ANNUAL **REPORT** 2021

"Hope is the light at the end of the tunnel **guiding the way.**"

- Selena Smith -

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UNIVERSITY OF THE
FREE STATE
UNIVERSITEIT VAN DIE
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UFS

Natural and Agricultural Sciences ANNUAL **REPORT** 2021

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The Dean's Office 2021. Back row, from the left, Elrich Jacobs, Elfrieda van den Berg, Tracy Isaacs, Danie Vermeulen, Elzmarie Oosthuizen, Tamson Foster and Thabo Kototsi. Front row, from the left, Carrel Moqolo, Madeline Barnard, Sylvia Mogwera, Sally Visagie, Liesl van der Westhuizen, Heidiry White and Lubabalo Saba

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FOREWORD

MESSAGE FROM THE DEAN

2020 was a challenging year for all, due to the need for a rapid transition to digital teaching, a year characterised by an array of unfamiliar and unsettling events. Due to the ongoing COVID-19 pandemic, the situation continued in 2021. As I stated in the previous annual report, 2020 taught us a range of new and innovative things regarding tertiary education, and during 2021 the Faculty built on the lessons learned, in particular in improving the methodology of blended learning. Staff really became very innovative in their teaching methods to focus on student success, and we moved away from the narrow focus of outdated teaching techniques. Digital teaching becomes the norm. As the cover page illustrates, there is always light in the tunnel, despite the darkness that we had to go through. At the end of 2020, the COVID-19 vaccine rollout began in many countries, with many more eagerly awaiting delivery of their orders. With a light at the end of the tunnel, we are now all looking forward to returning to the activities, places and people we have missed so much in the past two years. In this time of crisis, we are often reminded of a famous quote attributed to Winston Churchill during World War II: "If you're going through hell, keep going." While South Africa is not in the middle of a physical war, we are battling the COVID-19 crisis in full force, and I am very optimistic that we will overcome this pandemic in 2022. We all suffered the loss of lives and livelihoods, and our hearts go out to those who lost loved ones.

The crisis has exposed South Africa's biggest challenge – its job market. Even in the best of times, the labour market has been marked by high levels of unemployment and inactivity. Out of a working-age population of almost 40 million people, less than 40% of South Africans are employed, which includes 3 million jobs in the public sector. The COVID-19 crisis has made a difficult situation even worse. In 2021, we saw a modest job recovery. Against the odds, there are also positive developments in the labour market, and young entrepreneurs are one of South Africa's best hopes to solve the jobs crisis. There are an increasing number of start-ups, especially in the digital sector, which are growing fast and will in the future become very important for job growth. This makes the content that we teach, the digitalisation of teaching and the Faculty's Graduate Attributes Programme, which is driven by our Teaching and Learning Manager together with the Centre for Teaching and Learning (CTL), so much more important.

In 2021 we maintained the high research output that we had in 2022. We had another record year, and I must thank all the staff for their dedication. Unfortunately, the tendency that only 50% of the academic staff publish, remains an issue and I trust that as the number of staff who complete their PhD degrees improves, the number of staff who publish, will also increase. In the Faculty we developed a very successful programme to assist staff to complete their degrees, with remarkable success over the last two years, and several staff who will also graduate in 2022.

As stated previously, the NRF-rating system is a valuable tool for benchmarking the quality of our researchers against the best in the world. Although the number of rated scientists did not increase in 2021, 13 newly-rated researchers (five emerging researchers in the Y-category and eight established researchers in the C-category) and four re-evaluated applicants were added to the list of rated researchers in the Faculty. The quality of the outputs also improved, with all the Faculty outputs published in journals with a quadrille rating. Our current goal is to focus on improving quality rather and not just quantity, which will bear fruit in the longer-term. Nearly 60% of all outputs were published by full-time staff members, and 18% by research associates. To continue to increase the number of outputs, we also have a drive through the Faculty Research Committee to appoint more

research associates who can contribute effectively to the number of publications.

In 2021, a number of staff were rewarded for their hard work. Prof Dirk Opperman (Microbiology) and Prof Angelinus Franke (Soil Crop and Climate) were promoted to Professors, and Nicky Matthews (Agricultural Economics), Francois Fourie (Institute for Groundwater Studies), Delson Chikobvu (Mathematical Statistics and Actuarial Sciences), Brian van Soelen (Physics), Johannes Belle (DIMTEC) and Frikkie Maré (Agricultural Economics) were promoted to associate professors. Four staff members were also promoted to senior lecturers, i.e. Marinda Avenant (Centre for Environmental Management), Adriaan van der Walt (Geography), Ismari van der Merwe (Sustainable Food Systems) and Kgosi Mocwagae (Urban and Regional Planning).

Several new initiatives were started in 2021:

1. Developments at the Experimental Farm are slowly reaching the point where the farm can be a showcase for the University. The Dairy Processing Unit was completed during 2021 and the reconstruction of the equipment for the brewery is well under way and will be completed in 2022. The rebuilding of the cattle kraal to host the Grow Safe research programme was also initiated in 2021 and is nearly completed.
2. The IGS water research laboratory obtained ISO 17025 accreditation from the South African National Accreditation System (SANAS) for all methods used in the IGS. ISO 17025 is complementary to the generic quality management system standard ISO 9001.
3. In 2021, the Department Microbiology and Biochemistry started an exciting new partnership with the South African National Biodiversity Institute (SANBI). Through this partnership the yeast culture collection facility was invited to become one of the core facilities of the Biobanks SA initiative.
4. In the first quarter of 2021, the Centre for Microscopy took delivery of multiple pieces of new research equipment. This was an exciting time for those who had been involved in the large equipment drive at the UFS, which started in 2020. The Centre will be fully functional in 2022.
5. The Sensory Laboratory is now also fully operational and contributes to several research projects as well as analyses for industry.
6. The study area for MSc students was completed in the Agricultural building and can host 50 students.
7. The newly built waste facility was completed on the West Campus, which allows the Forensic building more space for laboratories.
8. In honour of the work of more than 35 years by Prof Andreas Roodt who retired in 2021, the Inorganic Chemistry Division recently unveiled the Roodt Crystallographic Laboratory (Roodt XRD Lab).

International collaboration continued despite travelling restrictions. When reading through the report, it is noticeable how many staff have active collaboration with international universities. It is very important that we continue and build on these efforts. It is always important to interact with universities across the world which are rated higher than ourselves. This is also true for the top universities in Africa, but we are also committed to working with a range of universities in Africa, in particular in terms of assisting with building the capacity and co-supervision of staff members from other universities.

In terms of collaboration on the local front, the Department of Mathematics and Applied Mathematics started the year off on a high note by hosting the 64th Annual South African Mathematical Society (SAMS) congress, which was conducted fully online and yet was a great success. The Free State working group of the Agricultural Economics Association of South Africa (AEASA) hosted the FR Tomlinson Commemorative Lecture. This annual event was established in honour of the FR Tomlinson, the first president of AEASA and a leading figure in the establishment of agricultural economics in South Africa. The Department of Chemistry organised the Free State PhyChem-2021 Symposium at the UFS.

Although there were numerous achievements from staff and students, I want to highlight just a few:

- The highlight of 2021 was Prof Paul Oberholster, who received the award for the 2020/2021 National Science and Technology Forum (NSTF)-South32 Awards (Science Oscars) in the category NSTF-Water Research Commission Award.
- Dr Hlamalani Judith Ngwenya from the Department of Sustainable Food Systems and Development received the national Order of the Baobab from President Ramaphosa in honour of her work in sustainable agriculture and community empowerment.
- Prof Peter Taylor from the Department of Zoology and Entomology was elected a Fellow of the Linnean Society of London, the world's oldest active biological society. In October 2021, he was inaugurated as member of the Academy of Science of South Africa (ASSAf).
- During the 52nd South African Society for Animal Science (SASAS) Congress, three students won the SASAS student quiz for the first time. Two of the postgraduate students, Andries van der Merwe and Ofhani Michael Mavhungu, won the prestigious Koos Van Der Merwe/AFMA Student of the Year Award 2021-2022 and the Professor Rob Gous Scholarship (sponsored by Chemuniqué), respectively.
- Prof Jonathan Noble from Architecture received an award from the South African institute of Architects (SAIA) in the research category, for his book *The Architecture of Peter Rich: conversations with Africa.*
- Dr Pakiso Khomokhoana and Prof Liezel Nel received the Best Paper award at the 50th Annual Conference of the Southern African Computer Lecturers' Association (SACLA).
- Prof Johannes Belle from DiMTEC was appointed by the United Nations (UN) as part of the international team for thematic theme 4 on Nature-based Solutions (NbS) to organise the Global Platform (GP) for Disaster Risk Reduction.
- Prof Alice Brink from Chemistry was invited to serve as a member of the South African National Committee for International Union of Crystallography.
- Dr Elizabeth Rudolph and Mrs Marike Stander from Geography were elected as council members for the Southern African Association of Geomorphologists (SAAG) for the term 2021 to 2023, and Dr Rudolph was voted in as the new President-elect of SAAG, to serve as President from 2024 to 2026.
- Prof Frederick Roelofse from Geology was elected by the Mineralogical Association of South Africa (MINSA) to be the representative on the International Mineralogical Association (IMA) Commission for Gem Materials. He was also nominated to serve on the National ICDP Committee.
- Mr Frans Koning from Mathematical Statistics and Actuarial Science qualified as a Chartered Enterprise Risk Actuary.

I would like to make special mention of Prof Neil Heideman, the previous Dean, who retired at the end of 2021. He served as Dean of the Faculty of Natural and Agricultural Sciences from 2010 to 2015 and I want to thank him for his unselfish contribution to the Faculty. We trust that he will enjoy his retirement that he so thoroughly deserves.

Prof Neil Heideman, former Dean (2010 to 2015)

It is my pleasure to present to you our 2021 Annual Report and extend my sincere gratitude to the staff and students for their selfless commitment to make this Faculty and University great. In 2021 we started to see light in the tunnel, and we are very positive that in 2022 we will return to normality. At the National Archive in Washington there is a statue with the words "What is past, is prologue". I trust that in 2022 we will have a new beginning, putting all the hardship and uncertainty of 2020 and 2021 behind us, and that we will look forward with positiveness. Let us embrace the wise words of Confucius – "If you are positive, you will see opportunities instead of obstacles" – and remember there is always light in the tunnel! May 2022 be full of sunshine and no darkness.

AGRICULTURAL SCIENCES

Department of
AGRICULTURAL ECONOMICS

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OVERVIEW OF 2021

The Department of Agricultural Economics performed well during 2021, with our research outputs reaching new heights. We published 38 journal articles and one book chapter, and the number of postgraduate students also increased. There has been little change in our staff numbers, with only one contracted staff member who left at the end of 2021 when his contract ended. Although some COVID-19 restrictions were still in place during 2021, we were fortunate to be able to present most of our classes face-to-face. Although academic conferences were still mostly hosted online, staff members were able to start to connect with industry again on a face-to-face basis, which improved our scholarly engagement activities.

Dr WA Lombard

Prof Yonas Bahta

Dr Nicky Matthews

ACHIEVEMENTS

Staff Achievements

Two staff members in the Department were promoted at the beginning of January 2021. Dr WA Lombard was promoted from Lecturer to Senior Lecturer, while Prof Yonas Bahta was promoted from Senior Researcher to Associate Professor.

Dr Nicky Matthews received a Y2 NRF-rating, which brought the total number of NRF-rated staff in the Department to three.

We are very proud of our staff members who received awards and prizes at our annual year-end function and prizegiving ceremony. These were:

Dr Nicky Matthews receiving the Chairperson's Trophy for Service to the Department

Mr Walter van Niekerk receiving the HA Kotze Trophy for Outreach

Prof Yonas Bahta receiving the MF Viljoen Trophy for Research

Mr Walter van Niekerk receiving the CS Blignaut Trophy for Teaching and Learning

Mr Markus Monteiro (left) and Mr Johann Strauss (right) receiving the Theo Potgieter Trophy for Farmer Outreach

Dr WA Lombard receiving the LK Oosthuizen trophy for Community Service

Student Achievements

Heleen Viljoen, research assistant in the Department of Agricultural Economics, was invited to make a presentation at the Grain SA Congress on 4 March 2021. The presentation focused on the distribution of input costs in the winter grain production area of the Western Cape.

The following students received awards and prizes at our annual year-end function and prizegiving ceremony:

- Student ambassador trophy:
  Ms Grace Smythe
- Student assistant trophy:
  Ms Anje Erasmus

Heleen Viljoen

TEACHING AND LEARNING

The Department offers three undergraduate programmes – BSc Agricultural Economics, BAgric Agricultural Economics and BAgric Agricultural Management. At postgraduate level students can do Honours, Master's and Doctoral degrees in either Agricultural Economics or Agricultural Management.

RESEARCH AND INNOVATION

Our research endeavours during 2021 centred around three broad themes (i) water-related research mainly funded by the Water Research Commission (WRC), (ii) research on livestock economics, mainly funded by the Red Meat Research and Development South Africa (RMRD SA) and industry partners, and (iii) projects concerning drought and small scale producers, mainly funded by the National Research Foundation (NRF).

Prof Henry Jordaan is involved in research projects on water-footprint assessment to inform the sustainable use of water for food and fibre production in South Africa. The team is currently busy with a project, in collaboration with the South African Sugar Research Institute (SASRI), in which they assess the water footprint of fuel and fibre crops, with special focus on sugarcane production.

Another WRC project, led by Dr Nicolette Matthews and Prof Bennie Grové, which aimed to develop a bio-economic model to develop water and salt stress management guidelines within a precision agriculture framework, was in its final year.

Walter van Niekerk completed his PhD, titled 'An estimation of the downstream economic implications of predation in the red meat industry of South Africa'.

The predation of livestock in South Africa, and globally, by damage-causing animals or predators is not uncommon. Predation losses in the small (sheep and goat) and large (cattle) livestock-producing sectors have been projected to exceed R1390 million and R393 million respectively, in direct predation losses at producer level. Globally and in South Africa, ample research has been conducted on predator management and estimations of the physical losses of domesticated animals and wildlife species. However, few studies have focused on the financial and economic implications that damage-causing animals have for the livestock production sectors, related industries and the economy. These 'downstream' implications are most often overlooked when estimating the entire economic implications of predation losses. Because of predation in the cattle and sheep/goat production sectors, the total direct outputs decreased by R82 million and R536 million, respectively, with total reductions in output of R3 806 million and R648 million, respectively. The cattle-producing sector has contributed more to the GDP than the sheep/goat producing sector, being a much larger industry than the sheep/goat production sector is, and greater value is added to the final product. Labour income generated by the cattle production sector amounted to an indirect value of R61 056 million and reduced to R60 866 million due to predation losses. As a result of the simulated predation losses in the cattle and sheep/goat production sectors, it is estimated that there could be a reduction of 360 and 2 560 jobs (labour) that are directly linked to production in these two sectors, respectively

Dr WA Lombard led a project funded by RMRD SA in which the economic impact of heartwater disease on the South African livestock industry was investigated. Mr Mario van den Heever, a team member on the project, based his MSc on this project and will graduate in 2022.

Prof Yonas Bahta's research on agricultural drought resistance and the impact of drought, which has been funded by NRF-Thuthuka since 2018, continued in 2021. The study included assessing adaptation and coping strategies, the resilience to agricultural drought, its implications for the livestock sector's sustainability, the impact of agricultural drought on smallholder livestock farmers, and empirical insights from the Northern Cape. The Agricultural Drought Resilience Index, the Household Food Insecurity Access Scale, and descriptive analysis were among the quantitative and quantitative methodologies utilised. Since the start of the project, three Honours and three Master's students have graduated, with two of the Master's students graduating with distinction.

