NELSON MANDELA UNIVERSITY

Faculty of Science

IN THE SERVICE OF SOCIETY 2024

We are Nelson Mandela University

We are **Nelson Mandela University**.
We are the only university in the world to be named after Nelson Mandela.
Our iconic South African statesman, humanitarian and leader is known globally for what he achieved.
We are honoured as **Nelson Mandela University** to carry his name.
In return, we honour our namesake by endeavouring to live his legacy.
We honour him by using his name in full.
We are Nelson Mandela University.

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A Faculty of Science
in the Service of Society

FOREWORD

By Professor Zenixole Tshentu (Acting Executive Dean, Faculty of Science)

As the world ponders issues of planetary health and sustainable well-being, our Faculty of Science at Mandela is equally seized with these concerns. We seek multiple pathways to achieve solutions to the grand challenges of climate change, health and diseases, environmental and biodiversity degradation, and hunger and food insecurity. Faculty Executive Dean, Professor Azwinndini Muronga, once remarked, 'There are no laws of science that demand poverty, inequality, and destruction. These are human-made phenomena and humans can end them.' We maintain that a purely scientific approach to these questions is not the answer, instead we advocate for comprehensive transdisciplinary approaches to achieve the plan of action for people, planet, and prosperity. This publication seeks to map some of the work that we do in areas of:

- nature conservation with a focus on social-ecological systems;
- oceans and shallow water ecosystems;
- coastal palaeoscience;
- urban agriculture;
- resource recovery towards a circular economy;
- waste valorisation;
- renewable energy and clean technologies;
- digitisation;
- fibre technologies;
- disease monitoring;
- smart chemical production;
- drug manufacture;
- Indigenous Knowledge Systems;
- decolonising botanical nomenclature; and
- sustainable education.

Our vision is to be a world class engaged and transdisciplinary African Faculty of Science in the Service of Society. Our brand promise is 'Discovering, Educating, and Engaging to Change the World.' We believe in the intermingled nature of research and innovation, learning and teaching, and engagement. As we embark on new programmes in fields such as oceanography, biotechnology, and applied statistics, we believe that, alongside existing programmes, these too will find space to contribute to the end goal of a cleaner and healthier planet. There are many initiatives, clusters, and new programmes in the faculty that harness the kinds of training we envisage for our students.

Faculty of Science clusters, centres, and initiatives

- Life, Earth, Environmental and Agricultural Sciences (LEEAS) Cluster
- Physical Sciences Cluster
- Mathematical and Computational Sciences Cluster
- Biosciences and Biotechnology Cluster
- Natural Resource Science and Management (George Campus) Cluster
- X-Stream Cluster (transversal programmes)
- Research Chairs
- National Institute for Theoretical and Computational Sciences (NITheCS) node at Mandela
- International Research Laboratory: Reconciling Ecological and Human Adaptations for a Biosphere-based Sustainability (IRL-REHABS)
- Research and Engagement Centres, including:

Prof Zenixole Tshentu

- CHRTEM
- InnoVenton
- Centre for Broadband Communication (CBC)
- African Centre for Coastal Paleoscience (ACCP)
- Centre for African Conservation Ecology
- Centre for Rubber Science and Technology (CRST)
- Telkom Centre of Excellence
- Govan Mbeki Mathematics Development Centre (GMMDC)
- Sustainability Research Unit (SRU).

Our Natural Resource Science and Management (NRSM) Cluster on the scenic George campus offers a comprehensive approach to the question of sustainability. From an academic qualification, research, and engagement perspective, the position of the cluster and the campus itself are at the interface of the environmental, sociocultural, and business spheres of the region.

The Garden Route region is internationally renowned for its high levels of biodiversity, cultural heritage, and Indigenous Knowledge Systems. Research themes of common interest centre around ecosystem integrity, as well as the establishment of resilient multifunctional landscapes as a foundation for stable socio-ecological systems.

In this context, we are pleased to be hosting the inaugural Science Institutional Public Lecture on the George campus on 25 September 2024. We are equally pleased that Dr Albert van Jaarsveld will be delivering this important lecture, titled 'Systems Approaches to Fast-track Sustainable Well-being'. Dr van Jaarsveld formerly served as President and CEO at the NRF, Vice Chancellor and Principal at UKZN, and from 2018 to 2023 served as the 11th Director General of the International Institute for Applied Systems Analysis (IIASA), based in Austria. Dr van Jaarsveld is a highly respected expert in the area of social-ecological systems and we look forward to hearing his views on the question of humanity in nature, as well as responses from Nelsiwe Mpapane (a PhD student in the NRSM Cluster) and Dr Rhoda Malgas (a Senior Lecturer in the NRSM Cluster).

Dr Albert van Jaarsveld (Keynote Speaker)

Nelsiwe Mpapane (Respondent)

Dr Rhoda Malgas (Respondent)

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Africanisation and Decolonisation
in the Agricultural and Natural Sciences

By Debbie du Preez, Dr Paul-Pierre Steyn, Dr Musa Khapayi, Dr George Sekonya, Dr Samalesu Mayonde, Dr Rhoda Malgas, and Dr Jenny du Preez

Held on 7 and 8 March 2024, the inaugural Nelson Mandela University 'Africanisation–Decolonisation Indaba' featured presentations from each of the seven faculties, convened by their deans. The response to the call from the Faculty of Science revealed that academics in the natural and agricultural sciences and resource management are grappling with the call for Africanised curricula and teaching praxes.

A fundamental area of engagement is around the heterogeneity of knowledge systems in the South African context, and the ways in which certain of these were delegitimised through the colonial project. This includes the explicit acknowledgement of the multiplicity of knowledge systems and engaging with traditional curricula alongside discussions engaging with other understandings of the environment.

When teaching Conservation and Environmental Management, Indigenous Biocultural Knowledge (IBK) is explored in the classroom. Students are encouraged to use their own languages when doing so. Indigenous languages contain a wealth of expressions, idioms, and cultural practices relevant to ecosystems, biodiversity education, and protections, and these resources are lost when discussions are restricted to English.

Ethnobotany is another area where Indigenous Knowledge Systems (IKS) are explored. Not only are students invited to contribute to the ethnobotanical knowledge of the class by talking about the traditional uses of plants within their families or broader cultures, but the classes foreground the history of biopiracy by Western science. That is, the ways in which colonial power relations allowed (and still allow) for the bioprospecting of unique South African natural products, the value of which was captured within IKS.

Agricultural Management also engages IKS through creative teaching approaches. One such approach is the storytelling method, where the lecturer tells stories from African history related to traditional Indigenous farming methods. This approach has been found to encourage students to have conversations with one another and engage more deeply with the course content.

What emerges from these 'experiments' in Africanisation is that the integration of IKS and IBK enriches curricula – offering resources for enabling conservation, inspiring innovative teaching practices, expanding the range of languages used in the classroom, and centring students as active contributors to the knowledge project.

The ongoing Revitalisation of the Curriculum project in the Faculty of Science provides a valuable opportunity to advance these practices, and to explore what other pathways to Africanisation might be pursued.


Image: Sandra Falanga

From left: Mountain honeybush (*Cyclopia intermedia*) and rooibos (*Aspalathus linearis*) are South African plant species used to make honeybush tea and rooibos tea, respectively. Both are commercially successful products

Transforming the Teaching Lab
for Medicinal Plants Chemistry

By Dr Buyiswa Hlangothi and Dr Nehemiah Latolla

The aim of this project, funded by the Teacher Development and Innovation Fund, is to develop innovative chemistry learning materials to help students understand chemical concepts and make it easy to remember and understand the relationship between theory and context. It is also designed to help develop the academic skills of the team involved, including experience in curriculum design, assessment, and teaching methods. The team has diverse members from different parts of the institution, and the project has even involved inter-faculty collaborations.

Fundamental and advanced chemistry topics are taught at all levels in our chemistry department, from undergraduate up to advanced diploma level. Theory classes, from entry to advanced levels, go hand in hand with laboratory teaching. However, the module outcomes are often dependent on the availability of resources and infrastructure. During the pandemic, we saw how learning vigorously shifted from face-to-face teaching to online LMS (Learning Management Systems) platforms. Academic and support staff had to rethink the faculty's laboratories and laboratory teaching spaces. As a result, we have adopted a new approach towards teaching and assessment of medicinal plant chemistry. Innovative rethinking of laboratory teaching and learning have been a priority for the future.

