INSTITUTE FOR WATER RESEARCH

IWR

2014

ANNUAL REPORT

RHODES UNIVERSITY

Where leaders learn

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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 Mzwanele Makatli	Rhodes University Intern
Dr Sukhmani Mantel	Research Officer IWR
Ms Juanita McLean	Administration Manager
Dr Mutsa Masiyandima	Senior Research Officer IWR
Ms Ntombekhaya Mgaba	UCEWQ Intern
Dr Paul Mensah	Research Officer IWR
Dr Nelson Odume	Postdoctoral Fellow
Prof Tally Palmer	Professor | Director of UCEWQ
Dr Andrew Slaughter	Research Officer IWR
Dr Jane Tanner	Postdoctoral Fellow
Mrs Margaret Wolff	Part-time Project Manager UCEWQ-IWR

ASSOCIATES

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

REGISTERED POSTGRADUATE STUDENTS

Ms Louise Bryson	MSc (Water Resource Science)
Ms Jane Burt	PhD (Environmental Education)
Ms Karabo Chadzingwa	MSc (Environmental Science)
Mr Jai Clifford-Holmes	PhD (Water Resource Science)
Ms Athina Copteros	PhD (Geography)
Ms Yvonne Chiliboyi	MSc (Water Resource Science)
Ms Helen Fox	PhD (Water Resource Science)
Ms Pearl Gola	PhD (Water Resource Science)
Mr Onalenna Gwate	PhD (Water Resource Science)
Ms Alex Holland	PhD (Water Resource Science)
Mr Haden Jacobs	MSc (Hydrology)
Mr Zwidofhelangani Lidzhegu	PhD (Water Resource Science)
Ms Eunice Makungu	PhD (Hydrology)
Ms Ntombekhaya Mgaba	BSc Hons (Environmental Water Management Geography)
Mr Thabiso Mohobane	PhD (Hydrology)
Ms Lara Molony	M.Soc Sc. (Environmental Science)
Mr Coli Ndzabandzaba	PhD (Hydrology)
Mr Greg Pienaar	MSc (Water Resource Science)
Mr Ian Preston	MComm (Management)
Mr Hugo Retief	MSc (Water Resource Science)
Mr Dionis Rugai	PhD (Hydrology)
Ms Asiphe Sahula	MSc (Water Resource Science)
Ms Emma Stambuli	PhD (Anthropology)
Mr Gareth Thomson	MSc (Water Resource Science)
Ms Teboho Tsiesti	PhD (Anthropology)
Ms Madeka Tumbo	PhD (Hydrology); based at University of Dar es Salaam, Tanzania
Mr Emmanuel Vellemu	PhD (Water Resource Science)
Mr Agostinho Vilanculos	PhD (Hydrology); based at Eduardo Mondlane University, Mozambique
Mr Matthew Weaver	MSc (Water Resource Science)

2014 GRADUATED STUDENTS

Mr Garth Barnes	MEd (Environmental Education)
Mr Matthew Muller	MSc (Water Resource Science)
Mr Nelson Odume	PhD (Water Resource Science)
Ms Boluwaji Onabolu	PhD (Water Resource Science)
Ms Jane Tanner	PhD (Hydrology)

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INSTITUTE FOR WATER RESEARCH

DIRECTOR'S REPORT

Introduction

As usual, 2014 has seen some positive developments within the Institute and a number of success stories, but we have also not been without disappointments.

One of the main highlights of the year was the award of a prestigious international accolade to Dr Nelson Odume of UCEWQ at the 17th International River Symposium held in Canberra, Australia during September. Dr Odume received the Emerging River Professional Award (ERPA), an initiative of the International River Foundation. The award was established to recognise and foster those in the early stages of their careers in river and water resource management. The award identifies and rewards individuals who have been working in their field for ten years or less, and have demonstrated exceptional leadership, innovation and excellence in river, basin and water resource or river-dependent-community management. After entrants from around the world were screened by a panel of judges of international repute, Dr Odume was one of three finalists who competed for the grand prize at a special session. In his presentation entitled "Water Quality Management in South African Rivers – an Integrated Approach", he showcased a new research practice in which integration, collaboration and reflection are at the core of water resource management while emphasising stakeholder engagement and combining both ecological and social science approaches and methods in working towards the achievement of integrated water resources management in the context of social-ecological systems.

Dr Nelson Odume (left) receiving the Emerging River Professional Award at the prize gala dinner in Canberra, Australia from Mr Michael Holmes of the OceanaGold Corporation who sponsored the prize.

As regular readers of this report will be aware, the IWR have been attempting to launch a modular course-work MSc in Hydrology and Water Resources science for about the last three years. During 2012, Rhodes University allocated a Senior Lecturer post to the IWR to support setting up the course. Last year's report referred to the difficulties experienced in attracting and appointing a suitable candidate for this post. During 2013, we attracted interest from a suitable candidate (a PhD graduate from the IWR), but the salary and contract package being offered was not sufficient to attract the person to Rhodes. The post was re-advertised and we were fortunate enough to be able to appoint Dr Mutsa Masiyandima, who started with the IWR in July 2014. We were therefore confident that our problems were over and that planning for the launch of the MSc in 2015 could begin in earnest. Unfortunately, while the planning did start, Dr Masiyandima has experienced some almost insurmountable personal family problems that have prevented her from making the contributions that are necessary to initiate the MSc course. At the time of writing this report, Dr Masiyandima's status within the Institute was unclear, but it is almost certain that the launch of the MSc course will have to be further delayed.

More positive developments within the IWR included the start of the third (and final) phase of the SSAWRN project of the Carnegie RISE programme for 2014 to 2016. Four PhD students were recruited and started their studies in early 2014, while a fifth PhD student joined the Institute from Tanzania, mainly supported by USAID, but with some additional support from the RISE funding.

Earlier this year, Dr Sukhmani Mantel and Dr Tony Palmer (ARC) submitted an expression of interest to the NRF for an equipment grant under the National Equipment Programme (NEP) to acquire two eddy-covariance systems, a scintillometer and two 12 m towers to measure above tree canopy areaThe NRF has approved an amount of R1,249,000, which will be supplemented by a 2:1 grant from Rhodes University, for a final amount approximating R1,800,000. This equipment will be utilised for the WRC K5/2400 project (April 2014 to March 2019) entitled "Rehabilitation of grasslands after eradication of alien invasive trees". Eddy-covariance systems are useful for measuring carbon and water fluxes for developing and verifying models of net ecosystem carbon exchange and landscape scale water use. The equipment will also be of use in further future projects and for training postgraduate students.

The IWR continues to contribute to the excellent record of Rhodes University in terms of the award of post-graduate

degrees. At the 2014 graduation ceremony, we had one MSc and three PhDs, and we can confidently expect at least the same number in 2015.

As noted in last year's report, Professor Chris de Wet joined the IWR from the Department of Anthropology, where he worked for 37 years. Prof de Wet's academic interests in the philosophy of social science and development, with particular expertise in development-induced displacement and resettlement, have added a great deal to the Institute's research profile. In addition to his interdisciplinary experience, Prof de Wet has brought a wealth of experience in development research that is of benefit to other staff and students of the IWR. Prof Hughes joined Prof de Wet as one of the longer standing members of the Rhodes academic community when he received a 35-year long service award in June of 2014.

Dr Jill Slinger from the University of Technology in Delft (Netherlands) was officially appointed as a Rhodes University Visiting Professor in the IWR for the period October 2014 to December 2017. Prof Slinger's research interests are in the field of system dynamics, and she has been co-supervising Mr Jai Clifford-Holmes' PhD. Dr Neil Griffin has worked in the IWR for many years as a post-doctoral fellow, but has been retained on multiple concurrent short-term research staff contracts. During 2014, he was appointed to a 3-year contract position that will somewhat improve the stability of his position within the IWR. Ms Daksha Naran resigned her Rhodes University funded post as Senior Technical Officer during early 2014, and the decision was made not to re-advertise this position at this stage. The IWR are currently in negotiations with Rhodes to transfer one of the IWR funded support staff posts to the Rhodes funded position.

During the second half of 2014, Rhodes University agreed to offer additional salary support for Prof Tally Palmer. This is an encouraging development which recognises the tremendous achievements made by Prof Palmer in terms of research outputs and supervision of post-graduate students (not only within the IWR, but also in other departments).

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 will complete his term of office as a Vice President of the International Association of Hydrological Sciences (IAHS) in 2015. 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 was appointed an Associate Editor of the African Journal of Aquatic Sciences. Prof Palmer has served on the Department of Water and Sanitation Water Sector Board Member Selection Committees for Rand Water, the Inkomati-Usuthu Catchment Management Agency and the Olifants Catchment Management Agency. She also serves on the Editorial Panel of the Institute of Civil Engineers Journal, '*Water Management*', and was the Guest Editor of a Special Feature of the journal Ecological Systems. Ecology and Society (Volume 18/4) on Ecology and Society: Applied research for enhancing human well-being and environmental stewardship: using complexity thinking in Southern Africa.

International links and conferences

IWR staff and students have been well represented at a number of international and regional meetings during 2014 (the full details of the papers or posters presented are contained within the Research Outputs list at the end of the 2014 annual report):

- Prof Hughes attended the Dooge Nash International Symposium on 'The Grand Challenges Facing Hydrology in the 21st Century' (Dublin, Ireland during April 2014) and presented a paper on the constraints on contributions to hydrological research from Africa. He also attended the IAHS Bureau Meetings at the same time.
- Prof Palmer presented a keynote paper on 'Integrated Water Resource Management: Implementing the National Water Act' at the WISA Biennial National Water Conference in Mbombela during May 2014.
- Dr Slaughter attended the 7th International Environmental Modelling and Software Society (iEMSs) biennial meeting in San Diego, USA during June 2014 and presented a paper on climate change and water quality modelling (http://www.iemss.org/sites/iemss2014/papers/iemss2014_submission_318.pdf).
- Several members of the IWR (staff and students) attended the South African Society of Aquatic Sciences (SASAQS) 2014 conference at the Black Mountain Leisure and Conference Hotel in the Free State Province during June. Several papers were presented (see the list provided in the Research Outputs section of the annual report). Dr Carin van Ginkel also presented her work on eutrophication as a member of the 'Towards a New Paradigm' research team.
- Mr Jai Clifford-Holmes was also one of seven South African attendees at the 32nd International System Dynamics Conference (ISDC) in Delft, the Netherlands, July 2014, where he presented a paper on 'Using System Dynamics to Explore the Water Supply and Demand Dilemmas of a Small South African Municipality' (http://www.systemdynamics.org/conferences/2014/proceed/index.html).
- Prof Hughes attended an Elsevier Journal of Hydrology editorial board meeting in Amsterdam during July and also took the opportunity to visit Bristol University, re-establishing some links with Prof Thorsten Wagener of the Civil Engineering Department as well as meeting with members of the Geography Department who are engaged in research on floodplain inundation modelling, an overlap with some of our PhD student topics.

- Prof Hughes, Dr Jane Tanner, Dr Andrew Slaughter and Mr Greg Pienaar attended the 17th SANCIAHS National Hydrology Symposium held at the University of the Western Cape during September, 2014.
- Dr Nelson Odume attended the 17th International River Symposium held in Canberra, Australia during September and presented INR co-authored papers on integrated, participatory and stakeholder engagement processes for managing water quality, as well as macroinvertebrate-based biomonitoring in an effluent impacted river in the Eastern Cape.
- Prof Palmer also attended the SETAC Asia-Pacific conference in Adelaide during her visit to Australia in September, presenting a paper on transdisciplinary research on integrated water quality (with several IWR co-authors).
- Dr Jane Tanner attended the 41st International Association of Hydrogeologists International Congress in Marrakech, Morocco during September 2014, presenting a paper on 'Identifying and reducing uncertainty in surface and groundwater interaction modelling in data scarce countries'. During this meeting, she also participated in an 'Early career hydrogeologist meeting'.
- Prof Hughes, Ms Madaka Tumbo, Mr Dionis Ruigai and Ms Eunice Mukungu attended the CLIVET conference in Dar es Salaam, Tanzania during October 2014. The focus of this conference was on environmental change and translating science into practice on the African continent.
- Prof Hughes attended a short meeting in Nairobi, Kenya during October on Regional Post-Graduate Training Networks in Africa. This was attended by participants from several countries with different disciplines. The objective was to develop an African Higher Education Charter which will be presented for adoption at the Continental Summit on Revitalizing Higher Education for Africa's Future scheduled for March 2015 in Dakar, Senegal.
- Dr Mantel and four of the RISE post-graduate students (Mr Coli Nndzabandzaba, Mr Emmanuel Vellemu, Mr Dionis Ruigai and Mr Zwido Lidzhegu) attended the 15th WaterNet/WARFSA/GWP-SA annual hydrology and water resources symposium (IWRM for harnessing socio-economic development in eastern and southern Africa) in Lilongwe, Malawi during October 2014 and presented either papers or posters.
- Prof Palmer attended a conference on Water, Gender and Development in East London during November and presented a paper on 'Gendered perspectives on water resource management, service delivery, governance and indigenous knowledge'.
- Prof Palmer presented a paper on 'Transformative water research practice - a response to the multiple stressors of global change' at the National Research Foundation Global Change conference in Port Elizabeth during December 2014.

Dr Jane Tanner (standing on the right) facilitating a discussion at the Early Career Hydrogeologist meeting in Marrakech, Morocco.

This rather long list attests to the high exposure that the staff and students of the IWR have had at both local and international conferences during 2014. The Institute is very grateful for the travel support that these individuals received from Rhodes University.

Consultancy links

Consultancy projects now form a much smaller component of the IWR activities than in past years. This is a reflection of the expanded post-graduate training activity of the Institute, and the fact that with a limited number of experienced staff members, we cannot do everything. Prof Hughes, however, continues to generate some 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. It is also important that we do not lose the links with practical problem solving which has been one of the IWR's strengths, and has provided an immediate market for some of its applied research products.

The World Bank project on setting up the WEAP model for the Upper-Orange, Zambezi and Congo Rivers was completed during 2015, although we have yet to see the final version of the report from the main consultants (Stockholm Environment Institute, USA) to the World Bank clients. Mr Thabiso Mohabane is using some of this material for his PhD on the hydrology and water resources of the Caledon River (part of the Orange River system), while it also provided an excellent opportunity for Dr Raphael Tshimanga (former RISE PhD student now working at the University of Kinshasa, DRC) to develop further research skills, develop a research and consultancy profile within the sub-Saharan Africa region and maintain some links with the IWR.

Undergraduate teaching

The Institute contributed a 2nd and 3rd year module on water resources management to the Department of Environmental Science ENV302 course, with Prof Hughes, Dr Mantel, Dr Griffin and Dr Slaughter covering water quantity, quality and legal issue. We understand that this will be the last year that we will be requested to offer the ENV302 course.

As in the past, the IWR offered a ENV202 and semester course on Environmental Water Quality for Geography and Environmental Science Honours students. Contributions were made by Prof Palmer, Dr Griffin and Dr Mensah and Dr Odume with some valuable inputs from post-graduate students.

Post-graduate students

At the 2014 Rhodes graduation ceremony, Mr Matthew Muller obtained his MSc in Water Resources Science, while Dr Jane Tanner, Dr Boluwaji Onabolu and Dr Nelson Odume (all RISE students) received their PhD degrees in either Hydrology or Water Resources Science. We currently have four PhD students who have submitted and are at different stages in the examination process, while a further three PhD and three MSc students are expected to submit before the end of the year.

UCEWQ staff presented the annual Environmental Water Quality semester Honours course for students from the Department of Geography and Environmental Science.

Mr Jai Clifford-Holmes and Prof Jill Slinger were founding members of the South African chapter of the International System Dynamics Society, formed in February 2014, and Mr Clifford-Holmes represents the IWR on the policy council. The Emerging River Professional Award received by Dr Nelson Odume has already been mentioned in the opening paragraphs of this report and the whole of the IWR are very proud of our young scientist who was one of the first RISE students and obtained both his MSc and PhD in Water Resources Science.

Post-Doctoral posts

Dr Jane Tanner has been supported for 2014 by a Rhodes University Post-Doctoral Fellowship and is continuing her research on surface and groundwater hydrology. Dr Nelson Odume (featured prominently in other parts of this report) is supported by a NRF Post-Doctoral Fellowship with additional funding through contributions to a Water Research Commission project led by Prof de Wet.

RISE Sub-Saharan Africa Water Resources Network

The first year of the third and last phase of the RISE funding programme has come to an end and we have two years of guaranteed funding left. This has been a very important initiative for the IWR and our regional partners in SSAWRN, and we would like to see a similar programme sustained after 2016. We are aware that the Carnegie Foundation has been in discussions with various groups (including the African Development Bank), but we are not conversant with the details of these discussions. One of the ideas that have been mooted is to create a continental or regional fund to continue to support post-graduate education regional networks and that could receive contributions from private and government agencies. Prof Hughes attended a meeting in Nairobi during October where some of these issues were discussed by network leaders from various countries and disciplines. The objective was to develop an African Higher Education Charter which will be presented for adoption at the Continental Summit on Revitalizing Higher Education for Africa's Future scheduled for March 2015 in Dakar, Senegal, which will be attended by politicians from all over the continent, as well as high level lobbyists from the education sector. This therefore represents one possible opportunity that might help to



Dr Jane Tanner, Dr Boluwaji Onabolu and Dr Nelson Odume (all RISE students) received their PhD degrees in either Hydrology or Water Resources Science.

sustain the existing initiatives. One thing is certainly true, and that is that it will be very unfortunate if the IWR were not able to continue to attract and offer bursaries to students from all over the continent to come to Rhodes University. The existence of a multi-cultural group of African students within the Institute over the last few years has contributed benefits to the Institute that go way beyond the immediate and measurable ones of graduated MSc and PhDs and published papers.