Prof Edilegnaw Wale, Prof Henry Jordaan, and Dr Janus Henning worked on a WRC project, titled 'Entrepreneurial development for establishing small farming businesses and employment by youth in rain-fed crop farming'. The project aims to establish entrepreneurial development paths to facilitate the participation of rural youth in primary agriculture and value-adding activities along the food value chain. The project has been running since 2018 and involves one PhD and three Master's students. The project is expected to be completed in 2022.

Ms Pascalina Pilane is involved in a collaborative research project with, among others, scientists from Stellenbosch University, exploring the scope of using water-footprint assessment to inform sustainable water use in the production of table grapes and wine.

Prof Bennie Grové secured funding from WRC to transfer the custodianship of SAPWAT from PICWAT Consulting to the UFS. The project will be undertaken in collaboration with the UFS Department of Soil, Crop and Climate Sciences. During the project, the climate database will be upgraded to reflect current climatic conditions.

Dr Frikkie Maré completed two projects on the economics and environmental impacts of beef production. The Master's project of Chéri-Lynn Steyn revolves around the backgrounding of beef cattle. The research question addresses how long weaners of various weaning weights should be backgrounded. Factors such as animal production, market prices and the feedlot's facilities should be taken into consideration when establishing the optimal backgrounding period for different weight classes of weaners. The experiment was conducted at Sernick's Liebenbergstroom feedlot, where 405 Bonsmara weaners were assigned to different treatments, backgrounded and then placed on the feedlot. The project was funded by Sernick and the Faculty of Natural and Agricultural Sciences' Central Research Fund.

The other Master's project, undertaken by Grace Smythe, focused on health preconditioning weaners as a management practice that is aimed at enhancing weaner immunity to ensure that weaners are better equipped to handle the stress and increased exposure to diseases that they face in the feedlot environment. As it has many advantages, health preconditioning is internationally considered as a value-added management practice. However, in South Africa it is currently not known whether feedlots and cow-calf producers consider preconditioning to be an economic value-added management practice. This study aims to determine, through telephonic surveys, what the perceptions are of South African feedlot operators and cow-calf producers are, and, if they do consider it to be value-adding, what the monetary value thereof is. The project was funded by Zoetis and the Faculty of Natural and Agricultural Sciences' Central Research Fund.

ENGAGED SCHOLARSHIP

The Department is dedicated to giving back to the farming community at large by providing the agricultural sector with relevant information. During 2021, this was done in various ways, including farmer's days, farmer-arranged conferences, and popular media, such as Farmer's Weekly, Veeplaas, Landbou Weekblad, Stock Farm and Farmbiz. Our staff were also regular guests on radio programmes on OFM and RSG, as well as the YouTube channel Plaas TV.

Mr Walter van Niekerk remained actively involved with the National Lucerne Trust, which provides training days for lucerne producers and role players.

On 4 February 2021, Dr Frikkie Maré was one of the guest speakers at the Malemba Boerdery Farmer's Day near Louwna, North West. Malemba Boerdery organised the day to showcase their Simbra and Simmentaler studs and to provide attendees with information on the agricultural market and animal diseases.

Prof Frikkie Maré, Dr Faffa Malan, Mr Phillip Lee and Mr Jacques Swart

In June 2021, Johann Strauss, Walter van Niekerk and Markus Monteiro visited the high school Landboudal, in Jacobsdal in the Free State. The aim of this visit was to inform the learners about how the derivative markets can be utilised to mitigate price risk in agricultural commodities.

Johann Strauss and Markus Monteiro also presented the South African Futures Exchange (SAFEX) (JSE Agricultural Derivative Market) course. The course is aimed at those who would like to learn more about the agricultural derivatives market (ADM) and how derivative instruments can be used to mitigate price risk. The UFS is the only higher education institution that offers a course in this field to the industry. A total of four courses are normally presented, two in Afrikaans and two in English.

Johann Strauss (left) and Markus Monteiro (right) with the learners who attended the information session

NATIONAL AND INTERNATIONAL COLLABORATION

Mr Walter van Niekerk attended the annual Agri Benchmark conference, which is open only to members of the organisation. Over 36 countries are represented in the international network. Due to traveling restrictions the conference was held virtually. The aim of the Agri Benchmark imitative is to benchmark beef and sheep production systems internationally on a comparable representative basis., the theme of this conference was the implications of COVID-19 on livestock producers and setting up international producer price indexes used for international comparisons. The Agri Benchmark tool is used to benchmark different production systems globally.

In November 2021, the UFS Office for International Affairs (OIA) hosted a delegation from the Namibia University of Science and Technology (NUST). An outcome of the deliberations was the decision to formalise collaboration through a Partnership Portfolio, to be driven by the OIA. The UFS and NUST are planning to work together and share information on the development of a COVID-19 vaccination policy, leveraging on the Germany/Namibia green hydrogen partnership, joining forces on the application for centres of excellence administered by the African Union, establishing staff and student exchange programmes, and intensifying their research collaborations.

Prof Yonas Bahta (front right) with the Namibian delegation

OTHER ACTIVITIES

As the Department is part of a very diverse agricultural sector, we are actively involved in a wide range of activities in the sector. Over and above activities related to research, engaged scholarship and collaboration reported on above, the following activities are worth noting.

Every year the International Farm Management Association (IFMA) gives recognition to individuals who have made a significant contribution to the agricultural community. During their annual Agricultural Excellence Conference at the end of 2021, Dr Wilhelm T (Wim) Nell was recognised in this way. Dr Nell (1950-2021) was part of the UFS Department of Agricultural Economics, and served as South Africa's representative to the IFMA during his career.

Dr Wim and Mrs Louise Nell

The Free State working group of the Agricultural Economics Association of South Africa (AEASA) hosted the FR Tomlinson Commemorative Lecture in Bloemfontein on 3 September 2021. This annual event was established in honour of the FR Tomlinson, the first president of AEASA and leading figure in the establishment of agricultural economics in South Africa. The purpose of the award is to give recognition for contributions made to the Agricultural Economics discipline in South-Africa.

The FR Tomlinson medal awarded annually for contributions made to the Agricultural Economics discipline

The 2021 recipient of the FR Tomlinson medal was Prof HD van Schalkwyk who delivered an insightful talk on 'Success of agribusinesses in South Africa'. Prof van Schalkwyk, former Dean of the UFS Faculty of Natural and Agricultural Sciences, was born and raised in the Free State and holds a PhD in Agricultural Economics. He is a well-known and prominent agricultural economist who has distinguished himself academically and in terms of leadership within the agricultural sector. Currently, he is the Managing Director of Hinterland, Klerksdorp. He played an instrumental role in developing the turnaround strategy of the Landbank when he was the acting Chairperson of the Landbank Board. Furthermore, he was central to introducing Agricultural Economics as a field of study at the North-West University.

Prof Herman van Schalkwyk (left) receiving the medal from Mr Danie Retief (Standard Bank)

POSTGRADUATE STUDENTS

In 2021, a total of 47 students were registered for the three Honours programmes offered by the Department and 18 students fo the MSc and 8 for the PhD.

Thirty-six students graduated with an Honours degree, while Vuyiseka Asiphe Myeki completed the MAgric, majoring in Agricultural Economics.

Johann Strauss graduated with a PhD. The title of his thesis was "An alternative pricing method for physically settled maize futures contracts on the Johannesburg Stock Exchange', and his promotors were Dr Frikkie Maré and Dr Dirk Strydom.

STAFF MATTERS

After three years with the Department, Dr Johann Strauss's contract ended at the end of 2021. His main responsibility was training junior employees in agricultural derivative markets. It was a very productive three years with Dr Strauss obtaining his PhD in 2021.

RESEARCH OUTPUTS

Research Articles

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STAFF (2021)

Head of Department:

Dr FA Maré

Professor:

Prof EZ Wale

Associate Professors:

Prof YT Bahta, Prof B Grové, Prof H Jordaan and Prof AA Ogundeji

Senior Lecturers:

Dr JIF Henning, Dr WA Lombard, Dr FA Maré and Dr N Matthews

Lecturers:

Ms P Pilane, Mr P Mokhatla, Mr JS Strauss and Mr HN van Niekerk

Junior Lecturers:

Ms Z Coka and Mr MA Monteiro

Programme Director:

Mr ES Jacobs

Researcher:

Ms P Madende

Research Assistants:

Mr D de Kock, Ms A Erasmus, Ms R Hadebe, Ms H Mans, Ms Y Maphalala, Ms M Marais, Ms N Masegela, Ms B Mhlangu, Ms V Myeki, Mr C Richards, Mr M Roodman, Ms G Smythe, Ms S Songca, Ms C Steyn, Mr O Tswai, Mr M van den Heever, Ms H Viljoen and Mr A Wallace

Research Associates:

Dr B Riddout and Dr DB Strydom

Affiliated Researcher:

Mr PL Oosthuizen

Officers:

Ms I Combrinck and Ms C van der Merwe

Department of
ANIMAL SCIENCE

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OVERVIEW OF 2021

Agriculture in South Africa had an excellent 2021. The season started early and exceptional rains were recorded over a large part of the country. The recovery in natural pastures in areas where the drought had been severe, was amazing. All this led to higher meat and breeding stock prices for almost all livestock species. In addition, the proposal of the Expropriation without Compensation Bill by opposition parties in the parliament, further heightened the optimism in the farming community.

The Department also had an outstanding year with several achievements and highlights. Possibly the main highlight relates to the achievements of the staff and students during the 52nd South African Society for Animal Science (SASAS) Congress, held virtually in August 2021. Members of the Department were involved in 22 oral and poster presentations, and three students won the SASAS student quiz for the first time. Two of our postgraduate students, Andries van der Merwe and Ofhani Michael Mavhungu, won the prestigious Koos Van Der Merwe/AFMA Student of the Year Award 2021-2022 and the Professor Rob Gous Scholarship (sponsored by Chemuniqué), respectively. Sinebongo Mdyogolo, PhD student from the Animal Breeding section in the Department, won the bronze medal for her doctoral thesis. A gold medal, the highest award in the society, was awarded to Prof Michiel Scholtz – one of our affiliated professors – for his lifelong contribution to the animal science fraternity.

Two staff members, Dr Errol Cason and Dr Francois Deacon, received their NRF-rating in 2021, and several other academics made their mark in the industry.

On the academic front, the new curriculum in the BSc Agric learning programme was finalised and will be implemented in 2022. The Department is confident that the new programme is on par with the best in the country and even the world.

The Department works closely with the UFS Experimental Farm at which there have been substantial developments over the past few years. The facilities on the Bloemfontein Campus were also expanded to support developments on the UFS Experimental Farm. The Animal Nutrition division acquired a Daisy™ In Vitro incubator, and for the first time it is now possible to conduct in vitro research trials – simulating the fermentation process in ruminant animals.

ACHIEVEMENTS

Staff Achievements

Dr Francois Deacon was elected as Chairperson of the 57th Congress Organisation Committee of the Grassland Society of Southern Africa (GSSA). He was elected as chairperson of the UFS Animal Ethics Committee, and received a Y-rating from the NRF. He was also re-elected as a member of the International Union for Conservation of Nature (IUCN) on Giraffe and Okapi Specialist Group (GOSG), and as a member of the IUCN Species Survival Commission (SSC) on GOSG.

Dr Paul Malan and Ms Jamie Paulse were chosen as members of the GSSA, and they also form part of the organising committee for the 2022 GSSA Congress.

Prof Arno Hugo was elected as Vice-Chair of the Professional Advisory Committee of the South African Council for Natural Scientific Professions (SACNASP) and received an award from the Livestock Registering Federation (LRF) as Meat Scientist of the Year for his research and services rendered to the red meat industry in South Africa. The award was conferred during the 13th LRF Stockman School and Conference held at Aldam on 14 October 2021.

Prof Michiel Scholtz received the SASAS Gold Medal for lifelong contribution to Animal Science in South Africa.

Dr Errol Cason received a Y2-rating from the NRF. Dr Christopher Rothmann was appointed as a Postdoctoral Fellow to assist Dr Cason, but his main responsibility will be to set-up the Innovation Park at the Experimental Farm.

Student Achievements

A number of our students received awards at the SASAS Congress, which was held virtually from 10 to 12 August 2021.

The Koos Van Der Merwe/AFMA Student of the Year Award 202102022, was awarded to Andries van der Merwe, and Sinebongo Mdyoglo received the SASAS Bronze medal for her outstanding PhD thesis on the genetic diversity of beef cattle.

Ofhani Michael Mavhungu (MSc Agric) received the 2021/2022 Professor Rob Gous Scholarship sponsored by Chemuniqué, to further his postgraduate studies in Animal Nutrition.

Ofhani Mavhungu winner of the Rob Gous Scholarship

During the same congress, three students in the Department – Carina Lues, Ofhani Mavhungu and Andries van der Merwe - won the SASAS student quiz, outsmarting students from all the other universities in the country.

Carla van der Merwe, an Honours student, won the Library and Information Services Best Assignment 2021 Competition for her research project 'The resistance levels displayed by Haemonchus contortus towards different anthelmintic groups, tested in Dohne Merino lambs on a central Free State farm'.

TEACHING AND LEARNING

New BSc Agric Curriculum

The new BSc Agric curriculum was finalised in 2021 and will be implemented in 2022. The purpose of developing the new curriculum was not only to simplify the programme, but also to incorporate the latest developments in Animal Science into one core programme. This means that a student will complete a generic Animal Science programme covering all the major aspects such as breeding, nutrition, physiology, animal products and rangeland science in the first three years, and in their final year they can specialise in either Animal Science, Grassland Science, Meat, or Dairy Science.

Simbra Training Course

Fourth-year Animal Breeding students, along with staff members of the Department, attended the Simbra training course held on 19 and 20 May 2021 on the UFS Experimental Farm as well as at Simbra Richters, the farm of Chris Richter outside Bloemfontein. During this course participants were exposed to basic genetic principles, breeding values and their use, as well as the theoretical and practical appraisal of Simbra cattle.

Students at the Simbra Training Course

RESEARCH AND INNOVATION

Animal Science

In the last quarter century, the livestock sector focused primarily on improved production, modifying the environment and improved nutritional management. Areas such as improved stress resistance and heat tolerance did not receive nearly as much attention. This approach managed to increase productivity of domestic animals substantially, but it also increased their sensitivity to hot environments. The processes by which domestic animals respond to changes in their environment are critical to survival, often negatively affecting the productivity and profitability of livestock systems. Other aspects of improved production are balanced nutrition and disease control, which contribute directly to improving animal output as well as reducing the cost of production. To meet the increased need for livestock products, about two-thirds of this increased demand will need to be met by improving the production efficiency of feed, both forage and concentrate feeds. In 2021, Dr Cason received NRF-Thuthuka funding to further our understanding of how both these processes are controlled genetically. The project will focus on a closed Dexter population selected for adverse environmental conditions and will offer opportunities for improving thermal stress resistance and feed conversion.

The Department of Animal Science acquired two automated feeding systems for both small and large stock for the UFS Experimental Farm. BKB sponsored a radio-frequency identification (RFID) automated feeder system for measuring

the individual voluntary feed intake of small stock. In a collaborative project, ALFA and the UFS together with the University of Stellenbosch, are conducting annual growth efficiency trials for rams of different breeds, to evaluate and compare the two systems used by the universities. This same automated feeder system can be used for both commercial and research purposes, as well as teaching and learning.

