have been studied under the Water Resource Management KSA, very few of the abovementioned aspects have been researched. The information to be generated holds a key to the development of sediment water quality guidelines, which are urgently required. The project will supplement the sediment toxicity bioassays currently underway.

Application of aquatic ecosystems (natural wetlands) knowledge to constructed wetlands (bio-mimicking): This study will be undertaken in collaboration with the Water Use and Waste Management KSA and will focus on applying natural wetlands ecosystem knowledge to artificial or constructed wetlands. The idea is to tap into existing knowledge generated from wetland studies and use that in constructed wetland systems as tools to introduce and enhance the efficiencies of wetlands processes. Biological components and processes will be introduced to the constructed wetlands to enable the constructed wetlands to function as natural wetlands and be able to provide goods and services that are associated with aquatic (wetland) ecosystems.

BUDGET FOR 2010/11

The approved funding of the research portfolio for 2010/11 led to a committed funding budget of R12 635 883 (excluding roll-over), with R3 731 020 requested for new projects.

CORE STRATEGY

Healthy people depend on a healthy environment. This is particularly true in the case of the rural poor who rely directly on the environment for their livelihood. For instance, while poor quality water can be improved in treatment works (at increased cost); those directly dependent on the resource will suffer the consequences of drinking water containing pollutants or disease-causing organisms. At the same time, the flow of goods and services such as fish, fibres, cultivated and medicinal plants from a poor quality ecosystem will be less than it should be. For these and other reasons, sustainable management of the ecosystems making up the environment is central to an improved quality of life. The scale of ecosystem benefits varies from individual, for example fibre for mat- and basket-weaving or medicinal benefits for individual livelihoods, to universal, such as good quality water for abstraction and urban use and intact wetlands to aid in improvement of water quality and flood attenuation. In short, society cannot survive without the underpinning support from the environment.

The core strategy is fundamentally unchanged from 2009/10 but focus will be given to development of innovations that will help in speeding up implementation of relevant policies. The KSA will furthermore internalise national strategies such as Presidential priorities (government MTEF). Research funded from within this KSA will continue to address, within the mission and vision of the WRC, the three legs of sustainability (society, economy, and environment) as defined by the 2002 Johannesburg Summit and the needs of the legislation and international conventions (e.g. biodiversity conservation planning – Convention on Biological Diversity and Wetland Integrity – Ramsar) of South Africa.

Strategic context

The KSA for **Water-Linked Ecosystems** may be defined both by the physical boundaries of the area addressed by the KSA, as well as by the strategic role occupied by the WRC in the field, with relevance to organisations active in ecosystem research and management. Physically, the field includes aquatic and riparian ecosystems as well as those dependent on groundwater.

Research funded through this KSA not only provides knowledge for the protection of the resource and the biodiversity of aquatic ecosystems, but also supports sustainable utilisation of aquatic resources while ensuring equity between generations. The KSA strengthens the notion of promoting ecosystems as natural water infrastructure that should be valued by everyone. The KSA research further addresses the commitment to international conventions, the needs and implementation of policy as well as sustaining the capability of the environment to support the flow

of benefits on which society depends. Various aspects of climate change (including, adaptation and mitigation) are addressed by the KSA and this entails developing an understanding of the impact of global warming (water temperature) on aquatic biodiversity (ecosystems). This knowledge will enable societies (especially rural, poor people) depending on goods and services from the environment to improve their resilience to climate change.

The KSA is closely linked to the overall objective of the WRC, aiming at making a difference through research in society, economy, health and the environment.

Water and society

Knowledge is developed by the KSA to improve social-cultural dynamics or perspectives to understand and promote protection of biodiversity and its ecosystems. The KSA is involved in studies that are aimed at improving understanding of the societal factors or aspects affecting implementation of the National Water Act of 1998. The shared-rivers objectives that the WRC has funded address social (as well as political) aspects that are critical for implementation of environmental legislation.

Water and the economy

Ecosystems have an economic value and their appropriate utilisation is not only key for a sustainable environment and healthy and sustainable water resources, but also creates goods and services that can create wealth and empower communities. The KSA continues to support studies that improve understanding of the economic value of ecosystem goods and services. Methods and tools will be developed for use by water authorities to suitably use freshwater ecosystems.

Water and the environment

Most of the research studies funded by this KSA address mainly this impact area. The knowledge generated by the KSA studies is needed to improve protection of ecosystems and suitable utilisation of goods and services coming from aquatic ecosystems.

Water and health

The KSA has studies that address the health aspect of water or aquatic ecosystems. The research relating to the impact of environmental flows manipulation on water-associated vectors and diseases, the endocrine disrupting compound studies, and general water quality studies that the KSA is supporting will provide knowledge in this area.

Needs analysis

This KSA closely supports DWA in its strategy for Water for Growth and Development, and other Government departmental initiatives. The needs expressed by the Minister of Water and Environmental Affairs will be addressed in different KSA's thrusts. However, the specific need to sustainably manage and protect wetlands has been, and will be, fully addressed by both existing and new solicited projects. The KSA will internalise relevant outcomes from the WRC's stakeholder workshop. Effort will be made to introduce and promote ecosystem knowledge to local government institutions, especially SALGA, portraying ecosystems as natural (water) infrastructure that provides humans with different benefits such as flood control, and improvement of water quality and quantity. Other stakeholders' needs, and the manner in which KSA 2 will respond to those needs, will be addressed later on in this documents (stakeholders' views). However, the need also exists, possibly more than ever, for strategic research for innovation, the lead for which may come from global trends not necessarily reflected yet as needs in South Africa. There is also a need for repackaging of both the existing and new knowledge that will help in both water management, training and public awareness. The need to implement legislation tends to distract attention from this long-term need, although this is handled proactively as far as possible within this KSA so that anticipated research products are available when needed. The KSA will continue to support research that addresses the longer-term needs of the country. Funding research to contribute to the capability to sustainably manage ecosystems is an overarching need which this KSA continues to address. In addition, involving both the decision makers and the community in the above is key to the successful implementation of the research findings.

At the higher level, it is necessary to improve the interface between scientists on the one hand and managers and the public, including rural communities, on the other. Without this, the concept of sustainable management will remain in the realm of theory. The implementation of research findings requires specific attention and this will be addressed within the KSA through a WRC-wide initiative which will be implemented during the year. The KSA will also strengthen its technology transfer initiatives aimed at building capacity in communities and of the decision makers. The KSA will seek and pursue opportunities to build a knowledge-base of the officials, especially in relevant new government departments and other institutions.

Research is needed to address the processes and functions of various components of aquatic ecosystems. It is becoming increasingly apparent that with the switch to largely addressing the needs of management over the past decade and a half, we are reaching the limits of current knowledge. In recognition of this, the KSA has begun more

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research initiatives in selected areas in order to ensure that our knowledge remains ahead of the need to apply it.

Water quality deterioration has reached crisis levels in the country's heavily used catchments, with fish kills in the Vaal River and Olifants River (Mpumalanga) and crocodile deaths in the Lower Olifants River. A multidisciplinary approach is necessary to address this problem adequately, and to resolve these challenges this KSA has completed a scoping study which is being used to facilitate the formation of a larger research programme in conjunction with SANParks and other organisations. The KSA has also solicited a research project focusing on linking land use to water quality.

At the operational level, in addition to the issues around the implementation of legislation, there is a need to provide knowledge on the mitigation of the effect of development on ecosystems. The KSA, in collaboration with DWA and DEA, will continue to pay special attention to the effectiveness and efficiency of RDM methods and tools, particularly those used in the Reserve determination with the intention to meet the needs of users and beneficiaries.

Overview of technological trends

Several important trends in inland water research have been emerging internationally, and these are briefly discussed below. These trends are being implemented in the medium- to long-term planning within the KSA, where they are relevant to the country. Since the Strategic Plan presented herein addresses a number of years in a continuous manner, some of the trends mentioned in the previous year which are of importance to the future research portfolio are given in this Plan, with special reference to studies already undertaken in the current financial year.

- **Climate change:** Current knowledge further emphasises the importance of the phenomenon of climate change. There is an increasing body of knowledge on the effects of climate change from the temperate latitudes, but this deals largely with increasing temperature vulnerability and adaptation. More relevant to Southern Africa is the predicted change in rainfall, with the dry west becoming drier. The ramifications of this for management of the resource could be substantial. Research in this field has developed methods for continual monitoring of river water temperature, and this will be piloted in a new project. Moreover, the KSA is currently completing some preliminary studies on the effects of climate change on aquatic ecosystems, which will be finalised in 2010. One of those studies, as an example, has identified hydrological parameters or drivers with potential to determine the response of aquatic biota to the impact of climate change. Methods of assessment and interpretation of climate change data have been developed

by this study. However, it was recognized that, for the methods and data to be more useful at a local scale, ecologists' views and their interpretation of data is important. The KSA will initiate a process of taking the study forward to implement recommendations of the current climate change studies. Further research work is likely to emanate from these studies, such as the fate of threatened species and ecosystems, the fate of alien and invasive species in view of increasing temperature regimes and methods or technology required to manage and control alien and invasive species.

- **Payment for ecosystem services (PES):** This is a new trend. The development of a PES scheme and related economic tools are important and require attention in a developing country like South Africa. An appropriate PES scheme has potential to leverage business opportunities that can benefit poor people (especially rural people) in areas with ecosystems that supply goods and services. Another important aspect attached to a PES scheme is benefit-sharing mechanisms, which still has to be researched and developed in the context of the South African environment. While a scoping study in the form of a consultancy is planned for 2010/11 to address the aspect of benefit sharing, project K5/1978 will lay technical and theoretical foundation needed in developing a PES scheme appropriate to South Africa and Africa.
- **Aquaculture:** Aquaculture has been accepted globally as a cheap source of protein, particularly to the most vulnerable rural communities. Though the economic benefits of saline groundwater use in aquaculture are unknown in South Africa, cost-benefit analysis and feasibility scoping study will be started in 2010/11 as a consultancy. The study will support government efforts relating to rural development and those relating to fisheries.
- **Ecohydrology:** The science of ecohydrology is gaining momentum in many countries. Research conducted in this KSA and in the Water Resource Management KSA addresses aspects of ecohydrology, and these linkages will be further explored in all WRC projects relating to environmental flows or water.
- **Ecological limits on hydrological alterations (ELOHA):** This is a new trend. The KSA will interact with international researchers and institutions that are advancing this field or concept with intention to make a meaningful contribution in this emerging field. However, the KSA has found that the concepts upon which this field is based stem from past WRC research studies on environmental flows or environmental water requirements. The KSA will take advantage of the working relationships fostered during the February 2009 international conference organized and hosted by the KSA in Port Elizabeth.
- Application of natural wetland knowledge to constructed wetlands will be explored in collaboration with the KSA addressing Water Use and Waste Management. This will require assembling of experts in artificial wetland construction and those researchers with better under-

standing of wetland form, function, and process. There is a solicited project planned that will start in April 2011.