This project aims to make chemistry more engaging and relevant for students by developing innovative learning materials and transforming how certain topics are taught. The focus is on improving the understanding of basic and advanced chemistry concepts, particularly in the areas of organic chemistry and natural product chemistry, by linking theory with real-world applications, such as using medicinal plants in traditional medicine. Our approach consists of three phases:

1. Upgrading a specific lab space with new teaching equipment to enhance the learning experience for two advanced chemistry modules;
2. Connecting traditional medicine practices, such as using herbs for health care, with modern chemistry through hands-on, augmented learning experiences;
3. Sharing the knowledge gained from these new teaching methods through research papers and possibly a booklet to share with the communities.

Dr Lungelwa Mahanjana and Ruan Hall processing fresh plant material on aluminium foil pre solvent extraction in an oven

The goal is not only to improve students' understanding of chemistry but also to equip them with practical skills and knowledge that are relevant to the current needs of South Africa, especially in the context of challenges like diseases such as diabetes, COVID-19, and malaria.

The project supports the University's Vision 2030 by aiming to serve society through innovative teaching methods in organic chemistry. It incorporates Indigenous Knowledge into the curriculum, making learning more inclusive and relevant. Students also include their families in their learning process by leveraging the knowledge passed from generation to generation.

This more engaging and human-centred learning experience transforms how chemistry is taught, preparing students for success in the workplace and equipping them with skills for entrepreneurial ventures.

Diploma in Chemical Process Technology

By Dr Shawn Gouws

The Chemical Process Technology diploma resulted from a conversation between industry and Nelson Mandela Metropolitan University in 2011 suggesting a programme to train potential employees for the South African chemical industry. Collaboration with industry partners such as PetroSA, KBC, and NMMU ensured that the programme's content was relevant and up-to-date and in 2012 it was approved by the South Africa Qualification Association (SAQA) and the Higher Education Qualification Committee (HEQC). The curriculum for Diploma Chemical Process Technology was designed so that students become all-rounders. As well as understanding

Diploma in Chemical Process Technology students during the cheese-making process

chemistry fundamentals, physical principles, mathematics, statistics, and essential computer skills, they must be skilled in professional and personal skills such as ethics, group and teamwork, punctuality, and reading with comprehension. They should also be able to communicate effectively among peers, stakeholders, and other departments. The course content was developed to provide current teaching materials that would enable school leaver-level students to advance their career in becoming chemical technicians.

Over time, additional materials were developed to teach students about platinum group metal extractions and applications and to incorporate bio-processing techniques. The knowledge generated from the diploma programme was published in three peer-reviewed teaching and education engineering articles and presented at national and international conferences. Currently, a book manuscript is under review at the Mandela News Press entitled: *Chasing Challenges: Scholarly Learning and Teaching for Chemical Process Technicians.*

Hands-on bio-processing in the Diploma Chemical Process Technology

The programme component on bio-processing techniques was made possible through the generous support and collaboration of the industry. It aimed to provide a platform for Diploma Chemical Process Technology students to be hands-on in learning and applying the knowledge they acquired over the first and second year of their studies. A process training plant was built with funding from the Teaching Development Innovation Fund (TDIF) and Endress&Hauser industry support. The company, a global leader in measurement instrumentation, services, and solutions for industrial process engineering, donated instruments and sensors towards the building and commission of a process rig. Once the rig was built, it was commissioned, and the students were prepared for an experiment in the art of cheese-making.

The process needs to be controlled through temperature regulation to ensure the correct temperature is required for the curd. Before the process can start, it is imperative to ensure that all surfaces, reactors, and utensils are sanitised to avoid contamination. The students then charged the reactor with the milk and warmed it to the desired temperature before adding the rennet and micro-culture to produce curd. This is a long process with several steps and a one to two hour wait, which taught the students about process discipline. After the cheese-making, the students completed an ethics-approved anonymous questionnaire on the process and how they perceived it. The outcome was that students had enjoyed the real-time production, which involved long hours and process control disciplines. As a result, this is likely to become part of the experimental lab work that ties in with the Chemical Process Technology Laboratory II module.

YeboPhysics and YeboTutor: Enhancing STEM Education

By Dr David Waswa

The COVID-19 pandemic has significantly transformed online education, especially in STEM fields. YeboPhysics and YeboTutor are two initiatives designed to tackle educational disparities in South Africa. While YeboTutor supports grade 11 and 12 learners in mastering mathematics and physical sciences, YeboPhysics focuses on first-year university students studying physics. This dual approach ensures a seamless transition in learning, allowing students to build on their foundational knowledge. Together, they aim to enhance academic performance and improve access to quality education.

Both programmes emerged in response to the educational disruptions caused by the pandemic. YeboTutor provides real-time, interactive tutoring for grade 11 and 12 learners, particularly in under-served communities. It has a subscriber base of over 1 389 learners and has engaged with over 35 326 users. YeboPhysics builds on YeboTutor's foundation, targeting first-year physics students at Nelson Mandela University. It

YeboTutor final year Engineering student Vuyani Chipunza

addresses the weak foundational knowledge many learners possess when they enter university, offering tailored tutorials to strengthen their understanding of physics concepts. The initiatives emphasise critical thinking and problem-solving skills. This active learning approach prepares students for future academic challenges and equips them with essential skills for success in STEM fields.

The platforms utilise next-generation networks (4G and 5G) to provide accessible educational resources to students, regardless of their location. This is particularly important for reaching learners in remote areas. YeboPhysics also serves

Tutoring grade 12 learners in ILembe district, KwaZulu-Natal

students living both on and off campus, ensuring all first-year physics students can engage with the material. The interactive nature of these platforms fosters student engagement and collaboration.

The combined impact of YeboPhysics and YeboTutor is significant, as they enhance STEM education in South Africa. By bridging educational gaps, improving accessibility, fostering critical thinking, and promoting educational equity, these initiatives empower students and prepare them for future challenges. Both programmes remain committed to developing a skilled workforce capable of contributing to societal growth.

Collaboration with Kwadwesi Schools

The Centre for Broadband Communication (CBC) was recently approached by the School for the Blind and the School for the Deaf in Kwadwesi regarding their students' inability to apply to universities because they were unable to pass maths literacy – a key requirement for admission.

The CBC's YeboTutor team stepped in by compiling specialised materials and sent these to teachers for use in tutoring sessions. The team also visits each school regularly, ensuring that students receive the necessary guidance and resources to improve their maths literacy skills. Blind and visually impaired students were further assisted by CBC's innovative development of 3D-printed braille keyboards, which make it easier for them to engage with the learning materials.

Fixing the **Western Indian Ocean Climate Crisis**

By Professor Mike Roberts, UK-SA Bilateral Research Chair: Ocean Science and Marine Food Security.

Ninety per cent of global warming is occurring in the oceans, causing the water's internal heat to increase significantly since modern record-keeping began in 1955. The last 10 years were the oceans' warmest decade and 2023 was the oceans' warmest recorded year.

The Indian Ocean is not escaping this warming trend, and in fact, unusually fast warming is occurring in the western half. The Western Indian Ocean (WIO) comprises nine countries, four of which are islands – Seychelles, Mauritius, Comoros and Madagascar. The others – Somalia, Kenya, Tanzania, Mozambique, and the eastern side of South Africa – are coastal. It is estimated that some sixty million people live on the WIO shoreline in small villages highly dependent on the ocean for their livelihood and food security. Mangroves and seagrass beds proliferate in much of the Indian Ocean and play a vital role adjacent to coral reefs as breeding and nursery grounds for many species of fish. But ocean warming is beginning to negatively impact these habitats and ecosystems in general are showing change. Fish catches are also declining due to increasing commercial fishing pressure and rapid population growth.

Without some form of intervention, the loss of biodiversity and the lack of food security will soon have serious implications for communities in the WIO.