The second of the two automated feeder systems is the GrowSafe™ system. This system not only measures the voluntary feed intake of beef and dairy cattle, but also feeding behavior, live weight, and water intake in a more commercial setting, with no stress on the animals. The UFS is the only university in South Africa with this technology.

Both these systems will be used for undergraduate training, postgraduate research, as well as contract research. The Department of Animal Science is excited to use this state-of-the-art technology to generate accurate data, and also to see how different scientific disciplines can collaborate.

Dairy Science

Research is focused on the screening of various possible biochemical changes that may occur in milk when it is exposed to ultraviolet (UV) radiation. If detectable change is measured, it will be used in the development of a possible indicator to confirm cold UV sterilisation in milk. The researchers also explored the ability of bovine proteolytic plasmin to hydrolyse various species of milk. Cow's milk hydrolysis profiles were compared to the milk of rhino, impala, giraffe and elephant.

The Dairy Processing Unit at the UFS Experimental Farm started producing a natural semi-hard cheese of excellent quality and will start producing yoghurt in 2022. This forms part of the No Student Hungry (NSH) Programme, as well as the project in which students are exposed to the full value chain.

Dr Analie Hattingh and Mr Richard Timbela busy with cheese making

Meat Science

Two major projects were implemented in 2021 in this section.

The first project is titled 'Can the meat (nutrient value) from rejected wet carcass syndrome lamb carcasses, be recovered for human consumption?'. Wet carcass syndrome is a problem occurring in sheep, mostly in the Northern Cape. Such carcasses have a wet appearance, are difficult to process and unappealing to the consumer, and lamb carcasses affected with wet carcass syndrome are condemned for aesthetic reasons. Since condemnation of the carcasses implies a total loss for producers, sheep farmers from the Northern Cape expressed the need for research to be done to find possible utilisation of meat from these carcasses. This research therefore investigates the potential of wet carcass meat as an ingredient for pet food. The surface microbial population of carcasses will be determined and a microbiological shelf-life study during refrigerated storage of overwrapped meat will also be performed. If positive, this may form the basis of a further study and possible future application, to allow human consumption of such meat. Initial research results indicated that meat from wet carcasses is not inferior to meat from normal carcasses in terms of microbiological quality and chemical composition.

The second project investigates the effect of different sodium reduction strategies on the chemical, microbial and sensory quality of dried traditional South African beef products. High salt intake is associated with hypertension, heart disease and stroke. The target of the Directorate of Non-Communicable Disease of the South African National Department of Health is to reduce the population intake of salt to 5 g per day. A preliminary survey by our laboratory indicated that the salt content of currently available biltong and dry sausage is approximately 3 g per 100 g. That implies that consumption of 100 g of biltong or dry sausage provides more than 50% of the daily allowed salt intake. It is also important to make sure that these traditional South African delicacies keep up with and adhere to the health and nutritional demands of the modern consumer. The aim of the project is to reduce the salt and sodium content of biltong and dry sausage with 50%. Five different treatments are used – the positive control, which contains the amount of salt that most commercial biltong and dry sausage have; the negative control, which is half the salt content of the positive control; and potassium chloride, organic salts, and potassium lactate sodium replacers in combination with 50% salt reduction. Initial results indicate that the salt content of dry sausage and biltong can be reduced by 50% with salt replacers without having a negative effect on the shelf life and flavour of the products.

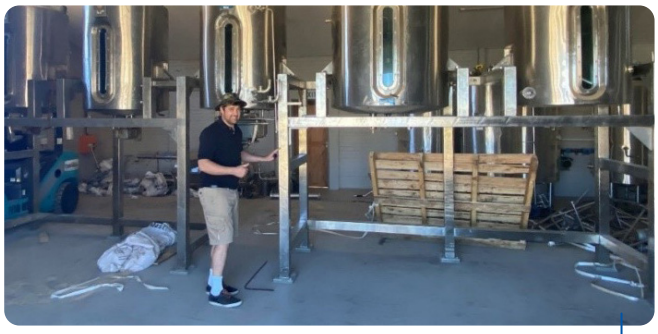
Kovsie Brewery

After several COVID-19 related delays, the revamping of the brewery building on the UFS Experimental Farm, along with preparations for brewery installation, was completed at the end of 2020. During 2021, all brewery equipment was moved into the brewery for installation.

However, finding suitable contractors proved difficult and work stalled during the middle of 2021. Towards the end of

2021, with the help of the Dean of Natural and Agricultural Sciences, Prof Danie Vermeulen, the HOD of Animal Science, Prof Frikkie Neser and the head of Instrumentation, Mr Adriaan Hugo, Barend 'Barry' Crous and Mark Jackson were recruited to finish the project. Since their involvement, the project has rapidly advanced towards completion with estimated dates being set for April 2022.

Dr Rothmann outside the completed brewery building



Brewing vessels mounted on support.

ENGAGED SCHOLARSHIP

In the first semester of 2021, Mr Leon Krüger, Lecturer in the Department of Animal Science, presented three short courses (one-day) on faecal egg counts and two courses (three-day) on small stock diseases at the UFS Experimental Farm. All courses were fully booked, confirming the need for such courses.

Mr Krüger and Dr Paul Malan are also involved in training and mentoring small-scale and upcoming farmers from Qwaqwa, Kroonstad and Gariep, on livestock health. The project is undertaken in collaboration with Standard Bank, and 30 farmers were trained in 2021.

The annual Animal Breeding course was again presented on the Experimental Farm in collaboration with Breedplan South Africa. A total of 40 participants were exposed to topics in breeding concepts, presented by local and international scientists, as well as stud farmers who are knowledgeable in the practical aspects of day-to-day stud breeding.

In 2021, Prof Arno Hugo started a service to industry to evaluate meat quality. Several breed societies have already made use of this service.

The Animal Nutrition lab, under Ms Jossie van der Merwe, deliver a valuable service on the analysis of feed samples to other UFS departments, as well as industry partners.

NATIONAL AND INTERNATIONAL COLLABORATION

No academic institution can operate in isolation, and the Department collaborates and operates nationally as well as internationally. Dr Vincent Ducrocq from INRAE, France's National Research Institute for Agriculture, Food and Environment, and Dr Mike MacNeil, Sole Proprietor of Delta G in Miles City, Montana, USA, are actively involved in research and postgraduate supervision in the Department.

Nationally the Department collaborates with the Agricultural Research Council (ARC) in research projects to the value of more than five million rand. Collaboration in research projects with universities such as Limpopo, Stellenbosch and Pretoria, has also proved to be an important way to share limited resources and serve the industry as a whole.

POSTGRADUATE STUDENTS

Thirty (30) students were enrolled at Honours level in 2021, with 42 at Master's level and 15 at Doctoral level.

A total of 21 graduated with the Bachelor of Science Honours in Agriculture – 15 in Animal Production Management and four majoring in Wildlife Management, and an additional two students graduated with Bachelor of Science Agriculture Honours, majoring in Wildlife Sciences.

One student graduated with the Master of Agriculture, majoring in Wildlife Science.

The PhD was conferred on one student in Animal Breeding in 2021:

Mdyogolo, Sinebongo

Thesis: Detection of selection signatures and genes associated with fitness in South African Afrikaner and Brahman cattle

Supervisor: Prof FWC Neser

POSTDOCTORAL RESEARCH FELLOWS

In 2021, the Department of Animal Science hosted two Postdoctoral Fellows – Dr Barbara Elizabeth (Lize) van Wyngaard and Dr Christopher Rothman.

STAFF MATTERS

Mrs Charlene Williams, Senior Assistant Officer, resigned in December 2021.

RESEARCH OUTPUTS

Research Articles

Abdelkrim, A., Tribout, T., Martin, O., Boichard, D., Ducrocq, V.P. & Friggens, N. 2021. Exploring simultaneous perturbation profiles in milk yield and body weight reveals a diversity of animal responses and new opportunities to identify resilience proxies. *Journal of Dairy Science* 104: 459-470.

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Freitag, A., Cluff, M., Hitzeroth, A., Van Wyngaard, B.E., Hugo, A. & Hugo, C.J. 2021. Community level physiological profiling of reduced or replaced salt fresh sausage inoculate with Escherichia coli ATCC 25922. *LWT-Food Science and Technology* 148: 111786-1-111786-7.

Harris, R., Lau Vetter, M., Van Heerden, E., Cason, E.D., Nyaga, M.M. & Gryzenhout, M. 2021. Baseline data of the Fungal Phytobiome of Three Sorghum (Sorghum bicolor) Cultivars in South Africa using Targeted Environmental Sequencing. *Journal of Fungi* 7: 978-1-978-19.

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Scheijen, C.P.J., Bercovitch, F.B., Luther-Binoir, I., Ganswindt, A. & Deacon, F. 2021. Sexual selection and endocrine profiles in wild South African giraffe (Giraffa Camelopardalis Giraffa). *African Journal of Ecology* 59(1): 299-304.

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Thutwa, K., Van Wyk, J.B., Dzama, K., Scholtz, A.J. & Cloete, S.W.P. 2021. Expression of cytokine genes at tick attachment and control sites of Namaqua Afrikaner, Dorper and South African Mutton Merino Sheep. *Veterinary Parasitology*.291: 109384. DOI: 10.1016/j.vetpar.2021.109384.

Valverde Portal, A., Cason, E.D., Gomez-Arias, A., Bozkale, D., Govender, D., Riddell, E. & Cowan, D. 2021. Pollution shapes the microbial communities in river water and sediments from the Olifants River catchment, South Africa. 2021. *Archives of Microbiology* 203: 295-303.

Van der Merwe, R., Van Biljon, A., Hugo, A. & Van der Merwe, J.B. 2021. Relationships between yield and nutritional components of vegetable-type soybean genotypes using correlations and principal component analysis. *MOL* 21(2): 1-12.

Yusuf, Z., Mohammed, W., Zeleke, H., Shimelis, H. & Hugo, A. 2021. Coheritability and Genetic Advances of Agromorphological and Oil Quality Traits in Groundnut (Arachis hypogaea L.) Genotypes from Ethiopia. *International Journal of Agronomy* 2021(5148772): 1-5.

Zenda, M. & Malan, P.J. 2021. The sustainability of small-scale sheep farming systems in the Northern Cape (Hantam Karoo), South Africa. *South African Journal of Agricultural Extension* 49(1): 105-121.

Zwane, A., Nxumalo, K., Makgahlela, M.L., Van Marle-Koster, E. & Maiwashe, A. 2021. Gene-set enrichment analysis of selective sweeps reveals phenotypic traits in Nguni cattle. *South African Journal of Animal Science* 51(6): 761-777.

Books/Chapters in Books

De Wit, M. & Hugo, A. 2021. Innovation Technologies for Extracting Opuntia spp. Seed Oil. Chapter 25. In: *Opuntia spp.: Chemistry, Bioactivity and Industrial Applications*. M.F. Ramadan, T.E.M Ayoub & S. Rohn (Eds). Springer, Cham. pp. 507-524. DOI: 10.1007/978-3-030-78444-7.

De Wit, M., Hugo, A. 2021. Food and Non-Food Applications of Opuntia spp. Seed Oil. Chapter 48. In: *Opuntia spp.: Chemistry, Bioactivity and Industrial Applications*. M.F. Ramadan, T.E.M Ayoub & S. Rohn (Eds). Springer, Cham. pp. 961-983. DOI: 10.1007/978-3-030-78444-7.

Conference Contributions

Conference papers/Posters

Boys, J. & Smit, G. 2021. *The effect of wood harvesting on the savannah ecosystem: A study in the Thornbush Savanna of Namibia*. Paper delivered at the Biomass Symposium, Otjiwa Lodge, Otjiwarongo , Namibia (Virtual symposium). 3 June 2021.

Chadyiwa, M.C., Scholtz, M.M., Dube, B.D., MacNeil, M.D. & Neser, F.W.C. 2021. *Variance component estimates for dam and calf weights for Afrikander cattle*. Paper delivered at the 52nd SASAS Congress, Pretoria, South Africa (Virtual). 10-12 August 2021.

De Villiers, M-S., Janecke, B. & Muller, L. 2021. *Population density and diet composition of free-roaming leopards (Panthera pardus) in the Piketberg mountains, Western Cape*. Paper delivered at the South African Wildlife Management Association 50th Annual Conference, Berg-en-Dal, Kruger National Park, South Africa (Virtual congress). 5-10 September 2021.

De Villiers, M-S., Janecke, B. & Muller, L. 2021. *Prey species and human-wildlife conflict of leopards (Panthera pardus) in Piketberg mountains, Western Cape*. Paper delivered at the 23rd International Congress of Zoology (Virtual congress). 21-26 November 2021.

Gavu, M., Hitzeroth, A., Hugo, A. & Hugo, C.J. 2021. *The determination of the spoilage characteristics of Chryseobacterium species isolated from fish*. Paper delivered at the South African Association of Food Science and Technology Virtual Congress. 20-24 September 2021.

Grobler, S.M., Scholtz, M.M. & Neser, F.W.C. 2021. *Calving percentage of beef heifers mated at 14 or 24 months of age under extensive bushveld conditions*. Paper delivered at the 52nd SASAS Congress, Pretoria, South Africa (Virtual). 10-12 August 2021.

Janecke, B. 2021. *Variety of mammals (dietary classes and body sizes) on a catena in Savanna Biome, Kruger National Park, South Africa*. Paper delivered at the 1st International Electronic Conference on Biological Diversity, Ecology and Evolution (Online conference). 15-31 March 2021.

Jordaan, F.J., Neser, F.W.C., Maiwashe, A., King, Z. & Scholtz, M.M. 2021. *Changes in cow productivity and its component traits in South Africa's landrace beef breeds*. Paper delivered at the Paper delivered at the 52nd SASAS Congress, Pretoria, South Africa (Virtual). 10-12 August 2021.

Kooverjee, B.B., Soma, P., Neser, F.W.C., Van der Nest, M.A., Scholtz, M.M. & MacNeil, M.D. 2021. *Preliminary results: Genetic variability in South African Nguni and Bonsmara cattle breeds*. Paper delivered at the 52nd SASAS Congress, Pretoria, South Africa (Virtual). 10-12 August 2021.

Mdyogolo, S., Neser, F.W.C., MacNeil, M.D., Scholtz, M.M. & Makgahlela, M.L. 2021. *Candidate genes in differentiated regions in South African Afrikaner and Brahman genomes reveal parallel adaptive mechanisms*. Paper delivered at the 52nd SASAS Congress, Pretoria, South Africa (Virtual). 10-12 August 2021.

Paulse, J., Malan, P. & Smit, G. 2021. *The comparative effects of short duration, high density grazing and conventional, rotational grazing on different soil, vegetation and animal parameters in dry and mesic grasslands of South Africa*. Poster presented at the XXIV International Grassland Congress / XI International Rangeland Congress (Sustainable Use of Grassland and Rangeland Resources for Improved Livelihoods) (Virtual conference). 25-29 October 2021.

Potgieter, B., Hugo, A., Josling, G.C., Fair, M.D. & De Witt, F.H. 2021. *Effect of ω-3 lipid sources on production performance of laying hens at peak production*. Paper delivered at the 52nd SASAS Congress, Pretoria, South Africa (Virtual). 10-12 August 2021.