- **Capacity for sustainable utilisation** in the context of sustainable development is a key intervention in this regard and is being built through initiatives (projects) in this KSA.
- **Shared-rivers:** The KSA has initiated a long-term initiative that focuses on management aspects of rivers that South Africa shares with her neighbours. A focus of this initiative is the implementation of the NWA as well as seeking to achieve congruence between the implementation of the NWA and related policies and legislation. The second phase of the study, which aims to look into compliance with the NWA, starts in 2010/11 and the output will assist government in strengthening its monitoring programmes and prosecution of the defaulters.
- **National freshwater priority areas (NFPA):** The WRC is working closely with its stakeholders (K5/1801) to carry out a study on national freshwater priority areas (NFPA) of South Africa, in recognition that these areas are water production (factories) of the country and the region in some cases.

Key stakeholders

The key stakeholders remain largely unchanged. In addition to the Departments of Water and Environmental Affairs (DWA and DEA), other Government departments such as Agriculture, Fisheries and Forestry (DAFF), Science and Technology (DST), and Rural Development and Land Reform (DRDLR), are of importance. This KSA closely supports DWA, specifically at this time when they are implementing new strategies such as Water for Growth and Development. Provincial and local government form another group of stakeholders, and the needs of the catchment management agencies (CMAs) which are currently being established influence research direction. Other end-users of the research are water boards, and rural communities and others living on the land.

Donor funding is available in this field, usually for specific tasks which satisfy the donor's mandate. The largest funder is the Global Environment Facility (GEF), funded by the World Bank, which has been instrumental in establishing large biosphere reserves as well as the Cape Action Plan for the Environment (CAPE) in South Africa. The IUCN, WWF and Wetlands International (international NGOs), fund specific projects within their mandates in this field, and the latter is becoming increasingly active in Africa. Funding may also be available from industry for specific projects.

Other players

There are 2 main groups in this category nationally, funders and end-users of research not mentioned above.

DWA give some funds for research, although this is largely for the purpose of consultancies aimed at addressing specific short-term needs. Some organisations, such as the science councils, fund research internally to increase their competitiveness in areas of opportunity. All of these offer the opportunity for leverage and synergy with WRC funds where the integration can be managed. Important international players are IWMI (currently mainly through their Challenge Programme), WWF, UNEP and the World Bank.

There are a number of other end-users of research such as South African National Parks and various consultants who have specific requirements and who also play, directly or indirectly, an important role in managing the aquatic environment. The needs of these groups are important as well.

Research providers

There is basically no change in the providers of new knowledge in the field covered by this KSA. Researchers are located at the universities (Limpopo, Venda, North-West, Witwatersrand, Johannesburg, Free State, Zululand, KwaZulu-Natal (both Pietermaritzburg and Durban), Fort Hare, Rhodes, Nelson Mandela Metropolitan, Stellenbosch, Walter Sisulu, Western Cape and Cape Town), science councils (in this field predominantly the CSIR and the ARC) and within various consultancy firms. Efforts will continuously be made to build research capacity in historically-disadvantaged individuals, especially at the academic institutions.

Within the above-mentioned universities the researchers are housed within specific research institutes or other units focused on specific aspects of research. The consultant firms which do work in the field of ecological research and management normally focus on the more applied aspects for rapid implementation. This is a good way of rapidly implementing research results and getting feedback into the research process at the same time.

STRATEGIC INITIATIVES

National initiatives

- A highly successful and well-attended seminar in celebration of the *International Year of Biodiversity* (2010) took place on 17 September 2010 at Tswaing Nature Reserve and Heritage site. The WRC initiated and led the organising committee including DWA, DEA and SANBI.
- Collaboration with IWMI continued, with the Gamampa Wetland in Limpopo (one of the anchor points for IWMI research) earmarked to be a case study on development and testing of the 'Wetlands and Livelihoods' framework/management guidelines. Expertise will be shared

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between IWMI, the Gamampa community, SANBI, DAFF, University of Limpopo and the WRC.

- Adopt-A-River Programme: KSA collaboration with DWA continued. The WRC provides Mini-SASS brochures and other water science materials which are used and distributed at the events relating to the Adopt-A-River programme, which is linked to the River Health Programme (RHP) of DWA.
- Leading FETWater Phase 2.

Leadership positions

- Board of the Institute of Water Research, Rhodes University
- Member, Executive Committee representing the Science Council Sector, National Science and Technology Forum (NSTF)
- Chairman of NSTF Science Councils & Statutory Bodies Sector
- Member of the Board of Sci-Bono Discovery Centre
- Member, South African Mercury Association (SAMA)
- Member, NSTF Awards Adjudication panel for 2010/11
- Member, Wetland Inventory Advisory Committee – Working for Wetlands
- Member, Steering Committee of the Working for Wetlands programme
- Member, Executive Committee of DWA's 'Adopt-a-River' programme
- Member, National Steering Committee of the River Health Programme
- Member, National Wetlands Action Group and Limpopo Wetlands Forum
- Member, Ramsar Scientific and Technical Review Panel (STRP) Focal Point for South Africa.
- Member, Advisory Committee to Ramsar Focal Point

Strategic positioning

- The KSA held **two strategic meetings with DWA**, which facilitated the start of five DWA-funded projects worth R11 million in the 2010/12 year. In addition, two more DWA-funded projects worth R2.5 million will start in the 2011/12 financial year.
- The KSA held **two meetings with DEA which** brought about a collaboration and partnership relationship between DEA and the WRC, and resulted in sponsorship by DEA for the First Ramsar STRP workshop in Africa, which organised by the WRC.
- **Ramsar STRP Focal point for South Africa:** The KSA 2 Director was nominated and appointed by DEA as the Focal Point for STRP in South Africa. The STRP focal point facilitates knowledge implementation and advises the government on matters relating to the implementation of Ramsar's COP decisions. The STRP Focal Point plays an important role in issues relating to wetlands.
- Planning and refocusing the **Shared Rivers Initiative**

Programme: The re-designed programme plan is now in place and ready for discussion with key role players with regards to implementation of the Reserve as defined in the National Water Act. These key role players are the National Office of DWA, specifically RDM, the Mpumalanga DWA Regional Office, Inkomati CMA Board and Kruger National Park (KNP) CEO. The programme has now expanded in scope to cover Mozambique and Swaziland.

- The KSA has begun a mission to establish working relationships with aquatic scientists in different cities in South Africa, and met with the eThekweni municipality and the City of Johannesburg managers and scientists. The KSA intends to enter into collaborations and partnerships with those cities that require knowledge on managing ecosystems and water resources in urban and peri-urban areas. This is proving to be a good platform to share and disseminate knowledge.
- KSA2 (together with KSA 1) is involved in the establishment of a collaborative initiative with KNP Scientific Services.
- The WRC is liaising, through providing ecosystem health assessment tools produced by the WRC, with the Orange-Senqu River Commission (ORASECOM), a joint basin study involving four countries sharing the Orange River. The countries involved in the agreement are: Botswana, Lesotho, Namibia and South Africa.
- **FETWater:** Phase II of this programme was implemented by the WRC until May 2011. The programme has had many achievements relating to capacity building in the water sector in South Africa, e.g. the development of curriculum and training in areas such as groundwater, resource directed measures, estuary management, catchment management, and beneficial use of water.

Impact studies

The following two impact studies were completed in the 2010/11 financial year:

- **The wetlands research impact study** was completed and the report is available on the WRC website. The study revealed that the WRC has been a main role player in the research and development of wetlands in South Africa. The report also estimated the monetary value of the wetlands research funded by the WRC and developed an assessment framework.
- **The estuarine research impact study** was also completed. The study shows that the WRC is a key player in the generation and dissemination of estuarine research and knowledge that is important in promoting estuary protection and sustainable use.

African initiatives

- **The first Ramsar Africa STRP Focal Points Workshop** was held in Johannesburg from 30 November to 2 December 2010. More than 40 African countries were represented by their STRP focal points and wetlands experts. The Department of Environmental Affairs (DEA) sponsored the event, which was used to share experiences on wetland issues (opportunities and challenges) faced by African countries. WRC knowledge and innovations with regard to wetlands were shared at the workshop.
- A research manager is a team member of the UNEP-IWMI committee that evaluates wetland projects in Africa.

International player

- Member, Technical Advisory Committee: *5th International Conference on Environmental Science and Technology* 2010.
- Reviewer for the following journals: *Agriculture, Ecosystems, and Environment*; *Hydrological Sciences Journal*;

Journal of Hazardous Waste; *Chemosphere Journal*; *Environmental Pollution Journal*; *Archives of Environmental Contamination and Toxicology*; *Science of the Total Environment*.

- Two presentations were made at the *5th International Conference on Environmental Science and Technology*, Houston, Texas, USA, 12-16 July 2010.
- A research manager was invited as a panel member at a workshop on the basin management of wetlands in the Olifants Water Management Area, organised jointly by IWMI and the WRC and held in Pretoria.
- Member of RAMSAR's Scientific and Technical Review Panel (STRP) representing the African Region. This has given the WRC a platform to influence wetlands research and technology transfer throughout the African continents through collaboration with RAMSAR focal points appointed in each member country.
- The WRC was one of the official sponsors of the *International Society of Limnology Conference (SIL)* that took place in Cape Town from 15-20 August 2010.

GROWING THE KNOWLEDGE BASE

Capacity building initiatives

Table 1 gives a breakdown of the students employed by each of the agencies with which KSA 2 has research contracts for the year 2010/11.

TABLE 1
Capacity building through student involvement in KSA 2 projects in 2010/11

Organisation/institution	No. of historically-disadvantaged (HD) students	Total no. of students
Association for Water and Rural Development (AWARD)	1	1
BioAssets Consultants	0	4
CSIR (Natural Resources and Environment)	1	2
DH Environmental Consulting cc	0	2
Freshwater Consulting Group	0	2
IWR Water Resources (Pty.) Ltd.	1	1
Nelson Mandela Metropolitan University	0	3
Prime Africa Consultants (previously CIC International)	7	6
University of Cape Town	0	4
University of Johannesburg	0	4
University of KwaZulu-Natal	0	4
University of Limpopo	3	5
University of Stellenbosch	0	3
University of the Free State	4	10
University of Venda	4	5
TOTALS	22	60

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The KSA had 60 students that worked or participated in WRC-funded research projects in the 2010/11 financial year, of which 22 were previously disadvantaged individuals (PDI)

The following strategic capacity building interventions were held:

- Twenty students (12 PDI) were sponsored by the WRC to attend the *2010 Southern African Society of Aquatic Scientists Conference (SASAQs)* that took place in June 2010. All of the students presented oral papers based on their research studies.
- The WRC was one of the official sponsors of the *International Society of Limnology Conference (SIL)* that took place in Cape Town from 15-20 August 2010. The WRC sponsorship funds supported South African students who presented oral papers.
- The KSA has continued to support the relocation and transfer of the South African diatom collection from the CSIR to South African Environmental Observatory Network (SAEON).

The KSA led, participated in and/or supported the following nine technical workshops:

- 'Consolidation of wetland integrity assessment methods for South Africa', April 2010.
- 'Reviewing existing information on the ecology and status of the lower Mfolozi and Msunduzi Rivers, with particular emphasis on future re-linkage to the St. Lucia system', May 2010.
- 'Wetland conservation targets', May 2010.
- 'Wetlands and livelihoods: Restoration of the wetland ecological process, form and function to provide the ecosystem goods and services necessary to support livelihoods' (K5/1986), June 2010.
- 'Planning and refocusing the **Shared Rivers Initiative**', July 2010.
- 'Biodiversity and heritage workshop in celebration of the International Year of Biodiversity – IYB: 2010', September 2010.
- Ramsar '1st Africa National Focal Points workshop', November/December 2010.
- National Freshwater Ecosystems Priority Areas workshops were held throughout the country.

