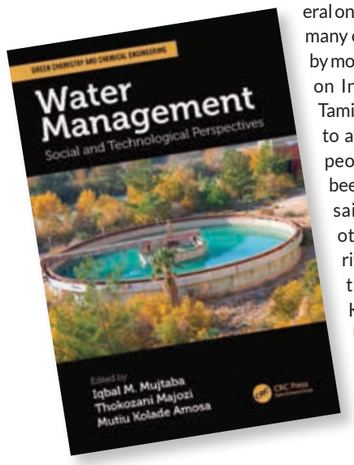
Water management: a lecture, a book and a collaborative effort

On February 28, 2019, professor Thokozani Majozi of the University of the Witwatersrand delivered a lecture on Water management: social and technological perspectives, a book written as a collaborative research project based on studies from 53 contributors who looked at water issues in 19 countries.

Stemming from a water management conference held at Wits in 2016 and funding and support from the British Council, the NRF, the Water Research Commission and Sasol, *Water management: social and technological perspectives* is authored by professors from three universities: Thokozani Majozi from SA's University of the Witwatersrand; and Motiu Kolade Amosa from Cairo Iqbal M Mujtaba from Bradford University in the UK; University in Egypt. The authors have transformed case studies from 19 countries and 53 contributors into a 30 chapter, 571 page reference manual on the current state of the world's water.

"It was Boutros Boutros-Ghali who first said: 'The next war in the Middle East will be fought over water, not politics'," says Majozi in introducing the Social Perspectives topic of the book. He highlighted several ongoing conflicts around the world, many of them relating to rivers shared by more than one country. "The dispute on India's Cauvery River between Tamil Nadu and Karnataka continues to affect hundreds of thousands of people and the disagreement has been going on for centuries," Majozi said, before adding examples of other water disputes related to rivers: the Okavango; the Mekong; the Rhine, Syr Darya dividing Kazakhstan, Kyrgyzstan, and Uzbekistan; and the Incomati, which is shared amongst South Africa, Swaziland and Mozambique.



Desalination technology is second of the book's themes. Majozi shows a slide comparing the relative costs of the different technologies taken from commissioned operational plants: Multi Stage Flash at 1.5 US$/m^3 in Singapore and 2.74 at the Saif plant in Qatar; Multi-effect Distillation in California at 0.46 US$/m3; Thermal Vapour Compression multi-effect in Qatar at 2.48; and, by far the most common, Reverse Osmosis (RO), for which Majozi cites three plants built at costs of 0.53, 1.1 and 0.50 US$/m^3, respectively.

While describing how RO technology works, he points out that the technology uses high pressure to force pure water permeate through the RO membranes, separating out brine concentrate (retentate) for disposal. "Generating RO pressures takes energy, though, so although currently cheapest, other technologies may be more beneficial in the long term," he points out.

Water Treatment also features in the book. Of note is the search for an alternative for activated carbon, currently used in 90% of water treatment facilities as an adsorbent for ammonia and nitrate. Several contenders have been found, including Ivy and strawberry leaves, which tend to be waste materials so they can be sourced easily and cost effectively. Of particular interest to South Africa and Egypt is the potential use of Water Hyacinth, which grows problematically on Hartbeesport Dam and on the Nile River. "Dried and pulverised, Water Hyacinth can be used as a direct replacement for activated carbon to give good adsorption from a fast growing and problematic plant waste," says Majozi.

The Water Networks chapters in the book discus water reduction case studies from Bradford. Given the task of reducing water usage at specific sites, Iqbal Mujtaba and his team applied a technique called Water Cascade Analysis to systematically identify and implement savings solutions. "Any chemical process or facility has a point where the mass transfers are optimised. By routinely hitting these points wherever freshwater is involved, water usage can be minimised. Of the cases analysed by Bradford, 80% of the findings were actually implemented," Majozi reveals.

Closer to home, he ends with a discussion on the Water Energy Nexus and his work at Wits. "South Africa is constrained by both energy and water. We are the 29th driest country in the world, out of 194 countries. Yet we need energy to get water and water to get energy," he says.

Food is the third aspect of the nexus. "People need to plant crops to get food and crops need watering, which means using pumps that require energy," Majozi explains.

"Also, though, chemicals almost always come into play in some way or another. In the 19th Century, predictions were that world population would be limited to about 2.5-billion people, but by the 20th the population was at least twice that at over 5-billion people. Why was the prediction so wrong? In 1918 we discovered ammonia, which led to fertilisers that doubled crop yields. So, a chemical changed the food supply aspect of the Nexus," he relates.

Describing current research interests in this area, he says that his team is looking at the relationship between water and energy use. "At a typical plant, fresh water for cleaning, heating, cooling and process reactions is consumed and effluent is created. "Treating the effluent and reusing it can bring down water use and associated costs, but additional energy is needed to do this, which increases the energy costs.