Pyoos, G.M., Scholtz, M.M., MacNeil, M.D., Theunissen, A. & Neser, F.W.C. 2021. *Intergenerational variability of predicted mean performance in two-breed rotational crossbreeding systems*. Paper delivered at the 52nd SASAS Congress, Pretoria, South Africa (Virtual). 10-12 August 2021.

Pyoos, G.M., Scholtz, M.M., MacNeil, M.D., Theunissen, A. & Neser, F.W.C. 2021. *Alternative measures of cow efficiency for Afrikaner, Bonsmara, Nguni, Angus and Simmental sired calves*. Paper delivered at the 52nd SASAS Congress, Pretoria, South Africa (Virtual). 10-12 August 2021.

Rautenbach, A., Cluff, M., Hugo, C.J., Bothma, C., Roodt, E., Van Wyngaard, B.E. & Hugo, A. 2021. *The effect of different sodium reduction strategies on the chemical, microbial and sensory quality of Boerewors*. Paper delivered at the South African Association of Food Science and Technology Virtual Congress. 20-24 September 2021.

Scholtz, M.M. 2021. *Climate-smart livestock production in the era of climate change through targeted interventions*. Paper delivered at the Climate Smart Livestock Production in Africa Congress, Ibadan, Nigeria (Virtual). 22-24 June 2021.

Scholtz, M.M., Makgahlela, M.L., Neser, F.W.C., MacNeil, M.D., Grobler, S.M., Jordaan, F.J., Pyoos-Daniels, G.M., Theunissen, A. & Seshoka, M.M. 2021. *Challenges and oppurtunities for beef production under climate change in Southern Africa*. Paper delivered at the XVIII Latin American Congress of Genetics, Chile. 5-8 October 2021.

Scholtz, M.M., Pyoos-Daniels., G.M., Jordaan, F.J., Hendriks, J., Makgahlela, M.L., Neser, F.W.C., Chadyiwa, M.C., Wepener, M.P. & Theunissen, A. 2021. *Climate-smart livestock production in the era of climate change though targeted interventions*. Paper delivered at the Climate-Smart Livestock Production in Africa, Ibadan, Nigeria. 22-24 June 2021.

Scholtz, M.M., Pyoos-Daniels, G.M., Seshoka, M.M., Grobler, S.M. & Theunissen, A. 2021. *The negative effect of heat stress on the fertility of extensive beef cattle in South Africa*. Paper

delivered at the Climate-Smart Livestock Production in Africa, University of Ibadan, Nigeria. 22-24 June 2021.

Seshoka, M.M., Theunissen, A., Scholtz, M.M., Pyoos-Daniels, G.M., Buchanan, G. & Neser, F.W.C. 2021. *The effect of temperature-humidity-index on fertility in the Vaalharts Bonsmara herd.* Paper delivered at the 52nd SASAS Congress, Pretoria, South Africa (Virtual). 10-12 August 2021.

Van Niekerk, J., Hugo, A., De Witt, F.H. & Neser, F.W.C. 2021. *The effect of rabbit genotype on carcass and meat quality characteristics.* Paper delivered at the 52nd SASAS Congress, Pretoria, South Africa (Virtual). 10-12 August 2021.

Van Niekerk, M., Neser, F.W.C., Van Wyk, J.B. & Ducrocq, V. 2021. *Genotype by environment interaction for persistency of production in multiparous SA Holsteins.* Paper delivered at the 72nd Annual Meeting European Association of Animal Production, Davos, Switzerland. 30 August-3 September 2021.

Zenda, M., Malan, P. & Geyer, AC. 2021. *Exploring wool characteristics that determine wool price in South Africa.* Paper delivered at the Applied Research in Accounting, Finance, Insurance and Economics on Africa Virtual African Finance Association Conference (Online conference). 11-12 May 2021.

STAFF (2021)

Head of Department:

Prof FWC Neser

Professors:

Prof A Hugo, Prof FWC Neser and Prof GN Smit

Affiliated Professors:

Prof HO de Waal, Prof JPC Greyling and Prof MM Scholtz

Senior Lecturers:

Dr ED Cason, Dr F Deacon, Dr FH de Witt, Dr OB Einkamerer, Dr MD Fair, Dr J Myburgh and Dr HA O'Neill

Lecturers:

Ms R Grobler, Dr A Hattingh, Dr BB Janecke, Mrs GC Josling, Mr L Krüger and Dr PJ Malan

Junior Lecturers:

Mr G Janse van Rensburg and Miss JW Paulse

Programme Director:

Dr M Fair

Research Fellows:

Prof FB Bercovitch Prof M Makgahlela, Prof N Maiwashe, Prof HA Snyman and Prof JB van Wyk

External Supervisors:

Prof CW Cruywagen and Prof OR Madidela

Farm Manager:

Mr J Barnard

Technicians:

Ms E Roodt and Ms JAM van der Merwe

Senior Assistant Officers:

Dr Q Kruger and Mrs CJ Williams

Officer:

Miss NAK Green and Mr KR Moopelwa

Secretary:

Mrs I Auld

Technical Assistants:

Mr NK Long and Mr SA Rowles

Cleaners:

Ms N de Bruin, Mrs TA Dumisi and Mr J Lamle

Department of
SOIL, CROP AND CLIMATE SCIENCES

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OVERVIEW OF 2021

In 2021, activities in the Department were still greatly influenced by the COVID-19 pandemic. Nevertheless, most of the teaching and learning interactions with students in the Department were face-to-face, thanks to the tremendous efforts undertaken by the Faculty to bring students back to Campus. In 2021, the Department concluded an undergraduate curriculum revision and a phased implementation of the new curricula that will start in 2022. In 2021, three new academic staff members were appointed – Dr Tinashe Lindel Dirwai, Prof Tesfay Weldelassie and Ms Lindsay Banda (the latter two to assume duties in 2022). The Department continues to implement a diverse research portfolio, funded by government agencies and private sector partners. Several new research projects were initiated in 2021, including research on resource efficiencies of potato, the performance of hybrid potato, an expansion of the long-term trials to an additional site in Kroonstad and new research on pecan nuts and pomegranates. To enable field research, major investments were made by the Department and the Dean's office on the experimental farm, Kenilworth, including the purchase of new equipment, including a zero-tillage planter and the construction of a security fence.

ACHIEVEMENTS

Staff Achievements

Dr Elmarie van der Watt was elected as secretary of the South African Society of Crop Production (SASCP).

Dr Elmarie Kotzé received an NRF-rating for the first time (C2). Prof Linus Franke renewed his NRF-rating, improving to a C1, and Prof Sue Walker (affiliated to the Department) received a B3-rating.

Student Achievements

Grain SA awarded bursaries to deserving postgraduate students falling under previously disadvantaged groups. Two MSc Agric candidates, Mr B Simelane and Mr UP Njombela, were awarded bursaries.

Two new Department of Science and Innovation-Human Science Research Council (DSI-HSRC) interns, Ms Sibabalwe Daniel and Mr Martin Tshimange, were appointed in the Agrometeorology section of the Department for the next two years.

TEACHING AND LEARNING

The Department enrolled its first group of six postgraduate students in the new structured MSc specialising in Climate Change. As part of this curriculum, two new courses were developed by Dr Stephan Steyn and Prof Linus Franke – a course on climate change and variability and another on sustainability and climate change adaptation of agricultural systems. Due to the COVID-19 pandemic, the courses were presented online. The students will continue in 2022 with a mini-dissertation.

Over the last two years, the Department has redesigned its undergraduate BAgric and BSc curricula. This process was concluded in 2021 and a phased implementation of the new curricula will start in 2022, with changes in the second-year courses. As part of this new curriculum, BAgric students in Crop Production can choose between a specialisation in field crops or a new specialisation in horticulture. To strengthen the teaching of subjects in horticulture in the Department, an additional lecturer in horticulture, Ms Lindsay Banda, has been appointed to assume duties in 2022.

RESEARCH AND INNOVATION

Dr Elmarie Kotzé and Prof Linus Franke are involved in a two-year project, titled 'Can pastoral grazing systems contribute to climate change mitigation? Gathering evidence and exploring future scenario's in the Grassland Biome of South Africa', for the Regional Universities Forum for Capacity Building in Agriculture (RUFORUM). The overall objective of this project is to improve current knowledge of the temporal and spatial dynamics of C cycles and the C footprint of pastoral grazing systems in the grassland biome of South Africa affected by management strategies. All fieldwork and laboratory analyses were completed in 2021. Dr Kotzé is currently investigating the response of sensitive soil biological indicators, such soil microbial biomass and active carbon, to regenerative agriculture practices, such as cover crops and integration of livestock in cropped fields on various farms in the Free State region.

Mr Mamera and Dr Loke collecting soil samples in grasslands near Brandfort to assess soil health status

Prof Johan van Tol is leading a tri-lateral NRF-funded project on the use of biochar to limit leaching from pit latrines, as well as another NRF-funded project on improving regional soil information for hydrological modelling. In addition, he is leading a project funded by the Department of Environmental Affaire-Natural Resource Management (DEA-NRM) on developing soil rehabilitation norms for selected catchments. Dr Elmarie Kotzé and Dr Makhosazana Aghoghovwia are part of this project team. Funding was also obtained from the South African Biodiversity Institute (SANBI) to improve the understanding of hydropedological processes in the Mngeni, Goukou and Breede River catchments.

Dr Johan Barnard was part of an interdisciplinary project team which successfully completed the project titled 'Economic management of water and salt stress for irrigated agriculture: A precision agriculture case study', which was funded by the Water Research Commission (WRC). He was responsible for the soil-crop-water modelling aspects of the project, with Prof Nicky Matthews (Agricultural Economics) as the project leader. Together with Prof Bennie Grové (Agricultural Economics), Dr Stephan Steyn (Soil, Crop and Climate Sciences) and Dr PS van Heerden (Consultant), Dr Barnard was instrumental in the successful application for another interdisciplinary WRC-funded project titled 'SAPWAT change of custodianship and climate database upgrade'. The project will start in 2022 with Prof Grové as the project leader. SAPWAT is a decision-making software tool for the estimation of crop water requirements by irrigation farmers, engineers, agricultural advisors, etc. Dr van Heerden is the current custodian of SAPWAT.

Dr Elmarie van der Watt continued with her project on natural product screening to identify plants producing potential fungicides, pharmaceuticals, insecticides and herbicides, with some encouraging results. New projects were started to test plant extracts' repellent activity against red spider mites (Tetranychus urticae) and other insects on several crops, and the effect of natural plant extracts with bio-stimulatory activity on the essential oil yield and quality of hail-damaged Rose geranium (Pelargonium graveolens L'Hér.). Screening of Cactus Pear (Opuntia ficus-indica) as potential bio-products and isolation of bio-active compounds was also started, together with Dr Gesine Coetzer.

Dr Gert Ceronio expanded his field trial research, with the main aim of training postgraduate agronomists. The second year of a three-year research project evaluating the effects of a changing environment and late-planting dates on maize plant development, yield and quality, was completed successfully at the Department's research farm, Kenilworth. This project forms part of the larger project, "Climate Resilience Consortium', which also includes the Agricultural Research Council (ARC) Grain Crops Institute, and the University of Pretoria.

A long-term experiment that includes crop rotation and tillage practices was established successfully in November 2020. This experiment will continue for at least four seasons to complete the first cycle, but the long-term goal is for at least four full cycles and longer, if possible. The first year was completed successfully and the second year's planting was completed in mid-November 2021.

This initiative is sponsored by the Maize Trust and Grain SA. We are excited that this initiative was expanded to a new site (with different crop rotation cycles than Bloemfontein but the same tillage practices) at Kroonstad in collaboration with Trio High School. Establishment of the trial at Kroonstad was completed in December 2021.

The expansion of field trials also necessitated the acquisition of new equipment (zero tillage planter and a roller) which was made possible by the Dean's Office and the UFS Directorate for Research Development.

Elias Nokwane, the farm technician, receiving the ILGI chisel plough

Elias Nokwane busy ploughing

The cactus pear project that was established in November 2015 on the West Campus in collaboration with the ARC by Dr Gesine Coetzer and Dr Herman Fouche, is still an important source for research outputs of the Department. Currently, two Master's students and one PhD student are working on their research projects in the cactus pear orchard. The genotype bank on West Campus is the only well-maintained planting in South Africa and an important source of plant material for the industry.

Dr Gesine Coetzer established a research project in collaboration with the South African Pecan Nut Production Association (SAPPA) and Kynoch. The aim of this project is to evaluate the influence of different foliar applied zinc carriers on the growth, physiology, quality and yield of pecan nuts. Zinc deficiencies are a common problem in pecan nut orchards and are considered a chronic feature in the production of pecan nuts. The project is currently being conducted on the West Campus and in a commercial orchard in the Jan Kempdorp district, as part of the MSc Agric study by Mr Wian Visser.

Dr Weldemichael Tesfuhuney continued to supervise two PhD students who completed three years of field trials on both summer and winter crops. For the summer crop, a sunn hemp cover crop was introduced into a maize-based cropping system under rainwater harvesting. For the winter crop (wheat), the research aimed to select optimum planting dates and cultivar choices for smallholders in the eastern Free State.

Admire Dzvene doing fieldwork

Experimental trial of sunn hemp cover crop on maize-based cropping system

A PhD research project on water use of sweet cherry trees in Ficksburg in the eastern Free State, by Mr PC Tharaga, a candidate in the Next Generation Academics Programme (nGAP), has been completed and the thesis has been submitted for review.

In 2021, Mr Phumudzo Tharaga started a research collaboration with the ARC focusing on water use of pomegranates under irrigation in the Western Cape. The project is funded by the WRC and the NRF and will include two students in Agrometeorology – Muthianzhele Ravuluma (PhD) and Raesibe Kgaphola (MSc) – to be supervised by Mr Tharaga. In 2021, the first task was to select the site and develop a student proposal.

Besides being engaged in the above-mentioned RUFORUM-funded project on carbon dynamics in grasslands, Prof Linus Franke started a new project on resource use efficiencies in potato production in the western Free State, together with Prof Martin Steyn from the University of Pretoria, with funding from Potatoes SA. Fieldwork in potato fields started in November 2021 and will continue in 2022. In addition, funding for research on hybrid potato varieties grown from true seed was initiated with a grant from NRF-DSI and Solynta

BV in the Netherlands. In this project, the UFS, the University of Pretoria and Zylem SA (Pietermaritzburg) are working together to develop agronomic practices and assess the potential of hybrid potato varieties in South Africa.

ENGAGED SCHOLARSHIP

Phumudzo Tharaga interacted with Rotondo Walnuts in Aliwal North, to assist farmers in minimising frost damage on trees during the critical flowering period in September and October. He drafted operational guidance for the growers on activities they should embark on when frost is forecast in the area.

Dr Stephan Steyn acted as external moderator for all the modules comprising the BSc Honours in Meteorology at the University of Pretoria. These included Numerical Weather Prediction, Satellite Meteorology, Radar Meteorology, Mesoscale Meteorology, Tropical and Extra-tropical Meteorology, and Research Project. Dr Steyn published a popular article ('It's all about connections – the ingredients of above-normal rainfall seasons over the summer rainfall region of South Africa') in the annual Angus Journal and presented a public lecture titled 'Climate Change: an Overview' on three different occasions to local societies in Bloemfontein, namely the Professional Retired Organization of Business Executives (PROBUS), Birdlife and the University of the Third Age (U3A).

Prof Linus Franke continued as the editor-in-chief of the South African Journal of Plant and Soil and as an associate editor for the journal Land. He also served as the convenor of the NRF panel assessing ratings in Earth Sciences.

