Producing the next generation of water resource experts in South Africa

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Introduction

The 2nd African Water Symposium, in conjunction with the 6th Orange River Basin Symposium, was held on the campus of the University of the Free State, Bloemfontein, on 7 and 8 October 2015. The theme of the symposium was 'systems thinking in environmental water resources management', with the aim of evaluating and debating a holistic approach to water management in southern Africa. The symposium included a panel discussion that was originally intended to define a roadmap towards effective water resources management, but it soon took on a life of its own and evolved into a discussion on how to develop and train the next generation of managers and scientists to tackle the current challenges being faced by the wider water sector. This commentary serves as a record of the main themes identified during the panel discussion and begins by setting the South African context and identifying the plurality of values and opinions held by stakeholders in the post-apartheid water sector. It then elaborates on the decline of water specialists in the country and identifies the characteristics needed from a new generation of water scientists and managers. Finally, it outlines some of the proposed strategies to cultivating a new cohort of specialists able to tackle the challenge of effective water resources management in South Africa.

Shaking off the shackles of history

The 2-hour long discussion session consisted of opening statements from a panel of scientists and practitioners specifically selected for their experience in different parts of the water sector (Table 1). After statements from these experts, the floor was opened to contributions from the audience, which included government officials, university researchers and professionals from environmental non-governmental organisations.

The panel of experts began by highlighting what they felt were the main constraints to effective water management, which included familiar culprits: poor governance caused by absent or ineffective communication between different governmental spheres and departments, lack of deployment and enforcement of our progressive national water policies, stop-start engagement of the new statutory institutions (such as water user associations) and the rapidly deteriorating infrastructure for water provisioning and sewage treatment. Overarching these dilemmas was the looming shortcoming of ever-eroding expertise and institutional capacity. Identifying these problems was certainly not unique; in fact, these same weaknesses were identified during the same symposium four years earlier.[1] However, reiterating these shortcomings during the panel discussion led to an important moment of reflection after the floor was opened to comments from the audience.

One of the major obstacles to effective water resources management became immediately clear after only a few moments of discussion. The first audience member, noting that the panel of experts was made up exclusively of white males at or approaching retirement age, pointed out that their criticisms were perhaps unfounded. Although she acknowledged that the efficacy of national water management has declined during recent decades, she argued that this was not necessarily the result of deteriorating institutional infrastructure. Instead, she reasoned that the water provisioning landscape in post-apartheid South Africa has stretched the water sector to breaking point. *The National Constitution (Act 108 of 1996)* and the *Water Act (Act 36 of 1998)* meant that the government's priority necessarily lay in correcting the historical neglect in servicing the very large number of South Africans with a right to clean drinking water. Inevitably, the unprecedented demand for water quickly outpaced the ability of the state to supply it. Immediately following the democratic elections of 1994, the first post-apartheid government faced a situation where one third of the population (estimated 12 million out of a total 36 million people) did not have access to clean drinking water.[2] A decade later, the government had reduced this number to an estimated 3.7 million people out of a total population of 48.1 million.[2] It was inevitable that the whole water sector would struggle to cope in a water-scarce country that almost doubled the number of citizens with access to clean water while also sustaining a 3% increase in gross domestic product (GDP) and a 1% growth rate in GDP per capita during the same period.[3]

This exchange lead to an instance of conflict in the meeting where the current decline of effective water management was brought face-to-face with the pressures to redress historical injustices. In this, the panel discussion in a small portion of central South Africa became a microcosm for the water sector at large. Fortunately, after a few anxious objections, the tension in the room dissipated after communal *mea culpa*. Those in attendance realised that both the panel of experts as well as the critical commentator from the audience had valid arguments. Just as it is unfair to ignore the historical context in South Africa, is it equally unfair to continue blaming our apartheid past for all our present shortcomings in the water sector.

The lesson learnt, therefore, was that different stakeholders hold different interpretations of the same situation. Moreover, the only way to prevent dialogue from disintegrating into accusations and blame-shifting is to acknowledge the fact that the water sector is a tangled knot of, sometimes contradictory, impressions and perceptions. Unless different groups in South Africa experience, what Brown[4] terms, a 'cultural revolution', then the legacy of apartheid – and the maligned perceptions of and by different groups – will continue to interfere with participatory approaches to water management.

Lamenting the lost limnologists

The panel discussion moved on to more technical topics once those in attendance had acknowledged and accepted the varying opinions of their colleagues in the room. However, the theme of the first comment from the audience lingered on. The experts on the panel were indeed hovering near retirement age. While it is convenient to dismiss this as poor planning by the symposium organisers, the truth is that this lack of diversity is symptomatic of the wider water sector.

Table 1: The panel of scientists and practitioners specifically selected for their experience in different parts of the water sector.

