



INSTITUTE FOR WATER RESEARCH



2015

ANNUAL REPORT



RHODES UNIVERSITY
Where leaders learn

Table of Contents

Staff and Members of the Institute	2
Institute for Water Research Director's Report	3
Unilever Centre For Environmental Water Quality (UCEWQ) Director's Report	9
Hydrology Projects	11
Environmental Water Quality Projects	15
Water and Society Projects	28
Postgraduate Activities.	30
Research Output.	46



Back Row: Mr S Mamkeli, Mr D Forsyth, Dr A Slaughter, Mr D Rugai, Mr S Mazibuko
 Third Row: Mr O Gwate, Mr M Weaver, Mr G Pienaar, Dr J Tanner, Mr M Mkatali
 Second Row: Mr E Vellemu, Prof C de Wet, Dr P Mensah, Dr R Dowse, Ms M Wolff, Ms K Mgaba, Dr N Griffin
 Front Row: Mr C Ndzabandzaba, Mr Z Lidzhegu, Ms J McLean, Prof D Hughes, Dr N Odume, Ms Y Chiliboyi, Ms N Libala
 Inset: Prof C Palmer
 Absent: Dr A Palmer, Dr S Mantel, Ms A Holland, Ms T Tsietsi

Front Cover (top to bottom): Dr Mantel, Dr Palmer and Mr Gwate, after successfully installing a Large Aperture Scintillometer at a site where wattle has been cleared near Maclear, Eastern Cape; Nognye Falls on Zambezi River, Zambia; Mr Mzwanele Mkatali, Ms Khaya Mgaba and Ms Alex Holland at Richards Bay Mineral site 19; Acid Mine Drainage decant found at a pre worked mining site, in Carolina, Mpumalanga. Current plans to rehabilitate the site have been abandoned due to the liquidation of the Mine responsible for the decant.

STAFF AND MEMBERS OF THE INSTITUTE

STAFF

Ms Joan Cameron	Research Assistant
Prof Chris de Wet	Professor
Mr David Forsyth	Principal Technical Officer
Dr Neil Griffin	Research Officer UCEWQ-IWR
Mr Nick Hamer	Research Associate
Prof Denis Hughes	Professor Director of IWR
Mr Sithenkosi Mamkeli	Rhodes University Intern
Dr Sukhmani Mantel	Research Officer IWR
Ms Juanita McLean	Administration Manager
Dr Paul Mensah	Research Officer IWR
Ms Ntombekhaya Mgaba	Senior Technical Officer
Mr Mzwanele Mkatali	Technical Assistant
Dr Nelson Odume	Postdoctoral Fellow
Prof Tally Palmer	Professor Director of UCEWQ
Dr Andrew Slaughter	Research Officer IWR
Dr Jane Tanner	Postdoctoral Fellow
Ms Margaret Wolff	Part time Project Manager UCEWQ-IWR

ASSOCIATES

Mr Greg Huggins	Research Officer Nomad Consulting
Ms Delana Louw	Research Officer
Mr Stephen Mallory	Research Officer IWR Water Resources
Dr Victor Munnik	Research Associate Rivers for Africa
Prof Jay O' Keffe	Research Associate
Dr Tony Palmer	Research Associate
Dr Jill Slinger	Research Associate and Visiting Professor

REGISTERED POSTGRADUATE STUDENTS

Ms Louise Bryson	MSc (Water Resource Science)
Ms Karabo Chadzingwa	MSc (Environmental Science)
Ms Yvonne Chiliboyi	MSc (Water Resource Science)
Ms Athina Copteros	PhD (Geography)
Mr Onalenna Gwate	PhD (Water Resource Science)
Ms Alex Holland	PhD (Water Resource Science)
Mr Haden Jacobs	MSc (Hydrology)
Ms Tia Keighley	MSc (Water Resource Science)
Mr Zwidothelangani Lidzhegu	PhD (Water Resource Science)
Ms Eunice Makungu	PhD (Hydrology)
Ms Ntombekhaya Mgaba	MSc (Water Resource Science)
Ms Vuyelwa Mvandaba	MSc (Hydrology); Based at CSIR
Mr Coli Ndzabandzaba	PhD (Hydrology)
Ms Nadia Oosthuizen	MSc (Hydrology); Based at CSIR
Mr Greg Pienaar	MSc (Water Resource Science)
Mr Ian Preston	MComm (Management)
Mr Dionis Rugai	PhD (Hydrology)
Ms Emma Sitambuli	PhD (Anthropology)

Mr Gareth Thomson	MSc (Water Resource Science)
Ms Teboho Tsietzi	PhD (Anthropology)
Mr Emmanuel Vellemu	PhD (Water Resource Science)
Mr Matthew Weaver	MSc (Water Resource Science)
Ms Margaret Wolff	Med

2015 GRADUATED STUDENTS

Mr Jai Clifford-Holmes	PhD (Water Resource Science)
Ms Helen Fox	PhD (Water Resource Science)
Ms Pearl Gola	PhD (Water Resource Science)
Ms Ntombekhaya Mgaba	Honours (Environmental Water Management)
Mr Thabiso Mohobane	PhD (Hydrology)
Ms Lara Molony	MSoc Sci (Environmental Science)
Mr Hugo Retief	MSc (Water Resource Science)
Ms Asiphe Sahula	MSc (Water Resource Science)
Ms Madaka Tumbo	PhD (Hydrology)
Mr Agostinho Vilanculos	PhD (Hydrology)

MEMBERS OF THE BOARD OF CONTROL

Prof Janine Adams	NMMU, Botany Department
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Prof Peter Clayton	Chairman, Rhodes University; Deputy Vice Chancellor: Research & Development
Prof Fred Ellery	Rhodes University, Department of Geography
Prof Denis Hughes	Rhodes University, Institute for Water Research, Director
Prof Heila Lotz-Sisitka	Rhodes University, Environmental Learning Research Centre
Ms Juanita McLean	Secretary to BOC and Administration Manager
Ms Deborah Mochotlhi	Department of Water Affairs
Dr Jennifer Molwanta	WRC (Water Research Commission)
Prof Carolyn (Tally) Palmer	Rhodes University, Institute for Water Research, Director of UCEWQ
Dr Angus Patterson	SAIAB (South African Institute for Aquatic Biodiversity)
Dr Dirk Roux	SANParks
Prof S Shackleton	Rhodes University, Environmental Science
Mr Craig Thompson	Amatola Water

INSTITUTE FOR WATER RESEARCH

DIRECTOR'S REPORT

Introduction

The Institute for Water Research was officially formed in July 1991, which means that 2015/16 represents the 25th anniversary of our existence as a single research institute of Rhodes University. The programme for the Open Day to be held at the end of January 2016 reflects this milestone in the life of the IWR. We will spend some of the time looking back at the last 25 years (and before, when the Hydrological Research Unit was part of Geography and when the Institute for Freshwater Studies was closely linked to the Zoology Department). We will also look to the future and decide whether we should continue on the same, or similar, tracks as the past, or whether we should start to move in different directions in terms of the type of research that we do, or the way in which we conduct our 'research' business within the setting of a South African University. A third component of the Open Day is designed to give the post-graduate students time to discuss career opportunities in the water sciences together with more experienced colleagues, both from Rhodes and other institutions and companies.

One of the main highlights of the year was the Rhodes graduation ceremony that saw six PhD's being awarded, three each in Hydrology and Water Resources Science (see photo). Ms Asiphe Sahula and Mr Hugo Retief received their MSc Degree's, while Ms Ntombekhaya (Khaya) Mgaba (a UCEWQ intern) received her BSc Honours Degree. The graduation picture is the largest the IWR has ever seen with seven of the students and the four staff members who contributed to the supervision. This was also a good year for the IWRs contribution to academic development in other parts of Africa as Dr Tumbo is from Tanzania, Dr Vilanculos from Mozambique and Dr Mohobane from Lesotho. Two of the three hydrology students were part of the Carnegie RISE programme and were the last PhD students to graduate from the first two phases of the programme.

The third and final phase of the Carnegie RISE programme started in 2014 and we currently have five PhD students who are either fully or partially supported. We look forward to these students graduating in either 2017 or



Graduation 2015: Students and supervisors (from left to right): Dr Sukhmani Mantel, Dr Jai Clifford-Holmes, Dr Pearl Gola, Dr Agostinho Vilanculos, Prof Denis Hughes, Prof Tally Palmer, Prof Chris de Wet, Dr Thabiso Mohabane, Ms Ntombekhaya Mgaba, Dr Madaka Tumbo, Dr Helen Fox.



Graduation 2015: Masters Graduates and Supervisors (from left to right: Dr Andrew Slaughter, Mr Hugo Retief, Prof Denis Hughes, Ms Asiphe Sahula, Dr Sukhmani Mantel, Prof Tally Palmer).

2018. One of these students, Coli Ndzabandzaba received an award for the “Best Young Water Scientist, 2015: Poster category” at the WaterNet symposium held in Mauritius during October. Over the years our RISE students have always done well at conferences and it is pleasing to see yet another award.

Other staff highlights included the award of a 25 year long service certificate to Ms Juanita McLean (see photo). On a personal note, I would like to express my gratitude to Juanita for the many years of diligent and loyal service to the IWR. I am sure that the other members of staff will agree with me that without her inputs, it would have been almost impossible for the Institute to manage its somewhat complicated finances. They may have been subjected to the sharp edge of Juanita’s tongue when they don’t follow the rules that Juanita has established over the years, but no staff member can deny that she does her main job of financial management very efficiently and very effectively. Other highlights were the appointment of Ms Ntombekhaya (Khaya) Mgaba to the vacant post of Senior Technical Officer in the IWR and the promotion of Dr Sukh Mantel to Senior Research Officer (effective in 2016). The former represents a very positive development given that Khaya has been an intern, undergoing training within the IWR and following some BSc Honours courses since 2012.

Dr Mantel’s promotion is also well-earned and she has worked very hard at, amongst other things, promoting the development of post-graduate students in the IWR.



25 year long service award being presented to Ms Juanita McLean by the Vice Chancellor, Dr Sizwe Mabizela

Towards the end of 2012, Prof Hughes heard the unofficial outcome of his re-rating application to the NRF (National

Research Foundation). He has improved his rating from a C3 (established researchers with a sustained recent record of productivity) to a B2 (researchers who enjoy considerable international recognition by their peers for the high quality and impact of their recent research outputs). With one year to go before retirement, perhaps a pertinent comment would be 'better late than never'.

The saga of finding new staff for the IWR continues, specifically for the new post that was designed to help launch a modular course-work MSc in Hydrology and Water Resources science. During 2012 Rhodes University allocated a Senior Lecturer post to the IWR to support setting up the course. Although Dr Mutsa Masiyandima was appointed and started work with the IWR in July 2014, she experienced some almost insurmountable personal family problems that prevented her from fulfilling her duties and eventually resigned in December 2014. We initiated some further discussions with Rhodes University senior management that included this vacant post, the longer-term position with regard to support for Prof Palmer's salary and the almost imminent retirement of Prof Hughes coupled with the associated succession planning. Unfortunately, no further progress has been made on any of these matters and it seems to be extremely difficult to get any kind of response from the University despite the urgency. The proposals that we put to the University were the outcome of many discussions within the IWR that included all staff and some of the students. It is therefore very disappointing to have these proposals all but ignored by the University. We can appreciate that the University is potentially facing some very tough times ahead with the crisis around student fees, but there is little doubt that the IWR will also be facing a crisis in the very near future if there is no agreed upon plan for replacement of senior staff. Part of the IWR proposal was for Rhodes University to allocate some salary resources (from the vacant Senior Lecturer position) to subvent the salaries of those contract research staff who contribute to post-graduate student supervision. It always seems very unfair that these staff have to struggle to generate enough income from research and consultancy contracts and are then expected to contribute to the subsidy earnings of Rhodes without any compensation. We certainly will find it extremely difficult to maintain the level of post-graduate degree outputs that we have enjoyed over the last few years without their inputs. This will be particularly true after Prof Hughes retires (even if he assumes the status of Emeritus Professor) and if there is no replacement at a senior and experienced level.

Prof Hughes continues to serve as chair of the Professional Advisory Committee for the Water Resources Science Field of Practice of SACNASP (South Africa Council for Natural Scientific Professions) and completed his term of office as a Vice President of the International Association of Hydrological Sciences (IAHS) at the Prague IUGG conference in July 2015. During the same conference he was appointed as a member of the new IAHS Working

Group for Representation of Developing Countries. He also remains actively involved as a co-editor (Journal of Hydrology – Regional Studies), or associate editor for several international journals (Hydrological Sciences Journal, Hydrological Processes, Hydrology Research) and regularly contributes reviews for many more. Dr Mantel serves as an Associate Editor of the African Journal of Aquatic Sciences, while Prof Palmer serves on the editorial panel of the Institute of Civil Engineers Journal, Water Management.

Prof Palmer has been involved in a number of policy and practice interface discussions during 2015 and attended workshops on 'Narratives of Hope' and 'National water quality policy and strategy' emerging from transdisciplinary research, as well as a workshop on 'Creating integrated research and action plans for DEA NRM initiatives – working towards research and rehabilitation activities that catalyse transformation towards environmental and social justice' that was held in Grahamstown.

International links and conferences

As usual, IWR staff and students have been well represented at a number of international and regional meetings during 2015 (the full details of the papers or posters presented are contained within the Research Outputs list at the end of the annual report):

- Prof Hughes attended XXVI General Assembly of the International Union of Geology and Geophysics in Prague. He co-convened and presented a paper in the symposium on 'Hydrologic Non-Stationarity and Extrapolating Models to Predict the Future'. He also attended the IAHS Bureau Meetings at the same time.
- Prof Hughes attended the International Conference on African Large River Basins Hydrology held in Hammamet, Tunisia during October 2015 and presented a paper on 'Modelling Large River Basins'.
- Prof Hughes attended the Fall meeting of the AGU (American Geophysical Union) in San Francisco during December 2015. He has been meaning to get to this annual meeting (with about 8 000 delegates) for a number of years, but never quite made it. The main reason for attending this year was to participate in a workshop on hydrological modelling uncertainty held in honour of Keith Beven from Lancaster University, who retires this year.
- Prof Palmer attended several conferences and meetings during the year (see UCEWQ Director's report for further details) including a conference on 'Complex Systems' in Phoenix, Arizona, a conference on 'Development and a Green Economy' in Durban.
- Dr Mantel attended the International Conference for Conservation Biology in Montpellier in July 2015. She co-organised a symposium and a roundtable discussion on 'Barriers to biodiversity in fluvial ecosystems' as part of the Freshwater Working Group of the Society for Conservation Biology.
- Prof de Wet attended the 75th Annual meeting of the (USA) Society for Applied Anthropology held in Pittsburgh

during March 2015. He served as a rapporteur for a session on 'Ethics and accountability for compulsory displacement' as part of a special colloquium on the World Bank's revision of its social and environmental safeguard policies.

- Prof de Wet and Dr Odume attended the Water Research Commission Research Development and Innovation Symposium held in Pretoria during September 2015. Prof de Wet and Dr Odume presented a paper on 'Ethics in Water Management'.

Dr Mantel and all of the RISE PhD students (Ms Eunice Makungu, Mr Coli Ndzabandzaba, Mr Emmanuel Vellemu, Mr Dionis Rugai, Mr Zwido Lidzhegu) attended (and presented papers or posters) at the 16th Annual WaterNet conference held in Mauritius during October 2015. This was the conference at which Coli Ndzabandzaba received an award for the 'Best Young Water Scientist, 2015: Poster category'.



Mr Coli Ndzabandzaba receiving the award for the "Best Young Water Scientist, 2015: Poster category" at the WaterNet conference in Mauritius.

Ms Margaret Wolff and Ms Athina Copteros attended the PECS (Program on Ecosystem Change and Society) Conference held at the Spier Wine Estate in Stellenbosch during November 2015. Ms Copteros did a 5 minute speed talk on her research and led a Dance Movement Therapy session exploring transdisciplinarity.

- Dr Odume participated in a plenary panel discussion on trans-disciplinarity and water science at the 1st African and 4th Biennial South Africa Young Water Professional conference held in Pretoria, November 2015. Co-panellists included Prof Coleen Vogel (BMW Chair of Sustainability, School of Geography, Archaeology and Environmental Studies), Mrs Nikki Funke (CSIR, Senior Researcher), Dr Inga Jacobs-Mata (Executive Manager, Water Research Commission).
- Dr Odume presented papers at the 1st African and 4th Biennial South Africa Young Water Professional conference in Pretoria, the Rhodes University Community Engaged Learning Symposium, in Grahamstown, and the Water Research Commission Ecosystems Research and Innovation Symposium in Hartbeespoort, Gauteng.
- Many of the postgraduate students also attended the Young Water Professionals Conference held during November 2015 in Pretoria.

As always, the Institute is very grateful for the travel support that some of these individuals received from Rhodes University.

During the IAHS Bureau Meeting at the IUGG conference in Prague it was decided that the next IAHS Assembly will be held during July in Port Elizabeth, South Africa. While Prof Graham Jewitt (National Representative for SA) will head up the local organising committee, the task of organising the venue will fall to the IWR, mostly through Prof Hughes and Ms McLean.

Consultancy links

Prof Hughes, continues to generate some useful income from consultancy projects which is mainly used for student bursaries, some salary support for contract staff and providing additional funds for travel to conferences for staff and students. More details are provided in the 'Hydrology Projects' section of the report. It is also important that we do not lose the links with practical problem solving which has been one of the IWR strengths and has provided an immediate market for some of its applied research products.

One of the larger consultancy projects formed part of Dr Jane Tanner's post-doctoral studies and looked at the impacts of afforestation on the water balance of the KwaZulu-Natal coastal lakes in the Isimangaliso Coastal Wetland Park. This was a joint project with Andrew Johnstone of Groundwater Consulting Services.

Post-graduate students and courses

The Institute continues to attract applications from more potential post-graduate students than we can accommodate in terms of space and supervisory capacity. However, we do accept as many as we can and the list at the start of this report (as well as the student project reports) illustrates the numbers of registered students.

Ms Nadia Oosthuizen and Ms Vuyelwa Mvandaba



RISE Students and Staff at WaterNet 2015 Conference. (from left to right): Mr Coli Ndzabandzaba, Mr Zwidofhelangani Lidzhegu, Mr Dionis Rugai, Mr Emmanuel Vellemu, Ms Eunice Makungu, Ms Bame Keabetswe, Prof Wellington Masamba, Ms Claire Sendela, Mr Francisco Macaringue, Dr Elonio Muiuane, Dr Sukhmani Mantel

registered for MSc's in Hydrology during 2015 as part of a collaborative Water Research Commission project on the water resources of the Limpopo River basin between the CSIR and the IWR. Dr Evison Kapangaziwiri (former student) is the project leader and co-supervisor of the two students, with Prof Hughes acting as the main supervisor.

UCEWQ ran a module on Environmental Water Quality as part of the joint Geography/Environmental Science Environmental Water Management Honours course. The module was attended by 12 Honours students, and four guests from SANParks attended part of the course. UCEWQ also presented a modified version of the Environmental Water Quality Module as a short course to eight water professionals from the Mozambican National Directorate of Water, Ministry of Public Works and Housing. The participation in the course by the Mozambicans was funded by the World Bank.

Post-Doctoral posts

Dr Jane Tanner has been supported for 2015 by a Rhodes University Post-Doctoral Fellowship and is continuing her research on surface and groundwater hydrology. She will apply to Rhodes at the end of 2015 for a contract Research Officer post supported by income from both contract research and consultancy work.

RISE Sub-Saharan Africa Water Resources Network

We have only one year left of the final phase of the Carnegie RISE funding programme, although initial budgeting suggests that quite a lot of the income will not be spent by the end of 2016. This is mainly because of the Rand-Dollar exchange rate changes and quite conservative spending. It also means greater security for the existing four RISE students should they not be able to complete their theses before the end of 2016. Dr Mantel and Prof Hughes will discuss the distribution of the remaining funds with the RISE coordinators (the Science Initiative Group at

Princeton University) and the other centres that are part of our network. The key issue is that any remaining funds should be spent on the further development of post-graduate education and training in sub-Saharan Africa.

It is also interesting that RISE alumni in the Sub-Saharan African Water Resources Network are now collaborating on research projects funded by the Carnegie RISE. Dr Odume and Dr Francis Arimoro (a previous post-doc RISE fellow at the IWR) won a USD 5 000 research grant from Carnegie to work on a project aimed at developing novel biomonitoring techniques and tools for Nigerian streams. In the same vein, Dr Odume and Mr N Siziba were awarded a USD 5 000 research grant to work on biologically-based tools for monitoring water quality in Zimbabwe. Dr Tanner is considering putting in a proposal for 2016 for a collaborative project on a review of critical surface water – groundwater interaction environments in the sub-continent, and the data as well as modelling tools that are available to understand and quantify them.

Concluding remarks

There is little doubt that the next few years will be critical for the future success of the Institute. The problem, already referred to, of not being able to attract applicants for vacant posts is not unique to the IWR but represents a real threat to our future. The lack of security for staff on short-term contracts has always been a worry for us, but when this is combined with the retirement of senior staff members (i.e. Prof Hughes), the problem becomes exacerbated.