Community Outreach and Public Understanding of Science

The IWR organised a MiniSASS and Drive-a-River day trip for seven schools involved in the Water for Dignity programme. The organisation was led by Dr Sukhmani Mantel and Mr Matthew Weaver, assisted by Khulumani Water for Dignity, WESSA, Kowie Catchment Campaign (KCC), Young Water Professionals and Albany Museum. WESSA and IWR funded the trip, and the KCC is funding a poster competition for a prize of a filter bucket for the winning school. Mr Weaver has included a report on this activity elsewhere in the annual report. Members of IWR collaborated with the Rotary Club of Grahamstown in taking young boys from the Eluxolweni Street Shelter on the John Porter outing which involved mini-SASS and invertebrate identification in the laboratory. More details about the IWR involvement in citizen research partnership activities are provided in the UCEWQ report by Prof Palmer.

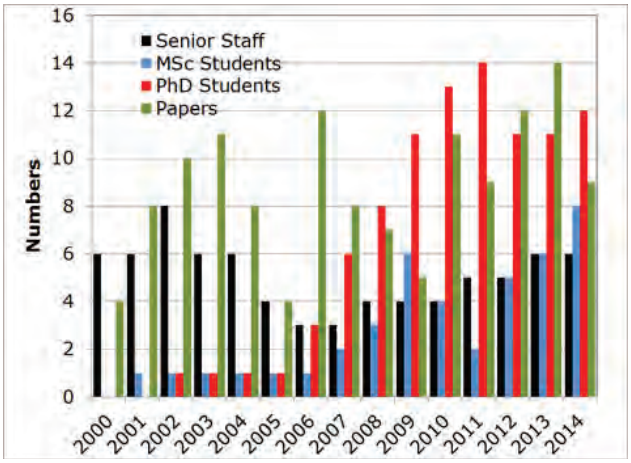
Eluxolweni learners identifying invertebrates in the lab with Prof Tally Palmer.

Concluding remarks

Change is part of the Institute and is generally a good thing. The figure below shows some of the changes that have occurred over the last 15 years. The fluctuations in research staff members (from a high of 8 to a low of 3) is indicative of the difficulties of attracting and retaining staff on short-term contracts, an issue that will always plague the IWR as long as it remains in its current format. However, this problem is likely to get worse rather than better, particularly when senior and older staff members retire, especially if there are no existing staff members with relatively high levels of experience to immediately replace the contributions of those retiring, especially in terms of PhD student supervision.

The graph clearly shows the growth in post-graduate student numbers, largely impacted by the start of the Carnegie RISE programme in 2008. Up to 2005, we had very few students registered in the IWR (although there were other students registered in other Rhodes departments and supervised or co-supervised by IWR staff). Some growth began after Prof Hughes was appointed to the Rhodes funded professorship, which allowed him to divert consultancy income to post-graduate bursaries, but it was the RISE programme as well as a number of UCEWQ initiatives (led by Prof Palmer) that generated and sustained the growth after 2008. It remains to be seen whether these numbers can be sustained into the future.

The numbers of peer-reviewed publications is not a real reflection of the total research output of the IWR, but are clearly important in terms of the contribution of the IWR to the total subsidy income to the University as a whole. Our per-capita output is amongst the highest in the University and Prof Hughes was listed amongst the top 30 researchers at Rhodes for 2010 to 2012. He could not have achieved that without the contributions of other staff and students. The 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 timely completion of research reports is critically important for sustaining the income necessary to support contract staff salaries.



Changes in the IWR over the last 15 years (Senior staff refers to Research Officers and above, the student numbers are only based on registrations for Hydrology or Water Resources Science within the IWR and 'Papers' refers only to peer-reviewed publications).

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 and post doctoral fellow Dr Nelson Odume) have been increasingly contributing to student supervision, and it should be emphasised that these contributions do not cost the University anything at all. With all of the developments taking place and given the changes in the position of the IWR within the University over the last few years (many more post-grads), some strategic planning for the future is long overdue. This is particularly true, given that Prof Hughes will officially retire at the end of 2016 and the time that is left is already too short for any effective succession planning to continue with research and training in the field of hydrology. This issue was raised with the University about three years ago, but unfortunately, Rhodes did not recognise the urgency then, and it appears from recent experiences that they still do not. 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. We also have to make some serious decisions about *inter alia* space issues for post-graduate students and the sustainability of contract staff salaries.

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 Unilever South Africa 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 (ORC, 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 Vice-Chancellor, 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 2014 included a number of staff members, post-doc 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. I believe that we have had several very successful years and that although the future is less than certain in some areas, I am convinced that we will achieve security as long as we continue to manage the operation of the IWR in a sustainable manner and as long as we get adequate support from the University.

UNILEVER CENTRE FOR ENVIRONMENTAL WATER QUALITY (UCEWQ)

UCEWQ DIRECTOR'S REPORT

Introduction

The Centre has been characteristically busy. Our programmatic research effort is now in its second year of consolidation, and all projects support the flagship project: *Integrated Water Resource Management (IWRM) in South Africa: towards a new paradigm"*. The project, dubbed the TNP, aims to develop and embed in practice transdisciplinary research outcomes and products that contribute to social-ecological justice and well-being. There are three TNP case studies: 1) the Makana case study, led by Nick Hamer funded through the TNP; 2) the Crocodile river development of a co-operative water quality management process (IWQMP); and 3) RESILIM – a partner project with AWARD where UCEWQ researchers are responsible for water quality input. A WRC project exploring the policy, law and practice connections between mining and biodiversity, led by Dr Victor Munnik, and Prof Chris de Wet and Dr Nelson Odume's aquatic ecosystems and ethics, also contribute. The whole TNP was showcased at a WRC-hosted Water Dialogue, in November.

"The WRC Dialogues are discussion-based events on topical water issues affecting the South African public, the aim of which is to serve as a platform to exchange ideas and opinions related to water. In this regard, the WRC Dialogues are guided by the principles of transparency, openness and honesty; plurality of perspectives and inclusivity, mutual respect; a commitment to problem-solving and mutual accountability; and in the broader interest of knowledge sharing. The value of the WRC's role as convenor of these events lies in its ability to be a neutral knowledge broker as South Africa's premier water knowledge resource. "
http://www.wrc.org.za/News/Pages/TheWRCWaterDialogues.aspx

The Dialogue, *Practising IWRM: Towards a New Paradigm,* was opened by the WRC CEO Mr Dhesigen Naidoo, who drew attention to the power and vested interest in those who currently still benefit from privileged access to water, and suggested that a return to street committees may be one way to deepen water democracy. This was an excellent introduction to a session where doctoral student Mr Jai Clifford Holmes and Sundays River Technical Director, Mr Phumlani Mbulawa jointly presented an impressive depth of systemic understanding of water security in the municipality. They were preceded by, a community leader and citrus General Manager - Luthando [citrus] Farm, Ms Nokwanele Mzamo . This inclusive demonstration of what is meant by engaged action research was followed by UCEWQ researcher Mr Nick Hamer, Water for Dignity team leader, Mr Mbulelo Lipile and Unilever Vice President Home Care, Mr Justin Apsey each presenting an aspect of the UCEWQ-Khulumani Support Group *Water for Dignity* initiative. This broad array of speakers including researchers, students, citizen-based, municipal and corporate research partners in a real *dialogue* was a clear demonstration of UCEWQ research practice.

We encouraged Dialogue delegates to seek out the Crocodile River Integrated Water Quality Management Process (IWQMP) team and the Inkomati –Usuthu Catchment Management Agency (I-UCMA) at lunch time for interesting conversations about the active involvement of industry partners, with a water management agency and a catalysing research team.

After lunch it was the turn of UCEWQ research-partner teams, and other research groups undertaking research from a similar perspective, so as to demonstrate the scope of engaged research in South Africa. Professor Kevin Rogers and Dr Thomas Gyedu-Ababio (I-UCMA Acting CEO) spoke about the development of the I-UCMA Catchment Management strategy, using Strategic Adaptive Management. They were followed by Dr Sharon Pollard from the Association for Water and Rural Development (AWARD), who, together with Mr Derick du Toit worked on the drafting of catchment management strategy guidelines for South Africa and have a large USAID funded project, RESILIM, on the resilience of the Limpopo basin to climate change and other stressors. Their work includes the Olifants River basin in South African and Mozambique, bringing a welcome trans-boundary focus to IWRM. RESILIM in founded on a systemic approach to social –ecological systems, acknowledging the importance of social learning.

Finally two research teams presented work that we recognise as being similar in nature to the UCEWQ approach. The Kwa-Zulu-Natal based collaborative group presented citizen-science aspects of their work (Dr Mark Graham and Mini-SASS as practiced by the Dusi-uMngeni Conservation Traust (DUCT). Several of their research partners were present, including Ms Sabine Stuart-Hill and Professor Graham Jewitt. Dr Jim Taylor was presenting their work internationally at the time. The mini-SASS DUCT Dusi walk, and the maps showing the length of South African rivers in relation to proximity to schools gave a fascinating challenge of citizen monitoring of a river – and the stimulation it provides for ecological stewardship. Prof Mark New leads the transdisciplinary UCT African Climate and Development Initiative (ACDI). Their interesting engagement with the Bergrivier Municipality was presented by Ms Tracey Stone, the municipal Strategic Manager. They have a very similar set

of academic goals for their TD work, and we look forward to reporting fruitfully on comparative material. We can learn from their insight into the importance of effective facilitation in stakeholder engagements.

The Dialogue presentations were called "narratives of hope" – not because we have provided immediate solutions – but because the process of engaged research – using systemic and complexity-based understanding, transdisciplinary approaches and a commitment to the co-production of knowledge – has begun in each case to offer a hopeful example of how this approach to research can be transformative.

Dr Jennifer Molwantwa and delegates at 'mirroring workshop'.

Mirroring Workshop Team.

The dialogue followed on from a "*mirroring workshop*" hosted by UCEWQ in Grahamstown in August. The notion of "mirroring" is derived from the work of Yrjö Engeström and is an aspect of a social learning process. In this instance the workshop focussed on sharing methods and approaches so that the TNP initiative is exposed to, and learns from, as wide a range of engaged social-ecological system IWRM researchers as possible. A valuable workshop outcome was the derivation of a draft set of principles on which such research initiatives can be based. These will be submitted for publication in 2015.

Both the dialogue and the mirroring workshop were aspects of the core reflection and integration process of the TNP where we take engaged social-ecological research practice into the broad embedded IWRM context.

The monthly Rhodes University Transdisciplinary Research Group Meetings have continued as a vibrant space to explore TD methods, theories and concepts. Now led by post-graduate students the meeting regularly attracts about 20 participants each month.

Partnerships

Unilever South Africa: The core partnership that founded the Centre remains with Unilever South Africa, and we are proud to recently have been designated a Unilever SA "legacy partner". Conversations and meetings this year served to underline the deep common ground we share in a commitment to actions towards sustainability, particularly of water. We worked hard on the challenge of ensuring this common ground is expressed in our new three-year strategy. We have also submitted a new 3-year Memorandum of Agreement for approval, hoping to revert to a 3-year, rather than 18-month commitment. During this year we have participated in the Unilever Future Leaders Programme, the Unilever support of the Khulumani Water for Dignity **One Street One Tank** project. Two tanks have been installed – and further installations are planned to 2015. *Khulumani Support Group:* The UCEWQ - Khulumani Support Group initiative *Water for Dignity* (KWfD) has progressed well. KWfD members Mr Mbulelo Lipile, Ms Nosiphiwo Lipile, Ms Xolelwa Nzwana and Mr Siyabonga Saki have continued to collect household water access information in Makana, worked with schools, and Mrs Lipile provided the text for several local newspaper articles. Mr Lipile and Mr Saki presented papers at the *Gender, Water and Development Conference* as members of the Eastern Cape Water Caucus; and Mr Lipile presented at the Water Dialogue. We also congratulate Mbulelo and Nosiphiwo on the birth of their new son this year. Dr Marje Jobson, National Director for the Khulumani Support Group has continued her active involvement in KWfD. She is a great inspiration to all of us.

Filling the Khulumani Water for Dignity Tank.

Research funders, industry partners and government As an independently funded researcher centre UCEWQ nurtures relationships with research funding partners carefully, ensuring attentive, adaptive and responsive proposals and effective delivery of research products and outcomes. We have long-standing relationships with the Water Research Commission, the NRF/dti Technology and Human Resources for Industry Research Programme (THRIP), the ESKOM Tertiary Education Support Programme and Richards Bay Minerals. THRIP industry partners in the Crocodile River catchment include TSB Sugar Holdings, Assmang Chrome,

Delta EMD Pty Ltd, Manganese Metal Company, and SAPPI. We ensure actively maintained links with local, regional and national government, working closely with DWS (especially water quality planning and institutional oversight. Tally Palmer served on the committee that recommended the appointment of the I-UCMA Baord, and will do so for the Olifants River CMA Board. Prof Palmer and Dr Griffin will be involved in planning a resource protection and water quality planning workshop to embed integrated water quality management plans in DWS practice.

Research partners We are delighted that Dr Jill Slinger (TU Delft) has been recognised by Rhodes University as a Visiting Professor. Jill has been an active supervisor of Jai Clifford Holmes – and brings great potential for South African students in soft systems analysis.

With our focus on TD research, the co-creation of knowledge and mutual learning we greatly value those researchers who work with us particularly Dr Sharon Pollard and Mr Derick du Toit, from the Association for Water and Rural Development (AWARD); Dr Tony Palmer and Ms Andiswa Finca from the Agricultural Research Council (ARC); Prof Kevin Rogers from the Centre for Water in the Environment at Wits, and Dr Victor Munnik, a UCEWQ associated researcher.

Internally at Rhodes we have generative partnerships with the Departments of Management, Economics, Environmental Science, Geography and the Environmental Learning Research Centre. UCEWQ Trans Disciplinary (TD) research and TD partnerships across the University is supported by the monthly two-hour meetings of the "Rhodes TD research group".

Performance, moves and appreciation

UCEWQ achievement highlights included the graduation of three UCEWQ students in April, with doctoral degrees being awarded to Dr Nelson Odume and Dr Bolu Onabolu, and a master's degree to Mr Matthew Muller; and Dr Nelson Odume winning a competitive international award: the inaugural "Emerging River Professional" award at the bienniel International River's Symposium. UCEWQ staff and post graduate students have collaborated, travelled and influenced the South African water sector-increasingly making a contribution to transformation and sustainability in South Africa.

The students and interns in UCEWQ are the engine room of the future. Intern Ms Nthombekhaya Mgaba has completed her Geography Honours examinations and, in 2015 Mr Mzwanele Mkatali will continue his internship and will register as an honours student in Geography. Jai Clifford-Holmes is in the final stages of completing his doctoral thesis, has conditionally been awarded a 6-month post-doctoral research fellowship by Rhodes university. We look forward to the publication of his innovative research as a result of this post-doctoral fellowship. Ms Athina Copteros has completed her training in dance movement psychotherapy with distinction, and is applying her training in doctoral research to water-related trauma in South Africa, using the concept that dance can be a healing and empowering activity. Ms Helen Fox has submitted her doctoral thesis, and Ms Asiphe Sahula and Mr Hugo Retief are close to submission. Both Ms Sahula and Mr Retief have been complimented by industry partners, commended because their research outcomes will be incorporated in practice in the I-UCMA in 2015. Ms Lara Molony (MSocSci) will graduate in 2015. Mr Garth Barnes, who graduated with an MEd distinction, in 2014, continues to work with us on green drop practice research. Ms Pearl Gola is busy completing her doctoral thesis corrections – so the 2015 graduation will be a great celebration. Mr Matthew Weaver and Mr Gareth Thompson continue with their Masters research, Emmanuel Vellemu initiated doctoral research into Acid Mine Drainage in a saline context, and Ms Tia Keighley will start her MSc in January – working with Prof Tally Palmer and Dr Victor Munnik in the Biodiversity and Mining project.

Prof Tally Palmer took a group of seven students to the SASAQS conference in Bloemfontein, and presented at the SETAC Asia-Pacific conference in Adelaide Australia. She also presented papers at the Gender and development conference, and the NRF Climate Change conference.

Dr Nelson Odume successfully started his post-doctoral research with a research report on the role of ethics is aquatic ecosystem and IWRM research – in collaboration with Prof Chris de Wet and Dr Paul Mensah initiated his first year as a UCEWQ researcher by actively supervising Emmanuel Vellemu and Yvonne Chiliboyi; attending an international salinity research workshop in Germany, and by initiating a renewed research effort in the eco-toxicity of salts. Dr Neil Griffin has contributed to the constant stream of research reports on UCEWQ research – particularly syntheses of the water quality status if the Olifants and Crocodile Rivers. We are delighted his 3-year contract research status has at last been processed by the University. Ms Margaret Wolff has become an anchor presence in UCEWQ, and this year she produced the publication that accompanied the Water Dialogue. Ms Joan Cameron joined the UCEWQ team in support of Dr Victor Munnik's research, and Mr Nick Hamer is invaluable as the research leader of the Makana TNP case study, with Prof Jay O'Keeffe as a valued member of the Makana case study team. We have also enjoyed the much closer research links with Dr Andrew Slaughter, within the IWR, as his WQ-SAM model is proving vital in the Crocodile and Olifants River work. It will be a strong contribution to the IWQMP workshop in2015.

UCEWQ continues as an integral part of the IWR under the leadership of Professor Denis Hughes, with much appreciated support from Mr David Forsyth and Ms Juanita McLean. My very grateful thanks go to everyone in UCEWQ for your contribution to a vibrant and exciting team and also to the wider IWR team.