NATIONAL AND INTERNATIONAL COLLABORATION

Dr Elmarie Kotzé and Prof Johan van Tol are involved with supervision of two PhD students as part of a cotutelle agreement with the University of Bourgogne, Dijon, France, working on soil and water related research in the montane fire climax grasslands of Cathedral Peak in the Drakensberg.

Prof Johan van Tol continued collaborating with researchers at TU Dresden (Germany), where a jointly supervised MSc student graduated in 2021. Prof van Tol is also actively collaborating with researchers from United States Department of Agriculture (USDA) Agricultural Research Service (ARS) in Texas, to improve model predictions following a hydropedological approach. A joint paper was published in 2021.

Prof Linus Franke initiated collaboration with Solynta BV in the Netherlands and Zylem SA in South Africa to study the performance of hybrid potato varieties.

nGAP lecturer, Ms Neo Mathinya, continued her PhD registered at Wageningen University in the Netherlands, under the joint supervision of Prof Ken Giller and Dr Gerrie van de Ven (Wageningen University) and Prof Franke.

As reported above, research projects were undertaken in collaboration with AgraForum, the WRC, South African Breweries (SAB), AB-InBev, SAPPA, Kynoch, Grain SA, Potatoes SA, NRF, RUFORUM, ARC, Stellenbosch University, University of Pretoria and the University of Fort Hare.

POSTGRADUATE STUDENTS

In 2021, eight students were enrolled for the Honours degree, 29 for MSc, and 19 for the PhD.

In terms of graduations, Khumo Jaola, Natasha Combrinck, Mischke Bouwer, Zikhona Gqalaqha, Lethabo Tlomatsana, Talana Cronje, Tabisa Tandathu, Cowan McLean and Isadore Smit graduated with the MSc degree.

Two PhD degrees were conferred in 2021:

Chichongue, Oscar Joao

Thesis:	Comparison of Crop Management Systems for smallholder farmers in Mozambique
Supervisors:	Prof JJ van Tol and Dr GM Ceronio;
Co-supervisor:	Prof CC du Preez

Gura, Isaac

Thesis:	Quantifying soil fertility parameters with electromagnetic induction, infrared reflectance spectroscopy and conventional chemistry procedures for maize and wheat under irrigation in arid climate
Supervisor:	Prof CC du Preez;
Co-supervisors:	Prof LD van Rensburg and Dr JH Barnard

POSTDOCTORAL RESEARCH FELLOWS

A Postdoctoral Fellow, Dr Achamyele Mengistu, supervised by Dr Tesfuhuney, wrote a review article on invasive alien plant species (IAPS) distribution, environmental threats and climate change impacts in the Free State. Data collection and preparation have also been conducted to model the distribution of IAPS under climate change scenarios in the Free State.

Dr Dolapo Adelabu implemented a field trial on the importance of pollinators for okra production and she published several manuscripts on ecosystem services from pollinators.

STAFF MATTERS

Dr Tinashe Dirwai was appointed as Lecturer in the Agronomy section. Also in the Agronomy section, Prof Tesfay Weldelassie was appointed as an Associate Professor, starting this position in January 2022, Lindsay Banda was appointed as a horticulturist, starting in February 2022.

RESEARCH OUTPUTS

Research Articles

Aghoghovwia, M.P., Hardie, A. & Rozanov, A. 2021. Characterisation, adsorption and desorption of ammonium and nitrate of biochar derived from different feedstocks. *Environmental Technology* 43(5): 774-787. DOI: 10.1080/09593330.2020.1804466.

Akinnuoye-Adelabu, D.B., Bredenhand, E., Van der Merwe, S. & Franke, A.C. 2021. Soil fertilization synergistically enhances the impact of pollination services in increasing seed yield of sunflower under dryland conditions. *Journal of Agriculture Science* 159: 258-271. DOI: 10.1017/S0021859621000514.

Baijukya, F., Van Heerwaarden, J., Franke, A.C., Van den Brand, G., Foli, S., Keino, L., Seitz, T., Servan, L., Vanlauwe, B. & Giller, K. 2021. Nutrient deficiencies are key constraints to grain legume productivity on "non-responsive" soils in Sub-Saharan Africa. *Frontiers in Sustainable Food Systems* 5: 1-11. DOI: 10.3389/fsufs.2021.678955.

Barnard, J.H., Matthews, N. & Du Preez, C.C. 2021. Formulating and assessing best water and salt management practices: Lessons from non-saline and water-logged irrigated fields. *Agricultural Water Management* 247(2021): 1-14. DOI:10.1016/J.AGWAT.2020.106706.

Clark, V.R., Mukwada, G., Hansen, M.M., Adelabu, S.A., Magaiza, G., Le Roux, A., Bredenhand, E., Voua Otomo, P., Steenhuisen, S., Franke, A.C., Van Tol, J.J., Mathinya, V.N. & Makombe, R. 2021. The Afromontane Research Unit: Driving Connections and Capacity Building for the Sustainable Development of Southern African Mountains. *Mountain Research and Development* 41(2): 1-5. DOI: 10.1659/MRD-JOURNAL-D-21-00038.1.

Deeb, M., Grimaldi, M., Aroui, H., Mthimkhulu, S., Van Antwerpen, R. & Podwojewski, P. 2021. Long-term effect of sugarcane residue management and chemical fertilization on soil physical properties in South Africa. *Soil Science Society of America Journal* 85(6): 1913-1930. DOI: 10.1002/saj2.20326.

Dirwai, T.L., Kanda, E., Senzanje, A. & Busari, T. 2021. Water resource management: IWRM strategies for improved water management. A systematic review of case studies of East, West and Southern Africa. *PLoS One* 16(5): 1-20. DOI: 10.1371/journal.pone.0236903.

Dirwai, T.L., Senzanje, A., Mabhaudhi, T & Buckley, CA. 2021. Moistube irrigation fouling due to anaerobic filtered effluent (AF) and horizontal flow constructed wetland (HFCW) effluent. *Scientific Reports* 11(1): 7124. DOI: 10.1038/s41598-021-86737-7

Dlamini, J.C., Cardenas. L., Tesfamariam, E., Dunn, R., Hawkins, J., Blackwell, M., Evans, J. & Collins, A. 2021. Soil methane (CH_4) fluxes in cropland with permanent pasture and riparian buffer strips with different vegetation. *J.Plant Nutr.Soil.Sci* 185: 132-144. DOI: 10.1002/jpln.202000473.

Du Preez, C.C., Lebenya, R.M. & Van Huyssteen, C.W. 2021. Change in total carbon stocks eight years after afforestation of a sub-humid grassland catchment with Pinus and Eucalyptus. *New Forests* 56(3): 1-18. DOI:10.1007/s11056-021-09854-1.

Dzvene, A., Tesfuhuney, W., Walker, S., Furie, A., Botha, C. & Ceronio, G. 2021. Farmers' knowledge, attitudes, and perceptions for the adoption of in-field rainwater harvesting (IRWH) technique in Thaba Nchu, South Africa. *African Journal of Science, technology, Innovation and Development* 13 (4): 1-19. DOI: 10.1080/20421338.2021.1960542.

Franke, A.C. 2021. Assessing the impact of climate change on crop production in southern Africa: a review. *South African Journal of Plant and Soil* 38(1): 01-12. DOI: 10.1080/02571862.2020.1844325.

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STAFF (2021)

Head of Department:

Prof AC Franke

Professor:

Prof CW van Huyssteen

Associate Professors:

Prof AC Franke and Prof JJ van Tol

Affiliated Professors:

Prof CC du Preez and Prof S Walker

Senior Lecturers:

Dr JH Barnard, Dr GM Ceronio, Dr GM Coetzer, Dr E Kotzé and Dr E van der Watt

Lecturers:

Dr MP Aghoghovwia, Ms L de Wet, Mr TL Dirwai, Mr JC Dlamini, Ms VN Mathinya, Dr AS Steyn, Mr PC Tharaga and Dr WA Tesfuhuney

Programme Director:

Dr E van der Watt

Senior Officers:

Ms L Henning and Mr BE Tshabang

Officer:

Ms N Radebe

Senior Assistant Officers:

Ms R Etzebeth, Ms A Moffat and Ms DE Terblanche

Messenger:

Mr E Moeti

Cleaner:

Ms T Mlobeli

Service Workers:

Mr G Madito, Mr G Mokoena, Mr E Ntoba and Mr E Yokwane

Department of
SUSTAINABLE FOOD SYSTEMS AND DEVELOPMENT

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OVERVIEW OF 2021

The COVID-19 pandemic has had an impact worldwide. Throughout the past two years, we saw this crisis unfolding, impacting food systems and affecting people's access to food and seriously influencing both nutrition and food security. We stood witness to disruptions in supply chains and an economic slowdown at a global level. Against this background, we remained committed to educate people in building a more resilient and sustainable food system.

To provide a comprehensive training solution, the production, preparation and marketing of food cannot be confined to single sectors, but must be studied from a food systems perspective, and understood from a range of interdisciplinary and practical contexts. During 2020 and 2021, we developed a comprehensive range of academic programmes focused on Food Systems to bridge the gap between food insecurity and knowledge and capacity building. We engaged local communities through our Standard Bank Agri-Business initiative and implemented a growing citizen-led community initiative through the RUFORUM wool project. Our Sensory Lab actively contributes to research and future innovation and completed at least 13 extensive sensory research analysis reports to determine, among other things, alternative food sources (such as crickets), and the sensory properties of edible plants, including Carpobrutus edulis and ***Portulacaria afra*** leaves.

During the course of the 2021 academic year, we formed a cohesive unit, growing from strength to strength.

ACHIEVEMENTS

Staff Achievements

Dr Hlamalani Judith Ngwenya received the national Order of the Baobab on 18 November 2021 from the President, Cyril Ramaphosa, in honour of her work in sustainable agriculture and community empowerment. The award is bestowed upon citizens who have contributed towards the advancement of democracy and who made a significant impact to improve the lives of South Africans, thus recognising South African citizens who contributed to community service, business and the economy, science, and technological innovation.

Dr Hlamalani Ngwenya receiving the National Order of the Baobab from President Cyril Ramaphosa

TEACHING AND LEARNING

Despite the continued COVID-19 pandemic, staff successfully adapted to virtual learning in a manner that allowed continuation without disruption.

In collaboration with the Oppenheimer Trust, a comprehensive online education Management System was successfully implemented in 2021. This system makes teaching adaptive and holds an increased online teaching focus, with interactive participation and continuous monitoring of academic progress. Through implementation of this delivery method, we managed to increase our undergraduate student enrolments by 36% and our postgraduate student enrolments by 43% from 2020.

RESEARCH AND INNOVATION

In 2021, research in the Department focused on the following key areas.

Textile sustainability and product development

Cathoyte was used to replace harmful detergents in the scouring process of wool. Merino wool, which was locally grown by communal farmers, was dyed using natural dyes, such as onion peels. Wool is used to create felt products, and training is provided to local members of the community to teach them how to generate an income from products utilising felt. Another project will evaluate the properties of the Dorper fleece to minimise wool waste and create an insulating product that can be utilised in the community.

Old and new methods of growing symbiotic culture of bacteria and yeast (SCOBY) were evaluated and natural dyes were incorporated to create a vegan leather product. Consumer acceptance of this product will be evaluated for future marketability.

The compulsory wearing of facemasks inspired research into the development of fabric masks. The masks function as a source control, able to filter micro-droplets in expiratory secretions and allow the wearer to breathe normally. This study investigated the effect of fabric structural properties on the filtration efficiency (FE) and air permeability (AP) of a range of textile fabrics, using a new method to measure the filtration of particles in the described conditions.

Food and product development

There is a rising rate of undernourishment in developing and underdeveloped countries, and South Africa is no exception. At a household level, 28.6% of South Africans do not have access to food. The world population is estimated to grow to approximately nine billion by 2050; therefore, the focus should be on developing, adapting and incorporating new food products into the food system. The most viable adaptation option to increase food production and profits in vulnerable hot and dry regions, is to include crops which are indigenous, edible and are less impacted by climate change. The pre-colonial people of southern Africa had a wealth of knowledge about wild edible plants. There is a wide variety of indigenous food flora in South Africa, with the potential of introducing new crops. In this study, wild, edible indigenous plants from semi-arid and arid African areas are evaluated for their suitability to be harnessed as a food source to broaden the food base in Africa.

Portulacaria afra, also known as *spekboom*, or pork bush, is among one of the succulent indigenous edible plants and is being investigated to establish if it could be used as source of food in South Africa. In this regard, a project has been running for the past two years to determine the nutritional value, most appropriate cooking methods, acceptable consumer products and recipes, and to evaluate commercial products in terms of quality and safety. The studies include physico-chemical and nutritional analyses, JAR (just-about-right) sensory analysis, and an exciting new eye-tracking analysis that determines the participant's point of gaze to establish where they look and what they read on product packaging, which influences decision-making and human behaviour.

Positive sensory experiences play a necessary role in the process of learning to accept a food, but are inadequate when unusual and culturally inappropriate foods are involved. Unusual and/or novel foods need to be introduced to consumers.

To address this, an understanding of consumer expectations regarding the consumption of edible insects is being investigated. The aim of this research is to find acceptable sensory ways of using crickets and meal worms as protein alternatives and as sources of sustainable protein. The development of various products using insect protein will test the willingness of consumers to use insect protein and also test the taste to determine if it is compromised in any manner. Results will indicate if the use of insects as a healthy, sustainable and affordable protein source will be acceptable to consumers.

Relationship between food insecurity and nutrition

Only a few studies have investigated the relationship between food (in)security and malnutrition of children, especially in urban informal settlements. Malnourishment (i.e., stunting, wasting, underweight) is prominent in children from low-income households, and has been exacerbated by the recent COVID-19 pandemic. The study sought to investigate the relationship between food (in)security of households and the prevalence of malnutrition of children living in low-income households in Gompo Village in the Eastern Cape.

A new project has been initiated to investigate the relationship between income and nutrition (not necessarily only regarding children). This project will be developed further with results expected in 2022.

ENGAGED SCHOLARSHIP

During 2021, more unforeseen lockdowns threatened the UFS Community Garden project, but with the help of groups of volunteers, we persevered. Between October 2020 to October 2021, we managed to harvest well over two tons of vegetables. The project, has two 300 m^2 tunnels on the Bloemfontein Campus, next to the Welwitchia Residence. Funds for the tunnels and vegetable boxes were made available by Tiger Brands (with assistance from Prof Michael Rudolph of Siyakhana Food Gardens). The UFS University Estates Department, under the directorship of Mr Nico Janse van Rensburg, contributed additional funding, and the Institute for Groundwater Studies (IGS) assisted with the boreholes. The tunnels were also equipped with two water tanks and water pumps.

Dedicated staff from Kovsie Act and the student volunteer group, Charitable Growth, assisted throughout 2021 with the maintenance and cleaning of the two tunnels. Staff from Farmovs Parexel came for a teambuilding exercise and assisted in planting new seedlings and seeds. They also planted fruit trees around the tunnels that have started bearing fruit.

The project is gaining momentum and two existing tunnels from Lengau were relocated to the UFS Experimental farm. These tunnels also fall within the parameters of the UFS Community Garden project and should be completed and ready for planting of winter crops.