Our per-capita output is amongst the highest in the University and both Prof Palmer and Prof Hughes were listed amongst the top 30 researchers at Rhodes for 2013 (we are still waiting for the 2014 Rhodes Research Report). They could not have achieved that without the contributions of other staff and students. There are many

more outputs that also reflect the research productivity of the Institute staff and students, including research reports to funding agencies (notably the Water Research Commission) and papers presented at conferences and published in the proceedings. These may not earn subsidy points, but certainly enhance the local, regional and international reputation of the Institute and, by association, the University. The completion of research reports is critically important for sustaining the income necessary to support contract staff salaries.

The increases in post-graduate numbers and sustained research outputs have been achieved with no real growth in the staff available for supervising post-graduate projects. However, externally funded contract staff (Dr's Neil Griffin, Sukhmani Mantel, Andrew Slaughter and Paul Mensah) have been increasingly contributing to student supervision and it should be recognised that these contributions cost the University very little but still generate subsidy income. We have raised this issue, as well as that of succession planning for Prof Hughes, with the University a number of times over the last four years, but unfortunately Rhodes do not appear to recognise the urgency. Given the experiences with trying to attract a new staff member for the post to support the new MSc course (very few applicants), finding an appropriate replacement for Prof Hughes will not be an easy task – a situation that could seriously threaten the survival of hydrology as a discipline at Rhodes University.

Acknowledgements

We are very grateful for the contributions that the Board of Control make to the successful operation of the Institute, even if these are concentrated in a short period over the annual IWR Open Day. We would like to acknowledge all the support that we receive from the various South African funding agencies and specifically the Water Research Commission (WRC) who have provided the financial backbone of the Institute for many years. We continue to enjoy a strong association with the WRC, not only through projects being undertaken by IWR staff, but also through

the reference group meetings of other institutions projects and various policy and planning meetings.

Funding provided by the Unilever Foundation provides a significant contribution to the continued existence and success of the UCEWQ. The unencumbered funding allows UCEWQ staff and students to contribute to research initiatives at both local and national levels, allowing us to partner other researchers, government and industry in the development and implementation of an integrated and holistic approach for managing environmental water quality in water resource management.

The Carnegie Foundation (through the RISE initiative) has been an extremely important source of funding for post-graduate students within the Institute. We have developed excellent relationships with the fund administrators over the last seven years of the project. We are also grateful to the coordinators at the other nodes of the SSAWRN (Okavango Research Institute, Makerere and Eduardo Mondlane Universities) for their help in ensuring the success of this initiative and this success is also dependent upon the network administration work that is very ably undertaken by Dr Sukhmani Mantel.

We are also grateful for the support of the various divisions of Rhodes University including the staff of the office of the Deputy VC: Research and Development, the Dean of Science and the Science Faculty administration, the Finance Division, the Human Resource Division and the Communications and Development Division. We are very grateful for the travel support given by the Rhodes Research Office to attend local and international conferences. Beneficiaries during 2015 included a number of staff members, post-doctoral fellows and students.

Finally, as Director, I would like to offer my personal thanks to all the members of the Institute staff (both research and support staff) and students for their hard work, enthusiasm and loyalty to the aims of the IWR.

UNILEVER CENTRE FOR ENVIRONMENTAL WATER QUALITY (UCEWQ)

UCEWQ DIRECTOR'S REPORT

Strategic planning

This year began with important strategic planning for UCEWQ. In November 2014 Rhodes University agreed to support the whole of Prof Tally Palmer's salary for 18 months (June 2015-December 2016), which allowed for essential succession planning. Dr Nelson Odume took on the Acting Director position within UCEWQ, and from July, Prof Palmer took time to concentrate on developing publications. Given that the Centre has made good progress towards securing a three year Memorandum of Understanding (MOU) with Unilever SA, and that most salaries are already covered for 2016, it seems clear Dr Odume will take on the UCEWQ Directorship formally as soon as arrangements for a three-year appointment at an appropriate academic level have been made. Each Environmental Water Quality (EWQ) component has a research leader: i) water quality variables and water chemistry – Dr Neil Griffin, ii) biomonitoring and ecology – Dr Nelson Odume [the WRC has just awarded UCEWQ a new project on macroinvertebrate traits and water resource management, with Dr Odume as the project leader], and iii) ecotoxicology – Dr Paul Mensah. Prof Tally Palmer concentrates on the development and application of systemic, transdisciplinary action research within complex social-ecological systems (C-SES), in many instances EWQ components form part of these projects. UCEWQ strategic planning was presented to Rhodes University as part of the context for a motivation for greater University staffing support, the outcome of which is still to be announced.

Young Water Professionals

Dr Nelson Odume continues to provide strategic leadership to the Eastern Cape Chapter of the South African Young Water Professionals. Since assuming the Chairperson position, he has worked with his committee to achieve membership growth of over 300%. In the past year, together with his committee, he has organised more than 10 academic, leadership, technical tour, entrepreneurship and community engagement events and activities aimed at enhancing the professional skill sets of Young Professionals in the Eastern Cape. See the section on Young Water Professionals for more details of these events. Dr Odume also negotiated a special transdisciplinary session for UCEWQ students at the 4th Biennial Young Water Professionals Conference in Pretoria, 16 – 18 November 2015. Prof Tally Palmer was invited as a keynote speaker but was not able to attend.

Policy and practice influence

UCEWQ has contributed to key developments in water quality policy and strategy over the past decades. This trend continued in 2015. In collaboration with AWARD (the Association for Water and Rural Development) and

the WRC, UCEWQ co-funded, planned and presented a National Water Dialogue (February 2015) for invited water quality specialists from across the country, on transdisciplinary C-SES approaches to the development of the National Water Quality Policy and Strategy. The resulting Terms of Reference for drafting the policy and strategy was based on the outcomes of the Dialogue.



Participants at the WRC Indaba February 2015

Of the government departments, UCEWQ has most frequently collaborated with the now Department of Water and Sanitation (DWS). In November 2014 we were approached via the Rhodes University Department of Environmental Science (DES), to collaborate with the Department of Environment Affairs (DEA) in a large functional, sustainable, landscape restoration project in the upper reaches of the Mzimvubu River – in the quaternary catchments above the planned Ntabelanga-Laleni Dam complex. Once the scope and systemic challenge of this project became evident, UCEWQ partnered the DEA initiative with our WRC Towards Practising a New Paradigm (TPNP) for Integrated Water Resource Management (IWRM) – and hosted a strategic research and practice approach workshop: *Creating integrated research and action plans for DEA NRM initiatives - working towards research & rehabilitation activities that catalyse transformation towards environmental and social justice* in Grahamstown in March. The two-day workshop was attended by more than 40 delegates, including a Deputy Director General, Chief Directors, Directors and additional staff of the DEA. The TPNP concepts are proving influential in the planning and implementation of a range of DEA: Natural Resource Management projects.

Partnerships and performance

Unilever South Africa: The core partnership that founded the Centre remains with Unilever South Africa and has

been active in 2015, with a re-strategising of the focus of the partnership, and progress towards the three year MOU initiated last year. Water for Dignity has proved attractive to Unilever SA as a possible vehicle to promote new product technologies in early 2016. The Vukani Water for Dignity Group moved strongly towards independence this year, with UCEWQ and the Khulumani Support Group as their key founding partners. They are working on fund raising initiatives, and have collaborated with the Rhodes student volunteer organisation *Galela Amanzi*. Prof Tally Palmer presented on water scarcity in South Africa at an in-house Unilever product launch workshop. Ms Preola Adam, and recently Mr Akinseye Bukunmi, has offered substantive support and guidance in the development of the proposed MOU framework. Dr Odume also worked with Unilever SA in an involvement with the YWP conference, and we will collaborate with Unilever SA at WISA next year.

Early this year we visited the proto-CMA, which operates out of the DWS East London Regional Office. The Mzimvubu-Tsitsikamma CMA is developing steadily. A mosaic of Catchment Management Forums (CMFs) is emerging across South Africa as the on-the-ground institutional mechanism for participative water resource management. UCEWQ will be running a set of five CMF formation workshops in January and February 2016, based on TPNP principles. UCEWQ participated and supported the participation of key Eastern Cape delegates at the WRC "Forum of Forums" workshop, organised by colleague Dr Victor Munnik, in October. Collaborating with the MTCMA will be a key strategic research focus for Prof Palmer for the foreseeable future.

IWR research associate, Dr Jill Slinger (TU-Delft), once again visited the IWR, and is planning teaching collaboration between Rhodes University and TU-Delft. Two of our graduates, Dr Jai Clifford-Holmes and Mr Hugo Retief joined our long-standing research partners AWARD. We are delighted as the AWARD RESILIM project is the largest systemic C-SES action research project in Southern Africa and it is exciting to see our graduates involved. Our other 2015 doctoral graduate, Dr Helen Fox, is working with another Rhodes research partner – Dr Georgina Cundill (DES). Both Dr Clifford-Holmes and Dr Fox were awarded short Rhodes University Post-Doctoral support to enable the publication of aspects of their work. Our collaboration with DES will continue actively in 2016 as the UCEWQ-hosted Rhodes Transdisciplinary (TD) group, with a strong DES contingent, was jointly awarded a "small grant" by the new Rhodes Centre for Post-Graduate Studies to develop and offer a two day post-graduate course in transdisciplinary research, to be presented in March 2016. Another 2015 graduate, Ms Asiphe Sahula joined the Endangered Wildlife Trust, and is planning to undertake doctoral studies, part-time, within UCEWQ from 2016. It will be a delight to have Ms Sahula working actively with us again.

We had an excellent crop of graduates in 2015: doctoral students Ms Helen Fox and Mr Jai Clifford-Holmes received outstanding thesis reviews and are our first transdisciplinary

doctoral graduates. Ms Pearl Gola received an ecotoxicology doctorate, and two masters students, Ms Lara Molony and Ms Asiphe Sahula, graduated.

We were delighted to have UCEWQ intern, and RU Geography Honours graduate Ms Ntombekhaya Mgaba join the IWR permanent staff as the Senior Technical Officer. Ms Mgaba has been a committed UCEWQ member for several years and we are delighted to have this opportunity to retain her, and to offer her a context within which to develop further. Ms Mgaba has already registered for an MSc degree, under the supervision of Dr's Odume and Mensah. Ms Mgaba also now supervises the UCEWQ laboratory interns, who in 2015 were Mr Mzwanele Mkatali and Mr Sithenkosi Mamkeli. The UCEWQ laboratories and cultures are in excellent condition.

Prof Palmer was invited to the Volkswagen Foundation to offer a course in Madagascar on transdisciplinary research to African Post-Doctoral researchers. She also presented papers in Phoenix, Arizona at the Complexity Systems Conference, and the Savannah Network meeting in Skukuza. Dr Odume presented papers at the Water Research Commission's Ecosystem Research and Innovation Symposium, the Rhodes University Community Engaged Learning Symposium and the South African Young Water Professional Conference. All of these papers were well received. Dr Mensah presented a paper, and represented UCEWQ, at the SETAC Africa conference in Langebaan.

Graduate students continue at the heart of UCEWQ, with Ms Copteros in the late stages of her doctoral thesis; Mr Ian Preston and Ms Karabo Chadzingwa completing in April and May respectively (both are currently undertaking corrections); Mr Matthew Weaver is moving towards completion; Mr Gareth Thomson will complete by April; and Ms Tia Keighley and Ms Margaret Wolff are in their first year of Masters research. Ms Notsiwa Libala joined UCEWQ as an intern in October and plans to register for a PhD in April 2016.

We were delighted to be joined for the last three months of the year by post-doctoral researcher, Dr Renee Dowse, who worked with Prof Palmer in Australia (2005-2008). Dr Dowse is working with UCEWQ doctoral student, Mr Emmanuel Vellemu; is lecturing in ecotoxicology to the group of visiting Mozambican professionals; and has completed one of her doctoral publications. UCEWQ once again offered the semester EWQ Honours course to DES and Geography students, and this year hosted four professionals from SANParks.

In this last year as Director of UCEWQ, I would like to thank especially Dr Nelson Odume who has taken on a leadership role with such success, and everyone with whom I have worked over the years, especially those across the IWR. UCEWQ was established in 1999, and we have reason to be both proud and grateful.

HYDROLOGY PROJECTS

The hydrology group of the Institute consisted during 2015 of Prof Denis Hughes; Dr Andrew Slaughter (focusing on water quality modelling); a postdoc fellow, Dr Jane Tanner (focussing on surface water – groundwater interactions) and six post-graduate students; Mr Sbo Mazibuko (MSc), Mr Haden Jacobs (MSc), Mr Greg Pienaar (MSc), Mr Coli Ndzabandzaba (PhD), Ms Eunice Makungu (PhD) and Mr Dionis Rugai (PhD). Four of the post-graduate students are part of the Carnegie RISE programme, while some are supported by the IWR and others by additional funders. The range of topics covered by these student projects include hydrological modelling uncertainty assessment, modelling wetland and floodplain dynamics and integrating uncertainty analysis into water resources decision making.

Other staff members contribute to some of the hydrology related projects that the Institute is involved in. Notably, Mr David Forsyth continues to be involved in the development and maintenance of the SPATSIM hydrological modelling framework software, as well as supporting other software developments. Dr Sukhmani Mantel has been assisting with some of the hydrology projects and co-supervises some of the students. Many of the hydrological projects (both research and consultancy) involve collaboration with other organisations, both within South Africa and overseas.

EXTENDING FUNCTIONALITY AND KNOWLEDGE TRANSFER OF THE WATER QUALITY SYSTEMS ASSESSMENT MODEL

Sponsor: Water Research Commission
AR Slaughter, SK Mantel and NJ Griffin
Project Dates: April 2015 – March 2018

A previous WRC project entitled 'Development and application of a simple South African water quality model for management of rivers and reservoirs under current and future development and climate change scenarios' led to the development of the Water Quality Systems Assessment Model or WQSAM. The broad aim of the aforementioned project was to develop a water quality model that integrates with routinely used systems models (yield models) in South Africa, and a water quality model that aims to be as simple as possible by representing only the water quality processes that explain the majority of the variability in observed water quality of fresh surface water. The reason for maintaining a relatively simple modelling approach was to be able to use the relatively scarce observed water quality data, and to prevent equifinality that tends to compromise over-parameterised models.

The aforementioned project was fairly successful, and WQSAM has been shown to be able to relatively accurately represent the frequency distribution of salinity and nutrients within various catchments, including the Buffalo, Crocodile and Olifants river catchments. WQSAM may therefore be useful for exploring water quality management scenarios, and could provide a more formalised link between flow and water quality within Ecological Reserve (ER) determinations.

However, several shortcomings, uncertainties and opportunities for further development and extension were identified within WQSAM. In this respect, an extension project proposal was submitted to the WRC at the end of 2014. This proposal proved successful, leading to the initiation of the current project.

The aims of the current project include:

1. The development of a formal quantified link between the incremental flow fraction water quality signatures and various land cover categories. This is of relevance as the previous process of assigning water quality signatures to the flow fractions in WQSAM was a calibration exercise broadly guided by predominant land cover and use. The development of a formalised approach reduces one aspect of uncertainty, and will help to prevent equifinality.
2. The inclusion of microbial water quality and acid mine drainage (AMD) simulation within the WQSAM model. The justification for this extension of the model is that both water quality variables are associated with serious water quality challenges within fresh surface waters in South Africa. In addition, microbial water quality can be fairly simply represented using a generic first order degradation process, whereas AMD can be represented by the simulation of sulphates.
3. The validation of primary production processes within fresh surface waters. Within the WQSAM model as it currently exists, the model simulates algae and hyacinth growth, as uptake by plants affects the nutrient concentrations in fresh surface waters. However, these simulations of plant uptake are fraught with uncertainty, and generally it is not certain whether WQSAM is correctly simulating uptake of nutrients by plants. The current project therefore aims to explore different types of observed data, such as remote sensing data, to attempt to validate the processes of plant growth and nutrient uptake represented within WQSAM.
4. The addition of a sediment transport model within WQSAM. Sediment is a very important water quality variable, as not only does it affect the quality of water for both human and ecological use, but sediment also reduces the holding capacity of reservoirs. A sediment transport model has already been

developed within a separate project. However, this sediment transport model has currently only been applied to an arid region, and current uses a large number of parameters. The current project aims to incorporate the sediment transport model into WQSAM, while also reducing the parameter set and testing the sediment transport model on a variety of catchments of different hydrological conditions. A student, Mr David Gwapedza will work on this aspect of the project as part of his MSc research.

5. The inclusion of cholera simulation within WQSAM. Cholera is an important water-borne disease caused by the *Vibrio cholera* bacterium. The current project aims to explore whether the WQSAM model can simulate historical outbreaks of cholera by simulating the input, transport and fate of the *Vibrio cholera* bacterium along a river reach. This part of the project offers the exciting possibility of linking WQSAM with human health.

To date, of the aims mentioned above, aims one and two have been completed and submitted to the WRC. Within aim one, linear regression models linked to specific biomes were created to link the water quality signatures of the surface fraction of incremental flow to land cover categories. Within aim two, sulphates as indicative of AMD were simulated within the Olifants and the Crocodile rivers, whereas *Escherichia coli* as indicative of microbial water quality were simulated in the Crocodile River. Figure 1 shows examples of the simulation of historical observed sulphate concentrations within the B11H catchment and the Bronkhorstspuit Dam on the Olifants River. Figure 2 shows examples of microbial water quality modelling within the Crocodile River catchment.

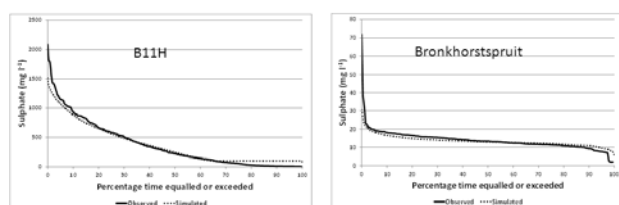


Figure 1 Simulation outcomes of sulphate modelling as indicative of acid mine drainage using the Water Quality Systems Assessment Model (WQSAM) within two sites within the Olifants River catchment. The results are presented as frequency distributions.

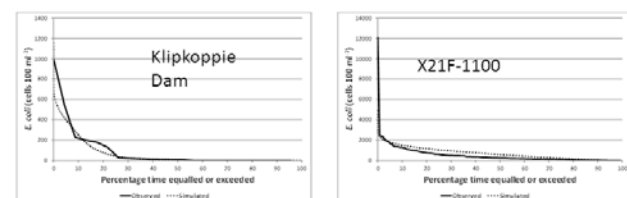


Figure 2 Simulation outcomes of *Escherichia coli* modelling as indicative of microbial water quality using the Water Quality Systems Assessment Model (WQSAM) within two sites within the Crocodile River catchment. The results are presented as frequency distributions.

DETERMINING THE IMPACTS OF CURRENT AND PROPOSED DEVELOPMENT ON THE WATER RESOURCES SUPPORTING THE ISIMANGALISO WORLD HERITAGE SITE

Sponsor: iSimangaliso World Heritage Site
JL Tanner and DA Hughes

Project Dates: March 2015 – November 2015

The iSimangaliso Wetland Park was listed as South Africa's first World Heritage Site in December 1999. The Park is approximately 332 000 ha and contains three major lake systems, eight interlinking systems, the majority of South Africa's remaining swamp forests, Africa's largest estuarine system, some of the world's oldest coastal dunes and is the last significant breeding ground for the giant leatherback and loggerhead turtles. The Park falls within an area characterised by a chain of barrier lakes, lagoons and swamps, situated behind high vegetated barrier dunes, where there are strong interactions between surface water and groundwater. The sustainability of the coastal lakes which fall within the iSimangaliso Wetland Park is reliant on both surface water and groundwater resources. Many of the lake's catchments (both surface and groundwater catchments) fall outside of the Park's boundaries, and the effects of water resource use and land management in these areas is unregulated by the park, and are therefore having an impact on the lake volumes. To achieve a sensible understanding of the effects of water use and land use change on the surface water and the groundwater, it is imperative that the linkages are understood and that the system is modelled in an integrated way.

The investigation included the Kosi Bay system, Lake Sibayi and Lake Mgobezeleni in the northern area of the Park, as well as Lake St Lucia in the southern part of the Park. While the water contributions to the northern lakes are mostly from groundwater and their catchment areas are relatively small, Lake St Lucia by contrast is sustained by a number of rivers in addition to groundwater. While previous work has been undertaken to better understand the complex estuarine environment, this study examined the impacts of various land use change activities on the surface water and groundwater, both in the 'buffer zone' surrounding the lakes and within the upstream reaches of the river catchments. A wetland sub-model developed by Prof Denis Hughes was used to represent the numerous and varied wetlands while a specific sub-model was developed to represent the estuary of Lake St Lucia and its complex connections to the sea.

The investigation found that all the lakes and wetlands were significantly impacted by current day land use, particularly forestry. Due to the shallow groundwater levels in the region, the forestry used large amounts of water throughout the year by tapping directly into the groundwater. This affected the groundwater contribution to baseflow in the rivers draining into the lakes, as well as the direct seepage of groundwater into the lakes. The

study enabled a clearer understanding of how the lakes are currently impacted together with a determination of the impacts of future development on the lakes.