Conference presentations and other activities by staff members

Involvement in knowledge dissemination activities by staff members included:

- A session was chaired of the *River Health Symposium*, organised by DWA, in Botswana, October 2010.

The WRC is one of the co-founders of the programme and has funded most of its biomonitoring indices. The symposium was attended by all provincial coordinators, as well as staff working on transboundary issues.

- An abstract was submitted entitled 'Implementation of the Adopt a River Programme and lessons learnt in the Republic of South Africa' which was accepted and published in the proceedings of the *30th International symposium of the North American Lake Management Society*, 3-5 Nov 2010, Oklahoma.
- A keynote address was delivered at the ARC Institute for Soil, Climate and Water (ISWC) during World Wetlands Week, 18 February 2011.
- Attended and participated in the 4-day *International Workshop on Local Action in Biodiversity*, held in Cape Town, Berg River View Municipality, from 30 January to 4 February 2011.
- Two papers were presented at the *5th International Conference on Environmental Science and Technology*, Houston, USA, 12-16 July 2010. The titles of the presentations were: 'Investing in our natural capital, biodiversity and ecosystems' and 'Remediation of pollutants in the environment'.
- A presentation entitled 'The role of the Water Research Commission of South Africa in the water sector' was made at the *Brazil-Africa and Americas Scientific Meeting on Water*, 13-17 September 2010, São Carlos, Brazil.
- A presentation on the 'Alignment of the WRC to DWA' was given in the DWA Strategic Session, 14-15 December 2011 at the CSIR Convention Centre, Pretoria.

IMPLEMENTATION PLAN

Research portfolio for 2010/11

In essence, the implementation plan follows that of previous years in that the primary objective of this research portfolio is the provision of knowledge to enable good environmental governance so as to ensure the utilisation and sustainable management of water-linked ecosystems in a water-scarce country during a time of demographic and climate change. The research portfolio for 2010/11 (broken down into thrusts and programmes) is presented in Table 2.

TABLE 2

Overview and description of thrusts and programmes for the research funded within KSA 2

THRUST 1: ECOSYSTEM PROCESSES

Scope: This thrust includes research addressing the biophysical processes, form and function of ecosystems. This understanding will assist those managing the resource (water services, crop and aquaculture, biodiversity, etc.) to maximise socio-economic benefits in a sustainable manner. The aim is to generate knowledge that informs policy and management.

Programme 1: Estuarine processes	Estuaries are fragile and highly productive ecosystems and are highly sought after as places to live. Projects in this programme address the ecological processes occurring in estuaries.
Programme 2: Riverine processes	Programmes to investigate the ecosystem functioning and processes of riparian zones, rivers and impoundments will be developed. This is an area in which South Africa needs improved capability to manage, and in the case of riparian zones, this is a topic attracting international interest.
Programme 3: Wetland processes	Within this programme research will be conducted to develop understanding of the ecological processes and functioning of wetlands, and assessing their value to both the catchment and the people living adjacent to them.
Programme 4: Groundwater-dependent ecosystems	Within this programme the dynamics of groundwater-dependent ecosystems will be investigated in relation to the aquifers on which they depend. This will be related to exploitation of the groundwater. Special attention will be given to the vulnerability of these systems.
Programme 5: Impoundments	Research within this programme will cover ecological functions and processes within impoundments with a view to improving our ability to manage these.

THRUST 2: ECOSYSTEM MANAGEMENT AND UTILISATION

Scope: This thrust includes research which specifically addresses the management of ecosystems for sustainable utilisation for the provision of the ecosystem benefits that people depend on. Central to this is the need to manage the social and economic requirements of society from ecosystems and the implementation of policy and legislation. Support will be provided in building the capacity to implement the research findings.

Programme 1: Ecological Reserve	Within this programme research will be conducted to develop and refine methods for determining and operationalising the ecological Reserve as required by the NWA. The programme will address the more strategic issues such as the development of new and improved methods as well as the shorter-term issues such as implementation of the Reserve. This programme is managed in close association with DWA.
Programme 2: Estuary management	Within this programme research will be conducted to develop an understanding of the ecological processes within estuaries, and the effect of anthropogenic disturbance on these. This understanding is then conveyed to stakeholders (tiers of Government, communities) as management guidelines to inform them on how to manage estuaries sustainably. This programme is managed in close association with Marine and Coastal Management, DEA.

KSA 2: Water-Linked Ecosystems

<p>Programme 3: Ecosystem health</p>	<p>The River Health Programme (RHP: custodians are DWA, WRC and DEA) aims to implement nationally (at the level of provincial Government and industry) a coherent bio-monitoring programme with well-defined indices. Much of the R&D is done within this programme. Additional issues on the management of river health, although they may not directly be part of the RHP, link closely with it and so are kept in the same programme. Research on the environmental health of wetlands, estuaries and impoundments is also included in this programme. As such the programme covers all water resource types, hence the inclusive name of: National Aquatic Ecosystem Health Monitoring Programme is used, with RHP focusing only on rivers. This programme links to the WRC crosscutting domain Water and Health and includes resource management actions which may affect human health.</p>
<p>Programme 4: Environmental water quality</p>	<p>Within this programme research will be conducted to develop bio-assays (both in the laboratory and the field) which will be employed to protect people and the environment from the effects of poor water quality. It will develop methods and competence to enable the use of toxicology in effluent discharge licences as well as its use in environmental water quality as required in the ecological Reserve. This programme addresses the longer-term development and refinement of methods and the competence to use them, as well as the shorter-term competence required to implement policy in terms of the NWA. This programme links to the endocrine disrupter programme within the WRC crosscutting domain Water and Health.</p>
<p>Programme 5: Endocrine disrupting compounds in water resources</p>	<p>The overall objective is to characterise, and acquire information for assessing the EDC effects of various chemicals and compounds in water (singly or in combination), both those occurring naturally and those resulting from pollution, which have the potential to cause detrimental health effects in humans, animals and the aquatic environment as a guide to develop and implement cost-effective treatment and control strategies. Further emphasis is on the development of simple, rapid and cost-effective detection techniques. This programme will be implemented in three phases, of which the first phase is already completed.</p>
<p>Programme 6: Socio-economic considerations</p>	<p>The overall objective of this programme is to develop and integrate knowledge on the sociological and economic aspects of water-linked ecosystems with the ecological knowledge in order to develop the understanding and competence necessary to sustainably manage the aquatic environment.</p>
<p>Programme 7: Ecosystem governance</p>	<p>The overall objective of this programme is to develop understanding of what is required for the successful governance of aquatic ecosystems and how to build the necessary capacity to implement this.</p>

THRUST 3: ECOSYSTEM REHABILITATION

Scope: This thrust addresses the rehabilitation of the aquatic environment (including both the abiotic and the biotic components) which has been degraded through anthropogenic activities with the view to restoring, as far as possible, process, form and function in order to provide the stream of goods and services that a healthy aquatic ecosystem should provide. This will be done in terms of both relevant international conventions and national legislation, and seeks to restore biodiversity where possible. Support will be provided in building the capacity to implement the research findings.

<p>Programme 1: Wetland rehabilitation</p>	<p>Within this programme research will be conducted to develop methods to rehabilitate wetlands which will address both abiotic and biotic components, and seek to rehabilitate ecological processes and restore biodiversity as far as possible in degraded wetlands. This will be done in terms of both the international conventions to which South Africa is signatory as well as recent legislation from both DEA and DWA. The programme will also develop the competence to implement rehabilitation. Projects in this programme link closely with each other, and are managed as a unit.</p>
<p>Programme 2: River and impoundment rehabilitation</p>	<p>The research conducted within this programme aims to provide protocols for the rehabilitation of rivers and impoundments, with the emphasis on urban rivers and the impoundments that they feed, that have been degraded as a result of anthropogenic activities or invasive biota.</p>
<p>Programme 3: Influence of instream-constructed barriers</p>	<p>This programme investigates ways to ameliorate the effects of barriers such as weirs and impoundments on natural river systems.</p>

RESEARCH PROJECTS FOR 2010/11 COMPLETED PROJECTS

THRUST 1: ECOSYSTEM PROCESSES

Programme 2: Riverine processes

**Deriving conservation targets for freshwater systems
Ground-Truth; Ezemvelo KZN Wildlife; Albany Museum;
ARC (Range and Forage Institute)
No.1796**

Freshwater ecosystems are the most threatened ecosystems globally, experiencing the fastest loss of biodiversity and the greatest number of species extinctions. The last national report of South African freshwater ecosystems estimates that over 80% of South African river ecosystems are threatened. The intimacy between catchment condition and river health is one reason why freshwater systems are amongst the most threatened systems globally. Systematic conservation planning has been applied to numerous regions in many different countries, and provides a structured approach in identifying biologically significant areas which require conservation action. Surrogates for biodiversity are typically used to predict areas of unique biodiversity. Owing to their complexity as fluid, longitudinal systems which show continuous gradients

and relatively high variability, conservation planning for freshwater systems is conceptually at least a decade behind the application of this process to terrestrial systems. In this study, alpha, beta and gamma diversities of aquatic macroinvertebrates and fish were assessed in nine rivers, though fish were later taken out of the study due to their long distribution rendering analyses inconclusive. The study revealed that the blanket 20% target for river types is inadequate. In recognition of the fact that the upper river zones are the key sections of river length driving species patterns, they should therefore be weighted more heavily in conservation planning than lowland zones. The study recommends an adjustment with at least a 20% target in lowland zones and a 40% target in the upper zones.

Cost: R404 015
Term: 2008 - 2011

THRUST 2: ECOSYSTEM MANAGEMENT AND UTILISATION

Programme 1: Ecological Reserve

Environmental water requirements in non-perennial systems
University of the Free State (Centre for Environmental Management)
No. 1587

The South African National Water Act, Act 36 of 1998, requires that the environmental Reserve be determined for each significant water body before water-use licenses may be issued. Methods currently available for the determination of environmental water requirements in South African rivers are based on perennial rivers and need verification for use on non-perennial rivers. This research programme began by identifying which existing methods, i.e. those being used on perennial rivers, might initially seem to be suitable for use and where further work would need to be done. It then took this research a step further with an overarching objective to develop a prototype methodology for determining the environmental water requirements for non-perennial rivers. In accordance with the study's objectives, research was conducted in five phases: selecting a suitable river system; preparing the sampling sites for field visits; sampling in the field; developing a trial methodology; and testing the trial methodology. The first three phases served to develop an understanding of an ephemeral river ecosystem, while the last two phases focused on the development and testing of the prototype methodology, respectively. The prototype method clearly places an important emphasis on creating an understanding of the nature of the river and its catchment. The method makes provision for a small core team to use available data and information on the physical catchment, together with the issues and concerns pointed out by stakeholders, to develop a preliminary basic understanding of catchment processes which will inform and guide subsequent project planning.

