CAPACITY BUILDING

Helen Dallas – A career dedicated to the conservation of southern Africa's freshwater systems

This article forms part of a series of profiles on high achieving water researchers supported by the Water Research Commission as part of the Commission's 50-year celebrations.

Dr Helen Dallas is the Executive Director of the Freshwater Research Centre in Cape Town.

Over the past three decades, Dr Helen Dallas has made a significant impact on the advancement of freshwater science in South Africa, so it may come as a surprise that she started out as a desert ecologist. Sue Matthews spoke to her about her career achievements and challenges.

After completing her Honours degree at Rhodes University in 1987, Dallas spent 18 months as a research assistant at the Desert Ecological Research Unit in Gobabeb, Namibia, then went backpacking for a year before finishing her time overseas with a six-month scholarship at the Mitrani Centre for Desert Research in Israel. Soon after her return to South Africa at the end of 1990, she visited the Zoology Department at the University of Cape Town (UCT), where she'd done her undergraduate degree, in the hope of finding a job.

"Fortuitously, I knocked on Jenny Day's door in the Freshwater Research Unit, and she said she'd just got the go-ahead for a project funded by the Water Research Commission (WRC), and needed a research assistant. Within six months the senior researcher had left, so I went from being very green and knowing very little to taking on much of the project. It was a baptism by fire, but writing the review on 'The effects of water quality variables on riverine ecosystems' brought me up to speed quickly."

The review, first published in 1993 and updated in 2004, remains one of the most cited documents on water quality worldwide. The initial project was followed by another WRC-funded one on tools for evaluating regional water quality guidelines, and during that period Dallas was also on the project team tasked with

writing the national water quality guidelines, published in 1996 by the then Department of Water Affairs (DWAF).

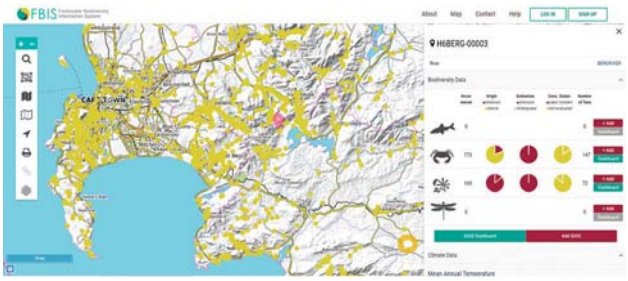
The initial project also introduced her to bioassessment methods, and, more specifically, the South African Scoring System (SASS), which became the subject of her MSc thesis, submitted in February 1995.

"I was really lucky in that project because I got to work with two of the gurus of freshwater science. One was Arthur Harrison, who took me to his original sites that he worked on in the 1950s and showed me the ropes so that I could do field surveys at the same sites. The other was Mark Chutter, who'd got funding from the WRC in 1994 to develop a rapid bioassessment method, which was SASS, building upon his biotic index from the seventies. Part of his project was to test it in different parts of the country, and I was so keen that I got to do it in the Western Cape. With Jenny as my mentor, I then did my Master's on evaluating SASS as a tool for assessing water quality."

Over the next decade, Dallas played an instrumental role in the South African River Health Programme, which incorporated SASS as the bioassessment method for aquatic invertebrates, but also made use of indices for fish, riparian vegetation, habitat integrity and geomorphological processes for monitoring ecosystem health. She served as the Western Cape champion for the programme, provided SASS training and accreditation, and designed the Rivers Database for the collation and management of data emanating from the programme on a national scale.

Dallas had gained database expertise when she developed the BioBase, the first version of which was completed with the technical support of Pierre Janssens in 1998. Biobase contained historical published data on macroinvertebrates and water chemistry from various studies on South Africa's rivers, and was one of the products of the earlier WRC-funded project on the effects of water quality variables on riverine biota. She subsequently led the development in 2006 of the Wetlands Database, which was part of a WWF-funded project to identify and collate existing information on the wetlands of the Western Cape.

These three pillars – physico-chemical impacts on aquatic ecosystems, bioassessment and database development – have provided the foundation supporting her research interests to this day. In 2002, she was awarded her PhD for her thesis on spatial and temporal heterogeneity in river systems and the implications for defining ecological reference conditions for macroinvertebrate bioassessment. In the same year she began conducting research and training in Botswana's Okavango Delta through projects funded by Conservation International, the Water Research Foundation of Southern Africa, and the Okavango Research Institute at the University of Botswana.