REHABILITATION OF GRASSLANDS AFTER ERADICATION OF ALIEN INVASIVE TREES

Sponsor: Water Research Commission

SK Mantel

Collaborators: AR Palmer (Agricultural Research Council), Z Munch (University of Stellenbosch), L Gibson (Cape Nature), A Perry (previously affiliated with Fort Hare's Institute of Social and Economic Research), R Scholtz (Joe Gqabi District Municipality)

Project Dates: April 2014 – March 2019

Clearing of the Invasive Alien Plants (IAPs) on their own is not sufficient motivation to proceed with the national Working for Water (WfW) programme, and there needs to be consideration of the sustainability of the landscape when the activities of WfW are completed. In order to ensure sustainability of landscape processes for human benefit, it is essential to build stronger links between the control of undesirable woody plants and the derived benefits to humans occupying the catchment. In order to strengthen this linkage, empirical evidence of the water use of every component of the landscape needs to be collected. The landscape units or land cover types that are encountered in the mesic regions of South Africa are diverse, comprising inter alia areas of irrigation agriculture, dryland cultivation, residential, extensive rangeland and forests. Superimposed on this are two different land tenure systems, namely freehold farms and communal or leasehold areas, with diametrically opposing approaches to landscape management. There is a need to improve our understanding of how to balance water use and carbon capture between different land cover types and land tenure systems as both these cycles are important to people and their livelihoods. Two possible approaches for assessing the relative efficiency of the landscape for secondary production are livestock water productivity (LWP) and water use productivity (WUP). In the rural landscapes of the south eastern parts of South Africa (e.g. former Transkei and Kwa-Zulu Natal), land use is dominated by a complex arrangement of dwellings, livestock grazing, dryland cultivation and forestation, all within a communal land tenure system. The capture of carbon by the landscape is the primary driver of livestock and food production in this human dominated social-ecological system (SES) and understanding the total economic value and water use efficiency (WUE) of these processes requires an empirical assessment of the water cycle.

Thus, the aims of this project are:

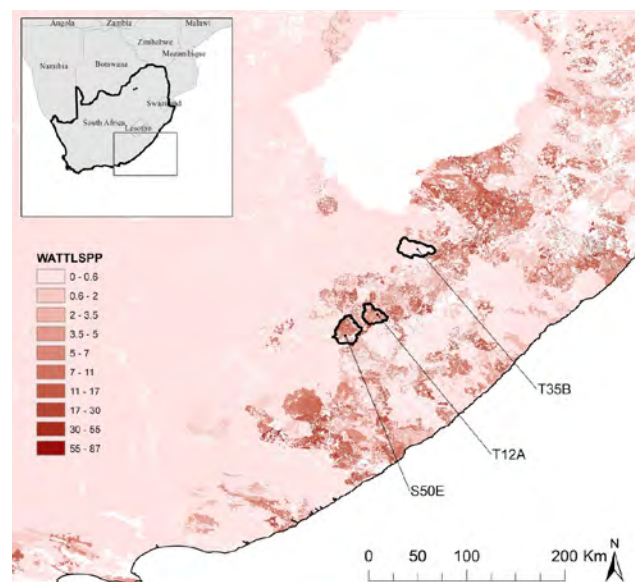
1. To parameterise, evaluate and modify suitable models for Evapotranspiration (ET), LWP and Net Primary Productivity (NPP) estimates for IAPs and grasslands.
2. To explore and compare ET, LWP and NPP in two

catchments with contrasting land tenure systems, comprising diverse biomass and condition states for grassland and IAPs.

3. To apply the selected models for predicting ET, LWP and NPP to these catchments.
4. To examine the possibility of using a Reward for Ecosystem Services (RES) system in rural rangelands as a possible solution to degradation and water issues (quantity and quality).

The project has three focal catchments in the Eastern Cape that are shown in the accompanying figure along with the percent wattle species density. The project is funding three postgraduate students – Mr Onalenna Gwate (PhD candidate, Rhodes University), Ms Perpetua Okoye (MSc candidate, Stellenbosch University) and Ms Bukho Gusha (PhD candidate, Rhodes University). The first 2 students are in their second year of research and Ms Gusha has started her PhD this year.

The project is progressing on track and three deliverables have been submitted to the WRC. A second year workshop is planned for early 2016 in Mahlangu Village to gather data on land use practices and future land uses on cleared areas. Dr Palmer and Dr Mantel have put in an additional proposal for a WRC project based on the results generated by the current WRC project and it proposes a wattle thinning experiment as an alternative to wattle clear-felling which is the current policy of the Working for Water programme.



The three focal catchments for the project located in the Eastern Cape shown on a map of percentage wattle species density extracted from the National IAP dataset (Kotzé et al. 2010; 250m x 250m resolution).

INFRASTRUCTURE FUNDING INSTRUMENT GRANT FOR EVAPOTRANSPIRATION FLUX

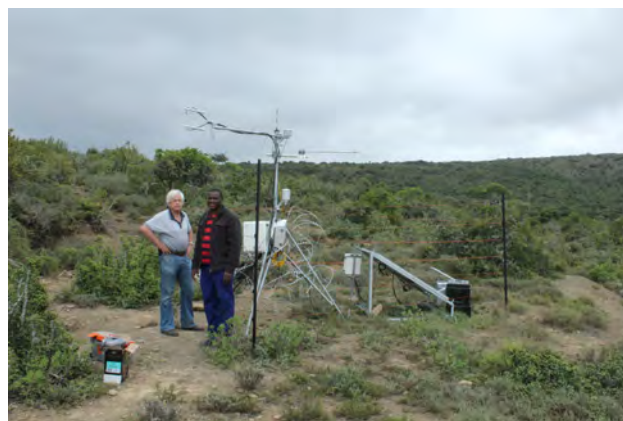
Sponsor: National Research Foundation

SK Mantel

Collaborator: AR Palmer (Agricultural Research Council)

Dr Anthony Palmer (Agricultural Research Council) and Dr Sukhmani Mantel motivated for a National Research Foundation (NRF) 2014 call for National Equipment Programme grant for equipment for measuring carbon and water fluxes using the Eddy Covariance and Scintillometer systems. The funding proposal for R1.8 million (of which R1.249 million is provided by the NRF) was approved and the equipment was ordered in April this year. Dr Palmer, Dr Mantel and Mr Onalenna Gwate have installed one Eddy Covariance system on a secure site outside Grahamstown at a thicket site (see accompanying Figure). A Large Aperture Scintillometer has been installed at a site where wattle has been cleared in order to assess the evapotranspiration of the recovering vegetation. The data gathered by the equipment will be used by PhD student, Mr Gwate, on the WRC project K5/2400/4 on rehabilitating grasslands after removal of invasive alien trees. The equipment is important for the IWR and the country as there are currently only five permanent eddy covariance flux towers

in South Africa. We are waiting for the delivery of a second Eddy Covariance system from Campbell Scientific. The data generated from the equipment will be fed into an international network (Fluxnet) that collaborates in using these data to parameterise and validate global circulation models for climate projections. We are also looking to collaborate with other South African researchers with similar equipment.



An Eddy Covariance system installed at a thicket site. The electric fence is to keep out the baboons. Pictured are Dr Tony Palmer (left) and Mr Onalenna Gwate (right, PhD student).

GENERAL CONSULTANCY PROJECTS

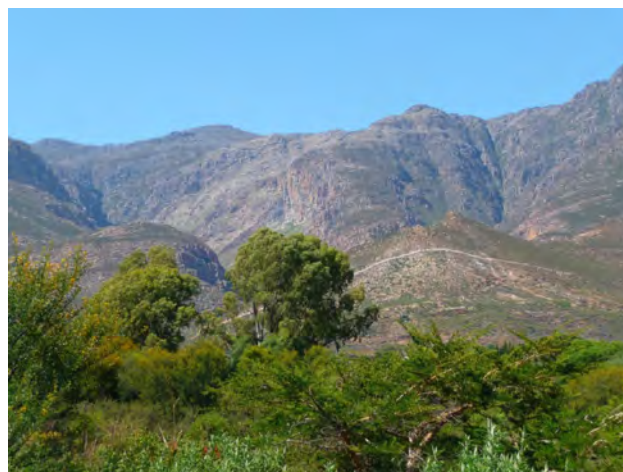
Sponsor: Various consultancy partners

DA Hughes

Project Dates: Ongoing

Prof Denis Hughes has been involved in several water resource assessments that have included quantifying environmental flow requirements using the Revised Desktop Reserve Model.

One of the projects involve a small tributary river (Huis River) flowing from the northern sides of the Langeberg Mountains in the Western Cape towards the Doring River in the Karoo. The primary purpose of the study was to determine the Ecological Reserve to assist with a court case over access to water. However, the project also ended up looking at different water sharing options and assessing the yield of two reservoirs within the system. Perhaps the most interesting aspect of this particular consultancy project was the almost total lack of stream flow information upon which to base the hydrological and yield modelling and the need to make, and justify, many assumptions. The court case has yet to be resolved and will certainly continue well into 2016.



The Langeberg mountains and headwaters of the Huis River in the Western Cape

Prof Hughes is working with Ecotone (an environmental and ecological consultancy firm based in Johannesburg) on an environmental flow and biodiversity assessment for the Zambezi River at Ngonye Falls in Zambia as part of a proposed hydro-power scheme. The falls are a spectacular natural feature (see Photo) in a very sparsely populated and largely undeveloped part of Zambia.



Ngonye Falls on the Zambezi River in Zambia

We are working with Jeffares & Green (consulting engineers) on a World Bank funded project to look at

investment opportunities (including irrigation and hydro-power) in the Okavango River system. This project involves hydrological and yield analysis modelling of the whole system and will be the third hydrological modelling project on the Okavango that Prof Hughes has been involved with. The difference is that the main consultants have agreed to adopt an uncertainty approach to the modelling, which is unique in terms of practical (rather than research) hydrological modelling projects.

We also completed a further hydrological modelling and environmental flow assessment project for Groundwater Consulting Services (GCS) on several small catchments and irrigation schemes in North East Zambia.

ENVIRONMENTAL WATER QUALITY PROJECTS

BUILDING CAPACITY THROUGH INTERNSHIP TRAINING IN ENVIRONMENTAL WATER QUALITY

N Mgaba

Project Dates: February – December 2015

The IWR -UCEWQ runs an internship programme in which young water research professionals are developed in all aspects of the Institute's work over a one year period. This Programme started in 2012 and the IWR-UCEWQ normally has one or two interns at time. So far, the interns have been students from Nelson Mandela Metropolitan University (NMMU), Walter Sisulu University (WSU) and Fort Hare University who are seeking to gain practical experience in support of their degree or diploma qualification. The internship training involves variety of scientifically based activities facilitated through supervision, by staff of the UCEWQ. The current supervisor is Dr Paul Mensah.

This year Mr Sithenkosi Mamkeli from NMMU secured internship position at IWR through the Rhodes University internship programme, from February 2015 to December 2015. Through this programme, he has gained skills and understanding in biomonitoring, ecotoxicology, chemical analysis and maintenance of the shrimp culture. As part of his training, he assists with field and laboratory experiments for both staff and postgraduate students. He works closely with Mr Mzwanele Mkatali, the technical assistance. He is currently working on a short term project as part of his analytical chemistry diploma requirements.



Mr Sithenkosi Mamkeli collecting macroinvertebrates samples using South African Scoring System (SASS)

Mr Mzwanele Mkatali started at IWR-UCEWQ as an intern 2014, but currently works as a technical assistance in the centre. He is responsible for culture maintenance, whereby he applies the culture and maintenance protocol to feed organisms with the correct ration, measures water quality variables (pH, temperature, DO, EC), cleans holding tanks, and identifies and find solutions to problems associated with the culture. He also assists with field and laboratory experiments for both staff and postgraduate students.



Mr Mzwanele Mkatali setting up 240 hours toxicity test using magnesium chloride (MgCl) to expose young adult shrimps

RICHARDS BAY MINERALS: ENVIRONMENTAL WATER QUALITY

Sponsor: Richards Bay Minerals (RBM)
NJ Griffin, AJ Holland, ON Odume, N Mgaba and M Mkatali
Project Dates: Ongoing to August 2016

Richards Bay Minerals (RBM) operations may compromise environmental water quality, and subsequently ecological health, of surface waters in or near their current operations. An environmental water quality monitoring programme was developed for RBM in 2006 by UCEWQ-IWR. The monitoring programme incorporates the use of macroinvertebrates and diatoms as biomonitors, and the collection of a range of selected water quality parameters. Since 2006, samples were collected in winter, spring, summer and autumn from sites around the mine in the RBM smelter area and from the as yet unmined Zulti South lease area. Monitoring of the Zulti South lease area was terminated in 2009 as the area is to be mined, and a biomonitoring baseline for mining site rehabilitation had been established. The smelter area is currently monitored in winter and summer only as assessment of past datasets indicated that little extra was gained by quarterly monitoring (one site draining the smelter complex is monitored four times per year).

Monitoring of sites around the smelter assesses streams around the mine for impacts due to mining operations, small-scale agriculture, residential settlements and other anthropogenic causes. The most recent sampling cycle took place against the background of low rainfall leading to a drought in the region. Water quality impacts were pronounced in this environment, with increased salinities and acidity at most sites, and a winter increase in inorganic nitrogen levels. Biomonitoring scores were generally reduced, and an obvious decrease in environmental health in the form of an algal bloom and fish kill was noted at one site. Flow decreased over the year and several sites dried during the monitoring cycle. Impacts were most pronounced in the mid- to upper Mpisini

River, and sites lower in the river maintained flow and impacts on macroinvertebrates seemed to be buffered by better habitat in this region. Increased salinity is to be expected during a dry cycle, but the cause of lowered pH and increased nitrogen loading was not clear from the available data.



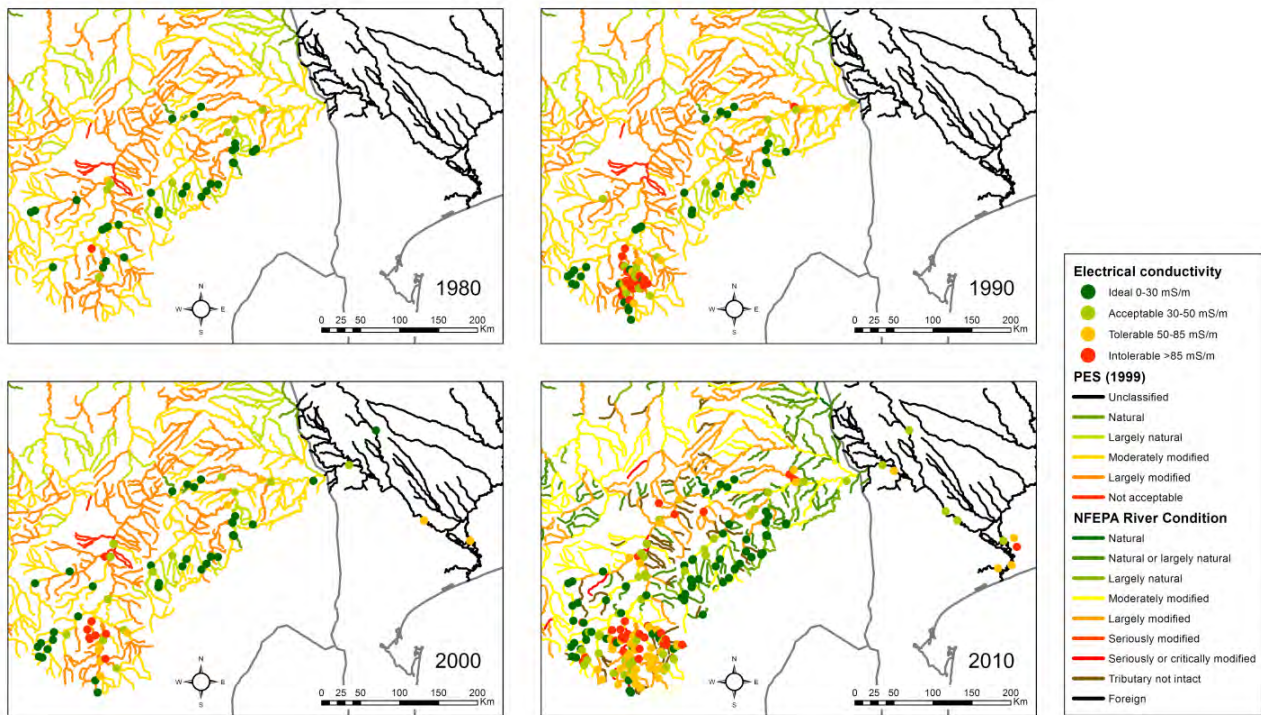
Ntombekhaya Mgaba assesses an algal bloom/fish kill at a site high on the Mpisini River

RESILIM-O: WATER QUALITY IN THE OLIFANTS RIVER CATCHMENT

Sponsor: USAID through the AWARD Resilim-O programme
CG Palmer and NJ Griffin
Project Dates: April 2013 – March 2015

The Olifants River and its tributaries are critical for supporting life in the Limpopo River Basin. Yet unchecked pollution, inappropriate land and resource use, weak and poorly enforced policies and regulations, and poor protection of habitats and biodiversity are degrading the Olifants at an alarming rate. Improved water security, wise resource management, and healthy ecosystems are necessary to continue to support livelihoods and resilient economic development. This project was undertaken under the auspices of Resilim-O, a USAID-funded programme, undertaken by AWARD aiming to reduce the vulnerability of people and ecosystems in the catchment through improved natural resource management and transboundary governance. Resilim-O in turn is part of the larger USAID-funded Resilim programme.

Our results found widespread and increasing salinisation linked to sulphate loading associated with upper catchment coal mining. Another major challenge to water quality was increasing and widespread phosphate loading causing several dams in the catchment to eutrophy. pH shifts with time were detected, with worryingly high levels attained in some places. Acidification associated with coal mining was detected, but this was more the exception than the rule. Mining-related activity at Phalaborwa has a major impact on the river, decreasing water quality as the river enters the Kruger National Park and before it flows into Mozambique. Salinisation associated with mining, irrigation, and land degradation was found in



Spatial trends in annual median electrical conductivity (a proxy for salinity) over time in the Olifants River catchment. Rivers are plotted showing the 1999 Present Ecological State (plots for 1980, 1990, 2000) or the NFEPA river condition (plot for 2010). Water quality data from DWS are classified according to DWS generic RQOs. Note the salinization of rivers in the upper catchment associated with coal mining, as well as largely continued salinization along the main stem of the Olifants River into Mozambique.

various regions across the catchment. Finally, though data were scarce, heavy metals at various sites reached levels likely to impact ecosystems in the catchment. Causal loop diagrams were constructed linking water quality with land use and management practices in the catchment. Further research was undertaken to assess water quality in the catchment in the light of the actors, activities and practices that enable or constrain them. Output from the project was used to feed into a DRIFT model of the effects of changes in water quality in the catchment and a WatRES stakeholder engagement process.

USING THE LOWER SUNDAYS RIVER VALLEY CASE STUDY TO FURTHER TRANSDISCIPLINARY RESEARCH INTO THE INTEGRATED MANAGEMENT AND GOVERNANCE OF WATER IN POST-APARTHEID SOUTH AFRICA

Sponsor: Rhodes University
JK Clifford-Holmes and CG Palmer
Project Dates: March – August 2015

The aim of this 6-month post-doctoral fellowship (funded by Rhodes University) was to 'synthesise novel research processes and doctoral findings [from Dr Jai Clifford-Holmes' PhD study] into suitable formats for journal and report publication, whilst contributing to on-going case study research into municipal-level water governance in South Africa'. This aim was met by submitting doctoral

findings for peer-review at an international conference and through publication in journals and books, and through a feedback workshop in the Sundays River Valley Municipality (SRVM) in September 2015.

Dr Clifford-Holmes' doctoral study employed a multi-method approach that integrated ethnographic analysis, institutional analysis, and systems analysis within an action research project. The aim was to develop an understanding of water issues in SRVM in terms of how these issues interacted to produce undesirable outcomes that are contrary to the principles of post-apartheid water policy, and how transdisciplinary, practice-based research could contribute towards addressing these issues. The post-doctoral fellowship provided the opportunity to further analyse the results of this study and to present these results in their various dimensions, in terms of the empirical reality of the 'modes of failure of South African local government' (presented at the International Conference of the System Dynamics Society); the methodological implications of the integrated form of analysis employed in the research (discussed in a book chapter to be published by Wiley); and the governance and policy implications (analysed in an article submitted to the journal of *Water Policy*).

DEVELOPMENT AND IMPLEMENTATION OF AN INTEGRATED WATER QUALITY MANAGEMENT PROCESS (IWQMP) FOR THE CROCODILE RIVER CATCHMENT

Sponsor: DST (THRIP)-NRF

CG Palmer, AV Munnik, J Cameron

Project Dates: April 2013 – March 2016

Background

The Crocodile River Catchment (CRC), like many South African catchments, is over-allocated and experiencing increasing pollution of source water, which is becoming a critical risk for many industries in the catchment. A previous Water Research Commission (WRC) project found that most catchment stakeholders saw an urgent need to develop and implement an integrated water quality management process (IWQMP).