Cost: R2 737 000
Term: 2005 - 2010

Programme 2: Estuary management

Valuation of estuary services in South Africa

Nelson Mandela Metropolitan University
(Department of Economics)

No. 1413

Estuaries yield many benefits, of which recreational value is an important one. Five primary hypotheses relating to this value were tested in this project. The contingent valuation method is a credible method by which to determine these values, albeit not without problems. The validity of the contingent valuation method has been and continues to be challenged from many angles and quarters, but estimates are acceptable guidelines when they are properly generated. The average and standard deviation values of the relevant predicted median estimates were found to be 11 and 44 cents per cubic metre of water, respectively. When three outlier (unreliable) estimates are excluded, the average and standard deviation of the mean drops to 7 cents, and the average and standard deviation of the medians drops to 3 and 4 cents, respectively. There are many people with an interest in using estuaries, but the

primary demand is for the recreation services they yield. There are two different user populations at the estuaries: people engaging in recreation activity and people engaging in subsistence activity. The former tend to be wealthy and the latter poor. The latter derive much of their value indirectly, by supplying services to those engaged in recreation activity. There are also many factors that explain the economic value of river inflows into estuaries. The first factor is the enhancement this inflow gives to the recreational appeal of the estuary. For some estuaries, a little water has a big impact, with the result that the water is highly valued. The second factor is the income of the people that use the services supplied by the estuary. High income earners correlate with high demand. The project found the demand for river inflows into estuaries to be best predicted by the number of Whites and the number of male users, the climatic zone in which the estuary falls and the length of time the estuary mouth is open.

Cost: R2 160 000
Term: 2004 - 2010

Programme 3: Ecosystem health

The effects of streamflow manipulation on the intermediate hosts and vector populations of disease and the transmission of associated parasites

Institute of Natural Resources

No. 1589

This report details the results of a desktop investigation into the relationship between regulated river flow, flow manipulation and the invertebrate hosts of malaria, bilharzia and liver fluke disease in South Africa. A literature review yielded several international case studies which informed the study and, together with expert input, all information was gathered and documented in order to understand the relationship and suggest possible flow manipulation mechanisms which may be used to control transmission of these diseases through control of their invertebrate hosts. The possible effectiveness of these flow-related control mechanisms was also assessed and the number of 'people at risk' who may benefit from flow related control was estimated. The report also documents estimated costs of the diseases to South Africa, the ability to predict the occurrence of the parasite and invertebrate host and the effect of river rehabilitation and water service provision on transmission of the diseases.

Cost: R400 000
Term: 2006 - 2010

Conservation model for threatened fish species

University of Venda

No. 1677

The presence of dams, weirs and alien fish also poses a major threat for freshwater fish species survival. A substantial number of freshwater fish species from South Africa are listed in the IUCN Red List, and it is possible that, apart from the species listed, many other fish species in Southern Africa are also threatened. The study was aimed at developing a conservation framework applicable to threatened fish species of Southern Africa's highly diverse and important freshwater ecosystems. Because of its sensitivity rating and conservation status the Southern Barred Minnow, *Opsaridium peringueyi*, was selected as a candidate species. The report consists of three sections. Section 1 is a generic framework which explains the methodology for developing conservation plans for threatened fish species. Section 2 is the conservation plan (biodiversity management plan for species) for the test species, *Opsaridium peringueyi*. Section 3 is the background report for the test species. The study recommended that the genetic status of the different *O. peringueyi* populations is still critical information that is needed for the BMP-S and further research on this aspect is encouraged. Moreover, the BMP-S process makes provision for the conservation plan to be endorsed by the Minister and thus formally incorporated into legislation. This gives the conservation plan a more formal status which could prove beneficial for the successful implementation of the plan. It is recommended that the *O. peringueyi* BMP-S be taken through this process in order to formalise the plan and give it legal status.

Cost: R1 078 170
Term: 2006 - 2009

Programme 6: Socio-economic considerations

Framework and manual for the valuation of goods and services of aquatic ecosystems for resource-directed measures

CIC International
No. 1644

The National Water Resource Strategy aims to strike a balance between the use of resources for livelihoods and conservation of the resource. This process invariably requires negotiation of trade-offs. These trade-offs are principally between the resource quality on the one hand and the beneficial use of water on the other. The framework developed through this project to achieve this is explicitly congruent with methods used by DWA in the determination of Resource Directed Measures and Source Directed Controls. Definition of the benefits yielded by an ecosystem have been based on the Millennium Ecosystems Assessment framework and comparative risk assessment methodology is used to develop the causal chains linking ecological production to the defined ecosystem services. Two case studies have been developed to illustrate the framework. This Framework and Manual explores how these scenarios

and their associated trade-offs should be evaluated.

Cost: R750 000
Term: 2006 - 2010

Knowing, caring, and acting: making use of socio-cultural perspectives to understand and improve conservation

CSIR (Natural Resources and the Environment)
No. 1800

The project's key findings indicate that the two disconnects, i.e. between conservation planning and an understanding of societal values and behaviours, and between values espoused by policy and held by societal (user) clusters, can be attributed to an array of factors that centre around the lack of societal support, community buy-in, the recognition of constantly changing mental models, and the 'diversity within diversity' (or the degree of heterogeneity). These include:

- The dynamic and inter-subjective meaning of conservation
- Analytical tools not being reflective of reality
- The social sanctioning around water conservation
- The compartmentalisation of conservation
- The juxtaposition of water as utility versus water as aesthetic value
- Conservation not being internalised in the mental models of many participants
- The normative aspect of conservation, and specifically, deciding what ought to be 'good' conservation behaviour
- The 'knowing, caring, acting' dynamic being non-linear and non-sequential, with the 'knowing' dynamic pronounced

A key connection made between participant responses and policy interventions, was the expressed perceptions that appropriate water conserving behaviour means saving water. Policy interventions that are based on this definition of appropriate water conserving behaviour ignore the inability by some people to use any less water than they already have due to limited access, priority given to using water for key household tasks and less for others, etc. It is argued in this report therefore, that water scarcity is not just physical, but also manufactured and constructed, which means that uneven access to water or varying perceptions about water use and water availability, also come into play when discussing water scarcity. Conservation planning and management efforts should therefore work to produce policy interventions and implementation strategies that factor into it the range of socio-cultural and socio-economic perceptions around water use and water availability, the range of water access challenges borne out of poverty, and a distinction made between different

KSA 2: Water-Linked Ecosystems

groups (especially those who have to function within a context of poverty) and the stipulations made on them to curb their demand for water in order to conserve water.

Cost: R500 000
Term: 2008 - 2010

Programme 7: Ecosystem governance

The Shared Rivers Initiative Phase 1: Part A - Contextual profiles of the shared rivers of the Kruger National Park
AWARD; SANParks (Kruger National Park); University of the Witwatersrand; CSIR; Tlou & Mallory (Pty.) Ltd.
No. 1711

Based on the findings of the study, achieving ERs – and indeed the Reserve – does not reside within the environmental domain alone; it is a collective action involving participation by multiple stakeholders in specific learning and training forums. Indeed, achieving the Reserve is predicated on water reform and IWRM and the collective contribution and synergies of a number of strategies, plans and practices. Of utmost importance is the recognition of the fact that achieving the Reserve cannot be done in isolation; the Reserve is but one of the key components of IWRM which is required for proper integral management of water resources at basin level. Progress towards this complex goal varies widely between catchments and at different scales. Cases where systems show a better balanced approach need strengthening – especially where this is achieved through collective action, good governance, strong leadership, feedbacks, learning and regulation. These can offer lessons and frameworks for weaker situations. If a people-centred approach that is guided by sustainability is to be sought, then there is a need to find new ways of understanding, collectively, the benefits associated with water resource protection measures (such as through the Reserve). Such thinking needs to extend across boundaries – be they upstream-downstream, sectoral or international. This is critical in ensuring mechanisms of sharing our scarce freshwater resources collectively.

Cost: R810 760
Term: 2007 - 2010

THRUST 3: ECOSYSTEM REHABILITATION

Programme 2: River and impoundment rehabilitation

The potential of food-web manipulation for the restoration of eutrophic South African impoundments
DH Environmental Consulting cc
No. 1643

Work done within this project examined the fish assemblages of six dams to examine the hypothesis that

impounded eutrophic waters tend to be dominated by coarse fish. It was hypothesised that the ecological state and water quality of eutrophic dams could be improved through the re-shaping of imbalanced fish populations, brought about by the deliberate harvesting of target species. In this project fish assemblages in six dams of known trophic status in the same region were examined. The fish biomass in all of the dams was dominated by sharptooth catfish. By contrast, the contribution made by common carp was less than expected. The canary kurper was numerically dominant in two dams. Fish assemblages of South African dams are fundamentally different to those occurring in lakes where biomanipulation has been successful. All of the dams supported fish populations that exceed areal biomass levels commonly associated with a swing towards algal dominance.

Cost: R1 649 360
Term: 2007 - 2010

CURRENT PROJECTS

THRUST 1: ECOSYSTEM PROCESSES

Programme 1: Estuarine processes

Biochemical processes in a groundwater-fed intertidal ecosystem: Biogeochemical controls on the plant biodiversity within a salt-marsh ecosystem in the West Coast National Park: Impact of saltwater-groundwater interaction on pore water chemistry and vegetation
University of Cape Town (Department of Geological Sciences)
No. 1591

The relationship between groundwater and surface water is poorly understood and the relationship between groundwater and the marine environment is even less well understood. However, the impact of poorly managed groundwater exploitation on the latter would have a severe impact on the ecology of the system. The groundwater – seawater mixing process impacts the salinity, anoxia and water movement, bioturbation and nutrient availability in the sub-surface coastal environment thereby controlling the distribution of halophytes and freshwater loving plants and any change in this balance will reverberate through the ecosystem. Over-exploitation of the groundwater resource will have this effect. This project aims to investigate this relationship in the West Coast National Park, an area of low rainfall and permeable geology where the Langebaan Lagoon which is primarily a groundwater-fed estuary. The area is undergoing development and so the demand for exploitation of the groundwater is increasing. This research will refine the understanding of the groundwater discharge around Langebaan, generate water quality maps, and identify any relationship between

plant species and geohydrological characteristics. It will also identify specific characteristics which may be used in a monitoring programme and make recommendations on environmental water requirements of the area.