Professor Mike Roberts' UK-SA Bilateral Chair in Ocean Science and Marine Food Security was created to address the WIO crisis. Established in 2016 and co-hosted by Nelson Mandela University and the University of Southampton, the Chair's team of researchers and postgraduate students have undertaken investigations using ships, marine robotics, satellites, and models to understand the ocean's physics, its biogeochemistry, plankton, food webs, fisheries, and the coastal communities, in relation to climate and a warming ocean. Well over 100 research papers have been produced. Much of this work has looked at historical trends, but in 2023 the direction changed to looking forwards. Using a new breed of ocean, biogeochemical, and ecosystem models, the team is attempting to create a road map of where the WIO ecosystems are heading and the potential impacts on coastal communities. Along this future trajectory, tipping points will be identified that mark radical shifts in the ecosystems. The first major tipping point predicted will be around 2035 when marine heat waves (MHWs) will be extensive and long lasting, wiping out most of the coral reefs.

Moorings being prepared for deployment off Bazaruto (Mozambique) from the Norwegian research vessel *Dr Fridjof Nansen* in 2023. These will measure ocean currents, temperatures, oxygen, salinity, and chlorophyll for nine months. The data will be used to validate an ocean model that Prof Mike Roberts' team is developing

The gravity of this situation has added another new thrust to Prof Roberts' work – getting national governments and international entities such as the UN to recognise the WIO crisis and to begin developing an action plan for intervention. To this end, he recently made a presentation to the 2024 G20 meeting in Brazil. Next Prof Roberts plans to organise two UN-AU Summits in the near future to explain the crisis to the governments of the WIO nations. With assistance from the international community, they will then design policy with implementation plans, dovetailing with a programme with the coastal communities to future-proof their livelihoods and food security.

(The UK-SA Bilateral Research Chair in Ocean Science and Marine Food Security – A partnership between Nelson Mandela University and University of Southampton)

Waste Tyres into Worth:
A Rubber Resurrection?

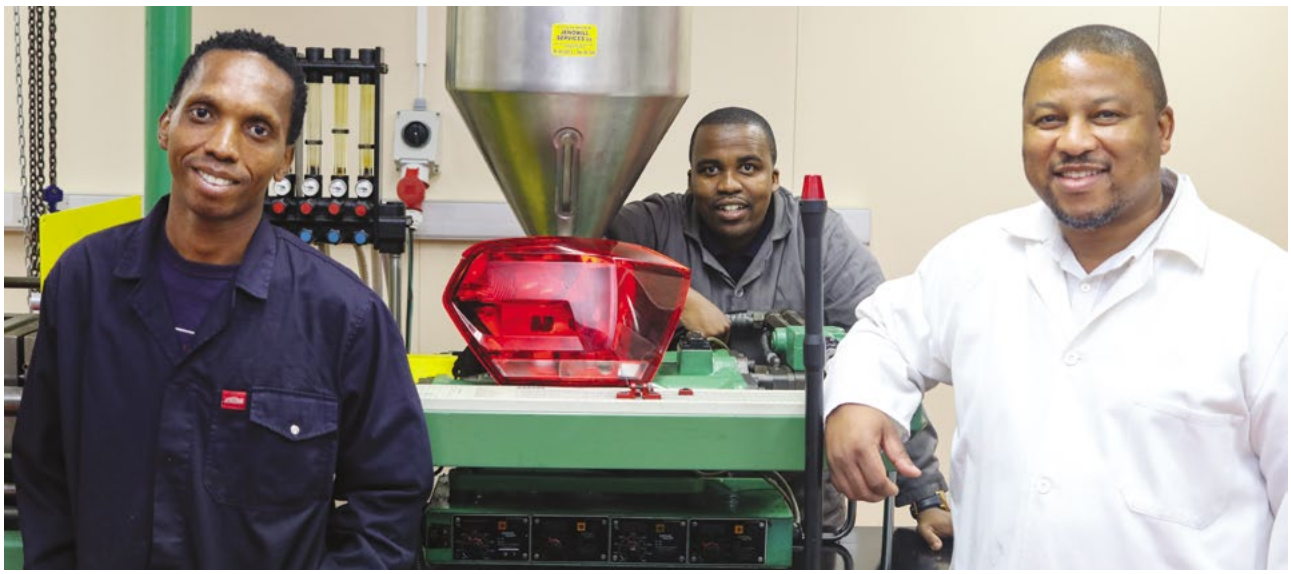
By Professor Prof Percy Hlangothi

As the saying goes, 'All good things must come to an end'. This includes tyres, whose purpose in our day-to-day life is to provide road surface support for vehicles when ferrying passengers or goods from one location to another. This support is critical as it includes spreading traction and braking forces to the road surface and absorbing road shocks. Tyres are currently produced in millions annually all over the world and this rate will remain for as long as vehicles continue to use tyres. But what happens when these tyres reach the end of their life? Can we realistically salvage some value out of them?

Different countries have different views on how best to handle and utilise end-of-life tyres. In South Africa, the Department of Forestry, Fisheries and Environment adopted an Integrated Waste Tyre Management Plan (IWTMP) that seeks to valorise waste tyres by encouraging and supporting the incorporation of waste materials as alternatives in the materials value chain. Despite these good intentions at policy level, millions of tyres are still in our landfills and piling up every day, posing environmental challenges.

The Centre for Rubber Science and Technology (CRST) at Nelson Mandela University was established about nine years ago to assist in finding alternative uses for waste tyres. Throughout these years, the CRST team has explored numerous ideas and technologies that are either already adopted by the industry or those that are touted as being suitable for South Africa's IWMP. These include secondary applications for waste tyre crumbs (e.g., partially replacing virgin rubber when making new rubber products, or to rubberise bitumen for road construction), raw materials recovery through processes such as devulcanisation, and pyrolysis to produce oil, gas, and recovered carbon black residue.

As innovative as these approaches may seem, they each have underlying scientific challenges that hinder their uptake into the mainstream as secondary materials. Numerous journal papers and book chapters have been published in these topics, and more than 50 Nelson Mandela University postgraduate students have graduated on research topics that sought to find useful solutions to this challenge. Yet the problem persists. The South African waste tyre processing industry is still small compared to that of many countries, especially developed countries, and their processing rates do not match the rate at which new tyres are produced here or imported. This means tyres will continue to pile up in our landfills until waste processing rates improve. Therefore, there is an urgent need for scientists to play their part in assisting the industry in finding economical ways to push waste tyre-derived alternative materials into the mainstream: a problem as big as a size 59/80R63 mining tyre.



From left: Sihle Nyakaza, Lukanyo Bolo and Prof Percy Hlangothi, Centre for Rubber Science and Technology

Advancing Indigenous Knowledge Systems via *In Vitro* Bioactivity Screening

By Professor Maryna van de Venter

As manager of the BioAssaix *in vitro* bioactivity screening platform in the Department of Biochemistry and Microbiology, Prof Maryna van de Venter and her team are committed to integrating and promoting Indigenous Knowledge Systems (IKS) within the scientific community. The platform serves as a critical bridge between traditional knowledge holders, researchers, and small and medium-sized enterprises (SMEs), facilitating the exploration and validation of bioactive compounds derived from Indigenous practices and natural resources.

Staff and students from Nelson Mandela University and the Lusaka Apex Medical University during an excursion to the Rufunsa Phytoceutical and Nutraceutical Research Centre in Zambia

The BioAssaix screening platform offers a comprehensive suite of bioactivity assays, including tests for cytotoxicity, antidiabetic, anti-inflammatory, anticancer, antimicrobial, wound healing, and cosmetic applications. These assays are designed to identify and characterise the therapeutic potential of natural products, which are often rooted in Indigenous Knowledge (IK). By providing these services, the team aims to support the preservation and commercialisation of IK, ensuring that traditional wisdom is recognised and respected within modern scientific frameworks.

Prof van de Venter and her team regularly collaborate with South African researchers, providing them with reliable and robust data to advance their studies. In addition, the platform has established strong partnerships with international research institutions, including the University of Lagos in Nigeria, the National Institute for Medical Research (NIMR) in Tanzania, and the Lusaka Apex Medical University in Zambia. These collaborations have been instrumental in fostering cross-cultural exchanges of knowledge and expertise, enriching the global understanding of IKS.

The team's engagement extends beyond academia as they actively support SMEs in their product development efforts. For instance, they have assisted companies in Tanzania and the United Kingdom in optimising skincare products derived from tradional botanical sources. This not only contributes to the economic empowerment of local communities but also promotes the sustainable use of natural resources.