The Inkomati-Usuthu Catchment Management Agency (IUCMA) is responsible for water quality management in the CRC but will be unable to implement and enforce compliance without stakeholders' collective commitment. The Unilever Centre for Environmental Water Quality (UCEWQ) of the Institute for Water Research (IWR), Rhodes University in collaboration with Association for Water and Rural Development (AWARD) won a Technology for Human Resource and Industry Program (THRIP) project to partner the IUCMA and stakeholders to develop and implement the IWQMP. The core stakeholders include IUCMA, MMC, Delta EMD, Assmang Chrome, TSB and SAPPI who provide funding. Other catchment stakeholders who are significant water users, such as local government, participate but do not make a cash contribution. The IUCMA hosts the project. The IWQMP is expected to reduce costs of enforcement, ensure water quality compliance, improve source water quality and thus, decrease industrial risks.

Aim and objectives

The aim of the project is to co-develop and implement an integrated water quality management process (IWQMP) for the CRC together with stakeholders. The project will serve as a prototype for application in the other Inkomati sub-catchments and then more widely to other catchments.

Achievements

- The project is integrated into the IUCMA's water resource protection and waste division's annual performance plan.
- The project has moved into the implementation phase, which is taking place within the IUCMA's Crocodile River Operational Committee (CROC OC), which decides on the operations including releases of fresh water and effluent. The integration of water quality considerations following the load principle (i.e. what is the absolute load of contaminants rather than the concentration, which is the usual measure), enabling participants and river operators to deal with the impact of seasonal variation in rainfall and river flow on water quality.

- The Water Quality Systems Assessment Model (WQSAM) was accepted by the Stakeholder Group and accepted as a tool for developing and implementing the IWQMP. The model has now been installed on the IUCMA server, with remote access for the team in Grahamstown.
- A Green Drop Support Campaign was launched with additional funding from the Water Research Commission (see below).
- A transdisciplinary Rhodes University, Wits University and AWARD research team works on the project.

Two MSC students have graduated from this project. Mr Hugo Retief has modelled relationships between flow and load. Ms Asiphe Sahula has examined the Integrated Water Management of the sugar industry along the Crocodile River.

National Integrated Water Quality Management Strategy

The UCEWQ played a central role in designing and facilitating a WRC Dialogue on 4 and 5 February 2015 that produced a robust Terms of Reference (written up by the Rhodes team) for the development of a fully fledged National Integrated Water Quality Management Strategy. The experience and knowledge gained in the CRC IWQMP was invaluable for this.

Forum of Forums

The UCEWQ played a strong role in creating the WRC "Forum of Forums", as a space in which participants in Catchment Management Forums (CMFs) and emerging Catchment Management Agencies (CMAs) could respond to proposals by the Department of Water and Sanitation for the revitalisation of CMFs.

THE DEVELOPMENT OF BIOASSESSMENT PROTOCOLS FOR NIGERIAN STREAMS BY REFINING AND REMODIFYING THE SOUTH AFRICAN SCORING SYSTEM (SASS)

Sponsor: Regional Initiatives in Science And Education (RISE) ON Odume

Collaborator FO Arimoro (Department of Biological Science, Federal University of Technology, Minna, Nigeria)
Project Dates: January 2015 – December 2015

Nigeria currently lacks formal bioassessment approaches and protocols to assist in sustainable management of water resources. Developing a standard biological assessment protocol is important in determining the health of streams because it enable water managers to identify and address watershed management problems especially the rising levels of pollution of water resources in Nigeria. The aim of this research therefore is to develop a practical, robust, easy to use macroinvertebrate-based bioassessment protocol for assessing the health of Nigeria's river ecosystems. The proposed protocol will be developed by drawing on the experiences of working in South Africa where a similar protocol, the South

African Scoring System (SASS) is used for monitoring river health in South Africa. The proposed protocol, hereafter referred to as the Nigerian Scoring System (NISS), will be developed by modifying and refining SASS to reflect the Nigerian situation. To refine SASS for use in Nigeria, there will be a systematic selection of candidate reference sites, testing various technical elements such as identifying macroinvertebrate taxa, subsampling efforts, metric selection, and index calibration. Specific physico-chemical variables will be selected to provide chemistry-based information supplemental to the biological indicators. The successful development of the proposed NISS will enable sustainable freshwater resources management in Nigeria, as it will serve as an effective, yet simple tool for river health monitoring.



Dr Nelson Odume, Dr Francis Arimoro and students on field trip during Dr Nelson Odume's visit to Federal University of Technology, Minna, Nigeria

AN INVESTIGATION ON THE POTENTIAL USE OF MACROINVERTEBRATE-TRAIT BASED APPROACH IN THE SUSTAINABLE MANAGEMENT OF RIVERINE SYSTEMS WITHIN AN URBANISED CATCHMENT, BULAWAYO, ZIMBABWE

Sponsor: Regional Initiatives in Science And Education (RISE) ON Odume

Collaborator N Siziba (Department of Biology, School of Natural Sciences and Mathematics, Chinhoyi University of Science and Technology, Chinhoyi, Zimbabwe)

Project Dates: January 2015 – December 2015

Maintaining healthy rivers and streams (referred to as riverine ecosystems in this proposal) is a prerequisite for healthy biodiversity and sustainable rural livelihoods. Globally, riverine ecosystems of urbanised catchments receive large quantities of wastewater (collectively refers

to municipal sewage, industrial effluents and storm runoff in this proposal). Most of developing countries struggle to manage wastewater due to exacerbated rapid urban population growth and budgetary constraints that in turn leads to poor municipal infrastructure. Poor management of wastewater results in the degradation of the receiving riverine systems leading to contamination of these ecosystems, and consecutively loss of biodiversity and compromised ecosystem services (ES). Bulawayo, the second largest city of Zimbabwe, is located on the watershed of Umzingwane and Gwayi catchments. Pollution, particularly within the riverine systems of Gwayi Catchment (GC), has been reported to be a life threatening crisis. However, due to lack of cost effective monitoring tools, the impacts of wastewater on the receiving riverine systems is yet to be evaluated. Thus, it is vital to develop sound scientific assessment protocols and ecological diagnostic tools for the sustainable management of affected riverine systems. Elsewhere, macroinvertebrate-based bioassessment approaches have provided the best alternative for understanding the full effects of anthropogenic activities on water resources and the best framework to guide the formulation of management strategies. Therefore, this study aims to develop the best bioassessment method to capture the magnitude of urbanisation effects on riverine ecosystems of Bulawayo, Zimbabwe. This project will contribute towards the designing of novel bioassessment techniques and management initiatives that will mitigate urbanisation effects in Zimbabwe.



Mr Dionis Rugai, Dr Nelson Odume, Dr Jane Tanner, Dr Paul Mensah and Dr N Siziba, during Dr Siziba's visit to IWR Rhodes in August 2015.

The main aim of this study is to develop a novel macroinvertebrate assessment and ecological diagnostic tool for the sustainable management of wastewater effects on Bulawayo's surrounding riverine ecosystems. It is envisaged that this study will provide the best scientifically defensible bioassessment framework that will guide the development of management recommendations with wider applications in Zimbabwe's urbanised catchments. The proposed study has the following specific objectives:

1. To characterise the spatiotemporal variations of physicochemical water parameters (including pollutants) in riverine ecosystems across varying gradients of urbanisation intensity;

2. To compare the responses of macroinvertebrate taxonomic and trait-based approaches to varying gradients of urbanisation disturbance;
3. To develop a novel and integrated macroinvertebrate-based tool for the urbanised catchment;
4. To make management recommendations for the sustainable management of riverine ecosystems for Bulawayo catchments.

DEVELOPMENT OF A GOVERNANCE FRAMEWORK AND INFORMATION MANAGEMENT FRAMEWORK/SYSTEM TO IMPROVE THE INTEGRATION AND EFFECTIVENESS OF LANDSCAPE LEVEL PLANNING BY THE DEA NATURAL RESOURCE MANAGEMENT PROGRAMMES

Sponsors: Department of Environmental Affairs and
Department of Science and Technology

CG Palmer

Project Dates: February 2015 – March 2017

DST-DEA Collaboration on Ecological Infrastructure

The Department of Science and Technology (DST), through its Environmental Services and Technologies (EST) Directorate is managing an Environmental Services Portfolio that has a particular focus on addressing research, development and innovation gaps relating to Ecological Infrastructure (EI). This focus area is particularly aligned to the DST Global Change Grand Challenge. Given this focus, EST has been interacting with the Department of Environmental Affairs' (DEA) Natural Resources Management (NRM) Operation Support, Planning and Research unit since July 2014 in order to understand synergies and areas for collaboration. This has given rise to exploring a partnership on projects in the Mzimvubu Catchment. This catchment is strategically important to ongoing NRM and EI developments with potential for lessons to be transferred to other catchments based on the current interventions in the Mzimvubu.

Strategic importance of projects in the Mzimvubu Catchment

The Mzimvubu catchment in the Eastern Cape is currently undergoing a series of developments. Ntabelanga Dam and Laleni Dam are both part of the ongoing Mzimvubu Water Project and on completion are intended to supply potable water to 730 000 people by 2050 and irrigate about 2900 ha of land. There is also a small hydropower plant planned at the Laleni Dam site.

In order for these dams to be filled with a good quality of water and to avoid sedimentation and other problems which dramatically reduces the lifespan of the dams, it is essential to have healthy upstream ecological infrastructure (EI) through effective Natural Resources Management (NRM) programmes. It is also important to protect the remaining upstream EI given the dependence that many

people have on this landscape for their livelihoods as well as to protect the intrinsic value of this landscape.

As a result of these needs the National Department of Environmental Affairs (DEA) is investing in this catchment for the next 8 years, which is essentially the time frame that remains before the Ntabelanga dam will be built. DEA is primarily investing in a range of natural resources programmes but is also investing resources into a research programme that will address existing NRM knowledge gaps in the catchment and assist in setting essential NRM baselines that will be important for future monitoring of the EI in the catchment.

The NRM restoration and maintenance investments are being linked up to existing activities in the catchment such as Working for Ecosystems, Working for Water, Working on Fire and so on. These are also linked to the activities of the Catchment Management Agencies and Forums in the catchment.

Similarly, the DEA funded research projects form part of the ongoing research activities that are already happening in the catchment. Rhodes University is a key role player in research in this catchment but there are also a range of NGOs and other role players that are involved in research too.

Ntabelanga Dam Catchment

This project focuses specifically on the Ntabelanga Dam catchment, but it is envisaged that the governance framework and IMS would be developed to be an optimal structure that could be applied in any project area. The proposed Ntabelanga Dam site is located approximately 25 km east of the town of Maclear on the Tsitsa River and will have a capacity of 490 million m³ when constructed. It forms part of the Mzimvubu Water Project, which also includes the Laleni Dam and other associated infrastructure. The main aim of the Mzimvubu Water Project is the socio-economic upliftment of the largely undeveloped and impoverished communities within the area. The Ntabelanga Dam is expected to supply potable water to 539 000 people, rising to 730 000 people by year 2050 and to provide water to irrigate approximately 2 900 ha. Furthermore a small hydropower plant at Ntabelanga Dam is expected to generate between 0.75 MW and 5 MW (average 2.1 MW).

Besides the infrastructural development planned for the Ntabelanga Catchment, a range of different stakeholders are implementing projects in the same area, many of which involve NRM-related activities. DEA has a number of implementers undertaking projects through their NRM programme, including Working on Ecosystems, Working on Water, Working on Fire and so on. In addition, a number of NGOs and tertiary education institutions such as Rhodes University are undertaking research within the catchment. These activities are largely uncoordinated and the DEA has seen the need to put structures and plans in place to ensure more integration of these efforts.

In terms of the socio-economic context, a large proportion of the catchment is land under communal tenure where people have a direct dependence on natural systems to support their livelihoods and traditional structures govern decisions around land and resource use. The catchment is also dominated by commercial forestry and private sector agriculture. Administratively the catchment spans two district and several local municipalities. The timing of this intervention is critical in terms of the water governance in that the Department of Water and Sanitation (DWS) is currently re-structuring water institutions. The Tsitsikamma to Mzimvubu Catchment Management Agency is in the early stages of planning and development, and there is a need to establish new, Catchment Management Forum (CMF), linked to the existing Umzimvubu Catchment Partnership Programme (UCPP). It will raise priority issues and associated actions with the new CMA and work collaboratively to address them. In summary, if the NRM intervention is to be sustained, there is a need to participate fully in the emerging catchment (landscape) governance process. The NRM involvement will contribute to institutional capacity building and governance integrity and strength.

NRM is currently working in an integrated way in several area-based (e.g. Umgeni River Catchment) and Project-based (e.g. Medupi) initiatives where different governance arrangements and models are being applied. The Ntabelanga Dam Catchment is at the initial stages and presents a good opportunity for developing an effective structure that draws on the experience from the Umgeni and Medupi examples. The work will draw specifically on the detailed internal analysis being undertaken by the INR in the Umgeni Catchment aimed at improving the internal coordination between and across the NRM Programmes. The outcomes of this work will feed directly into the development of this broader level governance framework and information management system.



Upper inundation area of the proposed Ntabelanga Dam

DEVELOPMENT AND BENCHMARKING OF A DECISION SUPPORT FOR AQUATIC TOXICITY TESTING: TECHNOLOGY TRANSFER AND IMPLEMENTATION OF THE TOXICITY TESTING GUIDELINE/TECHNOLOGY

Sponsor: Water Research Commission
NJ Griffin, ON Odume, PK Mensah and CG Palmer
Project Dates: 1 April 2015 – 28 February 2018

In South African water management, water quality and ecological health are addressed using a combination of chemical testing, biomonitoring and toxicological testing. The application of chemical testing of surface water and effluent is well established. Routine biomonitoring has more recently been established in the River Health Programme and in Water Use Licenses. Although toxicological testing has had a place in Water Use Licensing, its application has lagged, particularly in resource monitoring. Recent reviews have identified sufficient short-term capacity for testing at independent laboratories, most of which are not accredited and have varying levels of quality control. It is envisaged that an increase in accredited capacity will follow increased demand consequent on greater application of routine toxicological testing.

In 2014 – 2015, revisitation of the application of toxicology in Water Use Licensing led to the production of a tool, the Integrated Water Use Application Bioassay (IWUAB) Toolkit, that enabled selection of appropriate toxicological tests for the licensing process. Test selection and test timing is guided by a number of parameters broadly related to the industry or user, the affected river condition, and historic data and experience with testing. The IWUAB aims to address identified capacity gaps in the application of routine toxicity testing in South Africa.

The current project will test the application of the Toolkit in South Africa, in the process engaging with a range of stakeholders (DWS staff, SHEQ personnel in a number of industries, toxicological laboratories etc). The project aims to assess the suitability of the current tool from the viewpoint of a range of stakeholders, to improve it where necessary, and to capacitate DWS staff that deal with toxicological issues.

TOWARDS ECOSYSTEM FUNCTIONAL AND STRUCTURAL ASSESSMENT FOR BETTER DECISION MAKING TO ENHANCE THE DELIVERY OF ECOSYSTEM GOODS AND SERVICES

Sponsor: Water Research Commission

ON Odume

Collaborators H Dallas (Freshwater Research Centre), C Thirion (Department of Water and Sanitation)

Collaborating organisation: Department of Freshwater Invertebrates, Albany Museum, Grahamstown

Project Dates: October 2015 – March 2018

Managing aquatic ecosystem structures, processes and functions for sustainable water resource protection for use is at the heart of the WRC KSA 2 (Water-linked ecosystems). Although giant strides have been made through various institutional arrangements, regulations and scientific approaches, to manage aquatic ecosystem properties (i.e. structures, functions and processes), there is still wide spread degradation. Environmental change, coupled with increasing industrialisation and a growing human population would continue to exert increasing pressure on ecosystem structures, but more importantly on their functions and the services available to humans (Hassan et al., 2005). We are faced with an intractable situation where we need to pay attention to the sustainability of not just ecosystem structures, but their functions and services. Bearing this in mind, we must now ask questions such as what species traits enable the aquatic biological communities to perform sets of desired ecological functions that translate into ecosystem services and functions that need conservation.

Current approaches including biomonitoring and ecotoxicology used for assessing aquatic ecosystem integrity in South Africa are anchored on aquatic ecosystems' structural attributes alone because it is presumed that protecting structures would ensure the protection of functions. This project will improve our knowledge and practice of biomonitoring through the documentation of relevant species traits that can be used for assessment of human-induced perturbation in aquatic ecosystems. Specifically, the use of species traits has the potential to add the following to the practice of biomonitoring: i) diagnosis of impacts, ii) biodiversity assemblage prediction, iii) traits-linked ecological function assessment, iv) stability across large spatial scales (i.e. eco-regions); v) relative seasonal and inter-annual stability. The habitat template theory provides the theoretical basis for using species traits in freshwater biomonitoring and it states that traits evolves in response to environmental demand, which select for specific traits and bring about the elimination of others. Thus, where habitat characteristics are similar, the composition of traits selected should be similar, even across distant eco-region, thus their stability across large spatial scales (Southwood, 1977; Townsend

and Hildrew, 1994). The theory also provides the basis for mechanistically linking traits to specific environmental impacts. Impact diagnosis potential of traits can help resource managers to focus efforts and restoration/rehabilitation resources on the main drivers of biotic changes in ecosystems thus saving costs and time. Overall, this project will complement the existing biomonitoring tools through the incorporation of traits.

Furthermore, in addition to community structural assessment, this project adds the value of assessing traits-linked ecological function assessment. It is critical to develop methods that are directly linked to ecological function because a recent study on risk assessment of salinity and turbidity suggests that protecting structures alone does not always protect species traits, an important aspect of ecosystems function (Kefford et al., 2012). For example, the loss of one or few keystone species may have devastating effects on ecosystem functions because of their important ecological roles or their roles as ecosystem engineers (Forbes and Calow, 2002). Conversely, very little or no effect on ecosystem functions may occur when more non-keystone species are lost. In addition, certain pollution levels may not be high enough to result in the loss of species (structure), but could still affect their ecological functions, suggesting that protecting structure may not always protect function (Cairns and Pratt, 1986). We therefore believe that we need a thorough understanding of ecological roles of species to achieve the goal of aquatic ecosystem sustainability enshrined in the National Water Act (Act No 36 of 1998).

It is now clear that current approaches used in South Africa to assess ecological integrity provide an incomplete picture of aquatic ecosystem health because they do not include the assessment of an ecosystem functional attributes. To provide a complete picture necessary to manage ecosystems sustainably, we are of the view that we must rigorously assess both the structural and the functional aspects of the ecosystems. Therefore, we assert that new approaches need to be developed that do not focus on structural attributes alone, but also on ecosystem functions.

Empirical evidence suggests that particular macroinvertebrate traits (e.g. biological, behavioural, ecological traits) are associated with ecological functions, thereby providing an indirect means for assessing ecosystem functions (Statzner et al., 2001; de Bello et al., 2010). For example, ecosystem functions such as biomass turnover and changes in secondary productivity are reflected by a combination of certain macroinvertebrate species traits including body size, adult life span, emergence patterns, and voltinism (Huryn and Wallace, 2000). Further, resource acquisition and processing, nutrient recycling and energy transfer can be assessed indirectly through ecological traits including food and feeding habits. Species traits do not only provide an indirect means for assessing ecosystem functions, it offers an opportunity for developing improved methods and

approaches of linking ecotoxicology and biomonitoring to functional characteristics. In fact, with the reality of global environmental change (including climate change), and the resultant progressive change of aquatic ecosystems, Wepener and Chapman (2012) opined that maintaining ecosystem functional attributes (e.g. services) would take precedence over the current status quo of structure (e.g. species composition and diversity).

Therefore, we now believe that drawing on the habitat template theoretical framework of Southwood (1977, 1988) and Townsend and Hildrew (1994), which clearly links species traits to environmental factors (e.g. land use and pollution), we can move beyond the status quo (ecosystem structural analysis alone) to assessing multiple aspects of the ecosystem through the use of species traits together with current approaches. This will enable better protection of the ecosystems, and would enhance the benefit of ecosystems services derived from a structurally and functionally healthy systems.

To this extent, it is our view that the first logical step is the development of a framework for the use of traits in functional assessment of aquatic ecosystems in South Africa. This would involve developing a database of species traits of South African aquatic macroinvertebrates, a comprehensive framework for their potential application in water resources monitoring. Once this is accomplished, we could move towards developing new water resource monitoring, and ecotoxicological approaches. We believe that the database will stimulate further interest in the use of species traits for water resource assessment among applied ecologists and water resource managers. Already elsewhere, particularly in Europe and North America, considerable research efforts have gone into compiling trait information and developing trait databases (Usseglio-Polatera et al., 2000; Vieira et al., 2006; Statzner et al., 2007; Liess et al., 2008).

Project Aims

- To develop a comprehensive framework for the application of species traits that enables both structural and functional assessment of aquatic ecosystem health.
- To develop an updatable database of South African invertebrate species traits
- To provide a clear case study of the utility of the species trait approach in both functional and structural assessment of a selected South African riverine ecosystem.