Estimated cost: R397 400
Expected term: 2006 - 2009

Programme 2: Riverine processes

Periphyton flow dynamics

University of Cape Town (Zoology Department)

No. 1676

Periphyton (benthic algae) in rivers is highly sensitive to changes in both water quality and flow. Periphyton forms the base of the riverine food chain and any change at this level will be reflected throughout the ecosystem. In addition, the growth of undesirable periphyton can have negative economic consequences in several ways. Filamentous algae can clog irrigation and water purification equipment as well as render the habitat unfit for sensitive organisms, blue-green algae can cause toxin, taste or odour problems and any excessive algal growth will reduce the recreational value of the water body. Knowledge of the dynamics of the relationship between water quality and flow on the one hand, and the response of the periphyton on the other, will enable more accurate prediction of this response; this capability is required in the determination of the ecological Reserve. During this project understanding of the interrelationship between periphyton growth and water quality/flow will be developed to a point where preliminary predictions can be made, and this knowledge will be transferred to managers involved in determination and implementation of the Reserve

Estimated cost: R1 000 000
Expected term: 2006 - 2009

A framework for the classification of drainage networks in savanna landscapes

University of the Witwatersrand (Centre for Water in the Environment), SANParks (Kruger National Park); CSIR (Satellite Applications Centre)

No.1790

The character of rivers depends on the nature of their catchment. However, catchments are also shaped by their rivers. The gravity-induced movement of water and sediment down and through hill-slopes is a major control on the distribution of soils and vegetation. However, hill-slopes and channels are still generally studied separately, within different disciplines that use different paradigms and methods of investigation. Even within river science, individual river reaches are generally studied in isolation, neglecting linkages, either upstream-downstream or

within the river network. A holistic approach is needed, recognising the 4-dimensional character of river networks. This 4-dimensional character is often described using a hierarchical classification system. In this case, this will include patches of terrestrial landscape between channels, allowing the holistic study and management of river systems. In order to achieve this, the research seeks to describe the spatial organisation of savanna landscapes in the Kruger National Park in terms of the patterns constrained by both the drainage networks and the hierarchy of interdependent soil, vegetation and hydrological systems.

Estimated cost: R570 000
Expected term: 2008 - 2011

An assessment of the current biodiversity of amphibians associated with the major river systems of the Kruger National Park (KNP) and the physical and chemical factors affecting their distribution

Bioassets cc

No. 1928

Amphibian population declines and species extinctions are being recorded around the world (amphibians are proportionally the most threatened group of vertebrates). The declines cannot be attributed to any single causative factor because complex mechanisms involving abiotic and biotic interactions are responsible for this phenomenon. These declines have been attributed to a combination of factors, including climate change, chemical pollution, habitat loss and disease. This research project is aimed at determining the current status of the amphibian biodiversity in the Kruger National Park main rivers and associated wetlands.

Estimated cost: R1 036 500
Expected term: 2009 - 2012

Biomonitoring the fish health of two impoundments in Olifants River, Limpopo Province

University of Limpopo

No. 1929

In South Africa pollution of aquatic ecosystems can be linked to diffuse surface runoff and point-source discharges. As a result of these anthropogenic activities, organisms, including people, may be exposed to harmful contaminants which may affect their health and livelihood. The research will focus mainly on generation of information about the water quality of Flag Boshielo Dam and the Phalaborwa Barrage by testing selected abiotic and biotic parameters to determine the ecosystems' health.

Estimated cost: R674 500
Expected term: 2009 - 2012

KSA 2: Water-Linked Ecosystems

Programme 3: Wetland processes

To investigate the capability of the Mfabeni Mire (St Lucia) to respond to climatic and land-use stresses and its role in sustaining discharge to downstream and adjacent ecosystems

University of KwaZulu-Natal (School of Environmental Sciences)

No. 1704

The relationship between ground- and surface water is important and not well understood. The Mfabeni Peatland (at 1 250 ha one of South Africa's largest, and at ~45 000 years before present one of South Africa's oldest peatlands) is situated on the east shore of Lake St Lucia within the Greater St Lucia Wetland National Park. The water from this wetland flows into Lake St Lucia where it provides freshwater refugia for biota in times of drought. During times of climate change wetlands such as this will potentially become more important for maintaining the biodiversity of Lake St Lucia and other similar systems. The research undertaken during this project will quantify the water balance of the peatland, the contribution of fresh water to Lake St Lucia, and evaluate the effects of climate change and land use on the water flux. Principles drawn from this work will increase understanding of the relationship between ground- and surface water elsewhere and give guidance in managing this interface.

Estimated cost: R1 123 391

Expected term: 2007 - 2010

Establishing ranges of water quality variables in wetlands and their relationship to land use and ecosystem response: towards refining the ecological Reserve

University of Cape Town (Freshwater Research Unit)

No. 1921

Wetland water quality data, especially long-term datasets, are limited and, in addition, wetlands are naturally more variable in terms of water chemistry than rivers, both spatially and temporally. We have a poor understanding of the range of values of water quality parameters that occur in wetlands, both under natural conditions and in the impacted state and how this varies with different types of wetland. The research will further our understanding of the relationships between catchment environmental condition (and land use), water quality in wetlands and biotic response.

Estimated cost: R1 070 064

Expected term: 2009 - 2011

Regional wetland processes of the Maputaland coastal aquifer on the Zululand coastal plain

ARC (Institute for Soil, Climate and Water)

No. 1923

Previous studies about the wetlands on the Zululand coastal plain could not use environmental attributes to explain the wetland type and distribution on a regional scale. There is no clear classification and characterisation of wetlands which addresses the interaction of environmental factors and processes on a broad scale. An understanding of environmental factors and processes is required before human-induced changes can be evaluated. The research will provide a workable framework that will link environmental factors and processes for different wetland types and distributions on the Zululand coastal plain and enable the prediction of the response to land-use and water-linked ecosystem change on a regional scale.

Estimated cost: R893 364

Expected term: 2009 - 2011

Evapotranspiration from the Nkazana Swamp Forest and the Mfabeni Mire

CSIR (Natural Resources and the Environment, Pietermaritzburg)

No. 1926

There is general consensus amongst wetland scientists in South Africa that wetland evapotranspiration (ET) has not been adequately quantified. This research project will complement the WRC-funded project (K5/1704) at the Isimangaliso/Greater St Lucia Wetland Park by quantifying seasonal wetland evaporation using state-of-the-art ET measurement techniques.

Estimated cost: R908 000

Expected term: 2009 - 2011

Identifying relationships between soil processes and biodiversity to improve restoration of riparian ecotones invaded by invasive acacias

University of Stellenbosch

No. 1927

Invasive alien plants have now become weeds in conservation areas and agricultural land, threatening the country's biodiversity and agriculture. In addition, they can reduce runoff from water catchment areas, thus diminishing flow in streams and adversely affecting the water table. The research is aimed at finding ways to improve restoration of riparian areas invaded mostly by alien plants and the output of this work will provide knowledge needed in catchment management for holistic water resource management.

Estimated cost: R1 978 000

Expected term: 2009 - 2012

*Programme 4: Groundwater-dependent ecosystems***Framework development for the sampling, classification and geographical occurrences of stygobiont amphipods in South Africa**

North-West University (Zoology Department)

No. 1586

Groundwater ecosystems are virtually unknown in South Africa. However, in Australia recent research has shown them to be highly diverse. Fundamentally, they are of interest because there are certainly organisms which will be new to science, and the physiology and food chain dynamics of the organisms inhabiting these areas is of interest. In terms of the new legislation on biodiversity it is necessary to protect the ecosystems. However, the introduction of the concept of a groundwater Reserve in the national water policy means that if we are to implement the policy effectively we need knowledge of the ecosystem that is to be protected. The objective of this study is to broadly characterise the ecosystem in which stygobiont amphipods occur, develop a sampling method and conceptualise a biomonitoring protocol for groundwater using stygobionts.

Estimated cost: R1 350 000

Expected term: 2006 - 2009

THRUST 2: ECOSYSTEM MANAGEMENT AND UTILISATION*Programme 1: Ecological Reserve***Development of methods for Reserve determination of wetlands. Phase 1: Rapid Reserve**

Fluvius Environmental Consultants; Water for Africa; Golder Associates Africa; University of Cape Town; Wetland Consulting Services; Dr Patsy Sherman; North-West University (Potchefstroom); CSIR; University of KwaZulu-Natal

No. 1788

While satisfactory methods for determining environmental water requirements in permanent waters exist, wetlands have proved to be more complex. During the dry phase they provide a rich and productive flow of ecosystem services to the terrestrial system (e.g. grazing, agriculture) and during the flooded phase provide an equally important flow of ecosystem services to the aquatic system (e.g. water quality, flood attenuation, fish). The method developed needs to be able to cope with the alternate states of wetlands and their importance to the economies that they serve.

Estimated cost: R1 402 911

Expected term: 2008 - 2009

Application and testing of a strategic adaptive management system for freshwater protection, associated with implementation of South Africa's national water policy

SANParks Scientific Services; University of the Witwatersrand; Fluvius Environmental Consultants; Alexander & Llewellyn (Environmental Division); SAEON (Ndlovu Node)

No. 1797

River-based goods and services, with the explicit benefits to society, rely on healthy sustainable ecosystems. South Africa's water policy requires CMAs to manage the resource to achieve equity and social justice within ecological limits. These management practices are usually in conflict, but there is a growing body of research, geographically centred on South Africa's north-east Lowveld, on gaining coherence between these goals to achieve sustainable development. Strategic Adaptive Management (SAM) provides a proven vehicle for learning-by-doing by providing effective knowledge management. This project seeks to consolidate the SAM process developed within the Kruger National Park for wider and long-term implementation in water management areas (WMA) and to ensure that it is appropriately underpinned by the necessary knowledge, integration with the WMAs in the area and to support a wider enabling environment to ensure successful resource management

Estimated cost: R1 335 725

Expected term: 2008 - 2012

Testing a prototype methodology for environmental water assessments in non-perennial rivers

University of the Free State (Centre for Environmental Management); University of Cape Town; Rhodes University; Limpopo Province (Department of Economic Development, Environment and Tourism)

No. 1798

This proposal will extend an existing 3-year contract (K5/1587) on environmental water requirements for non-perennial rivers scheduled to end March 2008. The environmental Reserve must be determined for each significant water body before water-use licenses may be issued, but methods are needed to determine environmental water requirements for non-perennial systems as non-perennial systems predominate in the arid west of the country. Standard hydrological models cannot predict along the whole hydrological spectrum from perennial to episodic systems, so water licensing will have to be based on a new understanding of the non-perennial hydrology. This study will test the prototype methodologies which have been developed on one system on a different system.

Estimated cost: R3 000 000

Expected term: 2008 - 2012

Water temperatures and the ecological Reserve

Rhodes University (Institute for Water Research);
Freshwater Consulting Group; Albany Museum

No. 1799

In preliminary investigations, scientific literature has been seen to highlight the importance of water temperature as a primary abiotic driver for ecosystems. Northern hemisphere practices cannot be blindly applied to management issues in Southern African rivers. The persistence of these ecosystems is more likely to be achieved through a better understanding of water temperature patterns and processes. This project defines principles based on long-term trends and data of water temperature variation relevant to South Africa, in order to inform policy. Fundamental research, linking water temperatures and biotic response will inform about the baseline water temperature requirements for the ecological Reserve. The usefulness of these data will be further enhanced through a more complete spatial understanding of water temperatures, and a series of scenario analyses based on temperature simulations using a suitable water temperature model. This project will investigate aquatic invertebrates as indicators of thermal change and identify indicators of thermal change. In addition the team will adapt a generic water temperature model for application to Southern African conditions.