"We are trying to come up with systematic methods of identifying the point of minimum total cost between the rising energy costs and the falling water costs, that is, the sweet spot or the optimum operating point for water recycling. We are already using this idea to do case studies to optimise water use by identifying water streams and recycling opportunities – and we have had some significant successes. At an old power plant, for example, which was designed to use 1.8 l/kWh of water, usage has climbed over the years to 3.0 l/kWh. Through direct reuse and recycling, we were able to reduce usage back down to 2.1 ℓ/kWh, and we calculate that we can get it back to 1.9 with a more costly intervention.

Before the intervention, plant usage was sitting at 119 Mℓ/day, which is approximately ¼ of the daily use of the City of Cape Town. Reducing usage is, therefore, a valuable and necessary exercise.

"Whenever more electricity is needed, however, we need to accept the associated water cost, and vice versa," Majozi says. ❑

South African Chemical Engineering Congress: SACEC 2020

1st to 3rd July, Wits University

SACEC 2020 aims to bring the Chemical Engineers of the world together in the hopes of creating real world solutions to global issues.

The 21st century is likely to be the most profound for humankind. As we hurtle forward, there are clear signs that never before have we had so much impact on our planet. As chemical engineers our contribution to that impact is more profound than average. Our theme for this congress, *Entering the Anthropocene*, provides a forum to consider the possibilities of this century. How will we utilise our skills in the Anthropocene period to continue to improve the lives of all, whilst being cognisant of and reducing our impact?

Delegates will benefit from the opportunity to engage with peers at a professional forum in order to further their knowledge and understanding of their professional field. The congress will be CPD accredited.

Presenters who are invited to submit full papers that are accepted for publication will have their work published in the congress proceedings. The proceedings are fully peer-reviewed. They each have an ISSN and will conform to all DOHET requirements for accreditation.

The call for abstracts on the below topics is open, with a submission deadline set for Sunday 30th June 2019. Submission categories include:

1. Environmental Process Engineering.
2. Reaction Engineering.
3. Separation Technologies.
4. Process and Materials Synthesis.
5. Metallurgical Process Engineering and Coal Technology.
6. Chemical Engineering Education.
7. Other.

Please visit us at www.sacec2020.co.za and if you are interested in becoming a partner or sponsor, contact the congress secretariat at info@sacec2020.co.za

Big Data: SAIChE IChemE Gauteng's Branch Event

The Gauteng chapter of SAIChE IChemE kicked off 2019 with an event titled 'Big Data'. An interactive session was held where SAIChE IChemE member and Gauteng branch chairperson, Carl Sandrock, delivered a seminar focusing on Big Data Analytics, Industry 4.0, and the Internet of Things.

As a hot topic in Big Data and Data Analytics, much of the talk was about the development and use of Neural Networks and how technology companies make use of the science behind neural networks to organise their product catalogues and create algorithms that seem to be capable of predicting people's interests based on their online activity.

Neural networks were explained all the way from a simple starting point in MS Excel – training a three neuron network to regress a given function to the current state of the art. Reinforcement learning was demonstrated via experiments in arcade games involving machine learning and current developments in Generative Adversarial Networks, which were shown to produce impressive simulated photographs.

"This technology is highly relevant to our modern era, and members shared examples of how this science finds application in the agricultural and mining industries, for use in optimising crop yields or mineral deposits without the need for expensive human interventions," reports Qasim Fakir Senior Process Engineering Manager at Saint-Gobain Gyproc South Africa.

This was just the first of many events planned by SAIChE IChemE Gauteng for 2019, which include: the AGM in April; SAAFOST at DrinkTec in July; Engineers Without Borders in August and, in October, an interactive session on the Circular Economy.

"Look out for the details and we look forward to welcoming you at our next event," Fakir concludes. ❑

Carl Sandrock presents at SAIChE IChemE Gauteng's Big Data event.

The Gauteng chapter of SAIChE IChemE attend the first 2019 event titled 'Big Data'.

Most Promising New Textbook Award (College)

The Textbook & Academic Authors Association (TAA) has announced its 2019 Textbook Award winners, which include Attainable Region Theory, An Introduction to Choosing an Optimal Reactor, which is published by Wiley and co-authored by David Ming, David Glasser, Diane Hildebrandt, Benjamin Glasser and Matthew Metzger. Attainable Region Theory is one of 10 publications to receive The Most Promising New Textbook Award, which recognises excellence in 1st edition textbooks and learning materials.

The book discusses how to effectively interpret, select, and optimise reactors for complex reactive systems, using Attainable Region theory, which provides a means of understanding chemical reactor networks from a geometric perspective. This approach allows one to find all possible outcomes for all possible designs – even the designs one cannot imagine – giving one confidence that what is designed is always optimal for a given situation.

Covering both fundamentals and advanced concepts, this book demonstrates how knowledge of attainable regions can lead to powerful insights and discoveries that improve the performance of complex reactor designs.

Attainable Region Theory has over 70 worked examples and 200 illustrations, including interactive software tools written in Python, which demonstrate how AR theory can be used to solve reactor network problems. Interactive examples are also available on the book's companion website. ***attainableregions.com***