CROCODILE RIVER GREEN DROP SUPPORT CAMPAIGN

Sponsor: Water Research Commission
AV Munnik and G Barnes
Project Dates: February – November 2015

The Green Drop campaign emerged as a priority from the Integrated Water Quality Management Process

(IWQMP), and received special attention in the past year, in the form of Water Research Commission project. The project completed the set of seven dialogues and undertook a further investigation of frame conditions for the Green Drop through a series of interviews with national departments concerned with the performance of municipal Waste Water Treatment Works (WWTW). The project also undertook two training sessions supported by DWS Green Drop team.

The research found that although national departments are concerned about the bad performance of WWTW, they are hesitant to intervene in the local government sphere, which is constitutionally protected.

The research recommends that the awareness of the two greatest risks be highlighted in language that is accessible and convincing to the decision makers and majority voters in local government. These issues are the growing health risks as a result of contaminated water downstream from dysfunctional WWTW as well as the ongoing ecosystem degradation that result from dysfunctional WWTW. In policy terms, the removal of WWTW from the control of local government needs to be considered.

Possible replication of this approach is currently being considered in AWARD in order to replicate with local municipalities within the Limpopo basin.

ALIGNING AND INTEGRATING BIODIVERSITY AND ENVIRONMENTAL WATER QUALITY INTO THE MINING DEVELOPMENT LIFE- CYCLE

Sponsor: Water Research Commission
AV Munnik, CG Palmer, T Humby, G Thomson T Keighley and NJ Griffin
Project dates: April 2014 – April 2017

This three year project addresses the contested arena of coal mining in relation to water resource and biodiversity protection. The project will develop and test an integrated water resource quality management plan and decision support system, to facilitate streamlining of conservation mandates, minimize duplication of effort, and clearly specify roles and responsibilities of different authorities. It will take a form appropriate to adaptive, participatory and inclusive management. The project aims are to:

1. Conduct an analysis of available resource and catchment based tools aimed at sustainable development of water resources and management.
2. Investigate and evaluate the decision making processes followed in issuing mining authorization
3. Explore the relationship between licensing processes and ecological infrastructure from a landscape and connectivity perspective
4. Propose an integrative decision making process and institutional arrangement required to support licensing for sustainable use of natural capital

5. Develop guidelines necessary to understand the socio-economic value of selected wetlands demonstrating their importance to society
6. Develop and test a multi-sectoral integrative monitoring framework linked to a decision support system that will cater for bio-physical, economic and societal needs
7. Develop appropriate capacity for officials involved in licensing, business, and affected communities.

The approach will be developed and tested in the Upper Komati, in relation to Carolina, where an acid mine drainage event, polluting the town's drinking water supply dam, took place in January of 2012. The event deprived the town of Carolina's residents of drinking and household water for a period of seven months, imposing several externalities on them, and leading to social unrest. The event also stimulated a number of regulatory responses. An important consideration in case study site choice was that it falls within the area of the Inkomati-Usuthu Catchment Management Agency (IUCMA), where water quality regulation is arguably more advanced than in many other parts of the country. It thus allows a glimpse into the future, when other Water Management Areas will also be regulated by Catchment Management Agencies. The project benefits from other Rhodes University research activities in the IUCMA, including the development of an Integrated Water Quality Management Plan for the Crocodile River, and work contributing towards The Integrated Water Resource Management in South Africa: Towards a New Paradigm, WRC research.

Emanating from a fine paid by a coal mine for damaging a wetland, this project uses the evolving concepts of ecological infrastructure, and an in depth look at the changing paradigms for decision making around coal mining with ground truthing in the Carolina quinary catchment to arrive at an appropriate decision support system. The catchment was the scene of a dramatic impact of acid mine drainage on the municipal water supply, which led to a seven month period in which the town could not provide its residents with drinking water.

Early findings indicate that the current regulatory process does not adequately take the concept of ecological infrastructure into account. Piecemeal decision making - mine by mine - is inadequate to protect wetlands and other water resources. The regulatory system is overly complicated, leading to frustration among mine managers, while also not being accessible to catchment citizens. The research proposes a decision support system that contains rich descriptions of ecological infrastructure, and is aligned with catchment management strategies in order to achieve catchment based (i.e. regional), sustainable decisions and monitoring.

The research team has built close relationships with other WRC projects working with the ecological infrastructure concept in the Umsunduzi/Pietermaritzburg area

(K5/2354), the Southern Cape area (K5/2267) and the SANBI wetlands atlas project (K5/2281).

Two students are working in this project. Mr Gareth Thomson has undertaken an assessment of the requirements of existing regulations on mining managers in the Carolina district, using the Cultural Historical Activity Theory (CHAT) approach in order to identify points of tension which indicate where improvements are needed. Ms Tia Keighley is studying the wetlands in the area as part of evaluating ecosystem health and ecosystem services.

GENERATION OF NEW ECOTOXICITY DATA FOR SALTS USING INDIGENOUS SOUTH AFRICAN FRESHWATER MACROINVERTEBRATE: UPDATING THE NATIONAL SALTS TOXICITY DATABASE

Sponsor: Water Research Commission

PK Mensah, N Mgaba, N Griffin, ON Odume and CG Palmer
Project Dates: June 2014 - May 2015

Salinisation is an important problem facing freshwater resource managers in South Africa. Data on macroinvertebrate responses to salts strongly informed water quality management strategies. The current salinity ecotoxicity database, kept by the UCEWQ, includes NaCl, Na₂SO₄, MgSO₄, CaSO₄, and saline effluents. Such an ecotoxicity database is a valuable resource for the derivation of salt-specific species sensitivity distributions (SSDs), a very important water resource management tool. However, not many salts, including toxicologically important major salts and salt mixtures, are included in the database. The database has also not seen any update since it was first set up over a decade ago. Therefore, the aim of this project was to generate new toxicity data for both single and binary salt mixtures and subsequent update of the national salt toxicity database kept by the UCEWQ. The project also attempted to write a methodology for conducting ecotoxicity tests involving binary salt mixtures. The project was concluded and final report sent to the WRC. Toxicity data for both single and binary salt mixture were generated and attached as appendices to this report, and ready to be added to the national salt toxicity database host by the UCEWQ, IWR, Rhodes University. A summary procedure for binary salt mixture ecotoxicological experiments may follow this procedure: (i) consider the similarity and dissimilarity of cat-ions involved in the mixture; (ii) determine relative toxic fraction (RTF) for each single salt in the mixture; (iii) determine the relative toxic unit (RTU) by adding the RTFs; (iv) estimate concentration range and proportion of each single salt in the salt mixture; (v) apply standard exposure methods such as 96 h static non-renewal for short-term and 240 h static renewal for long-term and (vi) use standard statistical methods such as Probit to analyse the data.

THE APPLICATION OF ECOTOXICITY AND ACTIVITY SYSTEM ANALYSIS OF SALT MANAGEMENT TO WATER RESOURCE PROTECTION AND USE (DOMESTIC, AGRICULTURE AND MINING)

Sponsor: Water Research Commission
PK Mensah, CG Palmer and N Mgaba
Project Dates: April 2015 – March 2018

Freshwater salinisation in South Africa is on an increasing trajectory with elevated levels of sulphate, sodium and chloride ions in many of the country's rivers. A recent country-wide study reported 30% sample to have unacceptable electrical conductivity (EC) levels (i.e., >85 mS/m), while 25% sample have EC levels within tolerable range (i.e., 50-85 mS/m). This general review currently puts freshwater salinisation as one of the country's major water quality problems, and therefore appropriate guidelines for, and better ways of managing salts are required. The aim of this project is to develop salt guidelines for resource quality objectives (RQOs) and integrating these into salt management using Cultural Historical Activity Theory (CHAT). In order to achieve this aim, the following specific objectives have been set for the project:

- To conduct short-term and long-term lethal ecotoxicological tests using selected representative salts and organisms.
- To develop risk-based salinity guidelines using species sensitivity distribution.
- To use the resultant risk-based salinity guidelines as basis for setting resource objectives.
- To assess the current risk posed by freshwater salinisation in South Africa.
- To analyse salt management activities in agriculture facility and propose a new management practice using CHAT.

To date, activities that have been undertaken include the appointment of a reference group in accordance with WRC project management policy to act in an advisory capacity, and subsequently, inaugural reference group meeting at the WRC offices in Pretoria on 8th June 2015. There is ongoing laboratory exposure of different taxa (insect, crustacea, molluscs, and fish) to selected salts. Sites selected for field study have been completed, while field sampling for water quality variables, biomonitoring, and questionnaire administration is about to commence. The first three deliverables were met according to the project's time table, with the next deliverable due in February 2016.

INTEGRATED WATER RESOURCE MANAGEMENT IN SOUTH AFRICA: TOWARDS A NEW PARADIGM

Sponsor: Water Research Commission, with case studies supported by the National Research Foundation (THRIP), USAID, and Unilever SA

CG Palmer, AV Munnik, D du Toit, N Hamer, NJ Griffith. JH O'Keeffe, H Biggs, K H Rogers, M Jobson, S Pollard, MJT Weaver, A Sahula, H Retief, M Lipile, N Lipile, X Nzwana, H Holleman.

Collaborators: AWARD and Khulumani Support Group
Project Dates: April 2013 – March 2017

The project entitled *Water Resources Management in South Africa: Towards a New Paradigm* (TNP) started in April 2013, and is summarised in Figure 1.

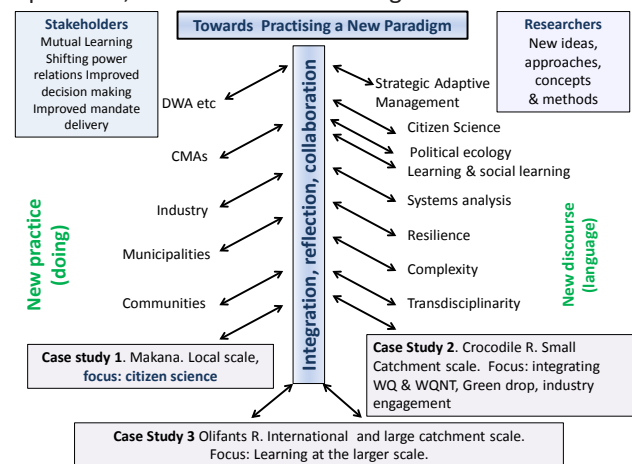


Figure 1: In this 4-year project, the vision is that engaged research undertaken with an understanding that people in catchments comprise complex social ecological systems, using appropriate complexity- and systems-based approaches and methods, could result in a deeper embedding of equitable, sustainable and adaptive Integrated Water Resource Management (IWRM) in South Africa.

A new project title: Towards Practising a New Paradigm (TPNP)

The WRC Reference Group meeting in July 2015 proved pivotal in the progress of the project. The research manager and reference group members communicated that the project must move rapidly from the collection of research data on new paradigm IWRM practice into communicating the “how” of such practices, and once again raised the questions about the notion of a “new paradigm”.

The project title came from a research solicited call. It is problematic in that the “new paradigm” is not really **conceptually** new. The theories supporting an understanding that people in catchments comprise complex social ecological systems, and that therefore complexity- and systems-based approaches offer provide appropriate research methodologies and methods to explore IWRM, are well-represented in the literature.

What is new is research that demonstrates these concepts in effective IWRM practice.

It is the practical implementation of IWRM that is contested. This project therefore seeks to contribute solid, evidence-based case studies of pathways towards practical, effective IWRM. We therefore propose a new title for this project - Integrated Water Resources Management in South Africa: Towards Practising a New Paradigm (TPNP).

The selection of theoretical and conceptual framings

Figure 1 lists a set of theoretical and conceptual framings with which a broad set of methodologies and methods are compatible. This selection emerged from the research practice of the authors' and from the literature. They are by no means exclusive or comprehensive; however, experience indicates that at least a sub-set of these is needed for effective new paradigm practice.

"How to...." series

There is an urgent need to communicate proposed practices in accessible ways to a wide range of participants across the water sector, with the aim of giving practical, research-based guidance. This has emerged into a project aim to produce a "How to" series as a project output.

Draft 1 of the "How to think...." handbook provides the foundational understanding of practising new paradigm IWRM. It illustrates the comparative challenges of applying combinations of the core theoretical perspectives (Figure 1) in aspects of IWRM at different bio-physical and institutional scales.

The "How to think" handbook presents:

- a text-box "Why read this handbook?" addressing why it is foundational;
- a brief introduction taking the reader from seeing a "troubled situation" to seeing a "challenging condition";
- a schema (the "fishbone diagram") to help think what one has to keep in mind along with all the complex, adaptive, social-ecological systems literature material already out there (which will be referenced but not reviewed);
- the imperative of thinking and working at multiple natural and social scales, recognising that the next immediate frontier is the local government scale;
- evidence that each problem needs to be addressed with enough of the right tools by teams that include some people who can use them;
- encouragement to everyone to become comfortable with the inevitable messiness and patchiness; recommendations to have patience alongside fortitude, expecting implementation to take longer than you would wish, yet persisting;
- making time to be pro-actively adaptive;
- the recognition that a developmental sequence of events or actions is necessary – because some feedbacks are only slowly effective and the foundation stages must be in place for them to be recognised;
- a narrative of where we are now, with pointers to how

we can move forward more practically, having become prepared to "think like this" at a general level.

The "How to ..." handbook series will include at least:

- How to move towards Green-drop certification,
- How to establish and run a Catchment Management Forum,
- How to integrate flow and water quality for IWRM in catchment management,
- How to achieve integrated water quality within IWRM in catchment management, and
- How to achieve effective water service delivery in local and district municipalities.

The TPNP case studies are reported individually

MAKANA CASE: CITIZEN RESEARCH AND GOVERNANCE

Sponsor: Water Research Commission

The Makana Case Study has focused on building an understanding regarding Integrated Water Resource Management (IWRM) based on what people think and experience, rather than prescribing the issues in advance. We are focusing on citizen science, local government and governance and aim to understand if and how researchers, community activists, government officials and other key stakeholders can work more effectively together to re-imagine IWRM to work towards a more sustainable approach. The case is analysing and learning how to most effectively support a citizen based research approach.

Makana Progress this year

Masters student progress: Mr Matthew Weaver has now completed his field work and is now writing his thesis "Exploring the Emergence, Practice and Learning of a Citizen Based Research Partnership in Relation to Water Service Issues in the Makana Municipality, Eastern Cape, South Africa". Please refer to Mr Weaver's section for further details.

Municipal Engagement: The project team were represented at the Makana Water and Sanitation Indaba on 13 March 2015, which provided an overview of the challenges the municipality is facing regarding water resource management and supply, as well as detailing the response from Provincial and National Government departments.

Whilst under the Provincial Administration of Ms Pam Yako, the project team contributed to the monthly 'work stream' process that was a mechanism for key local stakeholders to be engaged in assist in responding to the many challenges faced by the municipality. Unfortunately the impetus that was built up during the year dissipated once Ms Yako's term as Administrator ended July 2015.

Water for Dignity (WfD)

WfD presented a session at the Rhodes University Community Engaged Learning Symposium held on 4-6 May 2015.

Appreciative inquiry: Prof Palmer facilitated two Appreciative Inquiry workshop with the Water for Dignity team, as well as representatives from the Makana case, in February and July 2015. These workshops assisted the team to take stock of progress and agree on ways forward with the WfD team. The July workshop acknowledged the development of WfD as an autonomous organisation during the last 3 years, which has led to their collaboration with different organisations. They are now able to draw on separate support mechanisms from IWR and the Khulumani Support Group, who have both been seeking additional funding to carry the work forward. In addition WfD are now in a position to develop new partnerships to collaborate with other organisations, including Rotary International, Galela Amanzi, the Kowie Catchment Campaign and the Wildlife and Environmental Society of South Africa (WESSA).

School Water Forums

WfD efforts in establishing School Water Forums have led to a concerted effort in facilitating a turnaround strategy for Andrew Moyake Primary School, where over 250 learners currently only have access to one functional toilet. Other concerns WfD identified at this school include:

- Other toilet facilities have been subject to vandalism.
- Inadequate measures in place to prevent the vandalism.
- Broken pipes and sewerage backlogs exacerbating the plumbing difficulties.
- Water and sewerage from this school is flooding the grounds of a neighbouring school.
- The contractor who was awarded a tender for repairs and the school is not undertaking the work and disputing the terms of the tender.

WfD developed an action plan to engage various stakeholders at the school and amongst the community more broadly to respond to this issue. This led to teachers, pupils, parents and other volunteers making a start in improving the sanitation situation at the school, by cleaning the toilet block, re-painting it and putting additional toilets back into service. Work is ongoing to ensure that the intervention is sustainable and that further progress is then made to ensure the toilets are fully functional.

One Street One Tank and Emergency Water Initiative

In response to the challenge of regular water outages the WfD team and UCEWQ motivated for funds from Unilever to support an emergency water storage pilot, where citizens would have access to emergency water during an outage. This initiative started with the establishment of two 5000l JoJo tanks being erected in the yards of members of the 'Community Water Forums' set up by WfD. Although these tanks have been invaluable in assisting people with

emergency water supply, WfD's research has shown that supplying emergency water through 250l water barrels at a household level is likely a more sustainable option. During the remainder of 2015, 130 water barrels will be distributed to households experiencing regular water outages. Payments received for the water barrels will help ensure that emergency water barrels can be gradually delivered to many more households.



Water for Dignity and Unilever SA team examine One Street One Tank installation (Photo: Matthew Weaver)



One Street One Tank in action during water outages (Photo: Mbulelo Lipile)

Citizen Report Cards

WfD completed household survey work in Vukani this year. This work also involved collecting stories from households that have highlighted the lived experiences of people who have faced water related challenges. The strength of this work has been to clearly highlight the human dimension of the water challenges people face, including how people are actively responding to the challenges being faced such as regular water outages.

WATER AND SOCIETY PROJECTS

APPLYING NEW PERSPECTIVES FROM DISPLACEMENT AND RESETTLEMENT RESEARCH TO ENHANCE IWRM PRACTICE

Sponsor: Water Research Commission (K8/1065)

CJ de Wet

Project dates: June 2014 – January 2015

This project was designed to develop a framework to understand, assess and respond constructively to the socio-economic, institutional and ecological, i.e. social-ecological, impacts experienced by people in human settlements when they are impacted by planned changes in access to water supply, quality and habitats.

Water is central to human emplacement (i.e. the identification with, and the ability to sustain, settlement in a particular place, over time) and to its viability. Water flows across human settlement and society in many and interrelated ways (e.g. social, economic, political, religious, health, ecological). Water thus takes on a range of interrelated functions, and is central to the possibility and the sustenance of human settlements.

Interventions, or projects, which impact upon people's physical and social environment, notably in the form of infrastructure, impact upon emplacement, and its viability, in a range of ways. In this sense, such projects often significantly modify the spatial, social, economic, political, institutional and environmental bases upon which such emplacement rests, and the ways in which such bases are interrelated.

This project has applied ideas and insights from the field of displacement and resettlement studies as a new perspective, to understanding the wider implications for settlement sustainability, of changes in water access and distribution, and to the social and policy implications of such changes. It is argued that this perspective provides a new and multidisciplinary way of looking at the ways in which water plays a facilitating and diverse role in human settlements. Water flows in many, and multi-directional, ways in relation to the institutional, political, economic and ecological needs of human settlements - and thus has a range of interrelated impacts. This cross-cutting and foundational role of water in relation to human settlements and their wellbeing has not always been adequately understood or incorporated in approaches to a wide range of water focused interventions.

This **desk top study** investigates reported case studies (as accessible in e.g. theses, articles, books and project reports such as those of the WRC) of interventions or projects that have altered access to or distribution of water in

settlement situations in South Africa and elsewhere.

The project has been completed and has submitted two reports to the Water Research Commission, as follows

- An analytical review of the major theoretical approaches and issues in the field of displacement and resettlement studies, in terms of their potential applicability to IWRM practice
- An analysis of case studies of resettlement and of their lessons for IWRM, as well as a discussion of policy and ethical implications for water resources management in South Africa

THE ROLE OF ENVIRONMENTAL ETHICS IN SOCIAL-ECOLOGICAL SYSTEMS AND WATER RESOURCE MANAGEMENT

Sponsors Water Research Commission (K5/2342)

CJ de Wet and ON Odume

Project dates: April 2014 – March 2016

Despite developments in water resource policy, law, monitoring, regulation, management and research, the health and functionality of South African aquatic ecosystems continue to deteriorate. At the same time, there is a growing recognition that humans are integral components of complex social-ecological systems; as such, their beliefs, values and actions have direct implications, whether intended or unintended, for the environment. Human values are integral to the management of natural resources. This research project set out to review the field of environmental ethics in the context of trans-disciplinary research methods, so as to link ethical thinking and practice to current and emerging practices in integrated water resources management (IWRM).

A distinction which has been fundamental to this project, is that between morals or values, and ethics. Morals and values are here taken to refer to what specific individuals or groups of people believe to be good or bad, such as polygyny, or eating meat, or whatever. Ethics are taken to refer to a systematic concern with the principles by which we seek to distinguish between right and wrong in our behaviour towards other people and towards nature. Thus, we can look to the development of agreed ethical principles for water resources use, protection, and management, while providing guidelines that point to accommodating a plurality of individual and group morals/values.