Teddy Sibiya and Kyle Pretorius, from Kovsie Act, weighing carrots

Alina Ntsiapane, PhD student in Sustainable Agriculture and volunteer for Charitable Growth, harvesting carrots and beetroot

Volunteers from Farmovs Perexel planting onion seedlings

NATIONAL AND INTERNATIONAL COLLABORATION

RUFORUM

The Regional Universities Forum for Capacity Building in Agriculture (RUFORUM) wool project continued to flourish, despite the challenges of 2020 and 2021. The focus of the project remains to transform communal wool growers' production from an underachieving enterprise to a profitable, sustainable, and renewable venture to enhance the livelihoods of communal wool producers.

This is achieved through

- assisting in establishing a centralised infrastructure hub, to support wool production and processing;
- training wool growers, sheep shearers and the local community's capacity;
- introducing formal structures to organise wool growers and link them to markets, giving them a collaborative advantage; and
- assisting the beneficiaries to develop commercial market engagements for wool and wool products produced by the communal farmers and community.

To date 178 farmers, 74 members of the community and 259 students attended one or more of our training and skills

Wool classing workshop outreach in Botchabelo

building interactions/workshops. In addition, seven local community women showed potential during different workshops that were held and are now employed to make and sell different wool products. The community upliftment programme is making substantial progress, as women in the programme are learning new skills and are now able to generate a small income for themselves. Some of the products they make include soft toys, scarves, hats, pencil cases, tray cloths, bags and tablet sleeves. These products are on sale on various platforms.

Community women and UFS staff in the woolshed showing off their handmade wool products

During the next two years, the project will focus on:

- Entrepreneurship training, with assistance from the Faculty of Natural and Agricultural Sciences and the Department of Economic Sciences.
- Workshops focusing on felting, weaving and spinning to increase the production of wool products.
- Establishing more markets for the wool products and supply for the ever-increasing demand of the beautiful products.

At work making a product

Grain SA

It is estimated that by 2050, the demand for maize in developing countries will have doubled and that by 2025, maize will become the crop with the highest global production. Maize meal is South Africa's dominant staple food, and white maize constitutes more than 90% of Africa's total maize crop production.

The nutritional quality of maize is critical, and it is primarily determined by the genotype, growing conditions, and postharvest technology. White maize porridge (***pap***) is the staple food of the majority of South Africa's inhabitants; however, the nutritional value is lacking.

In Central and South America, the ancient traditional processing method of Nixtamalization makes crushing maize simpler, improves the bio-accessible protein and micronutrient content, and enhances the flavor and aroma, making the starch more digestible and destroying the mycotoxins.

Grain SA and the Department of Sustainable Food Systems and Development are working together to introduce the process of Nixtamalization to South Africans – in a South African context and by incorporating it into the traditional cultures and recipes. In 2021 a recipe book was developed for courses that demonstrate how to use Nixtamalized maize in various well-known recipes. Various products were developed, and sensory analysis was done to determine the consumer acceptability of the products. Participants of the sensory analysis also completed questionnaires to determine the attitude and mindset regarding different colours of maize and the products in general. A questionnaire to be administered at various locations in Mpumalanga, Limpopo, Free State and Northwest was developed and will be conducted in 2022.

Standard Bank Agribusiness Project

The Standard Bank Agribusiness project in collaboration with the UFS and the Department of Agriculture and Rural Development, entered its third year in 2021. A total of 25 farmers are selected each year from the Kroonstad, Bloemfontein, Bethlehem and Qwaqwa areas. Each year, farmers submit a business plan to expand their farms, to invest in more livestock or to make improvements on their current farm, which then will assist them to become more commercialised.

The success rate of the project, measured from the first year to the third year, increased to almost 90%. In October 2021, certificates were handed out to the farmers of 2021 and farmers from the previous two years addressed this group to share their success stories. The farmers from the initial group can now be classified as small-scale farmers who produce food products commercially. Their enthusiasm, passion for farming and their hunger to learn more is amazing. In 2022 the programme will reach its 100th farmer.

Award ceremony in Bloemfontein, from the left, Dr Tankisi Masiteng (Department of Agriculture and Rural Development), Dr Jan Swanepoel(UFS), Sivu Mlanjeni (Smithfield farmer), Dr Johan van Zyl, and Mr Oosterwalt van Staaden (Standard Bank).

POSTGRADUATE STUDENTS

During the 2021 academic year, 24 undergraduate degrees in Agricultural Extension and 15 Consumer Science degrees were awarded, of which 9 were with distinction.

Forty-five (45) students obtained their Post Graduate Diploma in Sustainable Agriculture (10 with distinction) and 11 students graduated with the Honours in Consumer Science, of whom three passed with distinction.

A total of 91 students graduated with the structured Master of Sustainable Agriculture (MSA), while four students graduated with a Masters in Consumer Sciences. Eight PhD students completed their studies in 2021 in Sustainable Agriculture.

PhD degrees were conferred on the following candidates in 2021:

Garwi, Jabulani

Thesis:	The Contribution of small-scale beef cattle farming to development in Chipinge Rural District, Zimbabwe (2000-2018)
Supervisor:	Prof J Matunhu

Venuane Hepute

Thesis:	Assessing the potential of food and fodder crops cultivation under perennial water irrigation cropping method in Kunene region, Namibia
Supervisor:	Dr J Abah

Katjatenja, Kaerumatua

Thesis:	A study to investigate the current constraints and challenges facing small ruminant production and marketing in Omaheke communal areas, Namibia
Supervisor:	Dr GN Hangara

Loock, Daniel

Thesis:	Sustainable management of fragmented landscapes can conserve mesocarnivore populations (Leptailurus serval): A case study
Supervisor:	Dr L Swanepoel;
Co-supervisor:	Prof JA Van Niekerk

Majaja, Andries Matong

Thesis:	Evaluating the outcome of government funding and sustainability for agricultural cooperatives in the Northern Cape Province of South Africa
Supervisor:	Dr C Botha;
Co-supervisor:	Prof JA Van Niekerk

Myeni, Nonhlanhla

Thesis:	Promoting sustainable agriculture amongst small-scale farmers through formal market linkages: The case of the uMkhanyakude District Municipality
Supervisor:	Dr E Mutambara;
Co-supervisor:	Prof JA Van Niekerk

Nombembe, Sakhiwo

Thesis:	A study of human capital dynamics and their impact on the sustainability of selected projects in the Eastern Cape Province
Supervisor:	Prof EM Zwane
Co-supervisor:	Prof JW Swanepoel

Thovhogi, Rendani

Thesis:	Farmers knowledge on fruit pest and their management towards sustainable agriculture in the Thulamela municipality of Vhembe district, Limpopo Province of South Africa
Supervisor:	Prof E Zwane

STAFF MATTERS

Prof Johan van Niekerk was elected to the board of South African Society for Agricultural Extension (SASAE) for a further two-year period. He also became a father with the birth of his beautiful daughter, Hilé-Irene.

RESEARCH OUTPUTS

Research Articles

Balehegn, M., Ayantunde, A., Amole, T., Njarui, D., Nkosi, B.D., Muller, F., Meeske, R. Tjelele, T., Malebana, I., Madibela, O., Boitumelo, W., Lukuyu, B., Weseh, A., Minani, E. & Adesogan, A. 2021. Forage conservation in sub-Saharan Africa: Review of experiences, challenges, and opportunities. *Agronomy Journal*. 1-25. DOI: 10.1002/1gj2.20954.

Behnke, A., Saha, S., Oldewage-Theron, W.H., Mubtasim, N. & Miller, M. 2021. Prevalence and factors associated with food insecurity among older adults in sub-Saharan Africa: A systematic review. *Journal of Nutrition in Gerontology and Geriatrics* 40(4):171 - 196.

Chalwe, J., Mukherjee, U., Grobler, C., Mbambara, S. & Oldewage-Theron, W.H. 2021. Association between hypertension, obesity and dietary intake in post- menopausal women from rural Zambian communities. *Health SA* 26: a1496-1-a1496-7.

Du Toit, A., Mpemba, O.S., De Wit, M., Venter, S. & Hugo, A. 2021. The effect of size, cultivar and season on the edible nopalitos from South African cactus pear cultivars. *South African Journal of Botany* 142: 459-466.

Gericke, A., Militky, J., Venkataraman, M., Steyn, H.J.H. & Vermaas, J.F. 2021. Investigation of thermal comfort properties of fabrics containing mohair. *Journal of the Textile Institute* 1-12.

Gericke, A., Venkataraman, M., Militky, J., Steyn, H.J.H. & Vermaas, J.F. 2021. Unmasking the Mask: Investigating the Role of Physical Properties in the Efficacy of Fabric Masks to Prevent the Spread of the COVID-19. Virus. *Materials* 14(24). 7756-1-7756-20.

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Loock, D.J.E., Rendon-Franco, E., Williams, S' & Van Niekerk, J.A. 2021. Viral Prevalence in Wild Serval Population is Driven by Season and Sex. *EcoHealth* 18: 113-122.

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Mavhungu, T.J., Nesamvuni, A.E., Tshikolomo, K., Raphulu, T., Van Niekerk, J.A., Mpandeli, N. & Nesamvuni, A. 2021. Characterization of women and youth smallholder agricultural entrepreneurs in rural irrigation schemes in Vhembe district, South Africa. *South African Journal of Agricultural Extension* 49(3): 104-122.

Miller, M., Oldewage-Theron, W.H. & Napier, C. 2021. Eat clean and safe food: a food-based dietary guideline for the elderly in South Africa. *South African Journal of Clinical Nutrition* 34: S4-S50.

Mokhesengoane, T.E., Van der Westhuizen, H. & Van Niekerk, J.A. 2021. Stocking rate of extensive land-reform livestock farmers during 2018/2019 drought: Bloemfontein grassland biome case study. *South African Journal of Agricultural Extension*. 49 2): 15-24.

Morales, S., Egal, A. & Oldewage-Theron, W.H. 2021. Do smallholder farmers need nutrition education? A case study from KwaZulu Natal, South Africa. Journal of International Agricultural and Extension Education 28(3): 14-27.

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STAFF (2021)

Head of Department:

Prof JA van Niekerk

Associate Professors:

Prof JA van Niekerk

Lecturers/Researchers:

Dr N Cronjé, Dr HJ Ngwenya, Dr N Tinta, Dr I van der Merwe, Ms F van Tonder (Contract) and Dr JF Vermaas

Affiliated Lecturers/Researchers:

Dr JH Barnard, Ms K Green, Dr E Kotze, Mr L Kruger, Dr P Malan, Prof E Nesamvuni, Prof F Neser, Dr D Nkosi, Ms K Thobejane, Mr J van den Berg, Prof J van Rooyen, Ms L von Maltitz and Dr E Zwane

Junior Lecturers:

Ms A Makamane and Ms Z Swart

Programme Director:

Dr I van der Merwe

Research Fellows:

Prof P Blignaut, Prof K Holmqvist, Dr O Oriola, Dr B Senekal and Dr C van Staden

Senior Officers:

Ms A Calitz, Ms G Green and Ms D Jacobs

Officers:

Ms R Coetzee and Ms C Denner

Assistant Officers:

Ms S Mocwana and Ms R Smith

Senior Assistant Officer:

Ms W van der Walt

NRF Intern:

Ms K Matlhoko

BUILDING SCIENCES

Department of
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OVERVIEW OF 2021

The resilience and flexibility of the University in the face of the pandemic has led to a successful academic year in 2021. Due to the pandemic, academic institutions throughout the globe have had to adjust to a new normal, new ways of teaching and administering. The challenges faced this year were mostly related to the integration of digital media (virtual) with face-to-face interaction, in our research and academic proceedings. Particularly noteworthy, is the fact that we held successful, international PhD symposia in February and October, with academics joining us from Adelaide, Namibia and New Zealand.

Our pending South African Council for the Architectural Profession (SACAP) validation of 2021 has required extensive preparation, with Prof Noble taking the lead in writing a draft of the required accreditation report, with extensive discussion and input from all staff.

ACHIEVEMENTS

Staff Achievements

Our Head of Department, Prof Jonathan Noble, received an award from the South African institute of Architects (SAIA) in the research category, for his book *The Architecture of Peter Rich: conversations with Africa,* published by Lund Humphries, UK, in 2020.

At the UFS Learning and Teaching Awards ceremony in 2021, Prof Gerhard Bosman was awarded second place in the Research in Learning and Teaching: Advanced category, and first place in the Innovative Methods Curriculum Enhancement and Transformation category, for two papers he presented at the UFS Learning and Teaching and Conference (online) from 13 to 15 September 2021.

Two of our staff members, David van der Merwe and Dr Hendrik Auret, were invited to present their co-authored paper at the International Union of Architects (UIA) International Conference, held in Rio de Janeiro, Brazil, in July 2021. They both decided to attend the conference virtually due to COVID-19 restrictions, and we are especially proud of David for presenting his first research paper.

Student Achievements

On 16 April 2021, 30 architecture students – with the blessing of the Mangaung Parks Department and the Free State Provincial Heritage Resources Authority, and with the generous assistance of a local land surveyor, Lappies Labuschagne, and half a ton of chalk – set out to both trace and rescript, on a one-to-one scale, the layout of the 'lost' Rose Garden, by re-drawing the vanished lines. This initiative was in memory of the inauguration of the Prince's Rose Garden on 25 May 1925 by the Prince of Wales, later Edward VIII. The event forms part of a larger research project related to the rescripting of King's Park as a 'colonial landscape'.

Four Master of Architecture (Professional) students received awards at the 35th Corobrik Student Architecture Regional Awards 2021 – Ms Lunell Greyling (Winner), Ms Chrizelle Loots (1st Runner Up), Ms Amirah Patel (2nd Runner Up) and Mr Altus le Roux (Best use of Masonry).

Department of Architecture ready to trace and rescript the layout of the 'lost' Rose Garden

The product of their labours

TEACHING AND LEARNING

Blended Learning

A leading concern of 2021 was the fact that social distancing does not allow for regular in-studio, drawing board-style discussion and feedback. Additionally, the lecture venues used for history-theory classes and other lecture-based sessions, are too small to accommodate social distancing for a full class. After discussion and debate, we decided to redesign our teaching timetable to allow all studio-based classes to be divided into smaller groups that can have face-to-face sessions on separate days. As all studio-based classes have two lecturers, the parallel sessions are rotated in separate venues.

To facilitate our blended learning plan, we purchased three additional digital projectors with internet connection and daylight screens, which were installed in the design studios. We thus now have eight separate venues with projection facilities (three downstairs lecture venues, four studio venues on the ground floor, and the multifunction hall on the upper level), which can rotate to ensure that parallel studio sessions are accommodated, and provide sufficient space for larger venues for history-theory and other lecture-classes.

New Undergraduate History–Theory Courses

The new undergraduate history-theory modules (HTRC1506, HTRC2606, HTRC3706) were conceptualised by Prof Noble in 2019, approved by the Executive Committee of Senate in 2020, and launched in 2021. The new modules integrate history with theory in a manner that allows for a direct dialogue with the studio-based modules (design and construction), achieving better integration, enhancing critical reflection and aligning our pedagogy with international and local trends. The new history-theory modules also address questions of decolonisation, with a curriculum that addresses African, South African and contemporary concerns.

Vertical History–Theory Studio

The 'vertical studio' workshop for Histories and Theories of Architecture, was introduced for the first time as part of the new history-theory curriculum. Hosted from 26 to 20 August by leading architect, Mokena Makeka, the workshop exposed our undergraduate students to leading themes that influence the design of sustainable cities. The students were divided into integrated groups of 15 members, consisting of five students from each study level. This collaborative format of students from various year groups enabled a vertical integration and sharing of knowledge amongst undergraduate students in the modules.