HYDROLOGY PROJECTS

The hydrology group of the Institute consisted during 2014 of Prof. Hughes, Dr Andrew Slaughter (focusing on water quality modelling), a postdoc fellow, Dr Jane Tanner (focussing on surface water – groundwater interactions) and ten post-graduate students; Mr Thabiso Mohobane (PhD), Mr S'bong Mazibuko (MSc), Ms Louise Bryson (MSc), Mr Haden Jacobs (MSc), Mr Hugo Retief (MSc), Mr Greg Pienaar (MSc), Ms Madaka Tumbo (PhD, based in Dar es Salaam), Mr Agostinho Vilanculos (PhD based in Maputo), Mr Coli Nndzabandzaba (PhD), Ms Eunice Makungu (PhD) and Mr Dionis Rugai (PhD). Six of the post-graduate students are part of the Carnegie RISE programme, while some are supported by the IWR and others by additional funders. Three of the MSc students have completed their research and left the IWR, but have yet to complete their theses. The range of topics covered by these student projects include hydrological modelling uncertainty assessment (including climate change impacts), water quality and sediment delivery modelling, 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 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 Mantel has been assisting with the 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. The various projects are discussed under three main headings 'Implementing uncertainty analysis in water resource assessment and planning', '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' and 'General consultancy projects'.

IMPLEMENTING UNCERTAINTY ANALYSIS IN WATER RESOURCES ASSESSMENT AND PLANNING

Sponsor: Water Research Commission
DA Hughes, JL Tanner and T Mohabane

Project dates: April 2011 – March 2014

This project was the second of two 3-year contracts with the WRC to investigate hydrological and water resources modelling uncertainty in a southern African context. The previous project focussed on establishing the concepts of uncertainty analysis in a as well as developing some appropriate methods for incorporating uncertainty analysis in hydrology and water resources systems models. This project was designed to investigate the uncertainties in surface-groundwater interactions in more depth than was covered in the previous project and also look at a range of issues associated with the practical implementation of uncertainty including the links between uncertainty and existing methods of assessing water resources yield and various approaches to reducing uncertainty. The two final reports for the project were accepted by the WRC during September 2014 and should be published either at the end of 2014 or during 2015.

A request for a 1-year extension was unsuccessfully made to the Water Research Commission at the end of 2013. The extension was designed to address the following issues and the following bullet points also indicate how the IWR will proceed with these initiatives in the absence of WRC funding:

- Firstly, the IWR previously identified some new opportunities to investigate some issues of making decisions with uncertain information. Mr Gregory Pienaar joined the IWR as an MSc student in early 2014, funded by accumulated funds within the Hydrology section of the Institute. He has several years of experience working for a UK water utility and therefore has a background of decision making in water resources development. His project will focus on identifying and testing some new approaches to uncertain decision making. The project is progressing well and we expect to be able to submit a first paper towards the end of 2014.
- Secondly, as part of the on-going development of hydrological modelling with uncertainty, we have been testing a new approach in the Caledon River basin which overcomes some of the previous practical difficulties. We would have liked to apply this approach to the whole country, but in the absence of WRC funding, Mr Coli Ndzabandzaba will be testing the approach in Swaziland as part of his Carnegie RISE funded PhD project. Mr Forsyth is currently reviewing the developments in software made by Mr Dale Tristram (graduated with an MSc in Computer Science in 2014) that allow uncertain hydrological models to run much faster. The intention is to incorporate these developments into the SPATSIM framework and make them standard analysis tools. This could be a critical development if we are to start running models for large areas.
- Finally, there are developments in other projects led by Mr Bennie Haasbroek and Prof Geoff Pegram on improved methods of stochastic rainfall analysis and how these can be applied to climate change studies. Prof Hughes is pursuing some of these initiatives with Prof Pegram.

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

Sponsor: Water Research Commission, South Africa
AR Slaughter and SK Mantel

Project dates: April 2013–March 2015

During the completion of a previous WRC project entitled 'Developing climate change adaptation measures and decision-support system for selected South Africa water boards', it was determined that no existing water quality models were sufficiently suitable to achieve the aims of the project from a water quality perspective. Consequently, towards the end of the aforementioned WRC project, the conceptual framework behind the Water Quality Systems Assessment Model (WQSAM) was born. A new WRC project funding the development of WQSAM was awarded to the IWR within the 2013–2015 funding cycle. The overall aim of the WQSAM project is the development of a water quality decision support system with the following characteristics:

1. WQSAM would accept as input, flow output information from established and routinely used yield models such as the Water Resources Modelling Platform or the Water Resources Yield Model.
2. WQSAM would simulate only the most important water quality variables and processes from a management perspective so as to limit the complexity of the model and allow the model to be calibrated against routinely collected historical monitoring data.
3. The outputs of the model would allow water resources managers an indication of risk associated with management decisions.

The objectives of this project are:

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

The conceptual structure of WQSAM is presented in Figure 1. WQSAM is run from within the modelling framework Spatial Time Series and Information Modelling (SPATSIM), which also acts as a database where observed and simulated data, as well as model parameters can be stored. It was decided that WQSAM should be run at a daily time step, since water quality is driven by transient flow events. Since the yield models typically operate at a monthly time step, monthly incremental flows obtained from the yield models have to be disaggregated to daily within WQSAM, using a process where observed daily rainfall guides the frequency of disaggregated flows. WQSAM simulates water quality variable load input from the catchment by assigning water quality signatures to the incremental flow components surface water flow, interflow and ground water flow. For this reason, WQSAM separates incremental flow into these four components. The actual water quality modelling components within WQSAM consist of the salinity, temperature, nutrient and sediment sub-models.

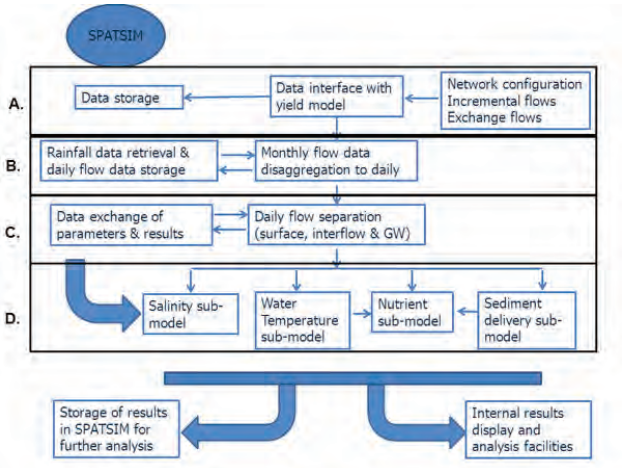


Figure 1 Conceptual representation of the model components in the Water Quality Systems Assessment Model (WQSAM): a) Input of WReMP output data and storage to the modelling framework Spatial Time Series and Information Modelling (SPATSIM) system, and replication of the nodal structure from the Water Resources Modelling Platform (WReMP) to WQSAM and SPATSIM; b) Disaggregation of simulated monthly incremental flow to daily and storage to SPATSIM; c) Base flow separation of simulated daily incremental flow to the flow components surface water flow, interflow and ground water flow; d) Water modelling components for salinity, water temperature, nutrients and sediment.

To date, the first three deliverables for this project have been completed. The model has been applied to the Buffalo, Crocodile and Olifants river catchments for historical conditions, and the possibility of using remote sensing data within the water quality modelling process has been investigated. The application of the model to case study catchments as well as stakeholder engagement in the Crocodile River Catchment has highlighted the strengths and weaknesses of the model. Initial modelling

results have shown than in most cases, the model achieves acceptable simulations of water quality for salinity and nutrients. Figure 2 shows some model results for nutrients in the Crocodile River Catchment. Cases where bad model simulations were obtained have highlighted the shortcomings of using static water quality model parameters where there are strong increasing water quality concentration trends with time, emphasising the need for dynamic water quality modelling within WQSAM. Stakeholder engagement has also indicated that WQSAM does not necessarily provide data that is useful to all stakeholders, with some stakeholders in the Crocodile River Catchment being concerned about manganese and pH; variables that unfortunately, WQSAM does not simulate at this stage.

Further work on this project will investigate climate change and development scenarios. In future projects, there are in addition plans to extend the number of variables simulated by WQSAM to include sediment transport and microbial water quality.

An exciting outcome of the project to date is the monthly to daily flow disaggregation technique, which appears to be fairly robust and accurate. A study of the technique indicates the possible use of regionalised parameters and satellite rainfall data, indicating the potential use of the method within ungauged catchments. Other conceivable applications of the technique include flood analysis, sediment transport modelling and daily environmental flows. A journal paper detailing the method has been submitted to the Hydrological Sciences Journal. Figure 3 shows a short temporal segment of the disaggregation results for X22A on the Crocodile River, showing a good match between flow disaggregated from monthly flows and daily observed flows.

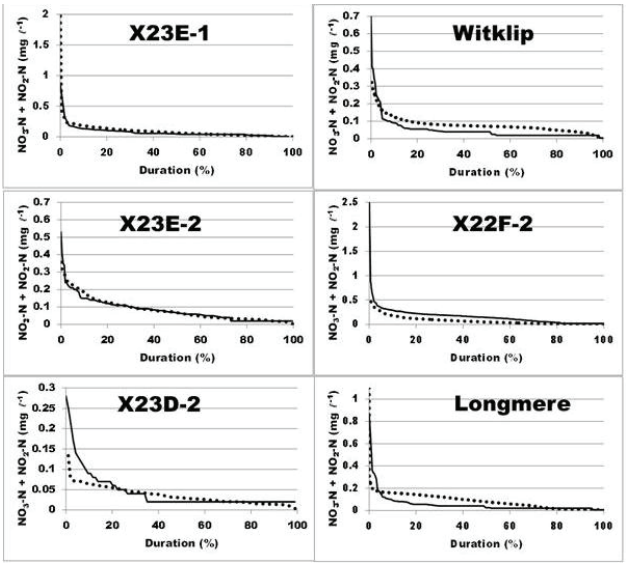


Figure 2 Some model simulations of nitrate + nitrite by WQSAM for subcatchments within the Crocodile River Catchment represented as frequency distributions. The solid lines represent observed data, while the dashed lines represent model simulated data.

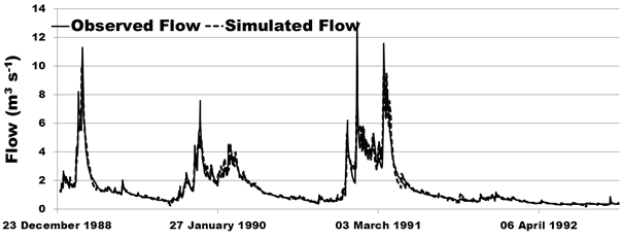


Figure 3. Results of monthly to daily flow disaggregation for the quaternary catchment X22A on the Crocodile River.

INTERACTIONS BETWEEN SURFACE WATER AND GROUNDWATER

Sponsor: Rhodes University Post-Doctoral Fellowship
JL Tanner

Project dates: January 2014 – December 2015

The fellowship focuses on reducing uncertainty in various aspects of surface water and groundwater interactions. These uncertainties are mostly input data uncertainties (rainfall and evaporation data) and model setup uncertainties (a general lack of physical basin property data) amongst others. The uncertainty version of the integrated Pitman model was used in a number of data scarce areas in South Africa to assess whether it is possible to reduce existing uncertainty using available data and the model. The results varied between study sites with some sites indicating reduced uncertainty while others clearly require further field based information before significant reductions in the uncertainties can occur. For example, some of the uncertainties examined in the Upper Breede River included widely varying groundwater recharge estimates, a lack of information as to the origins (surface water or groundwater) of the irrigation water used and the possibility of deep regional groundwater flows affecting the water balance in the basin. The method was able to narrow the likely recharge estimates, as well as identify that a significant amount of the irrigation water was likely sourced from surface water and that the regional groundwater flows were not large enough to be significant in the overall water balance of the basin.

Further work on ephemeral systems was undertaken which involved examining the transmission loss routines of the integrated Pitman Model. These loss routines are fairly simple and inflexible, while ephemeral systems are particularly varied and complex. Outputs from the model were compared to groundwater levels in an ephemeral system in South Africa and the results were promising. While there are still specific uncertainties within the loss routines, the simulations of groundwater levels were a reasonable reflection of the observed data and seemed to represent the real world system. Further work will examine some of the uncertainties identified within the transmission loss routines in the model and examine possible new ways to represent this process in the model.

The next stage of the fellowship will focus on the effects of land use change on the Kwazulu Natal coastal plain, particularly concentrating on the coastal lakes. The effects of afforestation on reducing stream flow and groundwater flow, and the subsequent effects of these losses on a number of coastal lakes will be examined. This work will assist with the Department of Water Affairs licensing of stream flow reduction activities, i.e. afforestation.

GENERAL CONSULTANCY PROJECTS

Sponsor: Various clients
DA Hughes

Ongoing

The IWR have been far less involved in consultancy projects over the last few years, partly because it is difficult to find time to supervise a relatively large number of pos-graduate students and be engaged in consultancy work. However, Prof Hughes has been involved in several water resources development consultancies in other parts of southern Africa (Zambia and Mozambique) mainly as a specialist hydrological modeller and providing environmental flow requirement modelling skills. Prof Hughes has also provided some remote (via e-mail) support to Ms Delana Louw and Dr Drew Birkhead who frequently use some of the IWRs software products in their consultancy projects associated with environmental water requirement determinations. Prof Hughes has previously been involved in training some of the staff of the Department of Water Affairs and Sanitation in the use of SPATSIM and the Revised Desktop Reserve Model (a model designed for rapid estimates of environmental flows). The IWR were contacted during 2014 to submit a further proposal for additional training and we are awaiting the outcome of this.

During 2013 and 2014, the IWR were part of a partnership that was contracted to the World Bank on a project designed to apply consistent methodologies (the WEAP hydrology and water resources system model) for climate change impact assessments on water resources to a number of large basins in Africa. The IWR have been responsible for the Orange, Zambezi and Congo River basins. Prof Hughes, Dr Mantel and Mr Mohobane participated in the project, while we also sub-contracted some of the work to Dr Tshimanga (Kinshasa University in the DRC) and Dr Desai (one of Mr Mallory's employees), both who are former PhD students of the IWR.

ECOLOGY PROJECTS

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 (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) or 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 parameterize, evaluate and modify suitable models for ET, LWP and 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 presently is funding two students – Onalenna Gwate (PhD candidate, Rhodes University) and Perpetua Okoye (MSc candidate, Stellenbosch University). A third PhD student is expected to join the project next year. A number of field trips have been conducted under this project for reconnaissance and to collect initial social surveys and scientific data. The project team obtained invasive clearing shapefile data for T35B with original and follow up clearing dates from Working for Water East London (Figure 1a); however, the clearing in S50E is being conducted by the Sakhisizwe District Municipality and WfW has no information on these clearings. The closest quaternary to S50E where WfW has information is T12A, however information on when the clearings have happened is not available (Figure 1b). Thus, a third quaternary (T12A) has been added to our project (Figure 2).

The first social workshop was held on 13 and 14 October in uMgwalana Village to gather data on land use practices and future land uses on cleared areas. The project is progressing on track and the results obtained so far are satisfactory. The project team is looking for additional collaboration with teams working in the catchments of uMzimvubu River which overlaps with the project's work in T35B.

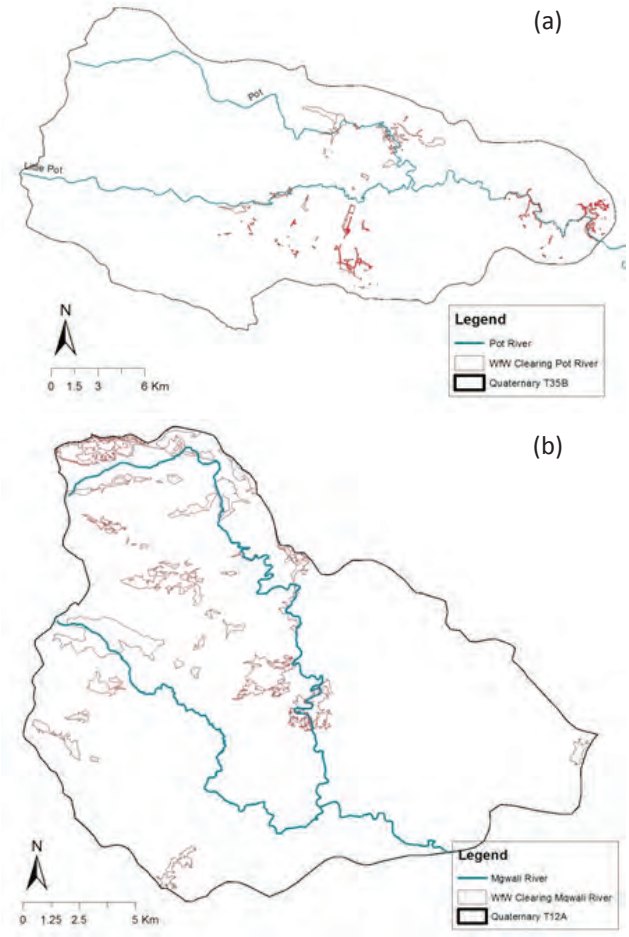


Figure 1. Cleared area polygons (shown in red) obtained from WfW East London for (a) T35b and (b) T12A quaternaries.

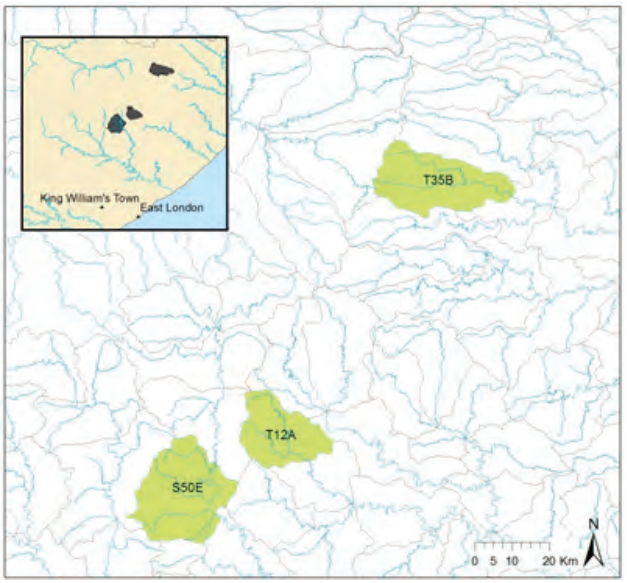


Figure 2. The three focal catchments for the project located in the Eastern Cape.