This is extremely important in South Africa, where our historical context has its own ethical imperative to effect transformation towards social justice, (which is inextricable from environmental justice). In a highly plural

society, the needs and desires of people will differ widely. This project has reviewed research and presented options for developing ethical thinking and practice in IWRM that will assist us in moving towards the realisation of the values of equity, affordability and sustainability, and thus of the priorities of social and environmental justice, as set out by the National Water Act, No 36 of 1998.

The project has been completed and has submitted reports to the Water Research Commission, which have focused upon

- Major theoretical approaches within the field of environmental ethics, their claims and arguments, and their implications for water resource management
- Case studies on the success and failures of the application and implementation of environmental ethics, globally and in South Africa
- Investigation of the relationship between environmental ethics and aquatic ecosystems health
- Role of environmental ethics in social-ecological systems and water resources management

GENERAL CONSULTANCY PROJECTS

EXTERNAL MONITORING OF THE DINGLETON RESETTLEMENT PROJECT AT KATHU, NORTHERN CAPE

Sponsor : Sishen Iron Ore Company (Pty) Ltd
CJ de Wet (IWR) and A Wiltshire (Stellenbosch University)

From October 2014 to June 2015, Prof de Wet and Ms Wiltshire were involved in monitoring the social impacts of the resettlement of people moved from the former mining town of Dingleton in the Northern Cape to the nearby town of Kathu. This move has been brought about by the planned expansion of the Dingleton iron ore mine. The project involved site visits to the old town of Dingleton before the first group of people moved in November/December 2014, as well as site visits to the town of Dingleton and the new resettlement site in Kathu town, to where people had moved, in March 2015. Meetings were held with local community representatives and involved households, and reports were submitted to the Sishen Iron Ore Company. The project ended in June 2015.

POSTGRADUATE ACTIVITIES

EASTERN CAPE YOUNG WATER PROFESSIONALS (YWP-EC)

ON Odume, N Nqgwala, D Abraham, TL Mpofo, L Bryson, T Mpholoane and N Masikane

It's been an exciting, challenging and rewarding journey for the Eastern Cape Young Water Professionals (YWP-EC). The Provincial Chapter, which was launched in August 2014 at Rhodes University, has achieved several milestones under the leadership of very enthusiastic group of young professionals. Indeed, as the Chairperson of the Eastern Cape Young Water Professionals, it's been an amazing privilege to work with such a talented and energetic group of people who are always eager and willing to make a difference in the society. In the past year, the YWP-EC has grown its membership by more than 300% and organised several academic, technical, leadership, strategic and outreach events. The YWP-EC was also the third prize winner of the WISA (Water Institute of Southern Africa) 2015 Water Week Competition.

EVENTS AND ACTIVITIES

Technical Tour: Driftsands Waste Water Treatment Works (11 December 2014)

The Driftsands Waste Water Treatment Works (WWTW) Technical Tour marked the first event organised by the Port Elizabeth node of the Eastern Cape Young Water Professionals. On Thursday, 11 December 2014, a total of 37 water professionals from Port Elizabeth, and surrounding towns of Grahamstown and East London met at the WWTW to attend the event presented by Aurecon's water engineer, Mr Chris Little.

The tour began with a brief introduction of the YWP-EC chapter by Vice Chair Ms Nosiphiwe Ngqwala followed by a health and safety overview from Superintendent of the works, Mr Selby Thabethe. Mr Little then provided a detailed presentation and guided the tour of the practical and operational aspects of the WWTW. Participants ask questions and provided comments throughout the presentation. The tour was truly interactive and informative. Mr Dan Abraham, treasurer of the YWP-EC, gave a vote of thanks to the presenters, sponsors and participants.

We ended the day at Como Café, a local restaurant, where most of the participants met and exchanged ideas in an informal and engaging atmosphere. This provides opportunity for networking, sharing and exchanging experiences and ideas relevant to the water sector with each other. One of major points of discussion was the issue of adequate and appropriate mentoring of young professionals in the work place.



World Water Day event 23 March 2015 (Grahamstown)

During the 2015 World Water Day YWP-EC committee organised a one day action packed event including a panel discussion, leadership workshop, presentation on challenges in the water sector and a technical tour. Opening the event, which had 45 professionals in attendance, Dr Nelson Odume Chairperson of the YWP-EC, argued that this year's World Water Day provided opportunity for young professionals to reflect on past and current developmental trajectories and to re-imagine better, secure and sustainable alternative developmental path(s).

Panel discussion on innovation, challenges and opportunities in the water sector: Professor Denis Hughes, Director of the Institute for Water Research at Rhodes University, argued that a major challenge in securing and sustaining competent young professionals for the South African (SA) water sector is the low numbers of established academics capable of providing academic leadership and

supervising students in the water sector. He lamented the dwindling numbers of established academics in the SA water sector. Another panellist, Dr Patsy Scherman, Director of Scherman Colloty and Associates tackled the topic from a private business consulting perspective. While highlighting that enormous opportunities abound in the SA water sector for consulting, she outlined critical factors to consider before going into the consulting environment. YWPs were excited to learn about the do's and the don'ts of setting up a private consulting business. A third panellist, Ms Leticia Greyling, a lecturer at the Rhodes Business School, shared perspectives on the role of water in corporate South Africa.

Leadership and ethics workshop: Professor Pedro Tabensky of the Allen Gray Leadership Ethics Centre presented on leadership and ethics. He alerted YWPs to subtle ethical attributes that we often overlook in our everyday lives. He challenged YWPs to reflect continuously on the consequences of their actions not just to themselves, but to other people and the world around them.



A cross-section of Eastern Cape Young Water Professionals during the 2015 World Water Day event.

Technical tour: A technical tour to the Howieson's Poort Dam and the Waainek Water Treatment Works (WTW) was undertaken on the same day. At the dam, most YWPs were excited to see how catchment processes support, collect and retain water within a dam. Enthusiastic Process Controllers at the Waainek WTW on the outskirts of Grahamstown meticulously conducted YWPs around the WTW, explaining every step of the treatment process. Indeed, building a sustainable, capable and competent workforce is a task that we must all take seriously. This is exactly what the YWP-EC is doing.



YWPs taking a tour of WTW (top) and the panellists: Prof Denis Hughes, Dr Patsy Scherman and Ms Leticia Greyling (above).

Academic event: Water Seminar: Water resources of Nelson Mandela Bay Metro, and Alternative Water sources (29 May 2015): The YWP-EC committee organised a highly powered academic seminar on water resources of the Nelson Mandela Bay Metropolis and alternative sources of water. A renowned engineer, Mr David Raymer gave a critical and in-depth insight into the water resources around the metropolis. He also gave insight into the management of water, with fascinating examples.

Mr Johan Barnard, a scientist with experience in water and wastewater treatment, presented on the alternative water sources. The presentation focused on alternative water sources and on new research into algal bio-filters. In a way, Mr Barnard's presentation contrasted with the first presentation as the YWPs learnt about alternative water sources. The presentation was a great eye opener to YWPs exposing them to unconventional water resources and promising cutting edge research into water recovery technologies.

A total number of 53 water professionals and students from Port Elizabeth, and surrounding towns of Grahamstown and East London attended the seminar.

Academic seminar: Life in Water – The river-estuary-sea continuum (17th July 2015) – University of Fort Hare: Eastern Cape Young Water Professionals collaborating with the Department of Zoology and Entomology at the University of Fort Hare hosted the Life in Water event with 60 YWPs and established practitioners in attendance. Three professors, Prof Daniel Okeyo, Prof Yusuf Assefa and Prof Ken Liu were in attendance.



Prof Allan Whitfield (top) giving a presentation and a cross section of YWPs and established professionals in attendance (above).

The lecture started at 11:00, where Dr Ntuthuko Masikane (YWP-EC Grahamstown Coordinator) welcomed everyone. He was then followed by the first speaker, Dr Nelson Odume (YWP-EC Grahamstown Chairperson) who introduced the Young Water Professionals to the audience. Those that were interested in joining the YWP EC were encouraged. There were no questions or comments from the floor. The lecture was then presented by Professor Alan Whitfield. Prof Whitfield is an A-Rated researcher and a Chief Scientist at the South African Institute for Aquatic Biodiversity in Grahamstown. The lecture focused on the connectivity of water systems; particularly between rivers, estuaries and the sea. As highlighted in the lecture, estuarine ecosystems are highly productive and ranked with the coral reefs in terms of their productivity. Riverine water is important in maintaining this productivity. Prof Whitfield provided two case studies (St Lucia and Kariega estuaries) in which he highlighted the consequences of breaking the connectivity between water ecosystems. The connectivity is not only broken off by physical structures such as dams but also by the introduction of alien species that disrupt the life in water. The lecture was then followed up by comments and questions from the floor. The comments and questions varied between management issues, pollution and ethics as well as research that must be accountable to and/or address social issues.

Prof Okeyo also advised young researchers to conduct research along the water continuum rather than focusing solely on either the river or estuary or the ocean. After the

question and answer session, Prof Whitfield advised the YWPs about careers in aquatic research and highlighted the importance of choosing the right career (which must be based on one's passion). He also highlighted the importance of networking and the benefits of being involved in a multi-disciplinary research. The event was concluded by the networking session over tea and coffee where young water professionals interacted with each other and with Prof Whitfield.



A cross-section of YWPs during the strategic skills workshop at Rhodes.

Strategic events: Strategic Skills workshop 27 July 2015

– **Rhodes University:** On the 27th July 2015 the YWP-EC the first “Strategic Skills” workshop at Rhodes University. The timing of the workshop coincided with the Rhodes Career Fair on the 28th of July 2015. The concept behind the workshop is to ensure that students are aware of the “soft” skills necessary in the working environment. Soft skills were grouped into Self-branding, Self-Promotion and Business Savvy.

The workshop started with an introduction to the workshop by Ms Louise Bryson and an overview of the strategic skills developed through the University by Christine Lewis of the Rhodes Career Centre. Owing to the nature of the workshop, the audience was very active and engaged. The workshop had about 100 postgraduate students in attendance.

Strategic skills workshop 17 September 2015 – Nelson Mandela Bay Metropolitan University:

This event, which was organised by the YWP-EC and hosted at the Senate Chambers of NMMU, was aimed at raising awareness among YWP on critical strategic skills one required in order to succeed both personally

and professionally. The skills were clustered broadly into Business savvy, Self-promotion, and Self-branding. Three key note speakers, Mr Sandras Phiri (Sanlam), Mr Mike Spearpoint (Zwartkops Conservancy) and Mr Jeanne Rossouw (Lecturer, Civil Engineering, NMMU) spoke extensively on the three themes. Mr Phiri speaking on personal finances, dwelt on the Psychology of money (your goals and relationship with money), the Science of Money (your money and what it does), and the Art of Money (your financial game plan).

Mr Spearpoint gave an interesting talk on self-promotion and the power of social-networks, while Mr Rossouw gave an informative, entertaining and interesting talk on Self-branding. Highlighting the self-power of controlling one's brand he stresses that everyone has a brand either by design or by default and that brands are communicated in a variety of ways, stressing that YWPs should think carefully before they act or speak. At the end of the presentations, the 48 YWPs in attendance were left to reflect deeply about their self-perceptions and brands.

An important outcome of the two strategic skills workshop was the development of a strategic skills handbook by the YWP-EC committee.



A cross-section of YWPs during the strategic skills workshop at NMMU

World Water Week Events (Monday 24 August 2015 – Thursday 27 August 2015, Rhodes University): The YWP-EC committee organised a series of events to mark the 2015 World Water Week.

Social outreach (24 August 2015): On 24 August 2015, the YWP-EC committee in collaboration with a Grahamstown-based NPO, Children of the Soil, organised a technical tour for about 60 school learners from Fikizolo and Good Shephard Primary Schools. The technical tour was to the Waainek Water Treatment Works just outside Grahamstown. It was really exciting to see future engineers and scientists eager and enthusiastic about the processes involved in the treatment of water.

Water Exhibition show (25 August 2015): On Tuesday 25 August 2015, the YWP-EC organised an exhibition stand in front of the Rhodes University Library. The exhibition was aimed at members of the university community to raised

awareness about water and development. Members were asked to write down the sources of their drinking water, their perceived problems with their drinking water and one big idea about how water can be used for development. As simple as these questions appeared, it was interesting to see that not everyone knows the sources of their drinking water. Several people indicated that 'colour' was the problem with their water. The public exhibition helped raised the profile of water among members of the public.



YWP-EC Vice Chairperson Dr Nosipiwe Ngqwala explaining the concept of water for development to a member of the public (top) and YWP-EC water exhibition at Rhodes Library (above).

Water Research Cross-Faculty Presentations (26 August 2015): As part of the week's activities, the YWP-EC co-ordinated cross-faculty presentations by students undertaking water research. Postgraduate students whose research involved water in some ways were invited to present their research in accessible language. Three students made presentations on various aspects of water, including a mobile lab for disaster management, biological control of invasive alien plants in water resources, and sediment and water quality modeling in the Ntabelanga Catchment. Dr Roman Tandlich of the Faculty of Pharmacy

at Rhodes University was the guest speaker. He presented on disaster and risk management as an aspect to managing water infrastructure and water services. His presentation highlighted critical issues such as inadequately sanitised households and informal settlements as risk to the water services delivery.

Water Research Cross-Faculty exhibition (27 August 2015): Rounding off the week-long activities, the YWP-EC committee organised a water research cross-faculty exhibition. The aim was to invite all postgraduate students to showcase their research in the form of postal exhibition. Students from various departments participated. It was refreshing to see wide arrays of research being undertaken that are related to water.

Meeting with the Management Committee of Amatola Water: At the beginning of this year, the YWP-EC initiated a strategic move to partner with Amatola Water as the bulk water services provider in the Eastern Cape. First, a concept note indicating the importance of a strategic partnership was submitted to Amatola Water by the Chairperson of the YWP-EC Committee, Dr Nelson Odume. On the strength of the concept note, the management committee of Amatola Water, on 27 July 2015, invited the YWP-EC committee for a strategic meeting at the Amatola House in East London. Both Amatola Water and YWP-EC have agreed to go into partnership in strategic areas including funding, technical tours, community outreach, institutional championship, mentorship, and workshops and training. An MOU between the two organisations is currently being developed that will spell out the exact nature of the partnership.

Provincial leadership structure: The leadership of the Eastern Cape Provincial committee continues to grow stronger and on a regular basis a self-audit is undertaken to track progress, lessons and ways of accelerating the provincial activities.

Committee names and organisation:

Name	Institution	Position in committee
Nelson Odume	Rhodes University	YWP EC Chairperson
Nosipiwe Ngqwala	Rhodes University	YWP EC Vice-chairperson
Dan Abraham	Aurecon	Treasurer
Trisha Lerato Mpofu	Rhodes University	Secretary
Louise Bryson	Aurecon	Coordinator: East London/Umtata node
Thato Mpholoane	AECON	Coordinator: PE and surrounds node
Ntuthuko Masikane	University of Fort Hare	Grahamstown/Alice node
Siyabulela Lupa	DWS: East London	Special Projects

The Committee has identified three main themes where assistance would be required from outside:

Theme 1: Working professionals and postgraduate students: Under this theme the following are envisaged for working group members:

a) organising young professional workshops and seminars once in two months to provide training (e.g. publications, research, technical, entrepreneurship and academic) to other young professionals in their various areas of expertise (peer to peer mentorship); b) create a community of practice where young professionals can tap into the expertise and experience of one another; c) device means by which YWP-EC can become the connector of all relevant water related groups in the universities; d) organise workshops twice a year where experienced water sector practitioners motivate young professionals and give a talk on topical water related issues and e) any other ideas to enhance the capability of young professionals in the Eastern Cape.

Theme 2: Undergraduate Students' involvement: Assist central committee to develop models for including undergraduate students and on the best ways of getting the 'water message' across to undergraduate students. Information could include career options in the water sector etc.

Theme3: High school learners (Grades 9-11): Social outreach: Come up with ideas and insights on engagement with high school learners on water education, water ethics, water conservation and demand management, career and scholarships in the water sector, as well as organising debates around water issues. These activities will be undertaken in collaboration with local NGOs and civil society organisations. The goal of this objective is two fold: i) to raise awareness among high school learners about water and water related issues and ii) to motivate learners to take up careers in the water sector through active mentorship by pairing them up with young water professionals.

Acknowledgement of sponsors and partners

The YWP-EC wishes to thank the following sponsors and partners:

Rhodes University Research Finance, Rhodes University Institute for Water Research, Rhodes University Unilever Centre for Environmental Water Quality, Volkswagen, Aurecon, AECOM, University of Fort Hare, WESSA, Salam, Nelson Mandela Bay Metropolitan University, Amatola Water and other organisations who have supported the YWP-EC in different ways.

EVALUATION OF LOW-COST TECHNOLOGY OPTIONS FOR SUSTAINABLE WATER SUPPLY AND SANITATION IN TWO PERI-URBAN AREAS OF LUSAKA, ZAMBIA

Student: Y Chiliboyi

Supervisors: PK Mensah and CJ de Wet

Degree: MSc (Water Resource Science)

Adequate clean water and sanitation are fundamental components to people's health, survival and growth. It is estimated that more than 700 million people in the world lack access to improved sources of drinking water, whereas, 2.5 billion people do not have access to better sanitation facilities. Consequently, over 2 million people, mostly children under the age of five, die each year from diseases associated with lack of access to safe drinking water, inadequate sanitation and poor hygiene, as most of the pathogenic organisms that cause diarrhoea, are transmitted mainly by lack of adequate safe drinking water and poor sanitation.

In developing countries, including Zambia, access to safe water and sanitation services is a major challenge for millions of peri-urban residents. Peri-urban areas are characterised by lack of infrastructure and space, high poverty levels, poor health, poor access and unavailability of water supply and sanitation services which often result in increased prevalence of diseases. Where services do exist, the provision is generally less. Provision of safe water and sanitation services in peri-urban areas will require the introduction of appropriate, low-cost and sustainable technological solutions

This study therefore aims at evaluating the existing low-cost technology options for sustainable water supply and sanitation in two peri-urban areas of Lusaka, Zambia. A multi-criteria analysis methodological approach was used to assess the available technologies that can be feasible in the study areas, taking into consideration the economic, social-cultural, technical, institutional and environmental aspects. Questionnaires and/or focus group discussions were conducted to obtain baseline data for perceptions and preferences of the selected feasible technology options by the communities.

This study forms an important basis for proper planning of sustainable water supply and sanitation services in dynamic environments such as peri-urban areas, and also aids in policy formulations and implementations by the government of Zambia for safe water and sanitation services.

AN EXPLORATION OF WAYS IN WHICH DANCE MOVEMENT THERAPY CAN BE USED WITHIN A TRANSDISCIPLINARY WATER MANAGEMENT RESEARCH CONTEXT

Student: A Copteros

Supervisor: CG Palmer, R Fox and V Karkou

Degree: PhD

Transdisciplinary (TD) research programs are increasingly being used to respond to complex social-ecological systems. These programs combine different ways of knowing in order to address societal issues that are complex and require multiple strategies needing constant adjustment and adaptation. Working within a TD research team requires the development of skills to cope with difference and to be flexible and reflexive. This research explores how Dance Movement Therapy (DMT) can contribute to reflexive practice. A group of TD researchers and postgraduate students have met monthly over three years to explore methodologies and approaches that enable a deep and rich exploration of the complex social-ecological systems that comprise people living in catchments (watersheds). In this study eight TD research group participants co-led each other through a movement-based exploration of the following questions: how to limit the variables of power, privilege and difference in the context of experience of water supply and quality in South African communities; how to maintain lively curiosity and acknowledge one's own racism; how to learn from each other and share practice with a range of disciplines; how to extend healing to the wider community and how to include oral histories and indigenous knowing. This is a new approach to working with social-ecological systems that recognises the significance of body in processes of transformation and interrelationship in order to heal divides and create opportunities for embodied change. Participant researchers learn by engaging in, as well as co-leading sessions and then apply tools gained to an existing community based project on greater water equity. The process aims to show how a body based creative movement approach can contribute to approaches that seek to align humanity to ecology by aligning mind and body.

The suite of concepts and theories that inform this study include: Complexity; Complex Social-Ecological Systems; Transdisciplinarity; Transdisciplinary Research; Embodiment and Phenomenology; Embodiment, Enactment and Dance Movement Therapy. The literature explores: the People Environment Relationship; Water and South Africa; Trauma and South Africa and the role of Arts Based Therapies. The overall methodological framing is Hermeneutic Phenomenology using Interpretative Phenomenological Analysis.

Conferences

- I presented and ran a movement session at the PECS 2015 Conference: Social-ecological dynamics in the Anthropocene on "An Exploration of Ways in which Dance Movement Therapy can be used within a

transdisciplinary water management research context”;

- I presented at the Healing and Social Transformation in Mental Healthcare in South Africa: Conversing, Connecting and Collaborating across Arts Therapy, Occupational Therapy, and Allied Psychotherapies Conference held on 14 and 15 July 2014.