Due to lockdown restrictions the workshop was held via Blackboard Collaborate. Mr Makeka presented a lecture each day and at the end of the workshop students were expected to present 90-second videos in response to the workshop. The videos had to illustrate the conceptualisation of an ideal, post-pandemic South African city, and were subsequently presented by Mr Makeka at the Smart Cities Expo Dubai 2021, representing the input of South African students in Mokena's global studio programme, which he has run for various universities around the world.

Digital Fabrication, Earth Unit and Seminar room

Although somewhat delayed, our intended building renovations commenced in November 2021. The renovations will divide and rearrange the upper-level rooms adjacent to the Media Hub, to achieve the following:

- A new digital fabrication room, with a newly acquired HS-T1390, 80 watt laser cutter with a 1 300mm x 900mm cutting bed, with plans to add a suitable 3D printer.
- A dedicated Earth Unit room, for storage and display.
- A new multipurpose seminar room primarily intended for honours and postgraduate seminars. The seminar room has an adjoining door to the Earth Unit room, to facilitate Earth Unit seminars/demonstrations.

In addition, we intend to acquire a few high-performance computers (suitable for incorporating software such as Lumion 3D rendering software), which will be placed in the Media Hub.

ENGAGED SCHOLARSHIP

Sophia Gray Memorial Lecture and Exhibition

The Sophia Gray Memorial Lecture and Exhibition has continued to honour local architects. Cape Town-based architect, Lucien le Grange, presented the 31st Lecture, held in 2021. The Lecture once again served to recognise a professional who has made a significant contribution to South African architecture, and exposed our students to architecture of a high standard. This event is usually attended by about 500 guests, many of whom travel from across South Africa. Unfortunately, the event of 2020 had to be cancelled due to COVID-19, while that of 2021 was a limited event with some 30 guests present at the Oliewenhuis Art Museum, but which was streamed live to a wider audience.

We also launched our new Sophia Gray website (www.sophiagray.co.za), which provides some history of the event, together with links for streamed lectures and virtual exhibitions. The website will be continually updated, and will form a growing archive of the Sophia Gray Memorial event.

Service learning

In June 2021, the Earth Unit and the Centre for Development Support conducted three tours to farms in the eastern Free State. Prof Gerhard Bosman, Dr Anita Venter, Mr Phadi Mabe and Mr David van der Merwe accompanied 42 second-year construction students on these service-learning tours. The five student groups visited and participated for three days on different parts of an assignment, including organisation tasks, collection of raw material, measuring existing homesteads and houses, and the preparation of wall surfaces and plaster panels. The focus was on a shared experience in which 36 women and six men taught the art of traditional Basotho ***litema*** and ***marela*** wall decoration to the students.

Students learning traditional litema and marela wall decoration skills

NATIONAL AND INTERNATIONAL COLLABORATION

Collaborative Online International Learning (COIL)

The iKUDU is an EU-funded Capacity Building in Higher Education (CBHE) project, which is being implemented over a three-year period from November 2019 to November 2022. It is coordinated by the UFS with the University of Antwerp (Belgium) as co-coordinator. The project, which is aimed at developing a contextualised South African concept of internationalisation of the curriculum, incorporates Collaborative Online International Learning (COIL) virtual exchanges. During the COIL student session held in April 2021, Prof Bosman was one of four international lecturers who presented to 29 BArch Honours students, as well as students from Akita International University, Japan (17 students), Farmingdale State College, New York, USA (22 students) and University of Siena, Italy (17students).

The course was presented in three parts over nine weeks, during which 12 teams had to collaborate in groups of seven to eight students. A follow-up COIL exchange for 2022, between these partner universities, is in the planning phases.

COASocial and The Saveetha College of Architecture and Design

Prof Noble was invited to present a series of streamed lectures in conversation with architect Peter Rich, relating to his book on *The Architecture of Peter Rich: conversations with Africa*, published by Lund Humphries in 2020. The first session (17 April) formed part of the International Literary Festival of Architecture, curated by Durganand Balsavar (Dean of the Saveetha College of Architecture and Design in Chennai, India), which was streamed to India, Bangladesh and South East Asia, as part of the Council of Architecture's (India) COASocial forum. The second session (21 August) provided an introduction to the four lectures in conversation, which were to follow. This session formed part of the Saveetha College of Architecture and Design Forum, together with the Jerusalem School of Architecture. Four subsequent sessions went into more detail regarding the book, with lectures in conversation that were conducted as a recorded live stream for COASocial in collaboration with the Artes Roots Fellowship. These sessions were also attended by UFS architecture students, as follows:

- 16 September – 'Vernacular Translations', attended by second-year history/history of architecture
- 30 September – 'The Implied Diagonal and the Raumplan', attended by second-year history/theory of architecture
- 14 October – 'Mandela's Yard', attended by third-year history/theory of architecture
- 21 October – 'Organicism', special lecture for all students

POSTGRADUATE STUDENTS

Four new candidates were admitted into the Master's and PhD with Design programmes in 2021, which required dedicated sessions conducted by Prof Noble for the new candidates. This resulted in four, one week-long PhD symposia, with the existing PhD cohort joining for the first and fourth symposia. These two symposia were international events, with academics joining from Australia, Namibia and New Zealand. The October symposium was a fully 'blended' event, which proved technically challenging to achieve, but which proved to be a resounding success.

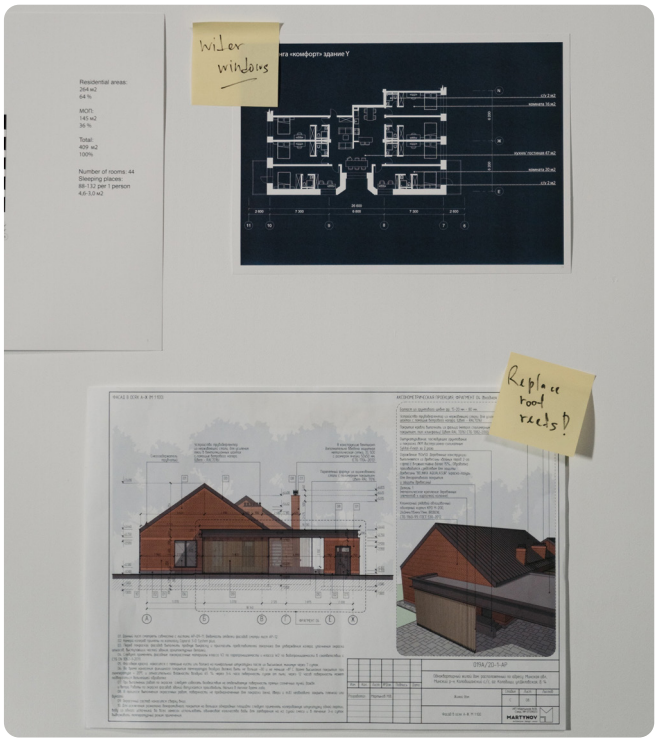
Heather Dodd is our first PhD candidate to have presented her 'completion' seminar. This was during the October symposium, and was adjudicated by a mixed panel comprised of a local and an international juror. The success of Dodd's 'completion' in October, means that she is now close to completing her PhD, which would constitute the first PhD graduation from the new creative research programme.

In 2021, a total of 29 students were registered for the Bachelor of Architecture Honours, and 22 students for the Master of Architecture (Professional).

Henry Pretorius graduated with a distinction for his design-based research Master's, supervised by Prof Noble, titled 'Extrapolating the Unseen – above, below and beyond the surface of my sketchbooks pages.

STAFF MATTERS

Mr Phadi Mabe joined the full-time staff as a Lecturer in January 2021.



RESEARCH OUTPUTS

Research Articles

Bosman, G. 2021. Change for contemporary earth construction: A second paradigm shift. *International Journal of Architecture and Urban Studies* 6(1): 90-100.

Hardman, T. 2021. Understanding Creative Intuition. Journal of Creativity 13.

Noble, J.A. 2021. Reimaginings at the Temple of Light, Venice Biennale 2018. *South African Journal of Art History* 36(1): 1-23

Conference Contributions

Conference Papers/ Posters

Bosman, G. 2021. *A new approach to Architecture of care and engagement*. Paper delivered at the UFS Learning and Teaching Conference 2021 (Online). Bloemfontein, South Africa. 13-15 September 2021

Bosman, G. 2021. *Service learning and COIL for Architecture*. Paper delivered at the UFS Learning and Teaching Conference 2021 (Online). Bloemfontein, South Africa. 13-15 September 2021.

Van der Merwe, D. & Auret, H.A. 2021. *Architecture as an art of care in historically marginalised communities: the case of Heidedal, South Africa.* Paper delivered at the XXVII International Union of Architects World Congress of Architecture, Rio de Janeiro, Brazil (Online). 8 July 2021.

Creative Outputs

Mathews, P. & Auret, H.A. 2021. *Social Works: The Braak Pavilion as an expression of Actor-Network Theory*. Available from:<https://maaa.co.za/creative-output-braak-pavilion/>

STAFF (2021)

Head of Department:
Prof JA Noble

Professor:
Prof JA Noble

Associate Professor:
Prof G Bosman

Adjunct Associate Professor:
Dr T Hardman

Senior Lecturers:
Dr HA Auret, Mrs MM Bitzer, Mr JL du Preez and Ms A Wagener

Lecturers:
Mr P Mabe, Mr JH Nel, Mr JW Ras and Mr H Raubenheimer

Junior Lecturers:
Mr JI Olivier and Mr DPG van der Merwe

Contract Lecturers:
Mr W Marais, Mrs K McDonald, Mr J Mitchell, Mr V Moutzouris, Prof JD Smit, Mrs P Smit and Mr C Viloria

Programme Director:
Mr JL du Preez

Research Fellow:
Prof WH Peters

Secretary:
Ms Y Nienaber

Assistant Officers – Professional Services:
Ms Z Bronkhorst, Mr LT Keswa and Mr MQ Myeni

Messenger:
Ms TJ Mohatlane

Department of

QUANTITY SURVEYING & CONSTRUCTION MANAGEMENT

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OVERVIEW OF 2021

The impact of the COVID-19 pandemic and subsequent restrictions, although slightly improved in 2021, was still being felt by staff and students. Overall, the impact was both positive and negative. Negative effects included that some students struggled to get to grips with increased online learning due to many factors, such as limited devices, poor internet connectivity, inability to proactively manage time effectively, which most online activities require. Some staff were also overwhelmed with the demands of the new learning approaches and had to adapt learning material, delivery methods and engagements with students. There was also a feeling of isolation by some staff and students. Administrative work did increase due to the increased support required by students and staff, as well as the need to respond and adapt various learning activities and processes timeously, as well as deal with various related support services.

On the positive side, many students seemed to thrive and enjoy increased online learning because of the flexibility it offered them to work at their own pace. Some staff were also able to reflect on their teaching and learning approaches and make improvements to enhance student learning experiences. In some cases, working remotely in 2021 yielded more productivity as staff were able to achieve a better work-life balance and lost less time travelling to and from work and other related distractions.

Overall, blended learning and teaching worked quite well for the Department, as some modules lend themselves more towards face-to-face learning and teaching than others. However, the Department made the most of the situation to ensure students and staff were supported as much as practically possible to ensure successful completion of the academic year.

As a student-centred and engaged Department, the COVID-19 lockdown restrictions limited student exposure to practical tasks, especially in that many construction firms and sites had to halt operations for months. A case in point is that site excursions could not be undertaken and practitioners were seldom invited to present various on-campus demonstrations to the students as part of their learning. Similarly, our Winter School which had run successfully for about two years prior, could not take place in 2020 and 2021.Thus, opportunities for students to draw better links between theory and practice, were somewhat diminished.

On a positive note, research activities for the MSc and PhD students progressed well. The Department held two successful research colloquiums for the students, at which other experienced academics from within Africa and the United Kingdom served as panellist to provide feedback and direction to the students. This added value to the students' research and learning experiences. Furthermore, the Department's research publication outputs showed a marked increase compared to the previous year.

The Department is indebted to its staff and students for their dedication and teamwork. The commitment and resilience demonstrated in 2021 is applauded! And there were many lessons learnt in 2021.

ACHIEVEMENTS

Staff Achievements

Staff members and their respective students were recognised for their research excellence at some of the conferences they participated in.

Prof Kahilu Kajimo-Shakantu and Ms Mariska Karsten won the best paper award in the Transformation and Sustainability category at the 2021 South African Council for the Quantity Surveying Profession International Research Conference, held in October 2021.

Ms Mariska Karsten

Prof Kahilu Kajimo-Shakantu

Ms Mart-Mari Els

Mart-Mari Els and Jean Muller were awarded the prize for the best paper at the Applied Research Conference in Africa, held in August 2021.

Student Achievements

The Department is pleased to announce the following students, who received recognition at the annual Faculty prize-giving:

- The Association of South African Quantity Surveyors prize for Best first-year student in the BSc (Quantity Surveying) programme – Ms B Groenewald.
- The Association of South African Quantity Surveyors prize for Best second-year student in the BSc (Quantity Surveying) programme (Shared Prize) – Ms Y de Beer and Mr J Louw.
- The Association of South African Quantity Surveyors prize for Best third-year student in the BSc (Quantity Surveying) programme - Mr M Engelbrecht.
- The Association of South African Quantity Surveyors prize for Best fourth-year student in the BSc Honours (Quantity Surveying) programme - Ms I van Wyk.
- Bell John prize for Best all-round year student in any year of study (Quantity Surveying) – Ms Y de Beer.
- PPS prize for Best student in BSc Hons (Quantity Surveying) – Ms I van Wyk.
- Ramabodu Foundation-prize for Best student in Descriptive Quantification in the final year – Ms I van Wyk.
- PPS prize for Best fourth-year student in the BSc Honours Construction Management – Mr S Ngobeni.
- Department of Quantity Surveying and Construction Management Prize for Best third-year student in BSc Construction Management – Ms Z Stapelberg.
- Department of Quantity Surveying and Construction Management Prize for Best Honours student in BSc Construction Management – Mr S Ngobeni.
- Department of Quantity Surveying and Construction Management Prize for Best student Research Project in the Construction Management Honours programme – Ms C Foster.
- Department of Quantity Surveying and Construction Management Prize for Best student Research Project in the Quantity Surveying Honours programme – Ms JA Engelbrecht.
- Department of Quantity Surveying and Construction Management Prize for Best student Research Mini Dissertation in the MLPM Programme – Ms B Mazomba.

The Department is also proud of the student achievements at the Association of South African Quantity Surveyors (ASAQS) Presidential Tour and Awards Ceremony, namely Ms Y de Beer, winner of the SAQS Turner and Townsend Great Outcomes Award, and Ms N Moss, Second Runner-up for the ASAQS Gold Medal Award.

Ms Nicole Moss

Ms Yolandi de Beer

TEACHING AND LEARNING

The Department offers a number of built environment-related programmes in Quantity Surveying, Construction Management and Real Estate Management (Property Studies). Within each of these main areas, there are numerous professional and career opportunities that can be followed in both the public and private sectors, and not limited to the construction sector.