ENVIRONMENTAL WATER QUALITY PROJECTS

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 until August 2016

Richards Bay Minerals 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 only 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. Samples from the most recent annual monitoring cycle indicated improved water quality compared with recent years, and all sites have fair to good overall ecological health. No obvious impact driving decreases in water quality could be identified. This is largely a function of the confounding effects of the number of residential settlements found along the monitored rivers. Richards Bay Minerals have extended their monitoring programme to more closely assess impacts identified by UCEWQ-IWR, and have contracted UCEWQ-IWR to continue with ongoing monitoring until at least 2016.

ON Odume processing and scoring macroinvertebrate samples from the Mdibi River near Richards Bay.

CRITICAL ANALYSIS OF ENVIRONMENTAL WATER QUALITY IN SOUTH AFRICA: HISTORIC AND CURRENT TRENDS

Sponsor: Water Research Commission (K5/2184)
NJ Griffin, CG Palmer and P-A Scherman (Scherman-Colloty & Associates)

Project dates: April 2012-March 2014

South Africa is widely recognized as having an admirable water law, and as being a leader in granting a right to water, in terms of quality and quantity, to the environment. However, the water quality of South African water resources is deteriorating rapidly despite good water quality management structures, strategies, approaches, programmes, instruments, and tools having been developed and implemented nationally over the past decade.

This project aimed to assess the link between management process and water quality by reviewing the development of policies and practices associated with environmental water quality management, assessing long-term water quality changes in the Olifants (Mpumulanga/Limpopo) and Crocodile (Mpumulanga) Rivers, and presenting recommendations for research that will support implementation of legal, policy and strategy requirements for environmental water quality.

Management structures in DWS were assessed, as were major water quality issues in South Africa. The extent of various monitoring initiatives in the country were described for riverine as well as wetland, estuarine and groundwater resources. In the light of these, major long

term trends in water quality in the two model catchments were assessed using DWS WMA datasets. Overall, the Crocodile River was found to be less impacted than the Olifants River, though threats to water quality exist in both catchments. Water quality threats were described and attention was also drawn to potential threats for which too little data are available for adequate assessment. Recommendations for research were presented in support of principles and strategic actions as outlined in the National Water Resource Strategy 2.

A report on the project has been submitted to the WRC and the project has been completed.

KENMARE MOMA WETLAND MONITORING

Sponsor: Kenmare Resources plc
NJ Griffin

Project dates: MarchAugust 2014

A slimes spill from a storage dam into a coastal wetland in 2010 threatened the health of the ecosystem, and an ongoing monitoring programme was instituted to assess the extent and severity of the impact. This year's trip contributed to ongoing monitoring of impacted sites with assessment of other potential impacts as identified. The biomonitoring approach selected was based on multivariate comparison of wetland macroinvertebrate communities.

The results confirmed previous conclusions that the macroinvertebrate biota have recovered following the spill as no statistically significant effect of the spill can be detected regardless of the impact measure assessed. However, several other potential impacts were identified, assessed and reported on.

Reference site in Izoa wetland, Nampula Province, Mozambique.

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

Sponsor: Water Research Commission (K8-1074)
PK Mensah, N Mgaba and M Mkatali

Project dates: June 2014-May 2015

Salinisation is an important problem facing freshwater resource managers in South African. 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 valuable resource for the derivation of salt-specific species sensitivity distributions (SSDs), a very important water resource management tool. However, not many salts, including toxicological 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 is 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 will also attempt to write a methodology for conducting ecotoxicity tests involving binary salt mixtures. The binary salt mixture tests are necessary to study the combined ecotoxicity effects of ions to aquatic organisms. For example, the combined effects of:

- Similar cations – NaCl + Na2SO4 or MgCl2 + MgSO4.
- Different cations – NaCl + MgSO4 or MgCl2 + Na2SO4.

We are in the process of writing the various experiments with single salts and binary mixture of salts. We shall submit our first deliverable on 30th November 2014.

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

Sponsor: National Research Foundation (dti THRIP)
CG Palmer AV Munnik, D du Tot, A Sahula, H Retief, J Cameron

Collaborators: I-UCMA, AWARD, TSB, MMC, Delta EMD, SAPPI, ASSMANG Chrome, SAN Parks, Elands River Water Users Association, Mbombela Municipality, SEMCORP, Suidkaap Farmers Association

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 (I-UCMA) is responsible for water quality management in the Inkomati-Usuthus catchments, of which the CRC is a part. The IUCMA is unable to implement and enforce compliance without stakeholders' collective commitment. The ICMA hosts the project, and the project forma part of their catchment management strategy. 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 ICMA's water resource protection and waste division's annual performance plan. The Rhodes University-ICMA water quality team meets every two months.
- A transdisciplinary Rhodes University, Wits University and AWARD research team works on the project.
- The Stakeholder Group has met regularly every quarter since April 2013. The Group has agreed to the development of an Integrated Water Quality Management Plan, with support from DWS, who sees this as a pioneering effort.
- A first round of interviews using the Cultural Historical Activity Theory was undertaken and mirrored back to stakeholders.
- The Water Quality Systems Assessment Model (WQSAM) was discussed in detail with the Stakeholder Group and accepted as a tool for developing and implementing the IWQMP
- From analysis it was confirmed that pollution from dysfunctional wastewater treatment works belong to four municipalities in the catchment, was a priority. A Green Drop Support Campaign was established to address he problem by developing a Community of Practice consisting of national and regional DWS officials, local government, industry stakeholders, civil society and the ICMA. Frontline staff from the WWTWs have joined in six dialogue sessions, analysed the problem structure and devised a strategy to raise the profile of WWTWs within municipalities. The campaign has been adopted as a working group of the Crocodile Catchment Forum. • Water quality and flow data have been made available by the ICMA, DWA and some stakeholders to Hugo Retief (MSc student) in order to model relationships between flow and load. Asiphe Sahula (MSc student) is currently collecting data to model the activities of TSB on the river with the help of Hugo Retief. This work will be completed with the calendar year.
- The project was presented at the WISA conference in Mbombela in May 2014.

What next?
- The November 2014 stakeholders' meeting will consider the next steps for the project: completion of the IWQMP using the WQSAM, including participation of other important stakeholders.
- Individual consultations with stakeholders using the WQSAM to analyse future WQ scenarios for these industries, and a consultation with the IUCMA to plan the embedding of the model in IUCMA operations.
- The IWQMP will be fully developed as soon as the new Resource Quality Objectives for the Crocodile River have been set (currently in progress).
- The Green Drop Campaign has applied for WRC funding to consolidate its first year of dialogues and action, and to intensify its efforts.

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

Sponsor: Water Research Commission (K5/2355)
AV Munnik, CG Palmer, T Humby, G Thomson 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 the 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 CMA, 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 New Paradigm WRC research.

Achievements so far

- A team including Prof CG Palmer of Rhodes, Dr Victor Munnik of the Nature and Society cluster at SWOP at Wits, Prof Tracy Humby of Wits Law School and Gareth Thomson, Rhodes Masters Student, has been assembled, who are undertaking the research in close co-operation with the IUCMA.
- The project has passed its inception reference group meeting in June 2014.
- The project was introduced to the Upper Komati Forum and its Acid Mine Drainage task team, which deals with the aftermath of the Carolina AMD event, the DWS team working on a wetlands position paper, as well as SANBI's John Dini, Director: Ecological Infrastructure at SANBI.
- A first report has been handed in, detailing the progress that has been made on developing a theoretical framework for the identification and development of regulatory instruments for coal mining, through its entire life cycle, that can adequately take into account the protection of ecological infrastructure with an emphasis on water resources. It takes the first step in developing a model of legislative requirements and the institutional arrangements that should be in place from the point of view of the relevant management institutions, and a theoretical framework that could balance water resource and biodiversity protection with water use for mining, drawing on international and national literature.

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

Sponsor: Water Research Commission and National , with case studies supported by the National Research Foundation (THRIP), USAID, and Unilever SA
CG Palmer, S Pollard, D du Toit, V Munnik, N Hamer, C van Ginkel, N Griffin, JH O'Keeffe, K H Rogers, M Jobson, M Weaver, A Sahula, H Retief, M Lipile, S Saki, N Lipile, X Nzwana

Collaborators: AWARD, Khulumani Support Group

Project dates: April 2012 – March 2016

The Towards a New Paradigm (TNP) project has three themes through which the practice of new paradigm thinking and practice needs to be demonstrated over the four years. These are water resource protection, eutrophication and microbial pollution in relation to human health. These themes are being explored in terms of TNP theory and practice through three case studies and through a central process on reflective, learning practitioner engagement:

1. Case Study 1 Makana Municipality: At the local government, sub-catchment scale, in the Eastern Cape, we are maintaining, and extending previous work in the Lower Sundays River Valley to Makana – another municipality in the Cacadu District Municipality. The focus is on local government governance linked strongly to community and citizen science through Water for Dignity activities. The research has begun with historical analyses and households surveys as citizen science engages with local government in order to progress water service delivery, equity and resource protection.

2. Case Study 2 Crocodile River in Inkomati catchment: At the Catchment Management Agency (CMA)-catchment scale, an independently funded (dti-NRF-THRIP) project, is building on previous work in the Inkomati Catchment. Case Study 2 brings together industries in the Crocodile River catchment (which is part of the Inkomati system) with local government and water service providers in working towards collaboratively improving water quality in the Crocodile River, contributing to social and ecological health and well-being. The Inkomati Usuthu Catchment Management Agency (IUCMA) has made this project part of their business plan for water quality as part of operationalising their Catchment Management Strategy (which was designed in collaboration with team member Professor Kevin Rogers from the University of the Witwatersrand). The IUCMA means this case study is embedded in the most developed example of water resources governance in South Africa, and has the opportunity to influence the development of a CMA in the

Olifants River Catchment. IWR-UCEWQ post-doctoral researcher, Dr Paul Mensah, led the case study from April to October 2013, after which Dr Victor Munnik took over. The case study is also supported by three Masters' students and a research assistant, all of whom have offices within the IUCMA in Nelspruit. In this way we are already practising the TNP approaches, in that researchers and water resource managers are institutionally embedded in a co-operative activity to improve in-stream water quality. This project is incorporating research into practices that affect all three themes: eutrophication, microbial pollution and resource protection.

3. Case Study 3 Olifants River Catchment: At the broadest biophysical scale, within an international catchment with regional institutional co-operation, the Association of Water and Rural Development (AWARD) are running a large USAID-funded project. The first stage of the project is underway with progress towards building a co-operative, systems-based understanding of the Olifants River basin across South Africa and Mozambique, with participants learning to move towards a more resilient Limpopo Basin System. The project name is RESILIM – towards improving resilience in the Limpopo. IWR-UCEWQ researchers are members of the AWARD team – and RESILIM has an explicit aim to build water resource protection which is feeding in to TNP. The RESILIM experience is being be reported directly into TNP. The Loskop Dam within the catchment will be a focus of the eutrophication theme of the TNP project.

Concurrently with the Case Study work, the TNP project team is working actively with IWRM practitioners, especially within government so that the new paradigm – or better still new practice, emerges rather than being presented in four years' time. The three case studies drive a core engagement process, drawing in a wide range of stakeholders and fuelled by a discourse or conversation about new ideas and methods. This core engagement process comprises repeated actions that ensure exposure to the ideas and the practice of the TNP process.

Appreciative inquiry workshop with the TNP team.

Importantly, the stakeholder engaged process is i) actively recording mutual learning, shifting power relations, improved decision making and improved mandate delivery among participants in *new practice*; and ii) ensuring that new thinking, experience and practice is contextualised, integrated and embedded through a *new discourse.*

Dr Nelson Odume and Ms Carin van Ginkel.
DWS Delegates at TNP Appreciative inquiry workshop

TNP progress this year

Case Study 1 Makana Case: Citizen Research and Governance

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 Khulumani support group has partnered with UCEWQ to establish the 'Water for Dignity' initiative, where community activists are undertaking a range of research and actions to build new practices. The case is analysing and learning how to most effectively support a citizen based research approach.

Makana Progress this year

Stakeholder meetings: Regular stakeholder meetings have taken place, including through Kowie Catchment Campaign (KCC) meetings. Our involvement in KCC stakeholder meetings has led to a more coordinated response to various water related challenges in Makana. KCC members have recently been collaborating with KWfD in a research project to test local tap water quality, as well as tests on rainwater tanks and a local spring.

Municipal Engagement: The project has had on-going formal and informal meetings with the Municipality, including meetings with the Environmental Manager, Mr Nongwe and the Technical and Infrastructure Director Mr Myalato. Municipal 'Water and Sanitation' employees have recently approached IWR for support in undertaking tertiary education.

Appreciative inquiry: Dr Sue Southwood facilitated an Appreciative Inquiry workshop in April 2014, which has assisted team members to adopt the AI approach when engaging with other stakeholders. Mathew Weaver's Masters study will include investigating the impact of the AI orientation agreed upon by the KWfD team, whilst the project has committed itself to using the AI approach in the work we carry out.

Monitoring of the Matyana River: Duzi-uMngeni Conservation Trust (DUCT): originally initiated by Ground Truth in 2005, is a registered non-profit organisation (NPO) with the motto "Healthy Rivers = Healthy People." Discussions with DUCT led to a partnership between IWR, KWfD, WESSA and the KCC to help organise Quarterly River monitoring days based on the principle of promoting sustainability through diversity. IWR is assisting by providing mini-SASS kits and facilitating training, as well as involving their interns Khaya Mgaba and Mzwanele Mkatali to managing the database for the Eastern Cape node.

Khulumani Water for Dignity: Khulumani Water for Dignity (KWfD) has achieved significant progress in terms of carrying out the different aspects of their work plan. Key actions include:

- The use of *Community-Based Citizen Report Cards* to document community water challenges.
- Unilever funding has been accessed, to install 20 water tanks under the One Street One Tank initiative (OSOT). The initiative will provide emergency water supply to areas that have had serious challenges with water provision in recent months.
- 51 people in Grahamstown East have been involved in Community Water Forums. This network grew through the house-to-house visits undertaken by KWfD whilst citizen report cards were being completed. Community Water Forum members have undertaken to ensure that water tanks in the OSOT initiative are set up and managed according to an agreed set of criteria.
- KWfD presented a session at the WRC commissioned, 'Gender, Water and Development Conference,' held 3-7 November 2014.

Case study 2 Crocodile River in the Inkomati Catchment (reported as an individual project)

Case study 3 Olifants River Catchment

The Olifants River ceased flowing for a number of days in 2005 prompting widespread concern and calls for an integrated focus on all of the easterly-flowing rivers of the Lowveld of South Africa. The Olifants catchment is of particular concern given that its heavy rainfalls make it the largest contributor to the transboundary Limpopo Basin. Despite the enabling legislative framework for water reform in South Africa since 1998, the integrity of most rivers in this catchment continues to degrade both in terms of quality and quantity. Given that all these rivers form part of international systems the implications are of wider significance than for South Africa alone. This ongoing degradation is caused by a complex interaction of factors that vary for different parts of the catchment and along the length of the river. Key drivers include rapid growth in mining, irrigated agriculture and various industries, coupled with weak governance, regulation and enforcement which, when combined with the threat of climate change, rural poverty and food insecurity particularly in Mozambique, threatens to cause widespread livelihood vulnerability, environmental degradation and intensifying conflict over resources.

Much work has been conducted in the Olifants catchment but a key issue is the lack of synthesis and co-ordination of efforts in respect of sustainability, livelihoods security and resilience. The Resilience in the Olifants Basin (RESILIM) program will endeavor to address those issues.

The RESILIM project, funded through USAID/Southern Africa, aims to *reduce vulnerability to environmental (climate) change through building improved transboundary water and biodiversity governance and management of the Olifants Basin*. It seeks to do this through the *adoption of science-based strategies that enhance the resilience of its people and ecosystems through systemic and social learning approaches*. The project is being implemented through the Association for Water and Rural Development (AWARD) a non-profit organisation with a long history of transformative research and development in the area and at a transboundary level (www.award.org.za). The Olifants Basin, and thus this project, also known as RESILIM-Olifants or RESILIM-O, is part of a broader USAID-funded initiative, known as RESILIM to address resilience in the Limpopo Basin as a whole.

Key issues

- Some 18 months into the project, we have a much better systemic (or catchment-wide) understanding of the basin as a whole. Through this vulnerability we are starting to identify key leverage points.

- The adoption of a systemic view indicates the wide-scale impacts of the above activities.
- We have experience in developing trans-disciplinary approaches with a strong focus on stakeholder involvement and key lessons are emerging.
- The need for coherent, systemic governance of the Olifants is urgently needed. We illustrate this at multiple scales.

Aim

- To draw attention to the benefits of taking a systemic approach to understanding and planning for integrated water resources management and governance.
- To highlight linkages, principally between water and human well-being and the impacts of degradation.
- To draw attention to, and discuss the urgent need for action with respect to institutional arrangements such as through the establishment of the Olifants-Letaba Catchment Management Agency, catchment forums and transboundary co-operative arrangements.

Olifants River Progress this year

Prof Tally Palmer and Dr Neil Griffin attended four RESILIM team leader and co-ordination meetings, which serve to enable concurrent research practice across the various themes and research foci. The investment in this process that the USAID funding has made, contributes substantively to the quality and depth of integration across parts of this big, complex project.