DYNAMICS OF RANGELAND PRODUCTION AND WATER USE

Student: O Gwate

Supervisors: AR Palmer and SK Mantel

Degree: PhD (Water Resource Science)

The research focuses on determining dynamics in rangeland production and water use. The study will model evapotranspiration and rangeland production in grasslands affected by invasive alien plants. Understanding trajectories in these across environmental gradients provides an insight to the potential of ecosystem services. In developing scenarios that can convince land users to change their behaviour and land use patterns, it is essential to have an empirical understanding of water use of each component of the ecosystem. Hence, the study will show how decisions on land use options can affect the type, magnitude and mix of services and goods provided by that ecosystem. It will also show what consequences land use trade-offs may have for the people dependent upon them.

ASSESSMENT OF FLUCTUATING ASYMMETRY IN THE FRESHWATER SHRIMP, CARIDINA SP., AS AN INDICATOR OF WATER QUALITY STRESS IN SOUTH AFRICA

Student: AJ Holland

Supervisor: WJ Muller and AK Gordon

Degree: PhD (Water Resource Science)

It is of great interest for the management and sustainability of water resources to monitor environmental stress impacting on biological systems. Biomarkers are defined as functional measures of exposure to various stressors, which can serve as early-warning systems of decreasing environmental quality and population health. Biomarkers can determine the presence of certain stressors and the degree to which community structures/taxonomic groups have been compromised. Fluctuating asymmetry (FA) – small, random deviations from perfect symmetry is a popular method to measure a phenological response to environmental stress and has several advantages over other biomarkers, such as biochemical ones. FA is 1) nonlethal; 2) applicable widely across biological systems and stressors; 3) associated with life history traits and fitness and 4) relatively easy to measure and therefore less costly than other methods. In addition, optimal levels are easily identified through perfect symmetry and FA has got the potential to measure responses on different levels: stressor-specific response (single traits), organism-wide

response (composite index) and population-wide response (multiple traits). Although FA has the potential to serve as a surrogate for estimating organisms or population coping with stress or environmental change, inconsistent results questioned the reliability of FA as biomarker in the past.

FA responses were measured in the freshwater shrimp, *Caridina* sp., collected from several sites and seasons posing different water quality issues: the Mpisini and Mdibi Rivers (KwaZulu-Natal) were possibly impacted by a smelter facility, forestry and human settlements, whereas the Luvuvhu River (Limpopo Province) was mainly impacted by agricultural run-off and urban impacts from the city of Thohoyandou as well as DDT from inhouse-residual spraying. Fluctuating asymmetry was present and measurable in selected traits of the freshwater shrimp, *Caridina* sp. from both areas investigated. Although FA was not linked to a specific stressor or impact, the FA response was able to indicate a level of population quality despite biomonitoring indices suggesting otherwise, which was mainly due to site-specific changes in habitat in the Limpopo Province and changes in habitat between sites in KwaZulu-Natal. It is therefore suggested to investigate FA responses further in order to consult this stress response method when changes in habitat are likely to impact on biomonitoring indices utilised.

MINING AND BIODIVERSITY IN THE UPPER KOMATI CATCHMENT: CONTESTATIONS IN A COMPLEX SOCIAL- BIOPHYSICAL SYSTEM

Student: T Keighley

Supervisor: CG Palmer and AV Munnik

Degree: MSc (Water Resource Science)

Mining in South Africa plays an essential role in the country's economy. However mining (specifically coal mining) is also one of South Africa's most contentious water users and in many cases has proven to be environmentally destructive (e.g. in relation to acid mine drainage); and its practices unsustainable. A major concern is coal mining's negative impact on the biodiversity of the country and the associated ecosystems. These ecosystems, also referred to as ecological infrastructure, provide an array of goods and services to the natural environment and surrounding communities' well-being (economically and quality of life). Examples of what is argued to be one of South Africa's most important, yet threatened ecosystems are wetlands. Wetland ecological infrastructure, as well as most ecosystems (aquatic and terrestrial), is not only vulnerable to mining, as other land uses have proved to have consequential impacts too. However conflicts and concerns have indicated that other land users and uses have too been impacted by mining activities. Therefore, an avenue to ensure the long term sustainable and natural flow of benefits from the landscape, in relation to mining, an understanding of conflicts, opinions, and extent of knowledge, of the different land users and

uses is required. With this knowledge future planning can consider careful location and management options for greater sustainable land use and conservation of biodiversity and ecological infrastructure.

A prime case study reflecting the above scenario of ecological infrastructure protection and land use activities, is the well explained incident of acid mine drainage impacting many aspects of biodiversity and community in Carolina, Mpumalanga. The Carolina X11B catchment is a highly used landscape including land use activities such as: dry land agriculture, livestock grazing, mining, and is part of a water transfer scheme each contributing towards the cumulative impacts of the subcatchment. A vast network of wetlands, streams, and springs are also present in the subcatchment, making the region a good example of varying contestations within such a complex social-biophysical system. Therefore using wetlands as a key indicator of ecological infrastructure and a nexus of contestation this thesis aims to:

- Describe the wetland ecological infrastructure of the Upper Komati Catchment (UKC)
- Analyse the mining and wetland biodiversity activity in the UKC
- Offer alternative future pathways

With a complex social-ecological systems focus, the study is using a transdisciplinary approach to collect data. The analysis of the cultural historical activity systems theory (CHAT) framework will be used to identify contestation. While the presence of the ecosystem goods and services, and activity-impact conditions of selected wetlands will give an indication of the cost of ecological infrastructure in the catchment from the activity taking place. These results will aid in provoking changes in practices that will include the appropriate protection of ecological infrastructure and biodiversity of the Upper Komati River Catchment. A scoping phase for this research has been completed and main data collection phase is in progress.

LINKING WATER GOVERNANCE DEVELOPMENT AND AQUATIC ECOSYSTEM HEALTH TO LIVELIHOOD DIVERSIFICATION AND EMPOWERMENT – THE CASE OF THE UPPER MZIMVUBU RIVER CATCHMENT, EASTERN CAPE, SOUTH AFRICA

Student: N Libala

Supervisor: ON Odume and CG Palmer

Degree: PhD (Water Resource Science)

I am currently working on my proposal with Dr Nelson Odume (supervisor) and Prof Tally Palmer (co-supervisor) for a PhD degree commencing in the 2016 academic session. I have a core research interest in linking Natural Resource Management associated with water and soil to the livelihoods and empowerment of rural people. In South Africa, most rural farmers rely greatly on aquatic

resources for their livelihood; however, aquatic resources have been destroyed to make way for agricultural and residential development. In a water-stressed country such as South Africa, there is a continued destruction of aquatic resources which will result in lower agricultural productivity, reduced quality of water, less reliable water supplies and increased downstream flooding. This will also result in plant and animal resources becoming more and more threatened. On the other hand people have used wetland animals and plants for medicinal purposes for thousands of years. Therefore action needs to be taken to conserve and rehabilitate aquatic resources for the benefits of rural people.

From the 5th to 8th October, we went to Maclear (Ntabelanga) to identify my study sites.

Intern report

Between 21st to 28th August, I assisted Prof Palmer and Ms Tia Keighley with field work (Wetland land assessment, Biomonitoring and Water Chemistry) in Carolina, Mpumalanga.

From 19th January 2016 to 25th February 2016, we are working with DWS to run a series of Catchment Management Forum workshops from Mzimvubu to Tsitsikama. Currently I am busy organising and compiling the list of the stakeholders that need to be invited.

A CLASSIFICATION OF LARGE WETLANDS IN AFRICA'S ELEVATED DRYLANDS BASED ON THEIR STRUCTURE AND FORMATION USING EARTH OBSERVATION (EO) APPROACHES

Student: Z Lidzhegu

Supervisors: F Ellery and SK Mantel

Degree: PhD (Water Resource Science)

The current research focuses on the classification of large wetlands in Africa's elevated drylands based on geological and geomorphological factors that determine their formation, structure and hydrological functioning. Specific objectives involve: identifying and mapping large wetlands in Africa's elevated drylands, identifying geological and geomorphological factors that determine wetland formation, relating wetland origin and structure to hydrological functioning, and classifying wetlands based on processes that determine their formation and their associated structure.

HYDROLOGICAL MODELING OF CHANNEL WETLAND EXCHANGES IN DIFFERENT LANDSCAPE SETTINGS IN AFRICA

Student: E Makungu

Supervisor: DA Hughes and SK Mantel

Degree: PhD (Hydrology)

This study focuses on simulating channel wetland exchanges in different landscape settings in Africa. Previous studies used a wetland sub-model which has been recently incorporated in Pitman model to simulate the impacts of wetlands on runoff generation within basins. However due to data limitation and complexity of exchanges, these studies yielded unsatisfactory results in some parts. Thus the current study aims to improve the model simulations by utilising earth observation data integrated with GIS techniques for advancing understanding of wetland characteristics and processes. Because of limitations in spatial resolution and temporal coverages, a LISFLOODFP hydraulic model will be coupled with wetland sub-model to provide parameters that will be used to calibrate the wetland sub-model (in Pitman hydrological model). Then the outcomes of simulations will be used to predict the impacts of wetlands on runoff generation in basins.

THE IMPACT OF AGRICULTURAL ACTIVITIES ON SALINITY IN THE KAT RIVER

Student: N Mgaba

Supervisor: PK Mensah and ON Odume

Degree: MSc (Water Resource Science)

South Africa is a water scarce country and needs to protect its available freshwater resources for the benefits of this and future generations. However, human activities have progressively worsened both quantity and quality of the country's water resources. Poor water quality can adversely affect the health of humans and aquatic ecosystems. It also has economic implications through high treatment costs before use for human consumption and industrial processes. Also, poor water quality could decrease agriculture yields. Recent studies have increasingly reported that agricultural practices have pushed up environmental burdens as pesticide and fertiliser residues ultimately enter surface or ground waters. All South African rivers, including the Kat River, are facing the challenge of deteriorating water quality due to anthropogenic activities. The Kat River is chosen for this study because its catchment is a hub of major agriculture activities such as irrigation of citrus fruits and livestock farming in the middle and lower reaches. Also, the communities living in the area use Kat River water for their daily activities, including drinking, washing clothes and bathing. In the early 1980's, commercial farming of citrus was threatened by high salinity due to decreased water in the river. Therefore, the aim of this project is to find out effects of agricultural activities on Kat River's water quality and the macro-invertebrate community and link that to agricultural practices. The study will also apply Cultural Historical Activity Theory (CHAT) to examine agricultural practice in relation to water quality management of the Kat River catchment. The findings will be used to formulate good management practices for salinity in the Kat River catchment.

This study forms part of a bigger Water Research Commission project, and was presented at the inaugural steering committee's meeting in Pretoria. Sites selection for the study have been completed, while field sampling for water quality variables, biomonitoring, and questionnaire administration are about to commence.

ESTABLISHING A WATER RESOURCES ASSESSMENT SYSTEM FOR SWAZILAND INCORPORATING INFORMATION AND MODELLING UNCERTAINTY

Student: C Ndzabandzaba

Supervisor: DA Hughes

Degree: PhD (Hydrology)

It has been noted that most basins of the world, more especially those in developing countries are ungauged and/or poorly gauged resulting in inconsistent and inadequate data and information. This precludes sustainable water resources management and policy making. Therefore, this research is aimed at developing a water resources information system for Swaziland that is based on both observed and simulated information and that incorporates uncertainty. The basis of the system is the uncertainty version of the threaded version of the Pitman model. Some global datasets have been collated and the hydrological response has been quantified for the whole of Swaziland. The regional characteristics of hydrological response are currently used to constrain the model output to establish *behavioural* but uncertain parameter sets. Water use and other modifications to the natural hydrology will be incorporated. Key regions and data sources where existing uncertainties might impact adversely on water allocation management and decision-making will be identified.

THE ALLOCATION OF WATER RESOURCES UNDER UNCERTAIN CONDITIONS

Student: GW Pienaar

Supervisor: DA Hughes

Degree: MSc (Water Resource Science)

One of the defining characteristics of water is that it is integral to all earth systems with complex relationships between it and many other environmental and human processes. This leads to large uncertainties when attempting to model these interactions and communicate them to stakeholders and decision makers. However the explicit inclusion of uncertainty is still not common practice among scientists and managers attempting to model complex environmental systems for the effective management of water resources. It has also been identified that different methods from those currently used are needed to take uncertainty into account when making decisions for water resources management. All decisions have a degree of uncertainty related to the outcomes of a given scenario

and because of the effect this will have on stakeholder values it is important that there is effective communication of uncertainty to decision makers. Highlighting uncertainty in the case of resource allocation allows the risk tolerance of users to be explicitly brought into the decision-making process. The importance of this type of feedback is that it frames the uncertainty within a set of limits that allows for an individual water user to deal with risk in a way that fits in with their particular aims and objectives.

In the context of South Africa, the interactions around the use of water are particularly complex due to an extremely variable climate and a history of social inequality. This and the need for integrated management of water resources, is recognised in South African legislation. Using a hydrological model is a means of decision support to generate feedback and consensus for community based decision-making under uncertain conditions. Although we have long relied on hydrology and water resources yield models for decision-making in water resources management in South Africa, we have not explicitly dealt with the different types of uncertainty that are inherent in such models. Additionally methods have not yet been developed that allow for the equitable allocation of water that take into account the temporal availability of the resource and the differences in beneficial use between stakeholders and the environment.

This study proposes an approach to water resources allocation that links the uncertainty inherent in hydrological models with decision-making outputs. It also puts forward a model for allocating water across stakeholders and the environment that provides a common measure to compare the impacts of a deficit in supply based on the integrated evaluation of beneficial use. Integrated Water Resources Management (IWRM), with its focus on sustainable development and cross sectorial approach has been criticised for being too complex and vague with a lack of agreement on how it should be implemented. Although these interrelated paradigms have shortcomings, combining the complementary strengths of IWRM with interrelated approaches such as Ecosystems-based approaches (EBM) and Adaptive Management (AM) could contribute to better water resources management. The method utilises the requisite simplicity approach, incorporating a number of complex interactions in a pragmatic way. This simplifies the process while still providing enough information to make a decision. The model outputs are intended to be used with existing decision making frameworks such as Robust Decision Making (RDM) and Information Gap (Info Gap).

The methodology and outputs are tested using focus group discussion based on a hypothetical set of scenarios and a real world case study. The focus group examines a water allocation problem for a group of water users, to determine the utility of the approach and outputs for making integrated decisions. The real world case study is based on a farm where cultivation is being changed from

lucerne to pecan and almond orchards. This highlights the use of the model outputs with the Info Gap decision making methodology to analyse scenarios and make a decision that performs well under a wide range of uncertainty.

UNCERTAINTY ANALYSIS IN COUPLED HYDROLOGICAL AND HYDRODYNAMIC MODELING FOR FLOOD HAZARD ASSESSMENT

Student: DS Rugai

Supervisors: DA Hughes and SK Mantel

Degree: PhD (Hydrology)

The interaction of hydrology with human activities can be beneficial for domestic, industrial and agricultural activities, as well as for hydro power generation. However, it can also threaten human life and cause damage to property through extreme events such as floods. Hydrological modelling has been widely used for the quantification of water resources and impacts of hydrological events. However, the unavailability of sufficient quality input data at appropriate spatial and temporal scales makes model outputs highly uncertain. Hydrodynamic modelling on the other hand is used for mapping and assessing flood hazards. This requires accurate representation of river and floodplain geometry and topography, data that are not always readily available. The source of these data are mainly field measurements and Earth Observation (EO). While the first source comes with high cost and time consuming the latter is characterised by low resolution (for freely available data) and high cost (for high resolution data). Efforts have been made to extract river bathymetric data from freely available EO data (DEM and Multispectral Remote Sensing images). However available data in existing global databases covers only major rivers in Africa. Furthermore, flood hazard analysis requires input data with finer temporal and spatial scales than frequently used in catchment hydrological models. This difference creates a challenge when using hydrological model outputs as upstream boundary conditions for hydrodynamic modelling of flood propagation and floodplain storage dynamics.

This study addresses the issues of uncertainty in hydrological modelling and the problems of linking with flood inundation models using freely available EO data. The study is designed to develop an uncertainty framework that includes uncertainty in both the catchment water balance and downstream flooding through a link between a hydrology model and a hydrodynamic model. The study is applied to two floodplains with different characteristics within Wami-Ruvu basin in Tanzania (Figure 1). The study is conducted in three main stages. The first one deals with uncertainty analysis in monthly water balance modelling using a revised Pitman model. The second deals with disaggregation of the simulated monthly discharge to daily discharge using both observed ground and satellite rainfall. The last stage will focus on flood hazard and floodplain storage dynamics

assessment using an integrated 1D-2D hydrodynamic model (LISFLOOD-FP). The study also investigates the importance of quantifying the effects of flood attenuation within coarse scale hydrological models. The framework will enhance proper decision making regarding land use management and flood mitigation practices by both policy makers, communities and individuals.

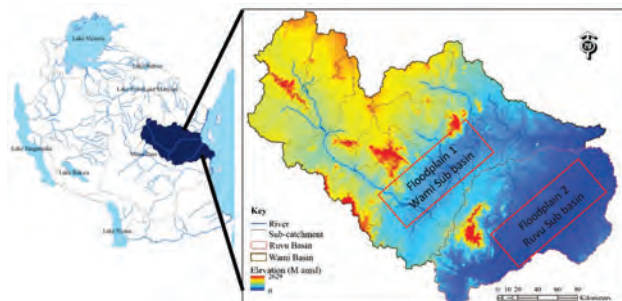


Figure 1: Location of Wami-Ruvu basin in Tanzania

THE INFLUENCE OF NON-GOVERNMENTAL ORGANIZATIONS UPON THE LONG-TERM OUTCOMES OF THE INVOLUNTARY RESETTLEMENT PROCESS, WITH SPECIAL REFERENCE TO THE KARIBA DAM CASE, ZAMBIA.

Student: E Sitambuli

Supervisor: CJ de Wet

Degree: PhD (Anthropology)

This study seeks to enhance our understanding of the long-term consequences of resettlement, via a study of the group of people (the Gwembe Tonga of Zambia/ Zimbabwe, resettled in the context of the construction of the Kariba Dam) among whom the most influential theoretical framework for the processual study of resettlement was developed. The field of research is thus the study of the long term consequences of resettlement. The thesis focuses on the impact upon the resettlement trajectory (and our modelling of it) of development interventions and support that take place, not during, but well after, resettlement. It thus makes a major contribution to our understanding of the processes of planned change and development, particularly in rural contexts.

The path-breaking empirical and theoretical research work with regard to resettlement, was done in the context of the Gwembe Tonga people resettled by the construction of Kariba Dam, with an ongoing study since the 1950s by Scudder and Colson, which has provided the basis for international thinking about resettlement in processual terms. The process model, while not assuming a post-resettlement return to a state of equilibrium, seems to operate as if major/significant external inputs are present predominantly at the time of resettlement, and immediately thereafter, rather than on an ongoing basis. This thesis asks how we are to understand the impact of significant external interventions – of longstanding

duration, which happen well after actual resettlement has occurred - on the way the resettlement process unfolds. The interventions concerned in the Kariba case are of this nature, and relate to NGO projects in the area. This research has investigated the influence of a sustained development intervention over time by an NGO on the post resettlement trajectory and its outcomes, on a particularly isolated group of the Gwembe Tonga people of Zambia - against the background of very detailed studies over fifty years of the impact of resettlement upon other groups of the Gwembe Tonga. The main empirical focus of this research has been on the NGO Harvest Help Zambia (HHZ). Specific HHZ project activities focus mainly on supporting community led initiatives encompassing agriculture, health, education and environment, civic education and business development.

Methods

This research has employed a mix of qualitative and quantitative data collection methods and techniques in an ethnographic framework which has allowed the researcher to explore and examine in-depth a group of people *in situ*, observing their context and behaviours, taking their own perspectives and experiences seriously. The major ethnographic methods that this research has employed, have been (i) document analysis; (ii) participant observation; (iii) ethnographic interviews; (iv) household level surveys and (v) aerial photos and maps. This research has been conducted in residence in the selected primary village site, and was planned based on the fact that the researcher is already familiar with the Gwembe Tonga language, the study area and locations, HHZ and local government officials.

COAL MINING AND BIODIVERSITY IN THE UPPER KOMATI RIVER CATCHMENT: THE ROLE OF MINING PRACTICE

Student: G Thomson

Supervisor: CG Palmer and AV Munnik

Degree: MSc (Water Resource Science)

Water resource use drives the economy, and the mining sector is a traditional economic driver in South Africa that depends heavily on water abstraction, waste disposal and landscape alteration. While agri-tourism and conservation efforts often offer alternative land-use and economic development options, it is not always possible to choose options that are 'less economically feasible'. At present prospecting and mining licensing processes are threatening more sustainable and less water-intensive development in many parts of South Africa. According to Inkomati Usuthu Catchment Management Agency (IUCMA) (2014), an estimated 12% of Mpumalanga's arable land will be transformed due to current and prospective coal mining, and a further 14% is affected by prospecting rights. The Komati basin receives 63% of its GDP from mining, with current and future mining posing a significant threat to the water quality in the Upper Komati (IUCMA, 2014).