In August 2024, Prof van de Venter's team hosted the 2nd IK Biotrade Indaba at the Boardwalk ICC, bringing together 200 delegates and exhibitors from across the Indigenous Knowledge spectrum. The indaba was co-hosted by the Technology Innovation Agency (TIA) and funded by TIA, the DSI and Eastern Cape Parks and Tourism Agency. The event featured academics, traditional healers, entrepreneurs, and representatives from regulatory bodies, fostering dialogue and collaboration. The Indaba was a significant milestone in efforts to bridge the gap between traditional knowledge and modern science, emphasising the importance of IK in sustainable development and innovation.

Prof van de Venter says, 'Through our work, we strive to honour and elevate Indigenous Knowledge Systems, ensuring that they play a vital role in the global quest for health and well-being.'

Sustainable Cost-Effective Access to Drugs

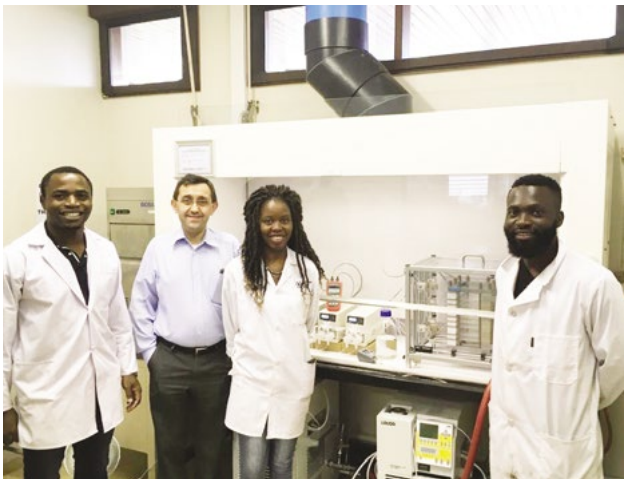
By Professor Paul Watts

For many countries, including South Africa, the COVID-19 pandemic spotlighted the importance of local pharmaceutical production. Indeed, the need for self-sufficiency in producing essential medicines has emerged as a strategic imperative for many countries. South Africa, with its burgeoning healthcare needs, stands at a crucial juncture where establishing robust local production capabilities can offer numerous benefits.

Dr Faith Akwi preparing multi-kilogram quantities of a malaria drug intermediate

Although South Africa has several local pharmaceutical formulation companies, the majority of active pharmaceutical ingredients (APIs) (the chemical compounds contained in the medicines) are imported into South Africa, most notably from India and China. According to the UN Comtrade database, South Africa imported pharmaceutical products to the value of US$ 3.06 billion during 2021 alone.

The flow chemistry research group led by Prof Paul Watts is making massive strides towards making the dream of locally produced APIs a reality. The way that chemistry is applied in the majority of industries has remained largely unchanged for more than a century. However, one of the advantages of starting an industry from scratch is the opportunity to utilise emerging technologies. One such area of technology is the synthesis of APIs using flow chemistry. Prof Watts and his team are experts in the development of synthetic methods to known APIs using this technology. The team is continuously working on several important APIs, including a selection of compounds used in the treatment of cancer, tuberculosis, malaria, and diabetes.



A kiloflow reactor (Chemtrix BV) with temperature control module under the fume cupboard. From left: Dr Cloudius Sagandira, Prof Paul Watts, Dr Faith Akwi and Dr Francis Mathe

The most advanced research has focused on drugs to combat and treat HIV, and research has been conducted to prepare eight of those currently in use. The team has now undertaken more than ten years of research to develop the necessary technology for the manufacture of the APIs in South Africa. Critically these can be made about 20% to 30% cheaper than using old-fashioned production methods. The vision is to establish local production that provides South Africans with guaranteed access to lower cost medicines.

Focusing on **Photovoltaics**

By Professor Ernest van Dyk

Nelson Mandela University's Photovoltaics Research Group (PVRG) is strongly focused on conducting research that addresses industry needs. Led by Prof Ernest van Dyk, Dr Freddie Vorster, Dr Jacqui Crozier McCleland and their team are shaping the PVRG into a launching pad for innovative ways to meet the needs of South Africa's photovoltaics (PV) industry.

The PVRG specialises in solar energy materials and device characterisation, focusing on performance degrading defects in the different types of solar cell and module technologies, as well as the characterisation of PV modules and systems, from small off-grid to large utility scale PV power plants. The group also has other focus areas, including concentrator photovoltaics (CPV), PV system energy yield analysis, big data analysis, and forecasting. The work in the CPV field involves the development of specialised characterisation techniques and CPV module and system technology development. The focus of this work is on the development of a patented hybrid CPV technology, which is in the pre-commercialisation phase.

The extensive PV research facilities that have been established at the University by the group include an indoor laboratory for the characterisation of PV devices according to recognised standards and custom developed techniques as well as an outdoor facility for the outdoor evaluation of various PV module technology types.

The group is closely associated with the University's spin-off company, PVinsight (PVi), which operates an ISO17025 accredited Photovoltaic Testing Laboratory for the evaluation of PV modules. The ISO17025 accreditation is through the South African National Accreditation System (SANAS, T0956).

The students of the PVRG have, in addition to their PV research projects, the unique opportunity of gaining valuable experience in an accredited environment, enabling them to gain first-hand knowledge of PV technology, as well as being involved in projects that work closely with utility-scale PV power plants.

Patented Nelson Mandela University Hybrid CPV module undergoing testing

World Heritage Status:
A Pinnacle of Palaeoscience

By Professor Curtis W. Marean

In July of this year, Pinnacle Point, on the south coast of South Africa near Mossel Bay, was declared a UNESCO World Heritage Site. World Heritage recognition is the Olympic gold medal of heritage, and is only given to sites of 'outstanding universal value' to all of humanity. Pinnacle Point was recognised for its outstanding contribution to our understanding of modern human origins.

View over the ocean from Pinnacle Point. Image: Dr Jan De Vynck

Homo sapiens is first recognised by anatomical features in the fossil records that appear about 300 000 years ago. Modern humans, however, are recognised by features that have more to do with cognition and psychology, features that probably evolved somewhat later, more likely between 200 000 and 100 000 years ago. This raises the question as to where and under what conditions did modern human cognition and psychology evolve?

Pinnacle Point is a source of crucial evidence, which dates to between ~160 000 and ~71 000 years ago. It records the earliest evidence for:

- humans eating sea foods and developing an adaptation to the sea;
- people modifying and working pigments, in this case red ochre;
- humans using fire to modify raw materials (pyrotechnology);
- the development of a new advanced technology, called microlithic technology, which is good proxy evidence for the use of advanced projectile weapons; and
- humans having thrived through the Mount Toba super-volcanic eruption .

While many important discoveries have been made at Pinnacle Point, it is important to understand that the broad transdisciplinary programme instituted by the African Centre for Coastal Palaeoscience (ACCP) not only contributed to Pinnacle Point's World Heritage status, but also made the project itself iconic in Quaternary studies of climate and environment. The ACCP's exceptional team created a sophisticated narrative of human evolution embedded in deep knowledge of the Pleistocene context. Their research showed how a shift from a focus solely on the land, to one embedded in the sea, had transformative impacts on the process of becoming human.

Some of these ACCP scholars merit special mention:

- Dr Hayley Cawthra, a marine geologist, used sophisticated methods to map the topography and geology of the now submerged Agulhas Bank, which during much of the occupation of the sites, would have been exposed and presented a now extinct ecosystem we named the Palaeo-Agulhas Plain;
- Dr Richard Cowling, with the assistance of this geological work, developed a model for predicting past vegetation systems and, with that model, he was able to predict the vegetation of the now submerged Palaeo-Agulhas Plain; and
- Dr Kerstin Braun used speleothems from caves (stalagmites and stalactites) to reconstruct the ancient rain and vegetation systems on the south coast.

Pinnacle Point's recognition as a World Heritage Site shows how science can have potent and positive downstream impacts on society. And, of course, the World Heritage Site badge of honour brings not only economic benefits, but also local and national pride.

Shallow Water Ecosystem Research – from Science to Society

By Professor Janine Adams

Janine Adams is a distinguished professor at Nelson Mandela University, Deputy Director of the Institute for Coastal and Marine Research and holds the Department of Science and Innovation/National Research Foundation Research Chair (SARChI) for Shallow Water Ecosystems. Her research focus on the conservation and management of estuaries has had a positive impact on the broader social environment by improving our capacity to manage shallow water ecosystems, ensuring that the multitude of services that these ecosystems provide directly benefit society.