Neil Griffin completed the water quality analysis of the Olifants River Catchment and has submitted the report. We are currently working on placing this information into a systemic narrative, and relating it to work practices in the mining and waste water treatment sectors. Dr Carin van Ginkel has reported on eutrophication in the Loskop dam catchment – but her work still needs to be integrated into the RESILIM narrative.

The RESILIM team report regularly into the TNP, providing relevant parts of deliverables. RESILIM is operating at the largest scale of the TNP case studies which offer valuable comparative opportunities.

Core Process Progress this year

The mirroring workshop hosted in August, the session keynote address at WISA, the session at the SASAQS conference, and the WRC dialogue were the major integrative and communication events and processes of 2014.

The mirroring workshop pragramme comprised:

- Introductions among participants and aim and process of work session (Prof Tally Palmer)
- Presentations sharing research approaches and methods:

1. IWRM in SA: towards a new paradigm (TNP methods concepts and approaches)
   - Overall TNP concept - Prof Tally Palmer
   - General complexity and Transdisciplinarity – Prof Tally Palmer,RU
   - Strategic Adaptive Management – Prof Kevin Rogers, WITS
   - Systems approaches –Mr Jai Clifford-Holmes, RU
   - Social learning – Mr Nick Hamer**,** RU
   - Political Ecology – Dr Victor Munnik **,** RU
   - Thick description (or general anthropological approaches) – Chris de Wet **,** RU
   - Integration – Prof Tally Palmer**,** RU

   TNP Discussion
2. Umngeni River Catchment
   - Overall Ecological infrastructure approach – Prof Graham Jewitt, UKZN
   - Social-ecological contextual profiling – Dr Jim Taylor, WESSA
   - Building Capacity for Catchments through Stepping Up - Mr Lemson Betha , WESSA
   - Moving from IWRM to INRM: the benefits of a more integrated approach for water resources management – Dr David Cox DUCT
   - The Dusi Umngeni Conservation Trust story and Citizen Science Initiatives & Research within the uMngeni Catchment. – Dr Mark Graham, Ground Truth

   Umngeni Discussion
3. Berg River Catchment
   - Overall framing of studies in the Berg River Catchment - Prof Mark New, UCT
   - The Bergrivier catchment: perspectives on laws and governance – Mr Jan Glazewski, UCT
   - Crossing boundaries into respect and care - Ms Tania Katzschner,UCT

   Berg Discussion

- Group work on linkage, emerging understanding and collaboration
- Reflections on our learning
- Planning the Water Dialogue.

The Water Dialogue:Practising IWRM: Towards a New Paradigm address the following:
Why are we talking?

- South Africa has a world-renowned Constitution, Water Law and Strategy.
- South Africa has foundational principles of fair, sustainable and efficient water management.
- South Africa has PROVIDED extensive additional water supply and sanitation since 1994.
- South Africa has still has regular water- and sanitation-related civil unrest.
- There are still many water-related inequities experienced by South African residents.
- The health of many water ecosystems has deteriorated since 1994.
- There are hopeful signs that we can act together, better

Welcome and introductions	Dr Jennifer Molwantwa, Research Manager, WRC
Opening Address	Mr Dhesigen Naidoo, CEO, WRC
Narratives of hope: What is this journey "towards a new paradigm" of IWRM practice?	Professor Tally Palmer
Kirkwood burning: happy oranges and unhappy people in the Sundays River Valley. How can this be hopeful?	Jai Clifford Holmes and partners from the Sundays River Valley
The Makana Municipality: from provincial administration to empowerment.	Nick Hamer and Partners from the Khulumani Support Group: Water for Dignity & Unilever SA
Lunch Conversations: The Crocodile River Catchment, with Dr Victor Munnik & stakeholders	
Narratives of hope: The Inkomati-Usuthu Catchment Management Agency – Strategic Adaptive Management	Professor Kevin Rogers and Dr Thomas Geydu-Ababio -IUCMA
The Berg River co-operative process	A stakeholder view
Resilience to stress in the Olifants River	Dr Sharon Pollard and partners from the Olifants
Citizen science: Mini-SASS and the Duzi-Umgeni Conservation Trust (DUCT)	Dr Mark Graham and partners from the Umgeni River catchment
DISCUSSION Emerging principles from this practice and a way forward	Prof Tally Palmer and an invited discussant to lead discussion
Closure	Dr Jennifer Molwantwa, WRC Research Manager

Water Dialogue Team.

WATER AND SOCIETY PROJECTS

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

Sponsor: Water Research Commission
CJ de Wet

Project dates: June – September 2014

This project seeks 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 affected by planned changes in access to water supply, quality and habitats. This includes the sense of disorientation and the reactions that such changes often evoke. Water is fundamental to human settlement. In the same way that access to place undergirds other aspects of human settlement and society (i.e. emplacement – see below), so too does water undergird and enable other aspects of human settlement and society. If we are to ensure viable and sustainable human settlement, it is necessary to understand water's foundational and emplacement role, and to develop guidelines for sound practice in that regard. This will make a substantive contribution to IWRM.

Being emplaced refers to the situation whereby human beings are sustainably settled in a place, in such a way that they are able to derive sustenance, society and significance from that place or settlement. This requires a basic institutional, social, economic and political - as well as territorial cum tenurial - viability at the local level, and also, more widely, at the regional level into which that local area is integrated. Because the various aspects of collective human emplacement are interwoven in a dynamic, complex system, modification of any of these bases feeds back into, and works through, the ongoing system of emplacement as a whole.

If those basic conditions of viability become modified or weakened, such that the inhabitants of the area are unable to adapt to these changes, an area may become unable to sustain some or all of its population. The members of a group or settlement may then become dis-emplaced, and find themselves, not forcibly displaced, but rather becoming progressively squeezed out of an area, and having to move elsewhere.

Water is central to human emplacement, and to its viability. Apart from the fact that water is necessary to the sustenance of biota, it 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, or what may even be seen as 'powers', and is central to the possibility and the sustenance of human emplacement.

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.

Many interventions or projects alter access to and distribution of water, whether in terms of quantity, quality or habitat, or in terms of the spatial or socio-political dimensions of that access and distribution. This influences 'the ways water flows across human society and settlements', and feeds back into the dynamics and sustainability of the complex system of human emplacement, in that particular context.

This project seeks to apply these above ideas from the field of displacement and resettlement studies (very briefly outlined here) 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 the emplacement 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, diverse, 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. Looking through the list of WRC projects, it is apparent that many of them have been very discipline- specific and have correspondingly focused on the investigation of very specific relationships and limited notions of systems. It is here argued that the insights from emplacement and dis-emplacement are able to bring out this multi-dimensional and integrating role of water in human settlements more clearly, and – via our understanding of what is involved with physical displacement and dis-emplacement - to assist us in opening out avenues of inquiry about ways in which water's 'emplacing' and integrating role in human settlements may be impoverished/undercut by poorly and narrowly conceived or executed water projects – or enhanced by well -conceived and executed projects.

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. The impact of such changes upon the ways in which water underscores and enables general human emplacement in specific areas or settlements are documented and analysed, using the perspectives of emplacement and of complexity and integration mentioned above.

The intention is to understand the way in which such alterations in the water regime impact upon human emplacement. This will be brought to the fore by analyzing a range of different kinds of 'water regime alterations' in terms of type and scale, as well as in terms of consultation/ participation process and ways in which the integrated role of water was consciously taken into account, or not considered i.e. whether the changes were/not seen and approached as part of a complex process. Bringing out these differences will help us to understand much more clearly the ways in which alterations in the water regime relate to and impact upon human emplacement, and so enable these understandings to feed into the development of more informed and more responsible policy and best practice in IWRM.

Aims of the Project

The project seeks to apply concepts and analysis from the discipline of displacement and resettlement studies to develop a framework that will enable us to understand, assess and respond constructively to the socio-economic impacts experienced by people in settlements when they are affected by changes in water supply, quality and/ or habitat. The intention is to apply this framework to help ensure viable and sustainable human settlement by contributing to the development of guidelines and so, of sound practice, in relation to upholding water's positive emplacement role in human settlements. This will make a significant contribution to IWRM.

It is the intention that the project will contribute towards

1. the conceptualization, design and implementation of future water related projects
2. the design and implementation of ethically and socially sound water research practice
3. the design and development of the continuing water and human settlement policy development process
4. development of more social-ecologically oriented practice in, and better implementation of, IWRM

The project is also of value to **the WRC's major new initiative on Lighthouses** (see below), as well as the WRC project K5/2248, **Water Resources Management in South Africa: Towards a New Paradigm**, which is directly concerned with a transformation of practice in water management through achieving an understanding and an upholding of the complex and the integrated nature of social-ecological systems, and of water's role in them. The project provides an innovative way of conceptualizing the integrating role of water in society. It is placed to make a contribution to the Lighthouses projects through the application of the emplacement framework to the role of water in human society and settlements.

This application of emplacement analysis is of value to several of the Lighthouses, as follows

i) Water Sensitive Design (WSD).

The emplacement framework, which emphasises the dynamic and integrated nature of the various aspects of human settlement, and of water's undergirding role in enabling and upholding that emplacement, cuts to the heart of WSD – and may in fact be pivotal in helping us conceptualise how we understand "sensitive". A settlement may be seen as a socio-ecological system, in which its socio-aquatic aspect is fundamentally important. To enable and to sustain this socio-aquatic component, what is needed is a settlement design that is sensitive to both people and water, as well as to the wider environment in which that settlement is situated. The conceptualization, development and implementation of such a water- and people- sensitive design flows logically from an emplacement perspective. This also relates to ways in which such sensitivity would contribute to settlement sustainability, by directing awareness, through an understanding of emplacement, of how interventions impact upon vulnerabilities in the interrelationships between the components within society and within a socio-ecological system.

To secure and to follow through on that design of requisite sensitivity requires the establishment of a committed and enabled community of water- and people- sensitive design practitioners. Such a community of practitioners would be of relevance across the range of Lighthouse projects (e.g. The Green Village, Freshwater Governance), and not only in WSD. I would be keen to bring my experience of integrated planning and change, to contribute to such a community of practice and practitioners.

ii) The Green Village

The Lighthouse document argues that the 'silo' approach to rural development and a corresponding lack of integration has been a principal reason why previous attempts at rural development have failed, and why rural communities remain in poverty. Yet a blanket call for 'integrated rural development', i.e. for 'a bit of this and a bit of that', for development as 'bring and share from across the silos', is not going to achieve anything substantial either. Integration needs to be focused to succeed. The ideal of the Green Village is focused around a community/ settlement which is economically viable and ecologically sustainable inasmuch as its members are knowledgeable and skilled – and which has been able to achieve dynamic adaptive integration between its various institutional components and its natural setting. It is clear how water- and people-sensitive design – and the contribution of the emplacement perspective in that regard – would be

central in achieving this kind of integration and moving closer towards making Green Villages a reality.

iii) Freshwater Governance
It is not only development that is all too often seen from a 'silo', i.e. single discipline or single problem, perspective. Water governance may also all too often be seen only in terms of "decisions around access to water", overlooking the other social and environmental issues which water - and therefore water governance - impacts. As has been advanced throughout this proposal, and as the argument from emplacement makes plain, water flows in many directions and in many ways through human society, and undergirds human emplacement. The emplacement framework thus provides a useful framework for re-conceptualising and renegotiating approaches to integrated freshwater governance

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

Sponsors Water Research Commission
CJ de Wet and ON Odume

Project dates: April 2014 – February 2016

Despite developments in water resource policy, law, monitoring, regulation, management and research, the health and functionality of South African aquatic ecosystems continues to deteriorate. At the same time, there is a growing recognition that humans are integral components of complex social-ecological systems; and as such, their beliefs, values and actions have direct implications, whether intended or unintended, for the environment.

In South Africa, considerable advances have been made in the inclusion of human values in the strategic adaptive management of natural resources, where values are the lead aspect of the established VSTEEP (values, social, technical, environmental, economic and political) analysis. This research seeks to thoroughly 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 resource management (IWRM).

The first distinction to be made is the difference 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 democracy, 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. For example I may believe polygyny is wrong for my own moral purposes, but, as a matter of ethical principle, I believe that people should have the right to choose how they wish to conduct their own relationships for their own purposes. Thus we can look to the development of agreed ethical principles for water resource 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. Our historical context has its own ethical imperative to effect transformation towards social justice, (which, we will argue, is inextricable from environmental justice). In a highly plural society, the needs and desires of people will differ widely. Each choice and action that is made, tends to preclude other choices and actions, so that particular actions inevitably open out and close down specific options in respect of access to the benefits of water use and/or protection - and will always be contentious. Trade-offs between values (e.g. between equality and liberty) or a compromise in standards for reasons of affordability (for example, resulting in water that is sometimes safe to drink) is not always meaningful or suitable, and there often will be winners and losers.

This research will review, research and present options for consciously developing ethical thinking and practice in IWRM that will assist us in navigating a journey, in a complex world, where all the outcomes of actions cannot be foreseen, towards the realisation of the ethical priorities of equity and sustainability (social and environmental justice) (National Water Act No 36 of 1998).

In as much as human beings ascribe value to nature, and do so in different kinds of ways - the discipline and practice of environmental ethics could guide our thinking about, and attitude and behaviour towards, the environment. An emerging ethical practice would reflect the way in which we value and relate to the environment, and help to make explicit the values that guide us - and that should guide us as humans.

Within the context of water resource management, environmental ethics are already implicit in water policies, regulations and laws. For example, the DWA slogan "Some for all, forever" speaks to the fact that it is ethical to see water as a public good, not to be owned by a few wealthy individuals in the society, and to manage it sustainably. The revolutionary National Water Act (Act No. 36 of 1998), which shifted from the conventional "command-and-control" approach to an ecological basis for managing water resources, has an explicit environmental ethical consideration, clearly captured in the notion of Reserve, whereby rights accrue to the natural environment and to people, for their basic needs for drinking, cooking and cleanliness. In providing water by right for both ecological and basic human needs, the Reserve serves social and environmental justice. All other water is administratively allocated for use. It is the decision making around the amount and quality of water secured for resource protection, and the amount and quality of water allocated

to various users with various levels of security, that makes real the notions of social and environmental justice. It is these practices that we seek to influence through an explicit consideration and development of a framework of IWRM ethics. The ecological Reserve concept, though difficult to implement, has led to some successful cases of improving water resource management, for example in the Sabie River. Consequently, the development, adoption and embedding of environmental ethics, at different spatial and temporal scales, among a plurality of water resource users, and in specific contexts, has the potential to encourage best water and ecosystem management practices.

This raises the consideration of whether the environment has an intrinsic value of its own, and whether this should be the basis of its respect and protection; or whether environmental protection should simply ensure sustainable access by humans to ecosystem services (i.e. the environment as an instrumental value). Discourses on environmental ethics in the context of water and ecosystem management could be located in several domains including, but not limited to, the water-user sector, the institutional-governance domain, and/or environmental ethics in relation to environmental law. These various domains should not be seen in isolation from each other, but as aspects of a complex interconnected system. They can be viewed through the lenses of the different approaches to environmental ethics, such as the intrinsic or instrumental value of the environment. An anthropocentric instrumentalism places human beings in the centre of the moral universe, viewing humans as intrinsically valuable, as the only moral agents, and seeing nature as having moral value in only an instrumental sense i.e. in as much as it serves human beings, their needs and purview. Placing an intrinsic value on the whole social-ecological system decentres human beings, and sees ecosystems, including humans, as having an intrinsic moral value . Using these perspectives and related questions from environmental ethics, we can then interrogate what is meant by the role and application of values in relation to water resource protection and sustainability.

Water and aquatic ecosystems goods and services have several potentially competing stakeholders/users e. g. domestic, industrial and agricultural. Perspectives from environmental ethics have the potential to make players in each of these user sectors more aware of the issue of values in relation to ecosystems, and the need for their protection in terms of water resource management. Therefore, within the water user domain, environmental ethics could provide the framework and insights for interrogating pertinent questions such as: what are the moral obligations of the various water user sectors to protect and use water resources sustainably? Why should people invest in protecting the aquatic ecosystems, even when is not in their immediate financial interest to do so? In the context of industrial discharge into a water resource, for example, why should an industry stop discharging into a water resource just because it is obvious that the resource has exceeded its receiving capacity - even when the legal discharge limits have not being violated?

Environmental ethics offers a valuable additional perspective for analysing the relationships between the aquatic ecosystems and their many users, with potential for improving ecosystems management through the recognition that these systems are part of large complex social-ecological systems, in which values and interests play a significant role. In this context, the relation-oriented approach in environmental ethics offers a useful perspective for investigating critical issues relating to water users and aquatic ecosystems. It seeks to avoid a dualistic approach, in which humans and nature are seen as opposed, as well as to avoid prioritising either nature or human beings in terms of the way they influence one another - but rather seeks to understand humans and their bio-physical context as in genuine interrelationship, and "suggests that we need to look into how environmental values (and the actions associated with those) are created and maintained in various contexts of humans relating to other humans, to nature and to technology" (Kronlid and Ohman 2013: 31).

Within the institutional-governance domain, perspectives and practices from within environmental ethics could potentially contribute to a framework for reforming water policies and governance, management practices, and existing institutions, through a systematic investigation of the value systems, beliefs, and moral affiliations of people living within a catchment, both in time and space. In this regard, a concern with environmental ethics may infuse greater awareness and transparency into water policy formulations - better enabling adaptive responses to changing conditions. In this regard, a rigorous and systematic analysis of values underlying present water policies and institutions will help expose existing deficiencies and provide for opportunities to guide a system that further embraces the vision of the bio-physical world as having rights, rather than limiting moral and ethical concerns to human beings only . In as much as they give us cause to reconsider the way we attribute value to, and thus relate to, the bio-physical world, several environmental ethics theories in the value-oriented and relation-oriented movements can profitably be taken up in the institution-governance domain of water resources management.