Expert	Expertise	Experience
Dr Harry Biggs	Adaptive management of aquatic ecosystems	Former Programme Manager of the Kruger National Park Rivers Research Programme; Programme Integrator for Systems Ecology for South African National Parks; IUCN/WCPA freshwater task force coordinator
Mr Nic Knoetze	Water usage in the agricultural sector	Former Deputy Regional Director for the Department of Water Affairs and Forestry in the Northern Cape Province. Currently Chief Executive Officer for the South African Association for Water User Associations (SAAFWUA)
Prof. Maitland Seaman	Aquatic ecology, biomonitoring training and education	Former researcher at the National Institute for Water Research and recently retired Director of the Centre for Environmental Management at the University of the Free State
Prof. Anthony Turton	Water governance and strategic planning.	Formerly at the national Council for Scientific and Industrial Research (CSIR) in the position of Strategic Research Leadership: Water Resources Management; Currently Professor in Environmental Management at the University of the Free State
Dr Johan van der Merwe	Geohydrology and water provisioning	Former Deputy Director at the Department of Water Affairs and Forestry (Water Quality and Geohydrology) in the Free State and Deputy Director of Strategic Support in the Department of Water Affairs. Currently an Affiliated Researcher at the Institute for Groundwater Studies at the University of the Free State

Harding[5] reported that from as early as 1989, scientists have complained about the insufficient financial support for South African limnologists, which at the time was less than that for a single Australian institute. He further argued that this lack of investment has not changed over the past 25 years, leading to many potential limnology students gravitating towards more richly-funded fields like chemistry and microbiology. This has resulted in a lost generation of limnologists with the necessary skills to grapple with water-related issues.

The heading of this section is restrictive for alliterative purposes, but it should not imply that the shortage of expertise is limited to limnology. South Africa also has a limited number of hydrologists and geohydrologists. All of these water specialisations are necessary to develop and manage South Africa's limited water resources efficiently. With more than 80% of our surface water resources already allocated to water users,[6] the need to develop and manage groundwater resources (of which approximately 3 500 Mm^3/a is available for further development) is critical. This seems the most promising way to address water deficits, which have already been reported in half of the water management areas in South Africa.[7] The challenge of meeting the current and future water demands, while redressing injustices of the past, can only be achieved by developing groundwater resources in tandem with managing surface water resources more efficiently. Moreover, surface and groundwater should be managed as one holistic system. To achieve this goal, we need to equip limnologists, hydrologists and geohydrologists with a skillset to develop and manage the water resources in the face of environmental and socio-economic change.

The sad reality, however, is that the number of freshwater scientists with active research programmes has declined in South Africa since the mid-1990s.[8] Furthermore, even when universities still offer study programmes in limnology, hydrology and geohydrology (as is the case at the University of the Free State), these programmes are offered independently and are spread across multiple departments. This thwarts any attempts to integrate surface and groundwater into one holistic system.

During a recent interview, the Minister of Water and Sanitation, Nomvula Mokonyane, stated that 'we need more bodies with the knowledge and capability...the right people in the right place with the ability to do the job'.[9] Yet, despite this encouraging endorsement, the estimated percentages of vacant posts in the Department of Water and Sanitation for hydrogeologists and geohydrologist in 2010 was 47% and 53%, respectively.[6] One reason for this is the difficulty of replacing recently retired experts, so much so that in 2010 more than 50% of the groundwater personnel at the Department of Water and Sanitation had fewer than 5 years' experience and lacked experienced mentors to guide them.[6]

The dearth of specially-trained water scientists was echoed during the panel discussion with many of the subsequent comments criticising the work-preparedness of recent graduates who, it was argued, lack the necessary deep technical understanding of the complexities of the water sector. Moreover, it was suggested that graduates are unable to respond quickly enough to the ever-changing demands of the water sector. This, therefore, begs the question: is it possible for individual students to embody a deep understanding of complex topics, have the ability to adapt to changing circumstances as well as the deliberative skills for coping with the diverse values and perceptions of their colleagues and stakeholders?

There are currently two predominant paths toward employment in the water sector. The first is the traditional path through a single academic discipline, such as civil engineering or aquatic ecology. The second path is one through modern transdisciplinary programmes, such natural resources management, public policy or environmental management. The trouble is that the former group often lacks the over-arching perspective of the broader sector whereas the latter group is missing the deep expertise to solve complex technical issues. Consequently, the path forward for training water professionals needs to amalgamate both core disciplinary competencies and a holistic appreciation of the broader sector together with the competence required to address complexity, all within a single curriculum.