The Freshwater Biodiversity Information System (FBIS) developed by Dallas and her team currently includes more than 300 000 biotic and 100 000 abiotic data records. It can be accessed at https://freshwaterbiodiversity.org/

This resulted in publications in 2007 and 2020 – co-authored with Belda Mosepele of the Botswana University of Agriculture and Natural Resources – examining aspects of the spatial variability of the delta's macroinvertebrate assemblages and considerations for developing a rapid bioassessment tool. Follow-on papers will explore temporal variability and the development of the Okavango Assessment System (OKASS), a preliminary macroinvertebrate-based biotic index. Dallas also supervised Lulu Kaaya from the University of Dar es Salaam in her doctoral research resulting in the Tanzania River Scoring System (TARISS), and collaborated with the Universities of Glasgow, Aberdeen and Zambia in a project funded by the European Union to develop the Zambian Invertebrate Scoring System (ZISS).

"The Okavango one is a bit different because the Delta is a wetland system rather than a riverine system, although it includes river channels, so it's quite a challenge and it's still a work in progress – people are testing it so that it can be refined," she explains. "But TARISS has started to gain traction, even though it's only been developed and tested in two catchments, while ZISS has students starting to use it, and is slowly gaining momentum within their governmental Department of Water Resources Development. These indices are not as entrenched as SASS is in South Africa, but they work well, and with countries that are under-resourced in terms of finances it's the only way to go."

Dallas recently wrote a review article titled 'Rapid bioassessment protocols using aquatic macroinvertebrates in Africa – considerations for regional adaptation of existing biotic indices', which was published in ***Frontiers in Water*** in February 2021. The article was partly in response to two papers from 2019 detailing the use of TARISS in Rwandan and Ugandan rivers. She points out that rapid bioassessment protocols and biotic indices can be applied in other countries or regions, but they should ideally be calibrated, validated and modified first to ensure their effectiveness.

As for the physico-chemical 'pillar' of her research, Dallas began honing in on the role of water temperature in riverine ecosystems from 2007, funded by the WRC via an initial research consultancy and then a suite of research projects. She is especially interested in the ecological consequences of climate change, and ways of promoting ecosystem resilience to rising water temperatures.

"Water temperature and flow are the two things that are obviously going to change in response to climate change, other than drought and flood events, and in the Western Cape the low-flow periods are in the summer months when it's hottest, so that's the most stressful period for aquatic organisms," she explains. "You can't change what sunlight comes in, but you can change the amount of water in the system by altering farming

Dr Helen Dallas has conducted freshwater research in several southern African countries, including Zambia, Tanzania and in the Okavango Delta.

practices to avoid abstracting during the peak summer period, so there's at least enough flow in the river to mitigate the increasing temperature. And then if you can maintain the system in as natural condition as possible – with riparian vegetation providing shading, buffer zones reducing pesticide and other pollution, and instream habitat like pools deeper than a metre ensuring cool-water refugia for fish – it's giving the biota the best chance of surviving that very stressful period."

Apart from participating in numerous field surveys to evaluate the influence of water temperature on biota, Dallas has played a leading role in developing laboratory methods to measure thermal tolerance of aquatic insects and fish, as well as sub-lethal effects such as egg development and thermal preference. She pioneered the use in South Africa of the non-lethal Critical Thermal Maxima (CTM) method, which involves observing the behavioural response of aquatic organisms while slowly increasing the water temperature, and removing them when they show clear signs of stress.

"Mayfly larvae, for example, lose their ability to grip onto the mesh and fall to the bottom, while fish lose their righting ability and don't swim well. At that point you take them out, put them back in the starting temperature, and allow them to recover," she explains. "We also did experimental work on the thermal preferences of fish by creating PVC gutter systems with a gradient from cool to hot and observing where they spent the majority of their time."

Most of the temperature-related WRC projects have been conducted with her long-time collaborator, Dr Nick Rivers-Moore, together with other researchers and students, and culminated in the production of the dual-volume ***Environmental water temperature guidelines for perennial rivers in South Africa*** (**WRC Report no. TT 799/1/19 and TT 799/2/19)** in 2019. While Volume 1 provides the background to the project and uses three cases studies to demonstrate the protocol for establishing environmental temperature guidelines, Volume 2 is the technical manual for setting water temperature targets. It serves as a road map for water resource practitioners needing to incorporate water temperature into Resource Directed Measures, including ecological Reserves and Resource Quality Objectives, as well as Source Directed Controls.