If we are to take seriously one of the foundational concepts on which this project is based, i.e. that of social-ecological systems, we need to consider ways in which value relates to, and/or derives from, the notion of a system - of which human and non-human components are part. It is then not only various kinds of components that may be seen to have intrinsic value. Value is seen to derive also from the relationship between the components, and, in a dynamic system, from the emergent, and complexity-generated properties of such a dynamic, interactive system.

This takes us into the heart of IWRM and the issues facing contemporary water managers - and the ways that values enter centrally into these matters. There are however, potential tensions between the component (intrinsic or instrumental) and relational approaches to value, with the first two seeking to ascribe value to specific components of the socio-ecological system, and the last approach seeking to decentre components and to locate value in the system itself. This tension will be explored in the context of IWRM as a system, and of the role of environmental ethics in relation to it.

Transformation and redress are at the heart of post-apartheid South Africa, especially in relation to resources seen as common goods such as the nation's water resources. Transformation and redress could meaningfully be addressed by giving voice to, and listening to voices from, all sections of our society. A critical analysis and presentation of ideas and approaches from environmental ethics in the context of social-ecological systems, and how they could be applied to water resources management, could potentially contribute to transformation. These perspectives could be used to channel the value systems, beliefs, cultural and moral affiliations of all sections of the society, particularly those of historically disadvantaged local communities, into policies and governance systems, in both ethical and effective ways.

Sustainable development solutions can only be achieved through coexistence between humans and nature, based on respect. Indeed, the notion of rights only has valence to the extent to which rights are respected. However, the notion of respect implies the idea of choice to respect or not to respect, and hence of agency. Arguments in relation to, for example, climate change, suggest that another kind of discourse, one of cause and effect - rather than of rights and respect - may come into play. If water resources management is to develop viable approaches and frameworks in relation to environmental ethics, and if ethics is about how we think about the choices we make and actions we take in relation to good and evil , then such frameworks are going to have to be clear about when we are talking about matters of choice and when we are talking about matters of cause and effect, about which we have little effective choice.

Aims of the Project

1. Review the subject of Environmental Ethics, and its applicability to the context of Integrated Water Resource Management, and of aquatic ecosystems use and protection.
2. Investigate case studies, both South African and international, showing the impact of environmental ethics on water resource management and aquatic ecosystems. Pay particular attention to best practice cases, and identify the ethics related factors involved in these situations.

3. Identify opportunities for application and improvement of environmental ethics in South Africa for constructive socio-ecological systems and water resource management.
   - 3.1 Identify ways in which environmental ethics can constructively be applied in South Africa, and what institutional and other foundations need to be laid/changes need to be made for this to be possible
   - 3.2 Analyse how environmental value and ethical systems operate at different levels of scale -local, regional and national - and the problems and possibilities of integrating such systems across such differences
4. Propose future research in relation to environmental values and ethics in socio-ecological research and water management.

POSTGRADUATE ACTIVITIES

EASTERN CAPE YOUNG WATER PROFESSIONALS LAUNCHED A PROVINCIAL CHAPTER

Young Water Professionals (YWP) in the Eastern Cape launched a provincial chapter at Rhodes University in Grahamstown. The launch, which took place on Saturday 2 August 2014, attracted over 80 enthusiastic young professionals who are either working or interested in the water sector, or studying towards a post-graduate degree in water and/or related disciplines. The YWP is an initiative of the International Water Association (IWA), in partnership with the Water Institute of Southern Africa (WISA). The initiative aimed to bring together young professionals in the water sector to share their experiences and provide a context for career development.

The launched of the EC-YWP kicked off with a key not address on water, governance, complexity and democracy delivered by Professor Tally Palmer, the Director of the Unilever Centre for Environmental Water Quality at Rhodes University. Professor Tally's personal experience of being a young professional in the water sector some year ago, and her involvement in drafting the SA National Water Policy (NWP) and the National Water Act (NWA) inspired confidence in all the YWPs at the launch who became eager to make a difference in the Eastern Cape water sector.

The Chairperson of the Eastern Cape YWP, Dr Nelson Odume and Shanna Nienaber, national chairperson of the YWP-ZA co-facilitated a water-based dialogue in which participants were made to discuss the challenges in the Eastern Cape water sector and to consider ways of addressing them. A presentation on biological treatment of wastewater by Prudence Mambo, the Secretary of the EC-YWP, sparked a huge conversation about technology uptake and implementation. A water service delivery game facilitated by Esther Shaylor of Amanz' Abantu Services, and Louise Bryson of Aurecon, provided the participants an opportunity to experience the task of providing water services in South Africa. An exciting networking game facilitated by Dan Abraham of Aurecon was an ideal way of ending a day-packed event.

The newly elected EC-YWP committee members are enthusiastic and eager to make a difference. The committe will strive to create an enabling environment for networking, connecting young professionals with experienced sector practioners and facilitating events and community-engagement activities throughout the Eastern Cape. The EC-YWP has nodes in Port Elizabeth, East London and Grahamstown, with each of the nodes serving as a central of activities.

Photos taken during the launch of the EC-YWP

BRIEF OVERVIEW OF THE SOUTH AFRICAN YOUNG WATER PROFESSIONALS (YWP) PROGRAMME

The world faces scarcity of skilled professionals in the water sector and this is particularly true for developing countries in Sub-Saharan Africa. In order to address some of these skill challenges and to ensure that the next generation of water professionals are adequately skilled and competent, the International Water Association (IWA) initiated the Young Water Professionals (YWP) programme, aims to connect and develop young professionals in the water sector. The programme brings together young people working in or interested in the water sector who are under the age of 35 years or have obtained their highest degrees within the last 5 years. This includes students who are studying towards a water related degree or who are interested in the water sector. The South African Young Water Professionals (YWP-ZA) is affiliated with the Water Institute of Southern Africa (WISA) and has become one of the most active divisions of WISA. Based on the last update of the databases of IWA and WISA, the YWP-

ZA has a membership base of 1135 YWPs. Of the 1135 members, 735 are student members and 400 are working professionals.

YWP-ZA has provincial chapters in Gauteng, Western Cape, KwaZulu Natal, Mpumalanga and Eastern Cape. Arrangements are almost completed for the launch of chapters in Limpopo, Free State, Northern Cape and North-West. The overall vision of YWP-ZA is to achieve distinction by connecting all young water professionals in South Africa striving for personal and professional evolution. This vision is achieved through the following objectives:

- Provide opportunities for YWPs to meet and communicate
- Provide career development opportunities for YWPs
- Support employers with the recruitment and retention of YWPs
- Ensure the Programme remains relevant to YWPs

RELEVANCE OF THE YOUNG WATER PROFESSIONALS PROGRAMME TO THE SOUTH AFRICAN WATER SECTOR

It has been acknowledged that the South African water sector is faced with shortage of skilled and competent professionals. As experienced professionals and industry practitioners in the water and wastewater sector reach retirement age and eventually retire, their knowledge and experiences are often not passed on to the young professionals who eventually step into their shoes. The outcome of this lack of continuity has been a young workforce that is inadequately prepared to deal with the water challenges that face our country. The YWP-ZA strives to address this challenge by ensuring that young professionals in the South African water and sanitation sectors are adequately prepared, equipped and competent to deal with challenges in the sector.

Through several activities and events the YWP-ZA has contributed immensely to the development, career advancement of young professionals in the water sector and to the education and empowerment of communities on issues relating to water. Within the past two years, the YWP-ZA has organised several events, some of them are listed below:

The third Southern Africa Young Water Professional Conference: This conference, which took place on 16 – 18 July 2013 in Stellenbosch, attracted over 500 young professionals from around the world. It provided a global context for South African young water professionals to present their work, network with other professionals and learn from and share ideas with other professionals in the water sector. Several workshops aimed at equipping young professionals were organised in the course of the conference.

***Entrepreneurship workshop*:** The entrepreneurship workshop aimed at providing YWPs with skills to set up their businesses in the water and sanitation sector took place in Gauteng in late February 2013. This event was highly successful and provided a context within which YWPs who are business oriented can start up their own businesses. Events of this nature are particularly important because they do not only equip YWPs, but have the potential to create jobs and thus benefit the economy beyond the water sector.

***Academic writing and publication workshop*:** In striving to improve the academic output of YWPs, the YWP-ZA organised an academic writing and publication workshop in February 2014 in Johannesburg. This event attracted over 50 YWP from across the country and several of them have testified that the workshop actually helped them to write their thesis and papers for publication.

***YWP events at the 2014 WISA Conference*:** During the 2014 WISA conference, the YWP-ZA organised several events including i) our dream for the environment in 2020, ii) global environment change talk show, iii) professional speed dating and iv) school challenge.

Several other events have been organised by the YWP-ZA and provincial chapters (More details about these events can be found on the YWP-ZA website: **http://www.sa-ywp.org.za**/).

More about the Eastern Cape Young Water Professionals
The Eastern Cape is one of the least developed provinces in South Africa and has witnessed several protests relating to water services delivery. In a predominantly rural province such as the Eastern Cape, its young workforce certainly has to contribute to improve the lives of the people on the ground. In line with the overarching goal of the YWP programme, the EC-YWP aimed to enhance the skill sets of its members through events aimed at career and personal development, enhancing academic and technical expertise and ploughing back to the society through community outreach programmes. The main objectives of the EC-YWP are as follows:

- To provide opportunities for career development and personal growth for EC-YWPs through events aimed at enhancing YWPs technical, academic, managerial and overall professional skill sets, and thus becoming competitive both in their places of work and in the employment market;
- To create a platform for connecting EC-YWPs with experienced professionals in the Eastern Cape and in South Africa at large,– thereby opening up the opportunities for YWPs to be mentored by experienced practitioners, in addition to peer-to-peer mentorship;
- To actively embark on water-related outreach programmes in communities and schools and collaborate with relevant organisations and government departments where necessary to uplift the quality of

life of the people;
- To provide opportunities for EC-YWPs to meet, communicate, share information and collaborate with one another in projects and other areas of interest;
- To ensure that the EC-YWP remain relevant through an active feedback mechanism from members and through an effective communication strategy.

Leadership and Operational structure of the EC-YWP
The EC-YWP runs a multi-nodal operational structure with nodes in Grahamstown, East London and Port Elizabeth. Nodal affairs are coordinated by nodal coordinators in collaboration with the chair person and vice chairperson. The rationale is that the East Cape is one of the largest provinces in South Africa; to cover its landscape and reach out to all young professionals in the water sector; its operational structure has to be spread out, hence the adoption of the nodal system.

The EC-YWP committee is made of the following offices: the chairperson, vice chairperson, secretary, treasurer, Grahamstown nodal coordinator, East London nodal coordinator, Port Elizabeth nodal coordinator and special project coordinator. The details of the committee are provided in the table below:

Name	Institution	Position in committee
Nelson Odume	Rhodes University	YWP EC Chairperson
Nosipiwe Ngqwala	Rhodes University	YWP EC Vice-chairperson
Dan Abraham	Aurecon	Treasurer
Prudence Mambo	Rhodes University	Secretary
Louise Bryson	Aurecon	East London node coordinator
Ntuthuko Masikane	University of Fort Hare	Grahamstown node coordinator
Sarisha Hurrisunker	Aurecon	Port Elizabeth node coordinator
Karabo Chadzingwa	Rhodes University	Special Projects coordinator

Progress by the EC-YWP thus far:
Within the space of four months, the EC-YWP has organised the following events:

***Outreach event: River walk*:** On 2 September 2014, the EC-YWP in collaboration with Khulumani-Water for Dignity, Kowie Catchment Campaign and WESSA organised a river walk for high school learners in Grahamstown. The purpose of the event was to raise awareness among the learners on how human activities in a river catchment influence the river health. 14 learners participated in this event. Presentation and practical water quality testing and river health sampling with invertebrate were undertaken with the learners.

School learners taking notes on their catchment

***Outreach event 2: Spring Fairview Walk*:** On 3 September 2014, YWPs in Grahamstown in collaboration with the Honours students in the Geography Department at Rhodes University walked to the spring on the outskirt of Grahamstown to raise awareness about the sustainability of the spring and its source. The spring has become an important alternative drinking water source for people living in and around Grahamstown.

***Workshop on bridging the inter-generational gap in the water sector*:** The EC-YWP and the Water Youth Network organised a workshop on bridging the international gap in the water sector. The workshop was organised during the Gender, Water and Development conference in East London held between 3 -7 November, 2014. The workshop attracted 23 participants from the Eastern Cape and the rest of South Africa, with few persons coming from outside the country. Eiman Karar from the Water Research Commission gave the keynote presentation, sharing her personal experience in the water sector with YWPs. She challenged young professionals to be bold and actively participate in the water sector and to come up with fresh insights and ideas that can lead to better management of our water resources. Representatives of WaterAid and the Stockholm International Water Institute also made presentations on a variety of programmes relevant to young professionals.

Eiman Karar giving a keynote address to YWPs at the Gender, Water and Development conference

THE MATYANA RIVER SCHOOL WATER FORUM DAY

Student: M Weaver

In celebration of the 24th annual World Water Week on the 2nd of September citizens from all over Grahamstown came together to broaden their understanding of the Kowie (Matyana) Catchment and how we as people living in this catchment play an integral role in caring for its health. The day was organized by Mr Matthew Weaver, Dr Sukhmani Mantel (IWR) and Mr Mbulelo Lipile (Khulumani Water for Dignity).

The group consisted of members from the citizen based research group Khulumani Water for Dignity, 14 learners from seven different schools and a member from the Community Water Forum based in Grahamstown East, representatives from the Institute for Water Research at Rhodes University, the Wildlife and Environmental Society of South Africa (WESSA), the Kowie Catchment Campaign (KCC), Young Water Professionals and the Albany Museum.

The contributions of all the participants ensured a hugely successful Matyana River Day.

The day started at the Albany Museum with a talk about river health and introduced the citizen science monitoring method known as miniSASS. From there everyone went out into the field stopping at various sites along the Bloukrans River investigating the effect that the various human impacts have on the river by conducting river health sampling using miniSASS. The Bloukrans River, into which all the river channels in Grahamstown flow, leaves town via the Belmont Valley and eventually connects to the Kowie River on its way to the sea at Port Alfred. The group stopped at several sites along the river; the first on the outskirts of Grahamstown, the second a few kilometers below the Belmont Valley Sewage Works, the third at the site of the new golf course that is under construction and finally at the Sacred Pools where the R67 to Port Alfred crosses the Bloukrans River.

The purpose of the day was twofold; firstly, it served as an event to establish School Water Forums within the schools of Grahamstown East, an initiative of Khulumani Water for Dignity. Many of these schools have substandard hygiene and sanitation conditions creating an undignified learning environment for school children. The objective of the School Water Forums is to capacitate interested and motivated learners with the understanding and skills to monitor hygiene and sanitation conditions within their schools on monthly basis. The findings of these reports will provide weight to initiate action by the school governing bodies to improve conditions within the schools that fail to comply with basic hygienic standards.

Secondly, the day served to nurture the understanding that everyone in the world lives in a catchment and that our catchment in Grahamstown is the Kowie Catchment of which the Bloukrans (Matyana) River is a tributary. The environment and the people who live in the Kowie Catchment are all affected by our behaviour towards it which in turn determines the quality of the ecosystem services that we receive from it.

The first site on the outskirts of Grahamstown was heavily polluted and posed the perfect example of the direct impact that people have on the river. A turbidity test showed that clear water is not the only sign one must look for when testing water quality.

The group followed the course of the river noting and discussing the different types of impacts that humans have on the river ranging from rubbish, detergents, human and animal waste to agriculture, the sewage treatment works and the construction of a massive new golf course. To connect these impacts to the condition of the river the water quality of the river was measured using miniSASS. miniSASS is a fun and easy way to monitor the condition of our streams and share our findings on a national online database (http://www.minisass.org/en/map/) which allows for the tracking of river health over time and space, comparison between catchments and networking with other miniSASS practitioners. Different aquatic macro-invertebrates (small animals) found in the river have varying tolerance to pollution and by identifying the composition of the aquatic community living in an area one can get an indication of the river health class ranging from natural to very poor. The groups conducted miniSASS samples at two different points on the river,

one site nestled in the agricultural lands downstream of the Belmont Valley Sewage Works and the other, the Sacred Pools, several kilometres downstream where the river crosses under the R67 to Port Alfred. The children enthusiastically took part in identifying all the insects and were amazed at what the sampling nets turned up. They learnt about dragonflies, mayflies, damselflies, beetles, bugs, worms and crabs and the different roles they play in the aquatic ecosystem and how sensitive they are to pollution.

MiniSASS is a simple and fun way for anyone to measure the health of a stream. Damselfly nymphs (bottom right) are sensitive to pollution and are an indicator of good quality water.

Under the shade of the trees beside the Sacred Pools the learners compared findings from the two sites and reflected on what they had learnt. There was a marked difference in water quality between the two miniSASS sampling sites, the first being largely modified with a low species diversity and the second improving to a moderately modified category but containing more than double the species diversity. So even though the Sacred Pools are situated in pristine Eastern Cape thicket and the water is crystal clear, the insects sampled tell a different story, that the lingering human activities occurring up river towards Grahamstown have far reaching effects.

The students reflected back to the group what they had learnt during the course of the day.