Estimated cost: R2 000 000

Expected term: 2008 - 2011

Development of a revised desktop Reserve estimation model: application of abiotic components of the Reserve within SPATSIM and other tools

Water for Africa; Rhodes University (Institute for Water Research)

No. 1856

The existing desktop Reserve model is dependent upon the characteristics of the reference hydrology used and largely ignores the advances in understanding of habitat-flow-ecology relationships that have emerged in the last 5 years or so. It also ignores regional differences in these relationships. While a comprehensive ecological Reserve study is expensive and typically addresses the main stem of major rivers and key tributaries and also takes a long time to complete, it is frequently inappropriate for many smaller water resource development assessments where the Reserve is required. The Desktop Reserve model has been demonstrated to be an appropriate analysis tool, whether used with default parameters or after adjustment through a Rapid Reserve assessment. However, the uncertainty associated with the outputs from the Desktop Reserve model remains a major concern, especially if these outputs are ever likely to be challenged in a court of law. Recent research has made a great deal of progress towards improving our understanding of the relationships between

physical drivers and biotic response and how these relationships vary in different parts of the country. The existing project is expected to develop initial databases related to the habitat requirements of fish and invertebrates that could contribute to quantifying the parameters of an improved Desktop Reserve model. The research will further enhance our understanding of the relationships between flow and ecological functioning, as well as enhancing our ability to use that understanding to make improved Reserve estimates. Research carried out within this project seeks to review the current understanding of the links between habitat availability and ecological functioning for different ecoregions, develop a hydraulic habitat generator model, and to incorporate the hydraulic habitat generator model and the ecological functioning rule base into an updated version of the Desktop model.

Estimated cost: R850 100

Expected term: 2008 - 2010

Development of methods for Reserve determination of wetlands. Phase 2: Intermediate and full Reserve determination

To be solicited

While satisfactory methods for determining environmental water requirements in permanent waters exist, wetlands have proved to be more complex. During the dry phase they provide a rich and productive flow of ecosystem services to the terrestrial system (e.g. grazing, agriculture) and during the flooded phase provide an equally important flow of ecosystem services to the aquatic system (e.g. water quality, flood attenuation, fish). The method developed needs to be able to cope with the alternate states of wetlands, and this phase will concentrate on the methods for the determination of the intermediate and comprehensive ecological Reserve.

Estimated cost: R2 000 000

Expected term: 2009 - 2012

Environmental water requirements for non-perennial systems: Phase III

University of the Free State

No. 1798

Non-perennial rivers are distinguishable from perennial rivers, in that their hydrology is spatially and temporally much more variable, creating high levels of disturbance for stream communities. Previous WRC research has shown differences in Reserve determination between perennial and non-perennial systems using existing methodology, e.g. the relevance of groundwater in relation to surface water. Furthermore, standard hydrological models cannot predict along the whole hydrological spectrum, from perennial to episodic systems; therefore, water licensing will

have to be based on a new understanding or model of the non-perennial hydrology. This study is aimed at testing the prototype methodologies on different river systems.

Estimated cost: R3 000 000

Expected term: 2009 - 2012

Shared Rivers Initiative: Phase II: Analysis of the ecological Reserve implementation scenarios with the intention to design an effective implementation approach/plan

AWARD

No. 1920

There are conflicting views among communities with regard to the use and management of water resources, which has complicated the implementation of trans-boundary water resource management, particularly the ecological Reserve, in RSA. In spite of all the challenges, there are situations where implementation of the ecological Reserve has been successfully executed. There are also situations where implementation has not been successful. Effective planning needs to critique these case studies, to identify the strengths and weaknesses (gaps) of the implementation approaches and methods and the policy itself. The results or output will be used to design 'a new way of doing things' as far as implementation of the Reserve is concerned. The output may also suggest refinement of the policy if need be.

Estimated cost: R800 000

Expected term: 2010 - 2013

Review and update of resource directed measures (RDM) for estuaries

Anchor Environmental Consultants

No. 1930

The increase in understanding of the RDM methodologies for estuaries, together with the increased variety of systems studied in the RDM process, has led to the realisation that some areas of the RDM methodology are problematic and need further refinement. The conducted modelling study, run in conjunction with the research and RDM study of the East Kleinemonde estuary, highlighted several issues of concern regarding assumptions made in scoring present condition and future scenarios. This research study will investigate and improve the alignment of the RDM process with the classification process.

Estimated cost: R604 400

Expected term: 2009 - 2010

Decision support system for determination of environmental water requirements

Southern Waters

No. 1873

Current methods for the assessment of environmental water requirements need the input of subject specialists, and this is a process that is both expensive and difficult for water managers who are not specialists to interact with. The feasibility of the decision support system (DSS) to be developed has been researched and shown to be possible. This DSS will enable water managers to set scenarios and to run the system themselves. In this way they will be able to predictively test different scenarios themselves, and thus select the scenario which best suits their needs, without ongoing specialist input. This will empower managers to make decisions themselves.

Estimated cost: R1 800 000

Expected term: 2009 - 2011

Programme 2: Estuary management

Estuaries and economic empowerment

University of KwaZulu-Natal (Centre for Environment, Agriculture & Development)

No. 1705

Earlier phases of the Eastern Cape Estuaries Management Programme researched the estuarine systems with the long-term aim of enabling communities living alongside the estuaries to generate income from the resource in a sustainable manner. Courseware was prepared and presented to local authorities (ranging from poorly- to well-resourced) on estuarine planning and management with a view to including the estuary in the Integrated Development Plan (IDP) of the local authority. This follow-up project will focus on subsistence livelihoods and will examine such issues as economic empowerment, institutional arrangements, participatory governance in the light of available opportunities, and will establish a framework where identified opportunities can be picked up in the IDP process. Principles developed during this suite of projects will be applicable to wetlands and other areas where natural resource-based enterprises may be developed.

Estimated cost: R1 500 000

Expected term: 2007 - 2010

The application of choice modelling techniques to guide the management of estuaries in South Africa – case studies at the Kromme, Bushmans, Sundays and Keurbooms estuaries

Nelson Mandela Metropolitan University

No. 1924

The research to be undertaken during this follow-on project will support managers in their decisions on the inflow of freshwater into estuaries, through the provision of in-

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formation on the economic value of the flow of ecosystem goods and services provided by estuaries and linked to the quantity of freshwater flowing into the estuary. Research conducted during the previous projects has developed the contingency valuation method for the valuation of freshwater inflows into estuaries, and the research proposed in this project will, working together with estuary managers, apply the methods developed to four specific estuaries, in a way that will provide the interface between the method developed during the previous research and the information requirements of the estuary managers.

Estimated cost: R770 000
Expected term: 2009 - 2011

Programme 3: Ecosystem health

Osmoregulation in freshwater invertebrates in response to salt pollution

Rhodes University (Institute for Water Research)
No. 1585

Salinisation is a major cause of water quality deterioration. Current methods for water quality assessment include boundary values for specific salts. Biological data is scarce for most of these salts, and what exists is based on acute toxicity data. This research aims to provide chronic toxicity test data, for selected indigenous stream organisms, which are biologically relevant for the country. This will be done through physiological experimental research (oxygen consumption and osmolarity), using samples generated during acute and chronic toxicity testing, and evaluating the salt boundary values in the setting of resource quality objectives.

Estimated cost: R201 160
Expected term: 2005 - 2009

Programme 4: Environmental water quality

Development of a diatom-based bio-monitoring protocol for South African rivers and streams. Phase III: Regional testing, method refinement & calibration; index formulation and river health programme

DH Environmental Consulting
No. 1707

The study is an extension of 2 earlier phases (Phases 1 & 2) of the development of a diatom-based biomonitoring tool. The National Water Act ensures the protection of water resources, and therefore methods are needed to identify the health of aquatic systems. It is envisaged that the results from this study will be used in State of River reporting and will form part of the River Health Programme. The Diatom Assessment Protocol (DAP) as a biomonitoring tool can be used to test the water quality of various waterways,

including the urban waterways. This study (Phase 3) will deal with the formulation and calibration of a Diatom Index for South Africa. Through testing of diatom species over a time period, the species that are most ecologically important will be determined for use in calculations. This study will determine those important diatom species in order to develop a South African Diatom Index. A diatom-based index will be accepted by DWA and key stakeholders as a biomonitoring tool related to the 6 RDM water quality/condition classes (A-F). The objectives of the study are to:

- Formulate and validate a unique SA Diatom Index for rivers and streams related to the 6 RDM water quality/condition classes
- Validate DAP methodology in close association with the ongoing development of the suite of aquatic ecosystem assessment models (VEGRAI, FRAI, GAI & MIRAI)
- Establish an inter-laboratory calibration and testing component for diatom identification
- Report on the modification of DAP for the rehabilitation of urban streams and canals with the inclusion of the DAP in the testing protocol
- Build capacity of scientists and DWA personnel in the use of this tool in determining water quality and as a supplementary tool to determine the eco-status of rivers and wetlands
- Develop courseware for DAP for tertiary level education
- Report on river reference conditions based on historical diatom data

Estimated cost: R1 824 450
Expected term: 2007 - 2010

Programme 5: Endocrine-disrupting compounds in water resources

The environmental exposure and health risk assessment in an area where ongoing DDT spraying occurs

University of Pretoria
No. 1674

The presence of DDT and metabolites in single pilot water, sediment and fish samples from the Vhembe district, Thohoyandou, Limpopo Province, is of concern. The concordant high prevalence of urogenital birth defects and the DDE concentrations in cord blood in babies born in a DDT-sprayed area should be regarded as a matter of extreme concern. The research question is whether environmental levels of DDT and DDE may contribute to adverse health effects in catfish and may pose a health risk for humans. The project will review the effects of EDCs on aquatic invertebrates and develop a comprehensive research programme to investigate the use of aquatic invertebrates as monitors of ecological health effects of endocrine disruptors. A further objective is to link possible health effects in biota from a DDT-sprayed area to adverse health effects in humans

living in the Vhembe area. A scenario-based health risk analysis will be performed, EDC assessment techniques evaluated, and a toolkit of tests for wider application in other spraying areas will be developed.

Estimated cost: R1 985 000

Expected term: 2006 - 2009

Thyroid-disrupting activity in South African waters: Amphibian metamorphosis as biological model to study effects of endocrine contaminants on thyroid function

University of Stellenbosch (Department of Zoology)

No. 1680

Endocrine disruption of the control and functioning of the reproductive system is of global concern but there is also evidence that EDCs may interfere with the normal functioning of the thyroid system. Changes in thyroid function could adversely affect several physiological systems in humans and wildlife but the specific effects and toxicants involved are not well-known. This project aims to set up, validate and review protocols of the *Xenopus* metamorphosis assay (XEMA) for testing effects of water-borne chemicals on the thyroid endocrine system. A chemical and water serial diluter system and a flow-through water exposure system for EDC screening will be designed and tested.