Nurturing new water resource expertise

Being an academic symposium, the panel of experts as well as many members of the audience had their foundations in a single academic discipline. However, as the discussion progressed it became clear that few of these people were constricted by their academic background. Amongst the expert panellists was, for example, Dr Harry Biggs who began his career as a veterinarian before moving into adaptive

management in complex systems and Prof. Anthony Turton, who started out in the National Intelligence Services before branching out into water-related issues. Furthermore, even though the other panellists largely remained in the discipline in which they were originally trained (engineering, geohydrology and aquatic ecology), their career paths included forays into water management, policy and provisioning. Each of their cases typified 'T-shaped' skills, where a depth of understanding is initially developed within a specialist discipline, but is then coupled with a capability to understand and interact with specialists from a wide range of fields.[10]

How can we encourage the proliferation of people with T-shaped skills in the water sector? Perhaps a suitable analogy – and one befitting the theme of the symposium – relates to how the management of natural systems has moved away from viewing nature as a static phenomenon to viewing it as dynamic and adaptable instead. Consequently, management interventions no longer try to keep these ecosystems in a fixed state, but rather allow for complexity, dynamism and resilience. Resilience in ecosystems is viewed as the capacity of a system to withstand shocks while still retaining it essential function and structure.[11] High-altitude wetlands, non-perennial rivers, man-made dams and estuaries might have completely different functions and structures, but their resilience can be defined by the same set of characteristics: slowly changing state variables, the extent of endogenous self-organisation (as opposed to external drivers) and mechanisms for the evolution of novelty.[12] Similarly, specialists in the water sector should not be pushed into constrictive boxes defined by specialist academic training. Instead, we should encourage these individuals to become resilient and adaptable to changing contexts, without jeopardising their core competencies.

Fazey and colleagues[13] propose that, like socio-ecological resilience, resilient individuals can be classified according to four main requirements. The first requirement is the willingness to maintain resilience, which is distinct from exclusively pursuing productivity and efficiency. This necessitates a conceptual change where innovation and flexibility are granted the same level of importance as efficiency and optimisation.[14] The second requirement is an awareness of current problems as well as the desired endpoint. This is where a deep technical knowledge of a specific discipline interacts with philosophical judgements of what is valued and desired. Moreover, it allows for value pluralism – and regular conflict between values – by acknowledging that utilitarianism and instrumentalism are only two of many ethical positions.[15] The third requirement is proactive behaviour, which borrows from post-normal science.[16] Post-normal science, unlike normal science, which is settled in a fixed paradigm, does not view ignorance as negative or threatening, but rather as an essential complement to knowledge.[16] It also means rethinking future uncertainties and not making misinformed assumptions about the future state of the environment.[15] The final requirement for a resilient individual is the ability to change existing behaviours. This requires the existentialist viewpoint that the narrative of any individual – the way she sees and fulfils her own role within society – is changeable through self-determination.[17]

The atmosphere in the panel discussion suggested that South Africa is failing to produce adaptive and resilient water professionals. This is likely because tertiary education institutions are not teaching students different ways of thinking for a variety of situations (i.e. metacognition).[13] Instead, increasing class sizes (without proportional increases in funding) are forcing universities to rely on less qualified staff using automated assessment methods,[13] which ultimately shifts the focus away from developing metacognition and towards the regurgitation of the facts and knowledge from other people's thinking. One can only imagine that the increasing financial burden on universities in the aftermath of the #feesmustfall protests in the higher education sector will only weaken the capacity of universities to invest in developing resilient and adaptable graduates.

The reality is that we cannot predict in what state the water sector will be when the current generation of students graduate. As the higher education sector, we should, therefore, be preparing our graduates for uncertain futures and the only way to do this is by focusing on producing resilient individuals, not fact-spitting parrots.

The path forward

The South African water sector still faces many challenges; amongst them are the biophysical constraints caused by supplying an increasingly polluted resource to meet an ever-growing demand. Coupled to this is the uniquely South African socio-economic realities typified by the need to redress historical injustices and alleviate wide-scale contemporary poverty. These are undoubtedly 'wicked' problems involving complex and unpredictable systems that contain stakeholders with conflicting interests.[18,19] Solving such problems will require political will and intellectual resolve. Perhaps even more unsettling is the scarcity of well-trained adaptive individuals that can meet the challenges of water resources management in this country. To this end, the onus is on the higher education sector in South Africa to not only expand the training opportunities for aspiring water specialists, but to fundamentally alter the way we train our students. There has to be mindset shift away from producing a mob of superficially-trained graduates to producing a cohort of deep reflective thinkers.

The current water landscape in South Africa is approaching a state of crisis. In this metaphorical war, we need a taskforce of specially-trained operatives, not a troop of cadet soldiers. To reach this goal, emphasis should be placed on drawing in the expertise of the few remaining water experts to share their knowledge and experience by mentoring the upcoming generation. More importantly, higher education institutions should stop fighting over pass rates and how these figures relate to government subsidies. Instead, we should invest our time and energy into nurturing resilient individuals with the capacity to adapt to future uncertainties. Unless we do so, we will face several years of drought in terms of both water availability and intellectual capacity.

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