To further reflect on the importance of people living and caring for the Kowie Catchment the learners of each of the seven schools were forwarded the challenge of producing a poster that told the story of the Catchment drawing on what they have learnt and their findings on the day. The majority of the schools completed their posters in time for judging by a panel consisting of IWR, KWfD and KCC stakeholders. It was encouraging to see how many of the learners had grasped the concept of the "condition of the Kowie Catchment". The relationship between human impacts such as litter and agricultural land use and its impact on the condition of the river was well portrayed in all the posters. Nombulelo High School were judged to have produced the best poster and were subsequently awarded a water filtering bucket. The prize giving was conducted during their assembly and well received by the vice-principal and learners. The principal was excited about his learner's achievements and emphasised the importance of continuing and supporting KWfD's School Water Forum initiative in the schools of Grahamstown East. These posters allowed the learners to share their experience with their fellow classmates and teachers and hopefully provide a stepping stone towards changing perceptions, attitudes and behaviour the Kowie Catchment citizens have towards the river.

Thanks to the following organisations for sponsoring vehicles, food etc.: WESSA, KCC and IWR.

HISTORICAL PERSPECTIVES AND FUTURE DIRECTIONS FOR ACCESS TO LAND, WATER AND RELATED ECOSYSTEM SERVICES IN THE LOWER SUNDAYS RIVER VALLEY, SOUTH AFRICA: IMPLICATIONS FOR HUMAN WELL-BEING

Student: KL Chadzingwa
Supervisor: G Cundill and CG Palmer
Degree: MSc (Environmental Science)

The Lower Sundays River Valley is a predominantly commercial farming area in the Eastern Cape province of South Africa. The introduction of an inter-basin water transfer scheme which feeds water from the Orange River Catchment to the Lower Sundays River Valley (LSRV) has facilitated access to several ecosystem services. These ecosystem services include drinking water or food through the large citrus farming industry in this area. The relationship between land and water access in the LSRV is a complex one, where access to one of these resources usually defines how the other resource is used. In 2011 the Sundays River Valley Municipality had 39 recorded unsettled land claims through the Restitution of Land Rights Act 22 of 1994. Despite policy reforms, access to land and water in the LSRV has remained unequally distributed.

The aim of this study is to characterize the ways in which access to land and water over time has influenced current levels of human well-being for previously disenfranchised families in the LSRV. To this end, the following key questions were posed:

- How has well-being been impacted upon by access to land and water over time?
- Which ecosystem services have people had access to over time, how have these changed and which of these services are most valued by land claimants currently?
- How do land claimants perceive their current levels of well-being?
- What are the current sources of inertia or factors preventing increased access to desired ecosystem goods and services?
- What are the sources of innovation in the LSRV that could support access to desired ecosystem services?
- What trade-offs will need to be made, and by whom, in pursuing more equitable access to ecosystem services in the LSRV?

Through a complex social-ecological systems framing, the study used a mixed methods approach to collect data. The main results were divided into three sections, namely: the intergenerational impact of loss of land on human well-being, current levels of human-well-being and Innovations. This research is in the writing-up phase, after which conclusions will be drawn from the three results sections.

A citrus farm in Kirkwood, Lower Sundays River Valley.

EVALUATION OF THE LOW-COST TECHNOLOGY OPTIONS FOR SUSTAINABLE WATER SUPPLY AND SANITATION IN RURAL AND PERI-URBAN OF ZAMBIA: OPPORTUNITIES AND CONSTRAINTS

Student: Y Chiliboyi
Supervisors: PK Mensah and CJ de Wet
Degree: MSc (Water Resource Science)

The current study seeks to address challenges that are associated with lack of access to safe water and sanitation in Zambia. Adequate clean water and sanitation are fundamental components of effective public health systems. 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 two 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.

In developing countries such as Zambia, disparities exist between rural and urban areas are the availability of adequate water supply and sanitation; rural areas are deprived of basic needs such as access to safe drinking water and sanitation. Likewise, high population densities in peri urban areas are putting pressure on the available resources, leading to poor sanitation and water facilities, and imposing a serious threat to public health. Additionally, African countries generally lack the technologies needed to improve water and sanitation.

This study focuses on the investigation of low cost technology options that can help mitigate some of the challenges faced in water supply and sanitation in rural and peri-urban areas of Zambia. Additionally, the study also intends to determine the opportunities and constraints that are associated with the implementation of these technologies.

A TRANSDISCIPLINARY INVESTIGATION OF WATER GOVERNANCE IN THE LOWER SUNDAYS SUB-CATCHMENT OF SOUTH AFRICA

Student: JK Clifford-Holmes
Supervisor: CG Palmer, CJ de Wet and J Slinger (Delft University of Technology, the Netherlands)
Degree: PhD (Water Resource Science)

This research investigates water governance in the Lower-Sundays sub-catchment in the Eastern Cape province of South Africa, employing a novel and integrative transdisciplinary research approach to draw-on on the real-life, local experience of a contentious water supply case. The study uses the water services provided by the Sundays River Valley Municipality (SRVM) as the focal point of the research, with a particular emphasis on bulk water management between the SRVM and the Lower Sundays River Water User Association. In 2010, national and regional government departments in South Africa initiated intervention processes into the SRVM, following an extended period of financial mismanagement in which the provision of water services in the municipality had suffered. In spite of extensive government interventions aiming to improve service delivery in the SRVM, declining water services in the region contributed to violent

service delivery protests in the main town of Kirkwood in September 2014.

This research uses a multi-method approach that integrates ethnographic analysis, institutional analysis, and systems analysis within an action research project. The aim is to develop an understanding of water issues in the Lower Sundays sub-catchment in terms of how these issues interact to produce undesirable outcomes that are contrary to the principles of post-apartheid water policy, and how transdisciplinary, practice-based research can contribute towards addressing these issues. To this end, an ethnographically-embedded form of system dynamics modeling was employed as part of a broader governance analysis, with the objective of understanding the 'muddled middle' between the formal institutional domain of state-initiated arrangements, and the informal institutional domain of water service provision on-the-ground.

EXPLORING THE WAYS IN WHICH DANCE MOVEMENT PSYCHOTHERAPY (DMP) CAN PROMOTE PERSONAL AND SOCIAL CHANGE IN A SOUTH AFRICAN COMMUNITY EXPERIENCING WATER RELATED INJUSTICE

Student: A Copteros
Supervisor: CG Palmer, R Fox and V Karkou
Degree: PhD

The method and practice development phase of this research involves reflecting on my experience of DMP training in the UK and the registration process with the Health Professions Council in South Africa. Once this has taken place within the framework of phenomenology, which best suits exploring embodiment and the lived experience of people through their bodies, I can move onto the application of the method of DMP with a community of people who have experienced water-related injustice.

The research is based on ideas of complex social-ecological systems and the role transdisciplinarity can play in dealing with 'wicked problems'. Once a DMP group process has been completed, the relevance of DMP to a transdisciplinarity process in Integrated Water Resource Management will be reflected upon. For now, there are strong theoretical links around creating an ecological identity through re-engaging with the active, perceiving and sensuous corporeality of the body with other bodies (human and more-than-human) in making meaning about the environments in which these bodies relate to nature.

SOCIAL-ECOLOGICAL RESILIENCE FOR WELLBEING: A CRITICAL REALIST CASE STUDY OF BOKSBURG LAKE, SOUTH AFRICA

Student: HE Fox
Supervisor: CG Palmer
Degree: PhD (Water Resource Science)

This thesis is based on a case study of the degraded Boksburg Lake social-ecological system and an environmental education initiative that aimed to support its transformation. This initiative aimed to involve local people in reclaiming the lake's social and ecological value, through a process of collectively reimagining possibilities, shaping identities, gaining knowledge and developing local human agency. The focus was on social learning processes in schools and churches to explore opportunities for co-engaged reflexivity that might produce transformation.

Critical Realism was my chosen philosophical framework as it provided tools to explore deeper mechanisms beyond empirical reality, both influencing the degrading trajectory as well as providing possibilities for transformation. The choice of Critical Realism informed the scope of my primary research question: What generative mechanisms constrain and enable the development of social-ecological resilience for well-being, in the modern social-ecological system of Boksburg Lake?

Drawing on a broad reading of social-ecological literature from different vantage points, tools with explanatory power were developed to probe for generative mechanisms operating in the Boksburg Lake social-ecological system (research goal 1). The human capacity for symbolic representation is identified as an emergent property of co-evolving human-ecological systems. These symbolic representations become expressed in culture and worldviews, and influence patterns of identifying, types of knowledge and forms of agency. The nature of these will determine the degree that cultural systems are embedded within ecological reality and the extent of cultural-ecological coupling. A cultural system closely coupled with ecological realities is likely to value ecological systems and manage them for their health, while less coupled cultural-ecological systems are likely to lead to the opposite. Because of their integrated nature, the extent of ecological health and value will affect the decline or sustainability of cultural-ecological systems. Normalising ideologies is a concept coined in the thesis to refer to symbolic representations of reality that have become integral to a social fabric and determine meaning, while maintaining the domination of the powerful. These ideologies determine patterns of identifying, knowledge and agency and are recognised as having a fundamental influence on the resilience of social-ecological systems. Four normalising ideologies are identified that promote apparent human progress at the expense of ecological integrity and social equality and thus alienation with each other and the ecological world. These are human-ecological dualism, anthropocentrism, nature is mechanised and nature is to be controlled.

Generative mechanisms driving the current degradation of the Boksburg Lake social-ecological system were identified

(research goal 2). Drawing on critical methodology, the main method adopted was document analysis of the *Boksburg Advertiser* archives, Boksburg's local newspaper. Four generative mechanisms are recognised as most influential. Two of these have been named hegemonic symbolic systems. The primary symbolic system consists of the four normalising ideologies, mentioned above, that promote human progress at the expense of ecological health. The secondary, more explicit symbolic system, built on this, consists of the following normative ideologies: economic growth is imperative, unrestrained development is promoted, competition is the necessary means and consumerism is the good life. These two symbolic systems have had causal influence on the systematic erosion of ecological processes and biological diversity that has occurred in Boksburg, with the consequent undermining of social-ecological resilience for well-being. The third mechanism constraining resilience is the power dynamics that have shaped Boksburg's economic history and social-ecological system. This has resulted in a society built on inequality and injustice with all its associated social and environmental ills, expressed as externalities. The fourth mechanism resides in Boksburg's political and municipal dynamics. These structures are not designed to tackle complex social-ecological problems and they hold considerable agential power, yet seem dysfunctional at present.

Learning mechanisms that support transformation for greater social-ecological resilience of the Boksburg Lake social-ecological system were identified (research goal 3). Findings indicate that schools and churches are important institutions that can positively influence patterns of identifying, knowledge about and agency for Boksburg Lake and can thus play a role in transforming hegemonic normalising ideologies. Important learning mechanisms identified included: Learning reflexively together within communities of practice that provide opportunities for active rather than passive learning; involving the youth as they are a group of people with notable enthusiasm, vision, energy and motivation; learning through information acquisition, investigation, action and deliberation; learning about abstract concepts and theoretical knowledge but embedding this in local realities; and learning that provides reference markers for how things can be different.

ESTIMATING WATER USE EFFICIENCY USING EARTH OBSERVATION IN THREE RURAL CATCHMENTS OF THE EASTERN CAPE

Student: O Gwate
Supervisors: AR Palmer and SK Mantel
Degree: PhD (Water Resource Science)

My research focuses on determining evapotranspiration and water use efficiency in three rural catchments of the Eastern Cape. Understanding trajectories in these across environmental gradients provides an insight to the potential of ecosystem services. This could enrich decision making on the management of natural capital so that it continues providing requisite ecosystems services. In developing scenarios that can convince land users to change their behavior 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 tradeoffs may have for the people dependent on them. This will enable planners to evaluate the consequences of particular practices on the water balance.

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) non-lethal 2) applicable widely across biological systems and stressors 3) associated with life history traits and fitness 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 got 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. Therefore, FA levels were measured in the freshwater shrimp, *Caridina* sp., in shrimp collected from several sites during two seasons in two different areas posing different water quality issues: 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, whereas the Mpisini and Mdibi Rivers (KwaZulu-Natal) were possibly impacted by a smelter facility, forestry and human settlements.

Fluctuating asymmetry was present and measurable in some traits of the freshwater shrimp, *Caridina* sp. Some of the single traits analysed showed differences in FA levels, whereas the multi-trait analysis as well as the composite index did not find significant differences between either sites or seasons. Composite indices and multivariate analysis can often pick up differences between conditions where the analysis of single traits fall short but on the other hand these indices can also mask trait specific responses. It is possible that differences between sites or seasons were not drastic enough to result in differences between FA levels or different stressors were present resulting in equal FA levels overall. It became clear, that the response of FA to stressors and stressor combinations occurring in the environment needs to be clearly defined in order to use FA as a biomarker of water quality stress in aquatic organisms. For future studies an approach, where as many of the stressors present in the surrounding areas, heavy metals in tissues, sediment load and effects of stressors once they appear in mixtures would have to be taken into account to ensure sources of elevated FA stressors can be clearly linked with FA responses.

A CLASSIFICATION OF LARGE AFRICAN WETLANDS BASED ON THEIR FORM AND FORMATION USING EARTH OBSERVATION (EO) APPROACHES

Student: Z Lidzhegu
Supervisor: F Ellery and SK Mantel
Degree: PhD (Water Resource Science)

The current research focuses on the classification of large wetlands in Africa using earth observation and geographic information systems. While this study mainly takes into consideration the geological and geomorphological factors that determine the formation of large wetlands in Africa, it also focuses on wetland form that in turn determines the ability of wetlands to attenuate floods. This study is centered on two conceptual ideas. (1) One would expect Africa's topographic anomalies and aridity to militate against wetland formation, yet the continent hosts some of the world's largest wetlands. (2) There is limited information on how some of the large African wetlands function from a hydrological perspective. Information about their formation and discharge characteristics is scarce and results in an inadequate scientific basis for assessing the dynamics of these freshwater ecosystems. The scarcity of field survey and gauge data can be attributed to wetland inaccessibility, but Earth Observation (EO) data can provide a practical means of understanding these large ecosystems. The main objective of the study will be achieved following three specific objectives. (1) To identify and map large African wetlands. (2) To identify geological and geomorphological factors that determined wetland formation. (3) To classify wetlands based on processes that determined their formation and their associated morphology.

HYDROLOGICAL MODELING OF CHANNEL WETLAND EXCHANGES IN DIFFERENT LANDSCAPE SETTING 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 setting 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 basin. 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 utilizing 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 LISFLOOD-FP 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 outcomes of simulations will be used to predict the impacts of wetlands on runoff generation in basins.

MACROINVERTEBRATE-BASED BIOMONITORING OF THE BLOUKRANS RIVER, EASTERN CAPE, SOUTH AFRICA

Student: N Mgaba
Supervisor: ON Odume and CG Palmer
Degree: BSc Honours (Environmental Water Management)

Discharges from wastewater treatment works (WWTW) and run-offs from informal settlements are major sources of environmental pollution, affecting the health of freshwater resources. The Bloukrans River, in the Eastern Cape of South Africa, receives both wastewater effluent discharges and run-offs from the surrounding informal settlement, which impacts on its ecological conditions.

This project aimed to evaluate aspects of the ecological health of the river using macroinvetebrate-based biomonitoring approaches, including the biotic index score (i.e. the South African Scoring System version 5) multimetric and multivariate analyses of the assemblage structure. In addition, effluent from the Belmont valley wastewater treatment work was characterised to ascertain its Green-drop compliance status. The study was undertaken between April and September 2013. Macroinvertebrates were sampled bi-monthly using the SASS5 protocol at one reference site (Site 1) in the Palmiet River and four sites (i.e. Sites 2, 3, 4, and 5) in the Bloukrans River. The Palmiet River is close to the Bloukrans River, which had no reference condition site. Concurrently, water chemistry variables were measured at each sampling sites

and at the effluent discharge point. The SASS5 scores and ASPT values in the reference site revealed "good" water quality category, whereas apart from Site 5, water quality at the remaining three downstream sites were either "critically modified" or in "poor" conditions. Both the physicochemical results and the macroinvertebrate assemblage structure at Site 5 indicated system recovery with improved river health condition. Of the 19 metrics evaluated, 10 enabled the discrimination of Site 1 from the four downstream sites. Between the four downstream sites, 14 enabled the discrimination of Site 5 from Sites 2, 3 and 4. In terms of Green-drop compliance, the results indicated that during the study period effluent quality was not compliant.

Overall, the study revealed evidence of deteriorating water and biotic condition in the Bloukrans River and the discharges from the WWTW and run-offs from the surrounding informal settlements and farms are likely the chief contributors to the observed deteriorating water and biotic conditions. The 10 metrics which proved sensitive in this study could be used in addition with SASS5 for regular monitoring of the Bloukrans River, with a view to putting in place appropriate catchment management strategies to improve the river health condition.

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

Student: C Ndzabandzaba
Supervisor: DA Hughes
Degree: PhD (Hydrology)

Coli Ndzabandzaba

Water management problems still exist in most parts of the world. Sustainable management policies and practices are required to respond to these trends, and these can only be developed on the basis of adequate information about the water resources availability, variability and current and future uses. However, in Swaziland and some parts of Southern Africa there is inadequate and inconsistent hydrometeorologic data which necessitate modelling. Therefore, incorporation of uncertainty estimation in modelling is extremely important.

The research is aimed at developing a system that is based on both observed and simulated information and that includes uncertainty. The basis of the system will be the Uncertainty version of the Pitman model. The objectives of the research can be summarised as follows:

- To collect and collate up-to-date data and information (for five catchments of Swaziland) about the natural water resources and their current levels of development and use that may be relevant to impacts on the natural hydrology.
- To quantify the regional characteristics of natural hydrological response and the associated uncertainty bounds
- To set up an uncertainty version of the Pitman model using the regional characteristics of natural hydrological response to constrain the model output to establish behavioural parameter sets
- To incorporate existing water use and other modifications to the natural hydrological response in the model set-up
- To identify key regions and data sources where existing uncertainties might impact adversely on water allocation management decision-making

The ultimate aim is to contribute to the improved understanding and management of Swaziland's current water resources issues. It is envisaged that this will then bring forth a practical solution to the country's water resources problems.