"We've recently received the go-ahead for a follow-on three-year project, in which we're going to develop a thermal module to automate some of the tools for water temperature screening and evaluation."

Belda Mosepele of the Botswana University of Agriculture and Natural Resources and Dr Helen Dallas in the Okavango Delta.

Although the manual includes several tools to facilitate use of the guidelines, such as a screening tool to allow users to check whether they should be particularly concerned about water temperature at their sites, Dallas says that the process will be even easier once a thermal module has been integrated into the Freshwater Biodiversity Information System (FBIS), her latest collaborative endeavour in bioinformatics and databases. In 2017 she successfully applied for funding from the JRS Biodiversity Foundation in the United States to develop the system, the third version of which was released in July 2020.

Designed with technical partner Kartoza and using open-source software, FBIS currently includes in excess of 300 000 biodiversity records for invertebrates, fish and algae in South African rivers, as well as 100 000 abiotic data records. These emanate from the Biobase, Rivers Database and various research projects, and data are also harvested from GBIF – the Global Biodiversity Information Facility. The system has several base layers and more than 40 spatial layers to contextualise and filter data.

"We've recently received the go-ahead from JRS Biodiversity Foundation for a follow-on three-year project, in which we're going to develop a thermal module to automate some of the tools for water temperature screening and evaluation," says Dallas. "We're also developing a mobile app for some components of FBIS so that users can upload data, such as SASS data, even while still in the field. We are hoping FBIS becomes an indispensable resource for decision-making in South Africa, and we also intentionally developed it in a generic way, so that it can easily be transplanted to another country. We already have an instance of FBIS running in Rwanda, where I have trained a team of biodiversity data scientists, and it looks like there may be further expansion to other regions in Africa and Europe – all very exciting!"

Dallas is also co-ordinating a Freshwater Bioinformatics in Africa seminar series, where other JRS grantees are able to share their experiences in developing information systems for serving freshwater biodiversity data. "It was supposed to be a workshop in Cape Town in March 2020, but the pandemic meant we had to switch to online sessions, although we hope to all meet in person in April 2022. It's really been a great learning and sharing opportunity, and going online has actually meant we can include more like-minded folks in our sessions and discussions."

Dallas notes that the FBIS has been welcomed by the freshwater community in South Africa and strong partnerships have been forged with several institutions, including South African National Biodiversity Institute (SANBI), South African Environment and Observation Network (SAEON), and Department of Human Settlements, Water and Sanitation (DHSWS), amongst others.

"We are hoping the Water Research Commission will join us as a partner in the new phase. The long-term sustainability of FBIS will best be achieved through multiple institutional financial support to ensure that these valuable data are available for decision-making. The final custodian of FBIS still needs to be agreed upon, but it may be SANBI, which provided some co-funding for the first phase of the project."

She points out that given the harsh funding climate in South Africa, ensuring that the Freshwater Research Centre (FRC), which she co-founded in 2012 and heads up as Executive Director, can keep going without dedicated institutional funding is a demanding responsibility. The need to source project funding and meet deliverables within tight time frames compromises her ability to publish scientific papers as often as she'd like, although she has about 50 peer-reviewed publications to her name to date. She's currently an NRF C-rated researcher, and an Honorary Research Associate at both UCT and Nelson Mandela University.

"It's been an enormous challenge to keep my academic hat on and continue trying to produce high-quality, peer-reviewed research articles," she says. "I know a lot of my FRC colleagues would like to publish their work too, but there isn't support for researchers who are not in salaried positions at universities or government institutions. Even though I received WRC funding for almost 30 years, there doesn't seem to be a mechanism to keep senior researchers funded so that they can mentor the younger ones. There are unfortunately too many researchers who have done excellent work, but have now been let loose and are struggling to fend for themselves."

"My journey in freshwater science has been incredible and I really am so grateful for all the opportunities that have come my way, and to my mentors, colleagues and students who I've worked with over the years. I've always been known as a bit of a gypsy, so have been lucky to be able to combine my passions for travel and freshwater ecology, by working in such special places in Africa."

Dr Helen Dallas has dedicated much of your career to conserving the region's freshwater ecosystems. This love of nature has also been shared with daughter, Kayla.