Mining is one of the most contentious water users. The mining sector has taken for granted that promises of economic growth and job creation will enable environmental concerns to be by-passed with as little interference as possible. More recently, the reality of the legacy issues of inappropriate sign-off of mining sites has become clear, with the enormous impact of, for example acid mine drainage (AMD). There are also increasing concerns of uncontrolled prospecting.

In order to understand coal mining practice in relation to regulatory provisions, one needs to critically explore the processes involved within the sector from cradle-to-grave, known as the coal mining lifecycle, and they need to understand the composite requirements of all of the legislative provisions that are involved within this industry. This has been researched in the Upper Komati through the use of the Cultural Historical Activity Systems (CHAT) framework, which gives a holistic understanding in the above mentioned processes, and sheds light on the issues, gaps and overlaps currently being experienced in the coal mining sector. Agents directly and indirectly involved with the mining license process have been interviewed, gaps, issues and overlaps in the system have been investigated and on the ground examples of how these factors have caused environmental degradation are currently being put together to finalise this thesis.

POLICY DEVELOPMENT AND THE PROMOTION OF RESPONSIBLE RESETTLEMENT OUTCOMES: A COMPARATIVE SOUTHERN AFRICAN – ASIAN EXPLORATION

Student: T Tsietsi

Supervisors: CJ de Wet (IWR) and R van Niekerk (ISER)

Degree: PhD (Anthropology)

Resettlement, often involuntary, arises from large-scale development projects, which are aimed at improving the lives of large numbers of people through the provision of basic needs such as water, energy, road networks, food, housing, etc. The irony of this process is, however, that those who are seen to be “in the way of development” and are therefore forced to move to make way for development, are often left in dire socio-economic conditions afterwards. These unintended consequences have led to serious interrogation of the way in which resettlement processes are planned, funded and implemented. The result has been the establishment of resettlement guidelines, and the development of resettlement policies, first by international financial institutions, such as the World Bank and the International Finance Corporation, followed by the development of resettlement policies in some countries and at sectoral level.

Over the last fifty years, various theoretical frameworks and models have been designed in an attempt to make sense

of the consequences of resettlement, as well as to feed into policy formulation and to inform its implementation. Two of the most influential approaches in this regard are:

- a) Scudder’s analysis, which sees resettlement as a process, with a resettled group of people going through various social, psychological and economic stages of disruption and challenge, readjustment and opportunity as the resettlement process unfolds. People accordingly respond in different and broadly predictable ways at different stages of the resettlement process.
- b) Cernea’s approach, which sees resettled people as exposed to a range of interrelated risks, which, unless consciously countered, serve to impoverish them in a range of mutually reinforcing ways. These risks, which are realised very widely in resettlement projects across the world, include homelessness, joblessness, landlessness, marginalisation, food insecurity, increased illness and death rates, loss of access to common property and social disarticulation.

In many communities and societies, people’s lives are organised around their physical environment, and what resettlement does, is to alter these interlinked spatial, social and economic patterns. Livelihoods are negatively affected as the resettled people lose access to natural resources that form a significant part of their livelihoods, social ties and patterns of organisation that play an important role in their lives, as well as essential services that contribute to their well-being.

Effective resettlement requires comprehensive, collaborative strategies in order to come to terms with its complexities. A lack of understanding of this fact results in simplified, partial strategies that effectively side line the primarily affected people and other key stakeholders. In this manner, the real needs of the affected people are neglected or under-accounted for.

A significant schism remains between policy formulation and policy outcomes. In many cases, resettlement policies have not brought a significant improvement in terms of the long-term consequences that people suffer, having gone through forcible resettlement. There are a number of factors through which such policy ineffectiveness can be accounted for; some authors have attributed the ineffectiveness of policies to the complexities of the process of resettlement itself, which neither policies nor implementation seem to be able to capture, as well as to the contradictions of development as a concept that raises serious ethical issues. The ineffectiveness of policies has also been attributed to a lack of political will on the part of implementing agencies to see things through properly.

Countries in Asia, such as China and India, have made significant progress in policy development. This has happened against the backdrop of their long-term experience in development, induced displacement and resettlement. In this context, this thesis explores

the impacts of policies on resettlement processes and outcomes, taking into account the Asian (Chinese/Indian) experiences. The aim is to learn, from their policy insights, the challenges of policy implementation and how the lessons from their contexts can be incorporated into the southern African context to inform resettlement policy making. In exploring the impacts of policy, the research is considering, among other factors, how the complexity of the resettlement process has been negotiated in the implementation process, and how that relates to the outcomes. It also explores how policies attempt to mitigate the impoverishment risks embedded in resettlement, and how the context within which policies are applied affect the end results.

None of the countries in the southern African region has developed resettlement-specific policies at the national level. This is despite the fact that a number of countries in southern Africa, including Lesotho, Swaziland, and South Africa, have engaged in large scale development projects that saw numbers of people forcibly moved to make way for development. And because more and more people need access to water, energy, etc. there is no indication that large scale development projects which induce resettlement will always be avoidable or decline. In fact, there are a few projects planned in the future, which will continue to see significant numbers of people being forcibly moved. An example is the second phase of the Lesotho Highlands Water Project (Polihali Dam) where planning is already underway.

While countries in the southern African region or sectors within these countries adhere, or at least should adhere, to the guidelines of international funding institutions such as the World Bank and the International Finance Corporation, it is difficult for this to happen in a sustainable or effective manner in the absence of national policies. Political will, or lack thereof, is one of the key determining factors to the success of resettlement processes. Governments, through formulation of policies, define their commitment as well as the commitment of other stakeholders in ensuring the success of resettlement processes. Furthermore, monitoring and evaluation of resettlement processes, as one of the key strategies for ensuring effective resettlement, are best carried out in collaboration with permanent structures such as government institutions. This also eases hand-over processes to permanent structures when the term of the project is near to the end.

The research hopes to inform policy making in relation to resettlement in the southern African region.

Goals of the research

This thesis, as an Asian-southern African comparative study, aims to establish the impacts of policies on resettlement processes and outcomes, bringing in long-standing Chinese/Indian policy dimensions and implementation experiences. Ultimately, the goal of the research is – through incorporating existing theoretical

frameworks, and learning from Asian insights into policy making and implementation problems – to design a framework that will contribute to the development of comprehensive national resettlement policies across the southern African countries. To make the undertaking of this research manageable for the purposes of this thesis, the focus is limited to the dams sector, within specific regions in Lesotho and India.

Methods, procedures and techniques

The research involves on site fieldwork in Lesotho over a period of three months, and another three months in India. The field research in Lesotho has already been completed, in the region of the Mohale Dam. Research is currently underway in the Jamshedpur region of Jharkhand state in India, having started in November 2015. This is being undertaken, building on the already existing working relationship between Professor Chris de Wet of IWR, and Professor Tata Raghu Ram, of the Xavier School of Management in Jamshedpur, India.

ECOLOGICAL RISK OF ACID MINE DRAINAGE (AMD) IN A SALINISING LANDSCAPE

Student: E Vellemu

Supervisors: PK Mensah and CG Palmer

Degree: PhD (Water Resource Science)

Mining is one of the important economic drivers for South Africa. Gold alone accounts for about 50% of the world's reserves while coal mining account for over 90% of South Africa's energy production – electricity. However, as the mining industry enters its twilight years, South Africa has begun dealing with the legacy of environmental mining impacts including freshwater contamination by high acidic or alkaline water from the extraction of mineral resources – mainly gold and coal.

One common water quality threat facing freshwater systems in the country is acid mine drainage (AMD). Acid mine drainage originates from mining gold and coal when pyrite rock gets fractured in the presence of water and oxygen, and produces acidic water, heavy metals, high concentrations of iron and sulphuric acid. The chemical process is driven by changes in pH mainly, and the sulphuric acid dissociates into sulphates and hydrogen ions. Further reactions occur until sulphates start to combine with other cations in water to form salts e.g. sodium sulphate and magnesium sulphate. This process increases the salt concentrations above natural limits and salts can be toxic to freshwater organisms in high concentrations. The problem with sulphates is that they do not change easily and can stay in their form over time in water. Some early studies noted that sulphates are more toxic to freshwater organisms but there is insufficient data to support this on a wider range of taxa.

However, AMD can also move downstream and affect everything in its path including plants and animals. In most

cases human well-being is also affected as contamination of water resources deprives their access to ecosystem services – e.g. supply of safe domestic water.

Therefore, the study is aimed at understanding the ecological risk of AMD in a salinising landscape. This is being achieved through a set of objectives. Since AMD is so sulphate (salinity), the study involves conducting series of ecotoxicity of sulphate single salt experiments such as sodium sulphate and magnesium sulphate. However, some mines treat AMD by the application of calcium carbonate (lime) which raises the pH to alkaline. Although the treatment process can be seen as 'effective', there is uncertainty surrounding the use of calcium carbonate in terms of ecological implications due to high calcium concentrations recorded in AMD affected water. This calls for the need to understand the impacts of calcium sulphate in terms of freshwater macroinvertebrate tolerances. The study exposes a range of taxa including fish (*Oreochromis mozambicus*), *Caridina nilotica*, *Leptophlebiidae* mayflies, limpets and freshwater microalgae to sulphate salts. The study will use these findings to determine the ecological risk of AMD in a salinising landscape. The results will also be useful in understanding how to manage water quality in the study area, Carolina, Mpumalanga Province.



Figure 1: Collecting acid mine water (AMD) in Carolina, Mpumalanga



Figure 2: Counting freshwater shrimp mortalities in an experimental beaker at the Institute for Water Research, Rhodes University

EXPLORING THE EMERGENCE, PRACTICE AND LEARNING OF A CITIZEN BASED RESEARCH PARTNERSHIP IN RELATION TO WATER SERVICE ISSUES IN THE MAKANA MUNICIPALITY, EASTERN CAPE, SOUTH AFRICA

Student: MJT Weaver

Supervisor: CG Palmer and J O'Keeffe

Degree: MSc (Water Resource Science)

The research is located within the complex social-ecological urban water catchment system located in the Makana Local Municipality (MLM) in the heart of the Eastern Cape province of South Africa. This social-ecological system contains the Bloukrantz River, locally known as the Matyana River, which has its source in the hills of Grahamstown and flows into the Kowie River before entering the Indian Ocean at Port Alfred.

Since the inception of the town in 1812 Grahamstown has experienced a variety of challenges in providing and managing an adequate supply of clean water to its ever increasing population. This history of development of Grahamstown's water supply provides important context to the current water challenges that the MLM faces today. The citizens of Grahamstown East, the former location of Grahamstown, are those that have and still today, suffer the most from water injustice and service inequity and it is here that the focus of the study lies.

This context of water inequity and crisis faced by the people of Grahamstown East and the building frustration as a result, has led to social response and action within the community. The Unilever Centre for Environmental Water Quality (UCEWQ) of the Institute for Water Research (IWR) at Rhodes University in collaboration with the nongovernmental organisation Khulumani Support Group (KSG) proposed a community based project to engage with water challenges facing people in Grahamstown East. Certain motivated community members then volunteered to work on that specific four year project and establish the civil society entity known as Khulumani Water for Dignity (KWfD). KWfD, as a citizen based research group, have adopted the attitude of "... changing from just complaining to becoming part of the solution" and the vision of "Building of a People's Science to underpin a People's Water Movement". KWfD are supported cooperatively by the KSG and the IWR through the Makana Case Study which has a focus on local water governance and citizen based research and forms part of the larger WRC project "Integrated Water Resource Management: Towards practising a new paradigm". KWfD is conducting several initiatives in Grahamstown East that range from: data collection exploring household water service experience of residents in Grahamstown East - Citizen Report Cards (CRC); Community Water Forums (CWF) to serve as communication hubs of water related issues between

citizens and the MLM and vice versa; an emergency water supply initiative that explored appropriate storage options ranging from large tanks, the One Street One Tank (OSOT) project, to personal 210 L water barrels; School Water Forums (CWF) to address sanitation, hygiene and catchment stewardship.

The main aim of the study is to explore the emergence and practice of a group of citizen based research partners, KWfD, in response to household water service delivery issues in Grahamstown East. It further looks at the enabling and constraining factors to this practice as well as explores the process of learning of the KWfD group.

Systems thinking is the overarching theory that frames this study which is under-laboured by Wenger's theory of communities of practice (CoP) (1998). By adopting a participatory action research methodology and employing qualitative research methods the study has tracked these four initiatives over a 16 month period. Communities of practice theory has provided a useful critical lens with which to analyse the emergence, practice and learning of the KWfD group. A community of practice is basically a group of people with a shared interest, who engage in mutual social interactions and together develop a shared practice. The study has shown KWfD to be core members of a KWfD CoP which contains many other members that vary in their degree of participation in the practice. The practice of the CoP has had varied levels of success. The CRC initiative and more recently the SWF initiative have been most successful, with the Emergency Water and CWF initiatives being the least successful. Initiatives were more successful when the core KWfD group regularly diversified their engagement with skilled periphery members of the CoP (IWR, KSG and other supporting partners). The core group having ownership of the agenda of CoP practice and a passion of the domain proved important for the sustainability of the CoP. Additionally, Appreciative Inquiry workshops were seen to play a particularly important role in relationship and trust building, renegotiation of the joint enterprise and renewing interest in the practice of the CoP. Initial results relating to the process of learning of the CoP indicate that the richest learning occurs at the team level, where the number of face to face interactions with other CoP members is highest. Learning included; context specific water service delivery knowledge, water rights understanding, water quality and conservation related knowledge and personal communication skills. Findings suggest that social learning relating to personal water rights, and best practices relating to improving water quality and conservation was fostered through structured citizen engagement, offered by the KWfD initiatives. These insights into effective pathways for learning between key individuals and the wider community play an important role in bridging the knowledge gap evident in many South African communities with regards to water issues.



Figure 1: Ms Notiswa Libala (IWR) assists as a translator as residents of Grahamstown East participate in a focus group to explore the social learning impact of the KWfD.



Figure 2: KWfD partner with the Department of Water and Sanitation, the MLM and IWR members to host a School Water Forum day which included a tour of the Waainek Water Treatment Works.



Figure 3: Ms Xolelwa Nzwane of the KWfD engages with Mr Matthew Weaver to develop her data analysis skills.



Figure 4: The core KWfD group plans for the week ahead with the skilled support of the IWR's Makana Case Study team.

DEVELOPING THE INSTITUTIONAL CAPABILITY OF RURAL COMMUNITIES IN THE NTABELANGA CATCHMENT, EASTERN CAPE

Student: MG Wolff

Supervisor: CG Palmer and H Lotz-Sisitka

Degree: MEd

The Mzimvubu Water Project forms part of the National Governments Strategic Integrated Projects (SIP3 – South-Eastern node and corridor development, PICC, 2012). The Mzimvubu River is one of the largest, unimpounded rivers in South Africa, in one of the poorest and underdeveloped regions. The Mzimvubu Water Project involves the construction of two multi-purpose dams in the Mzimvubu Catchment – the Ntabelanga and Laleni Dams. The dams will be constructed on the Tsitsa River, one of four primary tributaries to the Mzimvubu River (van Tol et al., 2014). The dams are expected to supply new water capacity, for domestic and industrial use, hydroelectric power generation and irrigation development (DWS, 2013). The project will spread over two district municipalities – Joe Gqabi and OR Tambo, both in the Eastern Cape.

The Department of Environmental Affairs: Natural Resources Management (DEA: NRM) programmes contribute to poverty alleviation through job creation and encourage rural development (SANBI, 2014). In order to mitigate the potential sedimentation of the dam, the DEA, through its NRM “Working for” suite of programmes, is investing in restoration projects in the Upper Ntabelanga Catchment (UNC) area. These interventions provide local residents with participatory opportunities through i) the programmes themselves (local participation and short term job creation), ii) involvement in the rehabilitation of the area to restore and maintain the landscape and iii) the opportunities to become involved in the formation of a Catchment Management Forum (CMF). Such participation can support sustainable resident engagement in the land and water management of the catchment upstream of the Ntabelanga Dam. This project aims to use the NRM intervention to support residents in the formation of a CMF.

Interventions currently taking place create an opportunity to engage pro-actively with the residents and through this, to support their opportunities via learning-centred engagements. The potential exists to increase their capabilities for representing their own interest in an emerging institution to govern the landscape.

The study is framed by the concepts of transdisciplinarity (*sensu* Max-Neef, 2005) and complex social-ecological systems (*sensu* Rogers et al., 2013) (Figure 1, level A). The dual framing places the research at the interface between people and the natural environment – between the social and the biophysical. The research will begin with a contextual description of the social-ecological system (SES) relevant to the broader integrated water management context in the Ntabelanga Catchment, Eastern Cape, in

which the two communities of practice (CoPs) which will form case studies in this research will be identified. The research will describe learning and capabilities in the two CoPs, and explore further development of learning and capabilities in both of these CoPs in the activities and interventions underway in the area via a series of action research workshops with the goal to inform on-going participation in an emerging Catchment Management Forum (CMF). During the course of the research process, interviews and a series of action research workshops will be conducted with participants. Analysis will take place in four phases 1) broader contextual analysis; 2) existing capability and learning analysis of the two CoPs; 3) analysis of extending capabilities and learning via action research workshops; and 4) analysis of implications and potentials for informing CMFs.

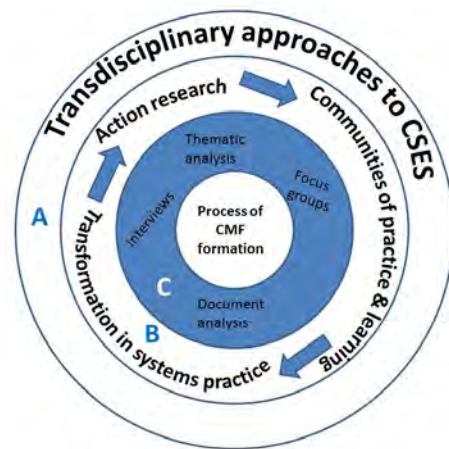


Figure 1: A conceptual and methodological framing.

Level A (Conceptual framing) places the research within transdisciplinary approaches to complex social-ecological systems. At Level B (Theory-led methodology) Wenger’s (1998, 2006) Communities of Practice theory provides analytical tools for capturing learning in transformation processes to be tracked retrospectively, (Ison, 2010) but which can also be facilitated via action research activities. Level B processes are used to guide the methods. Level C where the CoP learning categories inform the structure and content of interviews and focus groups and action research workshop activity. The outcomes of which describe and explore two interacting CoPs connected in the boundary practice of NRM restoration. Level C includes the use of action research workshops (designed using CoP learning categories) to catalyse participation in an emerging CMF.

During the first week of October 2015 Prof Tally Palmer, Ms Asiphe Sahula, Ms Notiswa Libala, Ms Kululwa Mkosana (Department of Water and Sanitation), Ms Renee Dowse (visiting Post-Doctoral Researcher from Australia) and I travelled to Maclear and spent two days in the field. We visited restoration sites in the upper Ntabelanga Dam catchment. The restoration work is being implemented by the Gamtoos Irrigation Board on behalf of the Department of Environmental Affairs: Natural Resources Management.



Field trip team listening to explanation of silt traps erected in small gullies



Signs of grass re-growth after a rain shower in the silt trap

RESEARCH OUTPUT

PEER REVIEW JOURNALS

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- Pienaar GW and Hughes DA (2015) Linking uncertainty and decision making outputs for equitable water resources allocation. Paper submitted to *Environmental Modelling & Software*.
- Rivers-Moore NR, Mantel S, Ramulifo P and Dallas H (submitted) Connectivity as a cost layer for improving choices in freshwater conservation planning. *Aquatic Conservation* (submitted).
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- De Wet CJ (2015) Water and emplacement: Applying insights from resettlement to IWRM. (Project K8/1065). Water Research Commission.
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- Copteros A (2015) An Exploration of ways in which Dance Movement Therapy can be used within a transdisciplinary water management research context. PECS Social-Ecological dynamics in the Anthropocene Conference, Stellenbosch, South Africa 3 – 5 November 2015.
- De Wet CJ (2015) Rapporteur/Discussant for Session on Ethics and accountability for compulsory displacement; Program of special series of sessions on the World Bank's revision of its Social and Environmental Safeguard Policies; *75th Annual meeting of the Society for Applied Anthropology*, Pittsburg, USA, March 24 to 28 2015.
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- Mantel SK and Palmer AR (2015) Impacts of high density of small farm dams on evapotranspiration and catchment water balance. Poster presented at the 50th Annual Congress of the *Grassland Society of Southern Africa (GSSA)* in Pietermaritzburg, 20–23 July 2015.
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- Vellelu EC (2015) Fighting Elephants, Suffering Grass: Towards a clumsy solution to solving acid mine drainage in South Africa. Poster presented at the *4th YWP ZA Biennial and 1st African Young Water Professionals (YWP) Conference* in Pretoria, South Africa, 16–18 November 2015.
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Back Cover (from top to bottom): Zambezi River Fieldwork, Zambia; Ms Khaya Mgaba sampling in riverine forest at Richards Bay Minerals site 11; Prof Tally Palmer, Dr Tony Palmer and Ms Notiswa Libala collecting simple water quality readings in a channelled valley bottom wetland in the X11B sub catchment, Carolina, Mpumalanga; Volunteers of Andrew Moyake Public Primary School, after a busy day of cleaning ablution area.