Research is currently aligned with the United Nations Sustainable Development Goals, the UN Decade of Ecosystem Restoration, and the UN Decade of Ocean Science. Dedicated research has built up long-term datasets on salt marshes, mangroves, and seagrasses, enabling comparisons between systems worldwide, particularly in the field of blue carbon research and climate change mitigation. This research informs management actions to reduce human pressures on estuaries to prevent the loss of ecosystem services such as nursery areas, flood prevention, recreation, and tourism. It is fed into to estuary management plans and at estuary management forums that involve all stakeholders. Restoration research is addressed using a socio-ecological systems approach that connects the state of the ecosystem to the state of the societal system through ecosystem services, and has already identified priority blue carbon ecosystems for national restoration.

Professor Janine Adams and Dr Gavin Rishworth doing research in the Bushman's Estuary in the Eastern Cape

Professor Janine Adams at the Knysna estuary

The SARChI team's work bridges the science-policy-practice divide, as outputs are used by a variety of stakeholders: they work closely with the Department of Water Affairs and Forestry informing the implementation of the National Water Act on the environmental flow requirements of estuaries and a national estuary management course is held in collaboration with the Department of Forestry, Fisheries and Environment (Oceans and Coasts) on the management of estuaries in line with the Integrated Management Act. Their participation in the National Biodiversity Assessment and on provincial and national Coastal Committees ensures transfer of knowledge. In addition, society benefits from the presentations, webinars, workshops, and interactions with the Shallow Water Ecosystems members.

The involvement of stakeholders and communities is essential. By celebrating conservation successes, hope is ignited and the next generation of thinkers and change-makers is inspired (#oceanoptimism, #GenerationRestoration).

Natural Resource Science and Management Cluster

By Professor Josua Louw

The Natural Resource Science and Management Cluster, which represents the Science Faculty on the George Campus, is well positioned to address the contemporary socio-ecological issues facing society. Our efforts to contribute towards creating climate-smart resilient landscapes, to maintaining the ecological integrity of our biomes, and to providing appropriate innovations and management interventions for sustainable socio-ecological systems are valued by business and communities alike. We are widely respected for the applied nature of teaching and learning programmes, as well as our research activities, which explains the popularity of our academic programmes and the exponential growth in research outputs.

The cluster comprises Agricultural Management, Forestry, Nature Conservation, Wood Technology, and Veldfire Management (Higher Certificate). Agriculture and Game Ranch Management is offered by the School of Environmental Sciences on the Summerstrand Campus in Gqeberha.

Our programmes cover a wide range of research themes:

- *Sustainable Management of Forestry Plantations and Agricultural Production Systems*: focusing on the refinement of best operational practice regarding the establishment, tending, harvesting, and processing within intensively managed forestry and agricultural production systems.
- *Environmental Management*: focusing on practising forestry and agriculture in such a way that social, legal, and environmental matters are considered in order to minimise negative impacts and maximise benefits.
- *Forest Engineering and Mechanisation*: focusing on the harvesting and transport of forest products, which is by far the costliest part of the forestry value chain. Mechanisation is an international trend and features prominently in research agendas to modernise forestry operations and increase efficiency and competitiveness.

The George Campus of Nelson Mandela University aims to ensure that it makes a greater impact on and contribution to sustainable development in the eastern and southern Cape regions. As part of the University as a whole, we strive to contribute to a sustainable global society and embrace the vision statements of all the faculties represented. From a research and engagement perspective, we have positioned ourselves at the interface of the environmental, sociocultural, and business spheres in pursuit of the common good. This allows scholars to appreciate the inter-relatedness of the natural, sociocultural, and economic environments, which is essential for formulating innovative solutions to the complex challenges that confront society.

The campus is in the UNESCO Garden Route Biosphere, which includes World Heritage and Ramsar sites. The region's combination of rural and urban areas and natural

Dr Mueḓanyi Ramantswana explaining forestry operations with students. The operations are noisy (chainsaws and machines are always running in the background) and students are not able to hear if he doesn't use a loudspeaker

Lion research in the savanna biome — part of large mammal conservation ecology. Image: Prof Josua Louw

habitats provides a complex mix of climates, sociocultural, and economic conditions. This combination of biodiversity, cultural heritage, and Indigenous Knowledge Systems also gives our research a wider relevance within the whole pan-African context. Research themes of common interest include unsustainable development patterns and urban sprawl, with the associated negative impacts on ecosystem integrity, as well as the establishment of resilient multifunctional landscapes as a foundation for stable socio-ecological systems.

The region's economy is underpinned by an abundance and diversity of natural resources. Consequently, any mismanagement of this resource base – already under threat – will have serious implications for ecosystem service delivery and sociocultural and economic systems. There are significant – and growing – disparities between the region's urban and rural areas, and disparities in wealth and poverty are crucial issues that need to be addressed. Moreover, several socio-ecological challenges associated with climate change, water scarcity, energy insecurity, and waste management are a growing concern. These issues are exacerbated by landscape transformation and habitat fragmentation, biodiversity loss, soil degradation, the spread of alien invasive plants, and inappropriate fire management.

The George Campus functions as an outstanding open-air laboratory for learning, teaching, research, innovation, and engagement from a socio-ecological perspective. As with other university centres, we see our academic mandate as being based on three pillars:

- The advancement of frontiers of new knowledge through research and innovation that underpins its relevance to society.
- The production and transfer of knowledge in an appropriate way through outstanding academic programmes and qualifications that reflect the full potential of staff and students.
- Engagement with relevant stakeholders from government, civil society, and industry to co-create learning and sustainable futures.

We aim to grow our postgraduate student intake and continue to enhance our sustainability research capabilities, generating cutting-edge knowledge for a sustainable future. We also aim to use research to prepare future generations of systems thinkers to achieve the radical transformations necessary to meet the objectives set by the UN Sustainable Development Goals and the African Union's vision for 2063 'The Africa we want'.

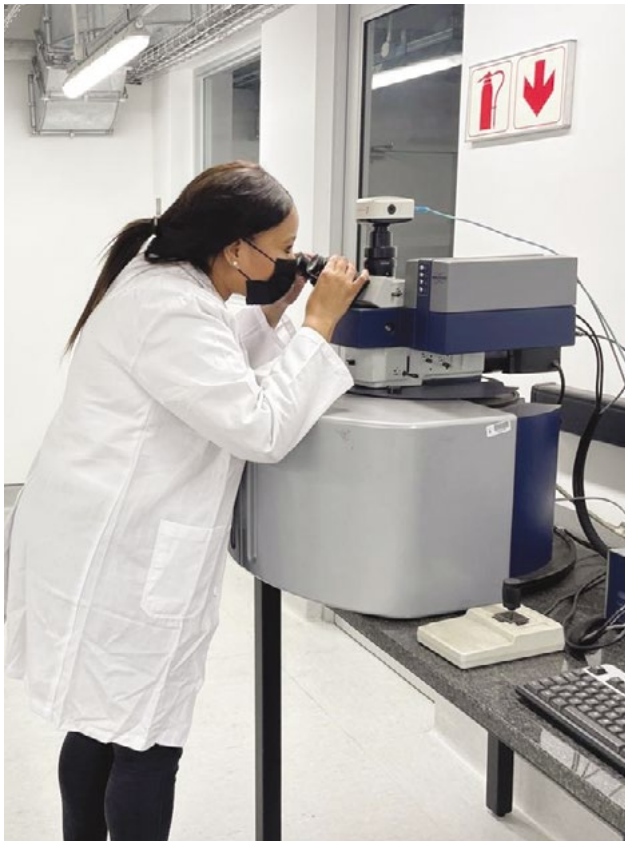
Our campus has developed a reputation for working closely with industry in the forestry, agriculture, conservation, and business management sectors. At the same time, we are recognised as a national leader in place-based transdisciplinary research that informs the functioning and governance of social-ecological systems. This diversity of our expertise and research experience forms a robust platform on which to build innovative inter- and transdisciplinary research projects.

Transforming Pineapple Waste
into a Water Treatment Marvel

By Dr Zikhona Tywabi-Ngeva

In a ground-breaking stride toward sustainability and innovation, a research group in Nelson Mandela University's Department of Chemistry has discovered a revolutionary method to convert pineapple waste fibres into filters for water treatment. This eco-friendly solution promises to address both waste management and water purification, marking a significant leap forward in environmental science particularly in water-scarce regions like Nelson Mandela Bay.