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. 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.

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.

All decisions have a degree of uncertainty related to the outcomes of a given scenario and the effect this will have on stakeholder values it is therefore 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.

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 proposed by Hughes and Mallory (2009)Socioeconomic evaluations of water allocation strategies should therefore account for the impacts of periodic restrictions (or shortfalls. 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 proposed approach attempts to simplify the inclusion of some of the complementary attributes of these approaches to produce information for decision scenarios that can be used with existing decision making frameworks.

WATER SUPPLY INFRASTRUCTURE DECISION-MAKING IN SOUTH AFRICA

Student: IR Preston
Supervisors: L Louw, CG Palmer and JN Blignaut
Degree: MCom (Management)

South Africa is a semi-arid country that has a well-developed network of water supply infrastructure. Dams have been built in nearly all of the economically viable locations in South Africa and further dams will have to be built in the less desirable and more costly locations. It is estimated that nearly all of South Africa's easily accessible water is already being utilised. In addition to this the water quality of many rivers in South Africa is declining due to increasing pollution, abstraction, degradation of wetlands and the impact of as alien invasive fish and plants.. It is also predicted that climate change will exacerbate these issues.

Future surface water development, such as building dams and inter-basin transfers, is limited and is insufficient to meet the growing demand for water. It is therefore important to consider and incorporate alternative options, alongside these supply options, into water resource management and decision-making. Examples of these alternatives include the conservation and enhancement of existing water supply (including the management of invasive alien plants, groundwater, soil erosion and wetland management), demand-side management, and the reallocation of water rights.

This study aims to gain a better understanding of the water resource management (WRM) decisions that need to be made in order to ensure the improved long-term management of South Africa's resources. It also aims to make available useful data and a decision-making framework to inform discussion among decision makers involved in water supply development.

The purpose of this study is to determine what the key costs, benefits and decisions are that should be taken into account when faced with choices concerning raw water supply in a South African context. More specifically, it will have a historical focus on the construction costs of dams and the cost of invasive alien plant management as an additional WRM option. Furthermore, an analysis of the decision-making that occurred during the planning and building of a dam (the De Hoop Dam) using Zindiye's (2012) decision-making framework will be carried out.

Construction cost data is not readily available for dams built in South Africa, especially those dams built more than twenty years ago. The cost data in question includes estimated costs; actual costs; operational and maintenance costs. In this study, the Inyaka, Nandoni, Berg River and De Hoop dams were analysed. In three of the four, the actual cost of the dams was at least 30% higher than the estimated costs (after inflation was taken into account). There are various reasons for these increased costs and

these still need to be scrutinised to derive a satisfactory explanation.

In the analysis of the costs involved in managing invasive alien plants (IAPs) it was found that clearing invasive alien plants is a much cheaper option than additional surface water development (e.g. building a dam). However, it does not increase the reliable yield to the same extent as the development of a new dam. If IAPs are not managed, the negative impacts are considerably larger than the benefits derived from additional surface water infrastructure development. It can therefore conclude that water resource management decision-making should not be limited to a single solution but should rather incorporate a selection of alternative options.

INVESTIGATING INTEGRATED CATCHMENT MANAGEMENT USING A "SIMPLE" WATER QUALITY AND QUANTITY MODEL: A CASE STUDY OF THE CROCODILE RIVER CATCHMENT, SOUTH AFRICA.

Student: DCH Retief
Supervisor: AR Slaughter
Degree: MSc (Water Resource Science)

Internationally, water resources are facing increasing pressure due to over-exploitation and pollution. Integrated Water Resource Management (IWRM) has been accepted internationally as a paradigm for integrative and sustainable management of water resources. However, in practice, the implementation and success of IWRM policies has been hampered by the lack of availability of integrative decision support tools, especially within the context of limited resources and observed data. This is true for the Crocodile River Catchment (CRC), located within the Mpumalanga Province of South Africa. The catchment has been experiencing a decline in water quality as a result of the point source input of a cocktail of pollutants, which are discharged from industrial and municipal wastewater treatment plants and diffuse source runoff and return flows from the extensive areas of irrigated agriculture and mining sites. The decline in water quality has profound implications on a range of stakeholders across the catchment including: increased treatment costs and reduced crop yields.

The combination of deteriorating water quality, and the lack of tools and understanding of the relationships of water quality and quantity (Palmer *et al*. 2013) for determining compliance/non-compliance in the CRC has seen the collaboration of stakeholders, willing to work in a participatory and transparent manner to create an Integrated Water Quality Management Plan (IWQMP). This project aimed to model water quality, (combined water quality and quantity), to facilitate the IWQMP aiding in the understanding of the relationship between water quantity and quality in the CRC. A relatively simple water quality model (WQSAM) was used that integrates with established water quantity systems models, and was designed to be a water quality decision support system tool for South African catchments.

The model was applied to the Crocodile River Catchment (CRC); achieving acceptable simulations of historical conditions for Total Dissolved Solids (used as a surrogate for salinity) and nutrients (including: Orthophosphates Nitrates +Nitrites and Ammonium). Validation results revealed that there is very little consistency within the catchment, attributed to the non-stationary nature of water quality at many of the sites in the CRC. The analysis of results using a number of tools including: seasonal load distributions, load duration curves and load flow plots, revealed that the WQSAM model was able to capture the variability of relationships between water quantity and quality provided there was good simulated hydrology. The data produced by WQSAM was seen as useful for the CRC, with the Inkomati-Usuthu Catchment Management Agency (IUCMA) planning to operationalise the model in 2015. The ability of WQSAM to simulate water quality in data scare catchments, with constituents that are appropriate for the needs of water resource management within South Africa is extremely beneficial to integrated catchment management.

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

Student: DS Rugai
Supervisors: DA Hughes and S 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 models are typically used for mapping inundation areas in floodplain areas and require input data with finer temporal and spatial scales than frequently used in catchment hydrological models. This 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. Two floodplains with different

characteristics within Wami-Ruvu basin in Tanzania (Figure 1) will be used as case study. The study will be conducted in three main stages. The first will deal with uncertainty analysis in water balance modelling using a revised Pitman model. The second will involve 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 storage dynamics assessment in the selected flood prone areas. An integrated 1D-2D hydrodynamic model (SOBEK and LISFLOOD-FP) will be used to simulate floods for selected scenarios.

This 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 to assess flood inundation areas. The importance of quantifying the effects of flood attenuation within coarse scale hydrological models will also be investigated. The framework will enhance proper decision making in terms of land use management and flood mitigation practices by both policy makers, communities and individuals.

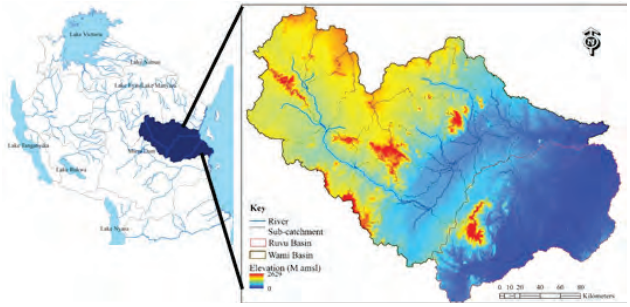


Figure 1 Location of Wami-Ruvu basin in Tanzania

A CRITICAL EXPLORATION OF THE DEVELOPMENT OF AN INTEGRATED, PARTICIPATIVE, WATER QUALITY MANAGEMENT PROCESS FOR THE CROCODILE RIVER CATCHMENT, FOCUSING ON THE SUGAR INDUSTRY.

Student: A Sahula
Supervisor: CG Palmer, SK Mantel and AV Munnik
Degree: MSc (Water Resource Science)

Water quality deterioration is reaching crisis proportions in South Africa (CSIR, 2010; Ashton and Dabrowski 2011). Many South African catchments are over-allocated, and decreasing volumes of source water mean increasing concentrations of pollutants. The Crocodile River Catchment in the Mpumalanga province in South Africa was identified through previous research, as a catchment faced with the deterioration of source water for water users in the catchment. Poor source water quality is becoming a sufficiently acute concern for the stakeholders in this catchment and they need to co-operate to develop a process that assists with compliance control of their water use and waste disposal to reduce costs, decrease industrial risks as water quality compliance increases, and improve source water quality. Affected industries in the Crocodile River Catchment include water boards, water user associations, mines, forestry, pulp and paper manufacturing and sugar mills. A viable solution to address this matter is for stakeholders to co-operate with each other and with the regulators to set their own management processes and to collectively hold each other to account.

The sugar industry is downstream within the Crocodile River Catchment and affected by the activities of upstream water users, and dependent on the stakeholders upstream participating in the effective management of the resource. However, the sugar industry is also located just before the confluence of the Crocodile River and Komati River upstream of the Mozambique border, thus the water quality of the sugar industry will affect the quality of the water that flows into Mozambique. Therefore, the sugar industry also has a role to play in the management of water resources in the Crocodile River Catchment.

This study provides a focused view of the role of the sugar industry in the development of a co-operative, integrated water quality management process (IWQMP) in the Crocodile River Catchment. In order to address the objectives of this study, this research drew from an understanding of the social processes that influence water management practices within the sugar industry as well as social processes that influence the role of the Inkomati-Usuthu Catchment Management Agency as a governing body in water management in the Inkomati Water Management Area. The study also drew from an understanding of scientific knowledge in terms of water quality analysis as a biophysical component to describe the water quality impact on the sugar industry and the impact of the sugar industry on the in-stream water quality of the river below the industry. The use of the contribution of scientific knowledge in terms of an understanding of the biophysical processes that influence water quality in the Crocodile River Catchment is important to inform societal response or decision making that will improve water quality management in the catchment. While an understanding of biophysical processes through scientific knowledge is critical in water management decision making, it is evident that an understanding of other actors, institutions and networks that inform water quality management decision making also plays a significant role. The notion of improving the role of scientific or biophysical knowledge in contributing to socio-ecologically robust knowledge co-creation, decisions and actions towards resolving water quality problems is emphasised. Specifically, moving towards improving interactions between scientists and other actors (water users in the Crocodile Catchment in this case), so that scientific practices become more orientated towards societal platforms were water quality management is tackled to enable improved water quality management practices. Therefore, linking the social and biophysical components in this study provides a holistic understanding

of how the sugar industry can contribute to the development of an IWQMP for the Crocodile River catchment.

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, in the context 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 modeling of it) of development interventions and support that take place, not during, but well after, resettlement.

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 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 happened - 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 proposes to investigate 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 will be on the NGO Harvest Help Zambia. Specific HHZ project activities focus mainly on supporting community led initiatives encompassing agriculture, health, education and environment, civic education and business development.

Goals of this Research
Research will address the following key overarching question:
How do development interventions by NGOs influence the long term trajectory of the resettlement process? Specific sub-questions are as follows:

1. What has characterized the way the resettlement trajectory has emerged in Simamba's chiefdom? Has /how has this been different /similar to the other Kariba chiefdoms? Has/how has the trajectory in Simamba's chiefdom been influenced by HHZ? Is it significantly different in areas of Simamba's chiefdom that have not been impacted by HHZ?
2. Is/how is the land use, demographic and socio-economic situation in Simamba's chiefdom similar to/ different from that in other Kariba resettlement areas? And how does this relate to i)its relative physical isolation ii) access/lack of access to socio-economic opportunities; iii) the NGO interventions, and iv) local politics over the years within Simamba's chiefdom - and its relations with the centre?
3. Has HHZ's project work differentiated between the resettlers and host populations? If so, how has such differentiation affected local welfare and relationships?
4. Has the approach of other NGOs been different / similar to that of HHZ? Have they/how have they impacted the resettlement trajectory?

Methods
This research has employed a mix of qualitative and quantitative data collection methods and techniques in an ethnographic framework which allows researchers 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.

Ethics
The research has been conducted in conformity with the requirements of the Rhodes University Ethical Standards Committee.

The thesis is currently being written up, and is due for submission in 2015.

EVALUATING MINING AND MINING-RELATED LICENSING PROCESSES WITH REGARDS TO WATER QUALITY, WETLANDS AND BIODIVERSITY CONSERVATION MANDATES.

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 of 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 ICMA (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 possessing a significant threat to the water quality in the Upper Komati (ICMA, 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. This MSc project will contribute to a larger project currently being run by the UCEWQ on the Crocodile river, which goes to the root of the mining-water resource protection interface and provides an opportunity to break new ground in aligning biodiversity and mining goals with the development of robust processes to negotiate appropriate controls, mitigation and even decisions to restrict mining.

I will be interviewing the Environmental Officers of a selection of coal Mines found in the Boesmanspruit Dam Catchment (X11B) in order to determine the Pros and Cons of the current Mining licensing procedure, while investigating the officers ideas and thoughts on ways in which it could be changed to create a faster, more sustainable and efficient process, i.e. I will be attempting to streamline the mining licence procedure. I will be interviewing other parties that are involved with this process to get better understanding on how the licensing process can be improved. I will also be investigating, using the framework of ecological modernization, how the mines have changed over time in response to increased pressure on mine to change its involvement in the deterioration of the environment. This framework will allow me to investigate the pressures on the mining industry and the regulator with regards to water and biodiversity, how the regulator responds to this framework, and how the mines respond to it.

Acid Mine Drainage decanting from a non-operational Coal Mine in Carolina, 2014.

POLICY DEVELOPMENT AND THE PROMOTION OF RESPONSIBLE RESETTLEMEENT 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 a 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 usually 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 capture 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, for 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 complexity 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 will explore 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 will consider, among other factors, how the complexity of the resettlement process has been negotiated in the implementation processes, and how that relates to the outcomes. It will also explore 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 and South Africa, have engaged in large scale development projects that saw masses forcibly moved to make a 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) whose 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. As argued earlier, 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 will only be on the dams sector, within a specific region in China/India and in Lesotho.

Methods, procedures and techniques
The research will involve fieldwork in India over a period of three months, and another three months in Lesotho. During this time the researcher will build on the already existing working relationships between the supervisor at Rhodes University, and the resettlement researchers at the Xavier School of Business and Human Resources in India, as well as with the Lesotho Highlands Development Authority (LHDA).

The research and writing up of this thesis will be conducted in conformity with the requirements of the Rhodes University Ethical Standard Committee.

THE ECOLOGICAL RISK OF ACID MINE DRAINAGE IN A SALINISING LANDSCAPE

Student: E Vellemu
Supervisors: CG Palmer and PK Mensah
Degree: PhD (Water Resource Science)

Emmanuel Vellemu

My PhD focus is on "The Ecological Risk of Acid Mine Drainage in a Salinising Landscape". Several studies have recognised salinity as a major challenge affecting South African freshwater bodies. However, salinity has been linked to Acid Mine Drainage (AMD), a very problematic issue in South Africa mainly arising from the mining activities such as coal and gold. This study aims to establish the links and ecological risks of AMD in a salinising landscape. One of the objectives of this study is to critically understand the socio-ecological aspects of acid mine drainage and salinity in the Olifants catchment area; and finding the system approaches that will address any existing challenges such as conflicts among water users and mining companies. The overarching aim of this objective is to develop and propose inclusive water management policies (in cases where some actors are excluded) in South Africa.

I plan to design an artificial AMD-salt model while running series of ecotoxicity experiments using freshwater macroinvertebrates. This model will be used to simulate the events that occur in the natural environment in order to be used as a prediction tool for possible risks, uncertainties and effects of any "would be" ecological disturbance acts by the mining industry in South Africa with an aim of protecting the freshwater resources. With regards to findings, I expect to find ways on how to solve emerging conflicts that arise among water resource users in a particular catchment system such as the Upper Olifants or Crocodile River systems. I also plan to develop AMD water quality guidelines for freshwater resources in South Africa.

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

Student: M 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 Municipality in the heart of the Eastern Cape province of South Africa. This social-ecological system contains the Blouwkrantz River locally known and 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 1813 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 Makana Municipality 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 non-governmental 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 team, have adopted the attitude of "… changing from just complaining

to becoming part of the solution" and the vision of "Building of a Peoples' Science to underpin a Peoples' 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 a new paradigm". KWfD is conducting numerous initiatives in Grahamstown East that range from establishing ward based Community Water Forums to serve as communication hubs of water related issues between citizens and the Makana Municipality and vice versa; an emergency water supply initiative the One Street One Tank (OSOT) project; School Water Forums to address sanitation, hygiene and catchment stewardship; to investigating local water service experiences through a citizen survey.

The main aim of the study is to explore how a team of citizen based research partners, KWfD, came into being, and acts to promote and practice effective and sustainable citizen based research in relation to water service issues in the Makana Municipality.

By adopting a participatory research methodology the study is tracking these initiatives with specific focus on that of the OSOT project. By using OSOT as a lens, engagement processes to establish effective and sustainable communication between OSOT stakeholders can be analysed. To date the team's successful engagement with Unilever South Africa has greatly contributed to the progress of OSOT. The study reflects on events such as a School Water Forum River Day that was hosted by KWfD where it was shown that a citizen based research partnership could improve its effectiveness by partnering with other stakeholders like the Wildlife and Environment Society of South Africa (WESSA), the Kowie Catchment Campaign and the Albany Museum.

KWfD engages with Unilever South Africa, Makana TNP and KSG on a site visit of the OSOT project in Grahamstown East (top). On a river day headed up by KWfD School Water Forum members from 7 schools in Grahamstown East learning about the impact humans have on catchment health through the citizen science bio-monitoring tool MiniSASS.

RESEARCH OUTPUT

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Back Cover (from top to bottom): Mini-SASS; Unilever Visit 16 September 2014; Dr Nelson Odume assists Victoria Girls' High School Learners in Identifying Aquatic Macro-Invertebrates during a field trip to the Botanical Gardens; Mr E Vellemu sampling at Palmiet River


Jojo