Estimated cost: R400 000

Expected term: 2006 - 2009

Environmental assessment in an area where ongoing DDT spraying occurs

Rhodes University (Institute for Water Research)

No. 1706

Previous research at Rietvlei Dam, (WRC Project No K5/1505) identified a number of possible endocrine disrupting compounds (EDCs). DDT was a major contributor in many of the samples analysed. In Limpopo Province and KwaZulu-Natal, DDT is used for malaria control, and higher environmental levels were expected in studies there. This research will add value to the variables being investigated by WRC Project No K5/1674 in the Limpopo Province. The data will also contribute to the risk assessment to be undertaken in the same area. Several invertebrates and vertebrates will be examined for the effect of DDT:

- Snails have been identified as a promising endocrine-disruption biomarker
- *Xenopus laevis* and other frog species will be collected at small ponds, and investigated for indication of endocrine disturbance, possibly related to DDT
- Pied Kingfishers (*Ceryle rudis*), have been shown to be good indicators of aquatic pollution, and eggs will also

be collected from other water birds as well from sparrows and this will provide an indication of the transfer of DDT from food and soil particles

- Small mammals (mice and rats as appropriate) will be collected and examined for EDC-induced abnormalities

This battery of vertebrate and invertebrate indicators, (snails, frogs, birds, rats and mice), collected in situ, could provide further evidence for endocrine-disrupting activity, and contribute towards risk assessment under locally-relevant conditions

Estimated cost: R398 330

Expected term: 2007 - 2009

A study of the interactive effects of pesticide mixtures in water on selected species

University of Stellenbosch

No. 1932

Scientific research revealed that all major aquatic wildlife groups are experiencing endocrine disruption (ED) in contaminated sites, and that at many sites this is caused by a complex mixture of substances. Our ability to predict higher-order effects is still weak, and the imperfect state of our knowledge about the effects of EDCs on ecosystem structure has implications for environmental risk assessment of EDCs; therefore ecosystem-based research is much needed. Only in a few cases could a causal link between EDCs in freshwater systems and altered endocrine activity/function in exposed fish or amphibians be established. This study will be a laboratory study to investigate the explicit ED effects of mixtures of at least two pesticides, used in agricultural areas of intensive and concentrated crop-cultivation practices, which could contribute to the ED effects seen in the environment (thus not taking the effects of industrial or other pollution into account).

Estimated cost: R1 600 000

Expected term: 2009 - 2012

Programme 6: Socio-economic considerations

Establishing the fishery potential of the Nandoni Dam in the Luvuvhu River, Limpopo Province

University of Venda

No. 1925

Nandoni Dam was completed in 2004, and is ideally suited for both an extensive commercial fishery and an aquaculture industry. However, in order to manage the resource sustainably it is necessary to know what the productivity of the impoundment is. Impoundments typically go through a period of high productivity just after filling, as a result of the release of nutrients from the recently flooded land. This then settles down to the long-term level once the ini-

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tial nutrient release is over. Nandoni Dam is reaching this stage and the level of fishery that the impoundment can sustain needs to be determined in order that the management target can be effectively set. The research conducted during this project is aimed at providing this information.

Estimated cost: R823 200
Expected term: 2009 - 2012

Programme 7: Ecosystem governance

The Shared Rivers Initiative Phase I: Communication and fundraising

CSIR (Natural Resources and the Environment); AWARD; SANParks (Kruger National Park); University of the Witwatersrand

No. 1783

There is growing concern about the continuing decline in the integrity of the Lowveld river systems despite an excellent knowledge base on the biophysical aspects of the rivers and an enabling legislative and institutional framework to support river management. These river basins are all shared between neighbouring sovereign states (Zimbabwe, Mozambique, South Africa, Botswana and Swaziland) and each has to achieve their own resource and supply priorities within their portions of these basins. There is a clear need to harmonize management and decision-making within relevant institutions and between neighbours to ensure fair and effective policy implementation and water service delivery. This must be done within the constraints of seasonal and longer term variability of the water resources. River systems are complex, comprising interrelated social and ecological sub-systems, which make addressing issues of implementation and compliance difficult within an international river context. Recognising the Lowveld rivers as complex social-ecological systems has many implications in the way they are/should be managed. This project (Phase 1 of a larger initiative) aims to understand and effect change in the implementation of policies and legislations relevant to the wise use of the Lowveld river systems by exploring water policy implementation as a complex social-ecological problem from a theoretical perspective, initiating an action research programme that combines research, learning and implementation to secure institutional and operational competency in river management and to improve broad stakeholder awareness and compliance that leads to the implementation of real solutions to real problems, the outcome of which delivers the river ecosystem goods and services upon which people depend. Research in the other countries with which South Africa shares these basins will depend on funding from sources other than the WRC. Thus, it is important that, during this phase, other funders are recruited to broaden the geographical scope of the research.

Estimated cost: R548 000
Expected term: 2008 - 2010

Identifying and enabling protection of national freshwater heritage ecosystems for South Africa SANBI; CSIR (Natural Resources and the Environment) **No. 1801**

Freshwater ecosystems and biodiversity comprise a valuable natural resource, but it is becoming increasingly apparent that these may be the most threatened ecosystems in the world. The National Spatial Biodiversity Assessment (2004) found that 44% of South Africa's freshwater ecosystems associated with main rivers are critically endangered, compared with only 5% of terrestrial systems. Rivers and wetlands reflect the state of the catchment and as such the conservation of freshwater ecosystems depends on whole-catchment management in a manner integrated to maintain ecological integrity as well as achieving sustainable development in the social and economic spheres. To this end, this project seeks to identify a national network of freshwater conservation areas, national freshwater heritage ecosystems and national freshwater rehabilitation priorities. It seeks also to develop an institutional basis to enable effective implementation of this national network of freshwater conservation areas.

Estimated cost: R930 000
Expected term: 2008 - 2010

THRUST 3: ECOSYSTEM REHABILITATION

Programme 1: Wetland rehabilitation

Wetlands and livelihoods: Restoration of the wetlands ecological process, form and function to provide the ecosystem goods and services necessary to support livelihoods

University of KwaZulu-Natal
No. 1986

We understand the biophysical nature of wetlands fairly well. We understand how they have evolved, but not their roles as integral parts of social-ecological systems. We continually strive to establish 'stable' wetland states rather than resilient social-ecological states. As long as we continue to take a simplistic view of such complex systems and adopt reductionist approaches we are not likely to progress with our understanding of the roles of the interactions between wetlands and livelihoods in the context of promoting resilience. Sustainable use cannot be understood or promoted unless we strive to achieve social-ecological resilience. This research proposal is premised on the assumption that 'wetlands and livelihoods' should be contextualised as dimensions of social-ecological systems. This encourages a more inclusive, holistic and dynamic ap-

preciation for the 'institutional configurations the interactions among resources, resource users, public infrastructure providers and public infrastructure' (Anderies et al., 2004). Inherent in this assumption is the notion that we need to manage the social-ecological system for resilience and not manage the wetland alone for either the supply of services or resilience. Inherent in this interpretation is the critical role of evidenced-based analysis for co-learning, assessing risk and making tradeoffs that are supported because they are perceived to be legitimate. The aims of the research are: to adapt the Anderies et al. social-ecological system framework (currently being applied in an estuaries context) and other supporting frameworks for application in a livelihoods context on freshwater wetlands; to test the framework(s) through field and/or desktop application at four wetlands and refine accordingly; and to develop a decision support system that supports management action aimed at improving resilience in social-ecological wetland systems.

Estimated cost: R800 000
Expected term: 2010 - 2013

Guidelines for the determination and management of wetlands buffer zones

University of KwaZulu-Natal
No. 1789

Watercourses are able to adapt to changing circumstances, but the current state of watercourses in the country is a clear indication that a threshold is easily reached and impacts of surrounding land uses and human activities can be detrimental. The Reserve, resource class and resource quality objectives are, however, legislative tools developed to reverse or prevent such detrimental impacts/consequences for the resource. The main importance of a buffer zone is to act as a safeguard or a defence against surrounding impacts when resources are stressed or negatively impacted on. The research conducted within this project seeks to identify ways of delineating the riparian buffer zone in order to protect the resource and the riparian fringe in order to provide ongoing protection for the resource. It is envisaged that the results of this buffer zone study, in addition to the appropriate delineation, would be used by all relevant Departments for activities associated with watercourses.

Estimated cost: R2 500 000
Expected term: 2008 - 2011

Programme 2: River and impound rehabilitation

Conservation of tigerfish, *Hydrocynus vittatus*, in the Kruger National Park with the emphasis on the establishment of management plans for the protection of its riverine habitat

University of Johannesburg
No. 1922

The tigerfish is a flagship species in tropical and sub-tropical environments. It is also a species which requires healthy environmental conditions and as a result it is vulnerable to declined environmental quality. South African National Parks are charged with the maintenance of biodiversity, both aquatic and terrestrial, and so need to manage their parks to maintain conditions suitable for the biota. The rivers flowing through the Kruger National Park (KNP) are all heavily utilised upstream and these activities impact on both the quality and quantity of water in the rivers. Under the National Water Act the ecological Reserve has been determined for these rivers, and research conducted during this project will ascertain the state of the tigerfish population in the KNP and will investigate whether the ecological Reserve, as determined, is sufficient to maintain a viable population of tigerfish in the rivers flowing through the KNP.

Estimated cost: R1 844 120
Expected term: 2009 - 2012

Food-web manipulation Phase II: Food-web interactions in South African reservoirs traced using stable isotopes

DH Environmental Consulting
No. 1918

A number of the impoundments in and around Gauteng are highly polluted, and the pollution loads are increasing with the increasing load that urbanisation is placing on the treatment of effluents. Management of this pollution demands a multipronged approach, both in the catchment and in the impoundment itself. Elsewhere in the world it has been shown that the control of the numbers of zooplanktivorous fish species in the reservoir allows for an increase in the phytoplanktivorous zooplankton biomass. This in turn acts as a control of the phytoplankton, so reducing the retention time of nutrients, particularly phosphorus, in the water column. In this way the effects of eutrophication can be controlled to an extent. The research conducted in this follow-on project will investigate whether the removal of selected fish species may be effectively used as part of the suite of methods needed to bring eutrophication, and its deleterious effects on these water bodies, under control.

Estimated cost: R1 500 000
Expected term: 2009 - 2011

NEW PROJECTS

THRUST 1: ECOSYSTEM PROCESSES

Programme 1: Estuarine processes

Primary producers as sinks for nitrogen and phosphorus in the Great Brak estuary

Nelson Mandela Metropolitan University (Botany Department)

No. 1982

The study will provide knowledge of the processes that regulate nitrogen and phosphorus cycling in a temporarily open/closed estuary. The previous Great Brak Ecological Water Requirements Study recommended that further studies are needed to determine the loads of nitrogen and phosphorus flowing through the estuary and to determine how effective the estuarine flora, macro-algae and macrophytes, are at trapping and removing these nutrients from the system. Understanding this aspect has become critical in view of the increased water requirements from PetroSA and Mossel Bay and the related decreased inflow to the estuary. Less river inflow to the estuary translates into more closed mouth conditions, which in turn will cause more nuisance algal blooms in the system impacting on both the sense of place and biota of the estuary. The main aims of the study are: to identify the sources and determine the loads of nitrogen and phosphorus entering the estuary, through point-source discharge (e.g. river, sea and storm drains), diffuse discharge (e.g. groundwater seepage from septic tank overflow and golf course irrigation water), atmospheric deposition (rain water) and remineralisation from organic material trapped in the sediment; measure the flux of nutrients between the water column and the benthos; measure the nitrogen and phosphorus content in living plant material; describe the environmental conditions in the estuary that favour macro-algal blooms; provide recommendations to be included in the Great Brak Estuary Management Plan; and to compare results from the Great Brak Estuary, an estuary dominated by macrophytes and macro-algae, to estuaries dominated by phytoplankton (e.g. the permanently open Sundays Estuary).