Pineapples are a tropical fruit and their leaves are often discarded as agricultural by-products. However, we have identified that the fibres in pineapple waste have unique properties that make them excellent for water filtration. They are biodegradable, abundant, and cost-effective, making them an ideal alternative to conventional synthetic materials.



Dr Zikhona Tywabi-Ngeva in the lab

The process involves extracting the pineapple leaf fibres mechanically. They are then treated and processed to enhance their natural absorbent properties. The result is a highly efficient material capable of removing heavy metals, toxins, and other impurities from water.

This breakthrough is particularly beneficial for pineapple farmers, who often struggle with the disposal of agricultural waste. By turning waste into a valuable resource, farmers can now contribute to environmental conservation while generating additional income. This dual benefit is a testament to the ingenuity and practicality of sustainable technologies.

Water scarcity and pollution are pressing global issues. Traditional water treatment methods can be expensive and environmentally damaging. The use of pineapple waste fibres offers a sustainable and affordable alternative, particularly for communities in developing countries where access to clean water is limited. This project aligns with several United Nations Sustainable Development Goals (SDGs), including Clean Water and Sanitation (SDG 6), Responsible Consumption and Production (SDG 12), and Life on Land (SDG 15).

To optimise the extraction and processing of pineapple fibres for water treatment, ongoing research and development are crucial. Funding will support scientific studies, pilot projects, and technological advancements necessary to enhance the efficiency and scalability of this innovative solution. Securing funding for the pineapple waste fibres water treatment project is pivotal in turning this promising innovation into a global standard. The environmental, socio-economic, and health benefits, coupled with alignment with global sustainability goals and market potential, make a compelling case for investment.

With significant progress already made in the extraction process and a patent application underway, the focus now shifts to further optimisation and refinement of the methodology. The next phase of the project involves acquiring dedicated resources to develop and test cellulose nanomaterial-based nanofilters. This includes experimenting with different formulations, additives, and processing techniques to achieve the desired properties, such as water retention, biodegradability, and mechanical strength. Furthermore, field trials will be conducted to evaluate the performance of these nanofilters under real-world conditions.

Tangible Africa Coding Games
and International Impact

By Professor Jean Greyling

In January 2017, former computer science honours student Byron Batteson walked into Prof Jean Greyling's office with an idea for a new honours project to introduce learners to coding without the use of computers, electricity or the internet. At that stage the two of them had no idea what impact it would have.

It all started with the Tanks mobile app that Batteson developed, making use of a smart phone, image recognition, and customised physical tokens, in what is referred to as tangible coding or unplugged coding. The Tanks app has since been joined by Boats, Rangers, Juicy Gems, Speed Stars, and Code Cub apps.

Tangible Africa is an engagement project in partnership with the Department of Computing Sciences and the Leva Foundation non-profit organisation. The project's flagship is the annual #Coding4Mandela event in July, which grew from 30 learners in 2018 to 32 000 in 2024.

Since 2021, more than 40 000 teachers have been introduced to tangible coding through short workshops, mainly in partnership with the teacher unions SADTU, SAOU and NATU. These workshops have had a clear impact on the way unplugged coding is perceived nationally. In 2024, the Coding and Robotics Curriculum for Foundation Phase, which is 100% unplugged, was gazetted by government. This allows for all schools in South Africa to implement the curriculum.

Tangible Africa Regional Coordinator in Zambia, Bessy Nambela, introducing learners to coding

Jackson Tshabalala introducing a blind student to coding in Nairobi – we have a kit adapted for blind learners which uses 3D printouts and Braille

Across Africa tangible coding is accepted by numerous role players in countries such as Zimbabwe, Zambia, Ghana, Kenya, and Uganda. Libraries especially in many of these countries have proven to be very effective in introducing coding in their communities. One African country is currently exploring incorporating Tangible Africa's material in official teacher training.

Prof Greyling and his colleagues at Leva Foundation have been pleasantly surprised with the way countries on other continents have embraced the movement. In Indonesia it is seen as an effective tool to enhance computational thinking skills, while Ireland has launched a nationwide research project (incorporating the Rangers game and the Micro:Bit) investigating the impact it has on teacher confidence in teaching coding. The project team has recently returned from the USA, where various role players have shown a keen interest in rolling it out in schools. It is, for example, seen as complementary to the tools provided by the globally known movement Code.Org.

One of the highlights this year has been showcasing Speed Stars (Grand Prix theme) at the Silverstone British Grand Prix, as well as introducing major football clubs in the UK to Code Cup (football). Code Cup will form part of the Euro Code Week in October, culminating in a Euro Code Cup before the tangible coding World Cup on 5 December this year. Truly 'From Africa to the World'.

STEM Skills through Mathematics

By Professor Werner Olivier

For over a decade, the Govan Mbeki Mathematics Development Centre (GMMDC) at Nelson Mandela University has been a transformative force in Science, Technology, Engineering, and Mathematics (STEM) education across South Africa.

Situated within the Science Faculty, GMMDC has committed itself to addressing critical educational disparities, particularly in underserved schools, through innovative strategies designed to bolster STEM skills. Recognising the strategic risk posed by educational challenges in public schools, the Centre is dedicated to ensuring the country produces a robust pipeline of STEM graduates essential for economic growth.

Our focus is on elevating mathematics and science education through a bespoke techno-blended model. This approach integrates professional development for in-service teachers, supports promising learners, and provides curated digital resources to enhance curriculum delivery in schools. Each year, the GMMDC's accredited professional learning network programme for mathematics teachers, endorsed by the South African Council for Educators, significantly improves teaching quality, benefiting thousands of learners in the classroom.

A standout initiative is the Technology-Assisted After Schools Programme Support (TAPS) for mathematics. This flagship project empowers Grade 11 and 12 learners with tablets, curriculum-aligned software, and personalised mentoring, fostering their transition to higher education and promoting self-directed learning without relying on internet access. Interactive digital applications, such as GammaTutor™ and MobiTutorZA™, that cover the entire mathematics and physical sciences curriculum are central to TAPS' success in enhancing the educational experience. GMMDC also enriches STEM learning environments with curated mobile-compatible applets that offer dynamic and creative ways for students to explore mathematical concepts, particularly in under-resourced schools.

In response to the heightened demand for innovative STEM education solutions, particularly post-COVID-19, GMMDC has expanded its reach beyond the Eastern Cape. We have established multi-year partnerships across several provinces, collaborating with private sector funders, the Free State Department of Education, and higher education institutions in Gauteng. Since 2018, GMMDC has also embraced an integrated STEAM (Science, Technology, Engineering, Arts, and Mathematics) approach, catering to the growing need

Learners participating in a STEAM (Science, Technology, Engineering, Arts, and Mathematics) workshop

for transdisciplinary skills and creative problem-solving in today's workforce. Our annual STEAM workshops for teachers and learners feature real-life problem-solving activities and creative design challenges, linking STEM subjects with practical applications.

A significant milestone in GMMDC's STEAM initiative was the national Math-Art competition launched in 2018. Spanning all nine provinces, this project allowed thousands of learners to explore the intersection of mathematics and art, fostering creative expression through an annual theme. Supported by national and international education stakeholders, the competition concluded in 2023, solidifying GMMDC's role as a pioneering force in STEM education in South Africa.

With its innovative techno-blended approach and unwavering commitment both to teacher development and learner support, the GMMDC has established a substantial network and presence among education stakeholders and in South African public schools. Its forward-thinking practices not only advance STEM education but also contribute to the broader goal of enhancing science and technology in society. As a leading player in the quest for improved STEM education, GMMDC continues to drive innovation and inspire future generations.

Hot-Box Urban Agriculture Project

By Dr Gaathier Mahed

Imagine growing your own herbs and vegetables in a cupboard and never having to worry about whether they are taken care of or have enough water? This is exactly the vision of the Hotbox, which is the brainchild of Dr Gaathier Mahed, and is being developed by his team in Nelson Mandela University's geoscience department.

Still in prototype phase, the HotBox is a response to important issues facing the world today. It aims to address the significant challenge that climate change has presented for traditional agricultural practices. Several factors impact food security and sustainability, including irregular weather patterns, rising temperatures, scarcity of fresh water, and other unpredictable circumstances. This makes the cultivation of specific vegetable crops during their natural season problematic, limiting and affecting not only the availability and affordability of fresh produce but also the productivity and livelihoods of farmers.

The HotBox is essentially a mobile greenhouse in which anything can be grown all year round. A farm on wheels, it is equipped with sensors to regulate itself, meaning that soil maintains optimal moisture levels and the box's temperature is regulated to grow fresh greens in the best way possible. As such, the HotBox provides an innovative solution by creating a controlled environment for urban farming, optimising the use of available resources to overcome the constraints imposed by traditional farming methods.

In the long term, it is hoped that the project will become self-sustaining, creating employment and improving the lifestyle and livelihoods of many impoverished communities: an African solution for Africans, by Africans.

Dr Gaathier Mahed has a background in water research and sustainable development. He has done extensive technical training in Computational Geoscience, with a focus on Hydrology

Wastewater Monitoring,
Surveillance, and Epidemiology

By Dr Sharlene Govender

Although we may think COVID-19 is over, our wastewater tells a different story. Given the present water shortages across the Nelson Mandela Bay Metro, it is important not only to check the quality of drinking water but also that of effluent to provide an early warning system about the exposure to pathogens (disease causing microorganisms such as SARS-CoV-2). Since 2021, our research team at the Department of Biochemistry and Microbiology has been testing the water running down our drains and out through the sewers during and beyond the COVID-19 pandemic.

Nelson Mandela University is a partner in the South African Medical Research council's SARS-CoV-2 wastewater research and surveillance programme, which monitors five provinces. Results are uploaded weekly on a dashboard and are freely accessible to the public (*www.samrc.ac.za/wbe*). Through this collaboration, we have been working closely with the municipality on nine wastewater treatment plants around the metro. A microbiology master's student in the team focused on wastewater from student residences on the University's Summerstrand campuses. The wastewater surveillance looks at the non-infectious SARS-CoV-2 RNA, the fragments of the virus that causes COVID-19, which can be shed in faeces of individuals who are symptomatic or asymptomatic. We have discovered that, although levels are lower than at their peak in 2020 and 2021, the virus is still very much with us.

Wastewater based epidemiology is a useful tool to track different disease-causing microbes. For example, especially now when clinical cases are so low, it is easier to track the epidemiology of SARS-CoV-2 in wastewater rather than relying on people reporting having COVID. We have found high levels of viral RNA in the water just before, and during the peak of a wave of SARS-CoV-2, as well as when students are on campus. This information is useful to give us an indication of possible increase in COVID-19 transmission. We could track the different waves of COVID-19, testing the wastewater samples to assess levels of the SARS-CoV-2 virus. This was then linked to different student residences, some of which were placed in quarantine in 2021 when numbers of cases spiked. Whole genome sequencing analysis of SARS-CoV-2 showed that the majority of wastewater samples harboured mutations linked to the Omicron variant, with a 100% prevalence indicating that the fourth and fifth waves were driven by this variant. The Department of Biochemistry and Microbiology testing team reported these results to the appropriate University authorities to assist them in monitoring health on campus.

Dr Sharlene Govender's research team at the Department of Biochemistry and Microbiology has been testing wastewater since 2021

The objectives of the research project have been expanded to include monitoring of antimicrobial resistant bacteria, to monitor and track levels of various pathogens in wastewater as well as water safety and pandemic preparedness. The project is aligned with the University's support of UN Sustainable development goals. Wastewater surveillance ties in with two of these: Good Health and Well-Being and Sustainable Cities and Communities. It also contributes to scholarship of engagement and research capacity building at Mandela University by addressing the crisis of the COVID-19 pandemic, water safety and pandemic preparedness.

Monitoring pathogens in wastewater and water safety

Centre for **High Resolution Transmission Electron Microscopy**

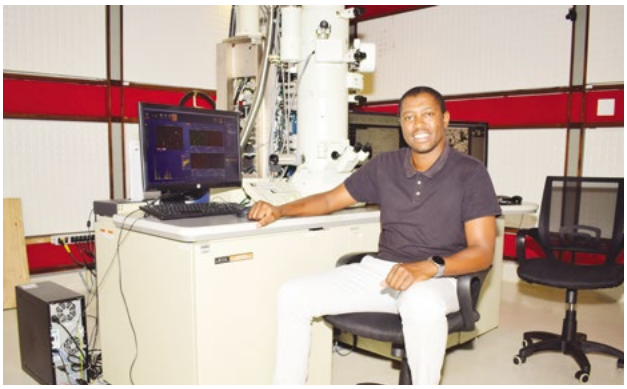
By Professor Jaco Olivier

The Centre for High Resolution Transmission Electron Microscopy (CHRTEM) is a Department of Science and Innovation/National Research Foundation (DSI/NRF) infrastructure platform for advanced electron microscopy at Nelson Mandela University. The facility houses four state-of-the-art electron microscopes – including the only double aberration corrected transmission electron microscope on the African continent – as well as the enabling infrastructure for sample preparation, data processing, and image simulation. The centre's main aim is to provide a broad community of South African scientists and students with a full range of state-of-the-art instruments and expertise for materials research.

Modern industrial applications use a wide range of materials, accurately engineered at the microscopic scale, to yield specific properties suitable for their application in harsh operational environments. In the case of catalysts used in various chemical industries for example, the catalysts' structural and chemical properties will determine the yield of the desired chemical products sought for commercial applications. The overall economic viability of such a process will further be determined by the length of time a material (catalyst) can maintain its key properties to produce the desired commercial product.

Changes in the properties of materials, and by extension performance, are due to structural changes at the microscopic scale, or microstructure, of the materials due to prolonged exposure to operational conditions. This in turn impacts the useful life of often extremely expensive components as there is a loss of their unique material properties over time. This could lead to a catastrophic failure of the material, impacting safety, or have detrimental effects on commercial output, impacting business performance. Routine monitoring of the state of materials used by industry is thus an important factor to ensure business performance and safety.

Dr Geneveve Marx, scientist at the CHRTEM, using the aberration corrected transmission electron microscope (TEM)



Dr Hlanganani Nyembe, scientist at the CHRTEM, does QEM for creep life assessment of steels used in turbine rotors for Eskom power plants

Quantitative electron microscopy (QEM) is an analysis approach that combines the rich imaging data obtained from microscopes, such as electron microscopes, with advanced data processing approaches to extract statistical parameters accurately describing the microstructural state of a material. By combining high-resolution imaging with precise quantification, QEM enables the accurate measurement of structural features down to the atomic or nanometer scale. This data driven approach provides an unambiguous and consistent assessment of the state of a material and enables decision-makers to make informed choices regarding process control, safety and failure mechanisms within an industry. This capability is crucial for industries where material properties dictate performance.

CHRTEM is actively involved in in providing these capabilities to South African and global industries. Scientists employed at the CHRTEM actively work with many industrial partners to develop sophisticated QEM approaches to assess the quality, life cycle and failure modes of materials used in their industrial processes. From the development of next-generation catalysts for the production of sustainable aviation fuel as part of the SASOL Care-o-Sene project to enhancing process efficiencies and production control at stalwart South African industries such as Hulamin and Eskom, CHRTEM scientists play an important role in driving the competitiveness of South African industries and growing the South African economy.

Chemical Industry Engagements

Towards Commercial Production

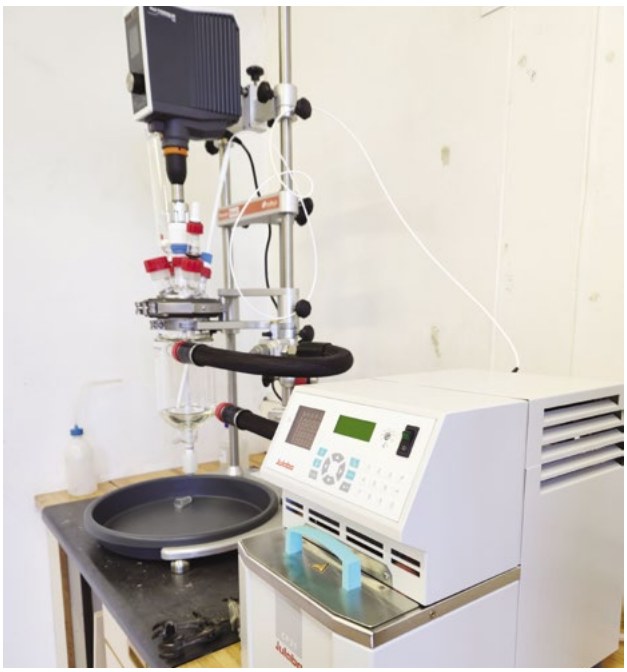
By Louise Hamilton and Dr Gary Dugmore

From the 1950s South Africa began to utilise its coal reserves through commercialising coal gasification using Fischer-Tropsch synthesis (Sasol's coal-to-liquid processes) to produce liquid fuels and form a basis for the country's chemical industry. During South Africa's economic isolation of the apartheid years, chemical manufacturing plants in South Africa were built to satisfy only local demand. However, once the country opened up post-apartheid, its economy faced the competition of global markets. Lacking the necessary economies of scale to operate at this level, many South African chemical manufacturing operations in fine and speciality chemicals were uncompetitive, leading to a sharp decline in manufacturing.