Estimated cost: R955 000

Expected term: 2010 - 2013

Programme 2: Riverine processes

Linking hydrology and lateral riparian vegetation zones

Southern Waters Ecological Research & Consulting

No. 1981

The research will focus on standardising the number of lateral riparian vegetation zones, their names and their

links to aspects of the flow regime. This has been proposed by Mackenzie et al. (1999) and underlies the recommended data collection approach for riparian vegetation in the Building Block Methodology (Kemper and Boucher 2008). Possibilities for standardising zone definitions have been explored to some extent in other work done on rivers in the Kruger National Park and also arose out of the previous WRC project (K5/1407), which proposed a biological description of four lateral zones but did not formalise the links with any hydrological data. This initial description requires testing on rivers elsewhere in the country. Therefore, a concise account of lateral zones with consensus on their names and predicted locations; descriptions of their floristic and other attributes, and an assessment of their correlation with flows of different return periods will be invaluable to specialists involved in Reserve determinations, practitioners involved in using VEGRAI under the NAEHP and, importantly, to new entrants to the field of riparian botany. The main objectives of the study are: to identify the number and composition of lateral zones in riparian vegetation communities in a selection of rivers around South Africa; suggest standardised names for the identified lateral vegetation zones; explore the relationships between these lateral vegetation zones and aspects of the daily flow hydrology and, if possible, link the identified zones to flows of particular return periods; and to seek simple methods for the identification of the lateral vegetation zones.

Estimated cost: R1 765 310

Expected term: 2010 - 2013

THRUST 2: ECOSYSTEM MANAGEMENT AND UTILISATION

Programme 1: Ecological Reserve

Linking of daily and monthly hydrological time series for use in monthly water resources models in support of the determination of ecological water requirements Water for Africa (Pty.) Ltd.

No. 1979

The purpose of this study is to develop an effective methodology which utilises the daily hydrology available from the ACUR model to generate statistical parameters which describe the incremental daily flow for any quaternary catchment in South Africa and utilize this within existing monthly models to address the shortcomings of existing in monthly EWR determination methodologies. The outcome of such a method would be a stochastic simulated stream-flow time-series of daily natural discharges for all quaternary catchments which is consistent with Pitman monthly hydrology. The daily time-series will not necessarily be a true representation of the flow on any particular day but will be statistically the same and will be of tremendous

value to the EWR ecologists. The main aim of this research is to incorporate daily natural stream flow time-series into existing monthly water resource system modelling tools in order to enhance the ability of ecologists to determine the ecological flow requirements of rivers, specifically to: establish regression relationships between ACRU daily flows and the existing nationwide monthly naturalised flows (Pitman); incorporate these relationships into an existing monthly water resource model so as to provide a modelling tool which can estimate the change in daily flow (statistically) at any point in a catchment under various development scenarios; and to incorporate daily output tools for use by the ecologists.

Estimated cost: R378 000
Expected term: 2010 - 2012

Programme 3: Ecosystem Health

Genetic diversity studies on selected taxa in the Klip River System: Towards the assessment of the usefulness of genetic diversity as an indication of ecological health

Sinelwati Scientific Research & Management
No. 1976

Whilst a lot of progress has been made towards developing various indices for assessing the ecological health of aquatic ecosystems, little is known about the organisation of genetic diversity in wetland and other ecosystems. There has been increased interest in rehabilitation of heavily impacted wetlands and in future this may require reintroduction of various biota. This study will focus on generating basic knowledge needed to strengthen understanding of the partitioning of genetic diversity as well as the responses to pollution at the molecular level. The main aims of the research are: to determine levels and patterns of genetic diversity among some biota on the Klip River Wetland and other selected sites; to assess the potential for genetic diversity for use as an indicator of water quality; and to determine correlations, if any, between particular genotypes and physico-chemical properties at selected sites.

Estimated cost: R1 650 000
Expected term: 2010 - 2013

Expanding on a National Wetland Vegetation Database for the purpose of conservation planning, monitoring and wetland rehabilitation

University of the Free State (Plant Sciences, QwaQwa campus)
No. 1980

This is a follow-up of a scoping study (based on three provinces; K8-789) on building a national database on wetland vegetation. It addresses the critical need for baseline data

on the biodiversity of South Africa's wetlands. Furthermore, it will support the Working for Wetlands Programme by establishing a method by which wetland biodiversity can be monitored after rehabilitation. In that sense it will supplement the Wetland Health and Integrity Programme already produced.

Estimated cost: R1 951 000
Expected term: 2010 - 2013

Programme 4: Environmental Water Quality

Survey of potential ecological and human health risks posed by persistent organic pollutants in aquatic environments in a densely industrialised and urbanised areas

University of KwaZulu-Natal (Chemistry Department)
No. 1977

A group of contaminants that is receiving ever-increasing attention in water and sediment quality surveys and monitoring programmes in many regions of the world is persistent organic pollutants (POPs). This attention is related to the fact that these compounds and/or their breakdown products are widely acknowledged as a significant health risk (e.g. direct toxicity, endocrine disruptors, carcinogens). Urbanisation is recognised as a far more significant source of contaminants to surface waters compared to agriculture, and surface waters in these areas are often the sole source of drinking and washing water to informal communities. Estuaries are the ultimate sinks for contaminants introduced into upstream waters and hence should provide an integrated understanding of potential problems at the catchment scale. The research has another aim in the context of costs of laboratory analyses and implementing monitoring programmes, namely, to assess whether the monitoring of estuaries (especially those in cities and towns) would be simpler and cheaper than for rivers. The overarching aim of the research is to perform a survey for an extensive suite of persistent organic pollutants in aquatic ecosystems from a highly industrialised and urbanised area and to assess the potential ecological and human health risks of measured concentrations.

Estimated cost: R1 543 176
Expected term: 2010 - 2013

Linking land use and water quality for effective water resource and ecosystem management

CSIR; Ground-Truth cc; UKZN
No. 1984

The effect of land use (especially mining and agriculture) on water quality and quantity is of concern and must be given special attention in order to ensure water security for South Africa. There is a need to begin with new ways

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of managing our water resources to abate water quality challenges that South Africa has been battling with for a long time. The investigation will generate knowledge on the effect of various land-use practices on water quality, sedimentation and river health. The study will have to integrate disciplines such as terrestrial and aquatic resource management. The research should reinforce the principles of IWRM and the importance of catchment management as the ideal way to protect water resources and ensure sustainable utilisation of aquatic ecosystems.

Estimated cost: R1 500 000
Expected term: 2010 - 2013

Programme 5: Endocrine disrupting compounds in water resources

Guidelines for the Management of EDCs in Water resources: Volume 2: EDC Sampling Guide

Golder Associates Africa (Pty.) Ltd.

No. 1983

The endocrine disrupting contaminants (EDC) research programme of the Water Research Commission (WRC) has been developed with the aim of providing aid to stakeholders and the Government in the monitoring and management of EDCs. Work on the Assessment and Monitoring Guide (Volume 1) and the Management Guide (Volume 4) started in 2009. The Bio-assay Toolkit Guide is currently being finalised and this will be followed by the Organic and In-organic Analytical Methods Guidelines; all three will be incorporated as Volume 3. It is therefore necessary to develop the Sampling Guide in parallel with these guidelines to make sure that the guides include all relevant aspects necessary for EDC management in water resources. This project would give specific guidance on the sampling and preservation procedures, transport and storage of sediments and water that need to be followed in taking and handling the samples to be analysed for EDCs for treated water, raw groundwater and surface water.

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

Programme 6: Socio-economic considerations

Extracting scientific evidence for the development of ecosystem services production functions for the Resource Directed Measures

Prime Africa

No. 1978

The project will attempt to get a new interpretation from existing study results, by placing relevant socio-ecological work into a production function framework, and by highlighting the ecosystem service functions. The rationale is

that water resource management decisions, particularly as they relate to a scarce and precious public good, need to be justified by good scientific evidence. This study is on the proposition that evidence-based ecology (EBE) should be a mechanism for increasing support to experts and practitioners by improving the information flow to stakeholders and decision-makers within an evidence-based framework (Pullin and Knight, 2003). In EBE, information-mining is described as 'systematic review'. The main aims of the study are: to gather scientific evidence (data and information) from past and ongoing WRC studies, DWA- RDM studies and other studies in a format that is useful in the development of ecosystem services production functions; to seek to influence the manner in which evidence accumulates from future studies, such that it is more amenable to incorporation in the procedure set out in the previous WRC project (K5/1644). This will include (a) guidance on how data/knowledge should be captured or documented in the future in order to provide input into this additional step and (b) analysis of the requirements for establishment of a centre of evidence-based aquatic ecology for South Africa; to identify areas of weakness in production function evidence, and encourage more research to address practical issues in these areas; and to provide outputs that are useful and highly accessible to the community of practitioners in this field

Estimated cost: R500 000
Expected term: 2010 - 2012

Programme 7: Ecosystem governance

The Shared Rivers Initiative Phase 2: Implementation of the Reserve (NWA)

AWARD

No. 1920

Research conducted will develop a dynamic synthesis of the reasons for the lags in the implementation of the National Water Act (NWA) of 1998, focusing on the ecological Reserve. It will not be a blueprint for solving the problem, but it will provide the principles and framework to guide water practitioners and managers in solving context-specific problems. Key to the whole programme is the building of capacity amongst the people involved in all levels of water resource and service management (relevant spheres of government, agriculture, mining, etc.) through action research. A means of working in this study is through collective action, networking, self-organisation and practice-based feedback loops, the aim being to develop these features where they do not already exist. It is anticipated that this will be a collaborative process and some of the outcomes will need to be negotiated. The overall aim of the Shared Rivers Initiative is to understand and effect change in the implementation of policies and legislation, specifically the ecological Reserve, relevant to the wise use

of the Lowveld river systems. In addition, the study will design and implement a series of actions that will build capacity and confidence in the legal competence to enforce obligations associated with environmental water requirements in the region and specifically the ecological Reserve in South Africa. This must be done in such a manner as to allow a generic way of introducing ongoing change which is consistent with adaptive learning.

Estimated cost: R2 500 000
Expected term: 2010 - 2013

THRUST 3: ECOSYSTEM REHABILITATION

Programme 1: Wetland rehabilitation

Wetlands and livelihoods: Restoration of wetland ecological process, form and function to provide the ecosystem goods and services necessary to support livelihoods

University of KwaZulu-Natal (CEAD)

No. 1986

Wetlands are highly productive and are important for the conservation of biodiversity as well as water resource protection. They are also used by people in both formal and informal (subsistence) agriculture as well as for various forms of recreation. Wetlands are susceptible to alteration through various forms of land use and upstream activities such as water abstraction and mining. Ecosystem goods from wetlands such as fisheries have been shown to be closely correlated to the area flooded, and so knowledge of the environmental water requirements (both quantity and quality) of wetlands is important. Recognising that certain uses impact negatively on the ecosystem goods and services that these wetlands provide, this project aims to define those ecosystem goods and services, to indicate the management activities (including rehabilitation where necessary) required to deliver the goods and services on which various activities (for example: those mentioned above) depend, and to describe interventions for the rehabilitation of impacted wetlands to suit specific uses and users.

Estimated cost: R800 000
Expected term: 2010 - 2012

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