However, the needs of global markets have changed in light of recent geopolitical developments, which have disrupted global supply chains. Industry has recognised that dependence on imports for production inputs is a major risk, which could be mitigated by re-localisation of production. InnoVenton, Nelson Mandela University's Institute for Chemical Technology, has engaged with local and international industry, to research their response to upscaling the development of chemical manufacturing of fine and speciality chemicals in South Africa. The country's industrial base, raw materials, and feedstocks provide a timely opportunity to develop competitive technologies to re-industrialise its fine chemical manufacturing sub-sector, contributing to economic growth and job creation, raising aggregate domestic demand and exports, and supporting the country's National Strategic Objectives.

Innoventon's engagement with industry and SMEs has led to the identification of products with high potential to be commercialised through manufacture in South Africa. Given the investment in time and resources, the importance of the initial selection of products and/or technology for further development, cannot be overstated. Engagement with the greater industry sector is essential to ensure that there is market demand to provide a business case.

InnoVenton scientists review and evaluate available technologies and formulate a synthetic route which could meet the commercial objectives. The technology is ready for licensing to the most suitable, previously identified commercial partner once techno-economic criteria are met and development has progressed as far as possible at InnoVenton. Where technologies require further development prior to commercial operations (e.g. Industrial Pilot Plant scale trials), a development license may be granted, and the necessary



Radleys Single jacketed 1 L Process Reactor for laboratory scale up in a plant-simulated environment. Image: Louise Hamilton

further external development supported by InnoVenton through Technology Transfer activities co-ordinated through the University's Technology Transfer Office.

The skills required for the successful development of process technology in the fine and speciality chemical manufacturing industry are extremely scarce. InnoVenton is actively involved in mentoring and upskilling postgraduates through work on industry and technology development projects, allowing them to apply theoretical and academic experience to innovating around commercially relevant technologies. We offer workshops and short learning programmes to students and unemployed graduates, to broaden their understanding of chemical process technology development and to nurture skills such as the techno-economic assessment of potential technologies at appropriate levels of detail or certainty.

Chemical process technology development also requires appropriate workspaces, laboratory facilities, and specialised equipment, so at InnoVenton we continue to invest in modern equipment and facilities to support chemical process technology development and re-industrialisation of fine and speciality chemical manufacturing in South Africa.

Engagement on Optical Fibre Technologies

By Dr David Waswa

The Centre for Broadband Communication (CBC), established in 2014, focuses on human capacity development, engagement in MeerKAT and Square Kilometre Array (SKA) mega-science projects, advancing broadband communication in South Africa, and researching next-generation optical fibre technologies. It is committed to enhancing human skills and addressing societal needs, fostering technological advancements that contribute to the socio-economic development of South Africa and beyond.

Human Capacity Development

By engaging with a diverse group of postgraduate students, the CBC not only enhances individual career prospects but also strengthens interdisciplinary collaboration. By empowering young researchers, particularly women and under-represented groups, they promote inclusivity and diversity in STEM, which is pivotal in cultivating a skilled workforce equipped to tackle the challenges of the future. CBC is also mentoring numerous researchers across the continent in collaboration with universities from other African countries. Many international students have graduated through CBC and are now employed in research institutions and industries throughout Africa.

Contributions to National and Global Research Initiatives

The CBC has successfully transferred innovative technologies to MeerKAT and SKA projects, utilising optical fibre to efficiently collect and transport vast amounts of data from telescope dishes across Africa. We are also developing compact optical fibre delay lines for the HERA telescopes, which not only enhance radio astronomy research but also have potential applications in environmental monitoring and disaster response.

CBC team together with HERA electrical engineer at the South African Karoo Astronomy Reserve.

Dr James Jena (postdoc) and Dr Victor Agbakoba (postdoc) preparing to install the delay lines to HERA telescopes

CBC Brings the Magic of Optics to the Eastern Cape

This year the CBC team reached out to students from Eastern Cape schools, demonstrating the use of optic fibre as the enabling medium for high-speed communication and access to the internet at home, at school, and at work. The Physics Department and the CBC crew together exhibited during the 2024 Nelson Mandela University Open Day in May, captivating audiences with interactive demonstrations showcasing the power of optics and bringing complex scientific concepts to life.

Building on this success, the CBC participated in a career expo in July, inspiring young minds with a deeper understanding of how technology works, and the possibilities of a career in science. These outreach initiatives highlight the CBC's commitment to sharing knowledge and inspiring the next generation of scientists and engineers.

Decolonising Botanical Nomenclature

By Professor Gideon F. Smith and Dr Estrela Figueiredo

For more than 270 years, living organisms have been formally named according to a so-called binomial system – consisting of genus and specific epithet – first introduced in 1753 by the Swedish naturalist Carl Linnaeus. Naming conventions are today regulated by nomenclatural 'Codes' for different fields of biology. The *International Code of Nomenclature for algae, fungi, and plants* is the set of rules and recommendations governing the scientific naming of all plants. Within this framework, historically, many plants have been named to indicate their region of origin, to note a prominent character, or to honour prominent members of society. However, a number of the descriptive terms used historically are now considered to be offensive or culturally insensitive. As a result, various scientific plant names that might once have been considered benign have since developed derogatory connotations.

***Erythrina afra* is one of the species whose culturally insensitive epithet was changed based on the decisions made at the at the 2024 International Botanical Congress.** Image: © Craig Peter

The coast coral tree, *Erythrina caffra*, which is a common roadside tree planted in many parts of South Africa, is a case in point. The specific epithet '*caffra*' derives originally from an Arabic word meaning 'infidel'. In colonial times, various forms of this term were used in naming the inhabitants, flora and fauna of southern Africa. However, the noun from which the term derives subsequently acquired an extremely negative connotation as a racial slur, and its use in common parlance is illegal in South Africa.

In the context of the negative impact of colonialism on Africa, Prof Gideon F. Smith and Dr Estrela Figueiredo of the Department of Botany at Nelson Mandela University raised the matter of potentially culturally insensitive plant names. There was much deliberation among botanical scientists in the literature and on social media platforms relating to the way these names should be dealt with, and these discussions quickly developed into a heated debate. It was clear that the plant systematics community was highly divided on the matter. In 2021, Smith and Figueiredo published an elegantly non-disruptive proposal to retroactively and permanently eradicate the use of this racial slur from international botanical nomenclature, for consideration at the Nomenclature Section of the 2024 International Botanical Congress held in Madrid, Spain. The aim of their proposal was to have the specific epithet, '*caffra*', replaced with '*afra-*', which means 'pertaining to' or 'from' Africa.

Current plant nomenclature rules require that historical plant names need to be maintained to ensure their stability and reliability. Consequently, offensiveness and cultural insensitivity have not been considered a reason for change. Smith and Figueiredo were therefore aware that voting on the matter would be close. As expected, the forum was divided; however with more than sixty per cent support – a supermajority that is required to amend the botanical Code – from those present in Madrid, the name changes were adopted. Consequently, more than two hundred plant names containing the racially offensive epithet '*caffra*', have been changed to '*afra*'. The meeting also tasked a committee with the assessment of newly proposed plant names to ensure that potentially insensitive honorifics are not used in future.

Change the World

PO Box 77000,
Nelson Mandela University
Gqeberha, 6031

info@mandela.ac.za

mandela.ac.za