In 2021, the Department implemented a BSc Construction Economics and Management (CEM) programme for the residential students. The value of the BSc CEM programme cannot be overemphasised, as it gives students the core foundational knowledge of both Quantity Surveying and Construction Management. Upon completion of this undergraduate degree, students should be in a better position to make informed decisions regarding which Honours programme to select. The CEM undergraduate programme can articulate into either an Honours in Construction Management or Honours in Quantity Surveying, making it an attractive programme for students to pursue. An exciting part of the CEM programme is the inclusion of customised work integrated learning modules (integrated industry exposure). The aim of these modules is to provide better opportunities for students to link theory with industry/practice, thus assisting to prepare the career readiness of the students early in their formative years. The modules focus on developing students' ability to think critically and practically and to apply discipline-specific knowledge in practical situations, to analyse and resolve problems, to work in a team and lead, to take responsibility of own learning and to become increasingly aware of current construction industry issues. This new direction reflects initiative on the part of the Department and supports and the University's Teaching and Learning strategy, as well as institutional efforts in terms of graduate attribute development.

BSc Construction Management and BSc Quantity Surveying undergraduate degrees compact learning (part-time) were also offered, as in previous years.

In 2021, the numbers of students enrolled in these undergraduate programmes were:

- BSc Construction Economics and Management: 11
- BSc Construction Management and BSc Quantity Surveying residential (full-time): 58
- BSc Construction Management and BSc Quantity Surveying compact learning (part-time): 31

RESEARCH AND INNOVATION

Three research groups which had previously received funding from the Faculty Central Research Fund, continued with their work throughout the year.

Dr Christopher Amoah and Prof Kahilu Kajimo-Shakantu continued their research project titled 'Assessment of the satisfaction level of Reconstruction and Development Programme (RDP) housing beneficiaries in South Africa'. The study's primary objective is to assess the level of satisfaction of RDP housing beneficiaries to inform the improvement of housing delivery.

Dr Christopher Amoah

Mr Hendri du Plessis's research group continued its research under the umbrella topic of 'An evaluation of the Fourth Industrial Revolution (4IR) readiness of learning institutions and various professionals in the South African Construction Industry: An exploratory study'.

Mr Alfred Deacon's research group also carried on with the research on construction contract management.

ENGAGED SCHOLARSHIP

Prof Kahilu Kajimo-Shakantu was invited as a panellist to discuss issues and solutions on smart cities in Africa at the International Conference on Development and Investment in Infrastructure, held on the 8 September 2021. Prof Kajimo-Shakantu also delivered the presidential address at the 15th Built Environment Conference, hosted by Association of Schools of Construction of Southern Africa. Her address considered the impact of COVID-19 on the construction industry and industry responses.

Prof Kahilu Kajimo-Shakantu

NATIONAL AND INTERNATIONAL COLLABORATION

Prof Kahilu Kajimo-Shakantu collaborated with peers from other universities in South Africa and Nigeria on a research funding proposal. She also collaborated with other authors from Nigeria on three papers which looked at 'Bridging the gap in real estate enterprise: the impact of mentoring

on entrepreneurial intentions of real estate students in Nigeria', 'Coworking space practices: assessing space users' preferences and challenges in Ibadan, Nigeria', and 'Exploring investment paradigm in urban office space management: perspectives from coworking space investors in Nigeria'. The papers are all ahead-of-print and expected to be fully published in 2022.

Dr Christopher Amoah collaborated on a journal publication with peers from Nelson Mandela University, titled 'Causes of road projects' delays: a case of Blantyre, Malawi. He also collaborated with another author from the Cape Coast Technical University, Ghana, on two articles, titled 'The COVID-19 pandemic: the woes of small construction firms in Ghana' and "Barriers to the implementation of Covid-19 safety regulations: insight from Ghanian construction sites'.

POSTGRADUATE STUDENTS

The Department offers postgraduate degrees at Honours, Master's and Doctoral levels, majoring in Quantity Surveying and Construction Management. It also offers a Master's by research and the PhD in Property Science. Included in our postgraduate programmes is a Master's by coursework degree in Land and Property Development Management (MLPM), specialising in either Project Management or Property Valuation.

The total number of students enrolled in the various programmes in 2020 was:

BSc Hons:	88
MLPM:	53 (for both specialisations)
MSc:	13
PhD:	10

At the 2020 graduation ceremonies, the following degrees were conferred:

BScHons (Construction Management):	6
BScHons (Quantity Surveying):	52
MLPM (Project Management):	2
MLPM (Property Valuation):	7

In terms of the MSc programme, Ms Liezl Knobel graduated with an MSc (Quantity Surveying), and Ms Maureen Khati with an MSc (Construction Management).

POSTDOCTORAL RESEARCH FELLOWS

The Department was pleased to extend the contract for Postdoctoral Fellow Dr Timothy Ayodele, from Nigeria, for another year. Dr Ayodele has been dedicated to undertaking research work, mainly in the area of innovative technology in construction, construction sustainability and real estate development finance and education. He co-authored a number of publications during the reporting year.

Dr Timothy Ayodele

STAFF MATTERS

Mr Hendri du Plessis was accepted into the UFS Learning and Teaching UFS fellowship programme administered by the Centre for Teaching and Learning. His research topic for the fellowship is 'The evaluation of Construction 4.0 attributes of South African Construction Built Environment students using Activity Theory'.

The Department was pleased to welcome Mr George Moloi as an Officer.

Ms Tanya van Schalkwyk and Ms Matshediso Sepheka resigned during 2021; the Department is grateful for their contribution and wish them well in their future endeavours.

Ms Marie-Louise Roux retired from the UFS after serving the Department for many years. Her enthusiasm and dedication to her work will be missed.

Ms Marie-Louise Roux

RESEARCH OUTPUTS

Research Articles

Amoah, C., Kajimo-Shakantu, K. & Van Schalkwyk, T. 2021. Meeting the expectations of the social housing recipients in South Africa: a myth or reality? *International Journal of Building Pathology and Adaptation* 39(2): 218-234.

Amoah, C. & Simpeh, F. 2021. Implementation challenges of COVID-19 safety measures at construction sites in South Africa. *Journal of Facility Management* 19(1): 111-128.

Amoah, C. & Tyekela, N. 2021. The socio-economic impact of land redistribution on the beneficiaries in the Greater Kokstad municipality of South Africa. *Property Management* 3(5): 653-669.

Ayodele, T.O., Adegoke, O.J., Kajimo-Shakantu, K. & Olaoye, O. 2021. Factors influencing real estate graduates soft skill gap in Nigeria. *Property Management* 39(5): 581-599.

Mwamvani, H.D.J., Amoah, C. & Ayesu-Koranteng, E. 2021. Causes of road projects' delays: a case of Blantyre, Malawi. *Built Environment Project and Asset Management* 12(2): 293-308.

Simpeh, F. & Amoah, C. 2022. COVID-19 guidelines incorporated in construction site health and safety management policies. *Journal of Engineering, Design and Technology* 20(1): 6-23.

Tyekela, N. & Amoah, C. 2021. Implementation challenges of land redistribution programme in South Africa. *International Journal of Sustainable Development and Planning* 16(7): 1329-1337.

Conference Contributions

Conference Papers/Posters

Amoah, C. & Finger, M. G. 2021. *Alternative Sustainable Methods for Reconstruction and Development Housing Construction: The Perspective of Built Environment Students.* Paper delivered at the Applied Research Conference in Africa (ARCA) Sustainable Education and Development – Making Cities and Human Settlements Inclusive, Safe, Resilient, and Sustainable, Accra, Ghana. 25-26 August 2021.

Amoah, C., & Mlenzana, L. 2021. *Emerging Contractors' Challenges with the Compliance of Occupational Health and Safety Standards in South Africa.* Paper delivered at the Applied Research Conference in Africa (ARCA) Sustainable Education and Development – Making Cities and Human Settlements Inclusive, Safe, Resilient, and Sustainable, Accra, Ghana. 25-26 August 2021.

Cogle, T. & Els, M.M. 2021. *Creating Sustainable Cities: The Viability of Urban Regeneration in Bloemfontein, South Africa.* Paper delivered at the Applied Research Conference in Africa (ARCA) Sustainable Education and Development – Making Cities and Human Settlements Inclusive, Safe, Resilient, and Sustainable, Accra, Ghana. 25-26 August 2021.

Du Plessis, J., Simpeh, F. & Amoah, C. 2021. *Students Housing Occupancy Satisfaction: Perception of Tertiary Students in Bloemfontein.* Paper delivered at the Applied Research Conference in Africa (ARCA) Sustainable Education and Development – Making Cities and Human Settlements Inclusive, Safe, Resilient, and Sustainable, Accra, Ghana. 25-26 August 2021.

Muller, J. & Els, M.M. 2021. *The Impact of Climate Change on Construction Projects in South Africa.* Paper delivered at the Applied Research Conference in Africa (ARCA) Sustainable Education and Development – Making Cities and Human Settlements Inclusive, Safe, Resilient, and Sustainable, Accra, Ghana. 25-26 August 2021.

Opawole, A. & Kajimo-Shakantu, K. 2021. *Risk Management Techniques by Small and Medium Size Contracting Firms.* Paper delivered at the Applied Research Conference in Africa (ARCA) Sustainable Education and Development – Making Cities and Human Settlements Inclusive, Safe, Resilient, and Sustainable, Accra, Ghana. 25-26 August 2021.

Opawole, A. & Kajimo-Shakantu, K. 2021. *Technical Challenges Associated with Sustainable Land Use Through Vertical Construction.* Paper delivered at the Applied Research Conference in Africa (ARCA) Sustainable Education and Development – Making Cities and Human Settlements Inclusive, Safe, Resilient, and Sustainable, Accra, Ghana. 25-26 August 2021.

Conference Proceedings

Adaralegbe, O.A., Opawole, A. & Kajimo-Shakantu, K. 2021. Assessment of management strategies for residual on-site related risk factors in educational institutional building projects. In*: Proceedings of the 14th Built Environment Conference - Technology, Transformation and Sustainable Construction -Association of Schools of Construction of Southern Africa (ASOCSA),* Durban, South Africa. 21-22 September 2020. T.C. Haupt (Ed). ASOCSA. pp. 1-10.

Adisa, S. & Simpeh, F. 2021. Assessment of security measures: a compared analysis of two universities student housing. In*: Proceedings of the 14th Built Environment Conference - Technology, Transformation and Sustainable Construction - Association of Schools of Construction of Southern Africa (ASOCSA),* Durban, South Africa. 21-22 September 2020. T.C. Haupt (Ed). ASOCSA. pp. 1-7.

Agenbag, H., & Amoah C. 2021. The impact of modern construction technology on the workforce in the construction industry. In*: Proceedings of the 14th Built Environment Conference - Technology, Transformation and Sustainable Construction - Association of Schools of Construction of Southern Africa (ASOCSA),* Durban, South Africa. 21-22 September 2020. T.C. Haupt (Ed). ASOCSA. pp. 1-10.

Amoah, C. & Plessis, J. 2021. Factors Influencing Student's Accommodation Selection. In: *Proceedings of the Construction Business & Project Management Conference.* Cape Town, South Africa. 24 -25 June 2021. A. Adediran ***et.al*** (Eds). pp 60-70.

Ayodele, T. O. & Kajimo-Shakantu, K. 2021. The fourth industrial revolution (4IR) and the construction industry - the role of data sharing and assemblage. In*: Proceedings of the 14th Built Environment Conference - Technology, Transformation and Sustainable Construction - Association of Schools of Construction of Southern Africa (ASOCSA),* Durban, South Africa. 21-22 September 2020. T.C. Haupt (Ed). pp. 1-8.

Cloete, B. & Amoah, C. 2021. An evaluation of utilizing shipping container technology to address the housing deficit in South Africa, *In: Proceedings of The Economic Forum Conference.* Johannesburg, South Africa. 15-16 July 2021. S. Dlamini (Ed). Wits University. pp 191-211.

Kajimo-Shakantu, K., Groenewald, B. & Ayodele, T. 2021. Factors influencing perceived value of residential properties

in Free State Province, South Africa In: *West Africa Built Environment Research (WABER) Conference,* Accra, Ghana. S. Laryea & E. Essah (Eds). 9-11 August 2021. pp. 645-659.

Kajimo-Shakantu, K., Karsten, M. & Ayodele, T.O. Implementation of lean principles in the South African engineering construction industry: a quantity surveying perspective. In: *Proceedings of the 2021 SACQCP (The South African Council for the Quantity Surveying Profession) International Research Conference.*, Gqeberha, South Africa. 10 November 2021. G.J. Crafford (Ed). Department of Quantity Surveying, Nelson Mandela University. pp. 14-24.

Mbekushe, S. & Amoah, C. 2021. The Effect of unskilled labourers on the construction productivity. In: *Proceedings of the Department of Construction Management 50th Anniversary Conference 'The Next 50 Years'*. Gqeberha, South Africa. 15-16 November 2021. F. Emuze (Ed). Department of Built Environment, Central University of Technology. pp 184-194.

Morena, M., & Amoah C. 2021. Assessment of the mitigating measures for cost overruns in the South African construction industry. In: *Proceedings of the 14th Built Environment Conference - Technology, Transformation and Sustainable Construction - Association of Schools of Construction of Southern Africa (ASOCSA),* Durban, South Africa. 21-22 September 2020. T.C. Haupt (Ed). ASOCSA. pp. 1-10

Opawole, A. & Kajimo-Shakantu, K. 2021. Analysis of risk occurrence in projects executed by small and medium sized contracting firms. In: *Proceedings of the 14th Built Environment Conference - Technology, Transformation and Sustainable Construction - Association of Schools of Construction of Southern Africa (ASOCSA),* Durban, South Africa. 21-22 September 2020. T.C. Haupt (Ed) .ASOCSA. pp. 1-9.

Phiri, J. & Du Plessis, H.B. 2021. The Quantity Surveyor's Role in the Adoption of Microgeneration Technology in the South African Built Environment. In: *Proceedings of the 2021 SACQCP (The South African Council for the Quantity Surveying Profession) International Research Conference.*, Gqeberha, South Africa. 10 November 2021. G.J. Crafford (Ed). Department of Quantity Surveying, Nelson Mandela University. pp. 37-46.

Pretorius, B. & Amoah, C. 2021. Impact of cost overruns on contractual disputes. In: *Proceedings of the Department of Construction Management 50th Anniversary Conference 'The Next 50 Years'*. Gqeberha, South Africa. 15-16 November 2021. F. Emuze (Ed). Department of Built Environment, Central University of Technology. pp. 55-65.

Robbertse, C. & Amoah, C. 2021. Project managers' skills for enhancing construction productivity: the views of construction professionals. In: *Proceedings of the 2021 SACQCP (The South African Council for the Quantity Surveying Profession) International Research Conference,* Gqeberha, South Africa. 10 November 2021. G.J. Crafford (Ed). Department of Quantity Surveying, Nelson Mandela University. pp. 14-24.

Simpeh, F. & Akinlolu, M. 2021. A Scientometric Review of Student Housing Facilities Research Trends. In: *Proceedings of the 14th Built Environment Conference - Technology, Transformation and Sustainable Construction - Association of Schools of Construction of Southern Africa (ASOCSA),* Durban, South Africa. 21-22 September 2020. T.C. Haupt (Ed). ASOCSA. pp. 1-10.

Tunji-Olayeni, P. Kajimo-Shakantu, K. Ayodele, T. O. & Emmanuela, K 2021. Factors Affecting Students' Learning in Civil Engineering Measurement. In: *Proceedings of the 14th Built Environment Conference - Technology, Transformation and Sustainable Construction - Association of Schools of Construction of Southern Africa (ASOCSA),* Durban, South Africa. 21-22 September 2020. T.C. Haupt (Ed). ASOCSA. pp.1-11.

Tunji-Olayeni, P.F, Kajimo-Shakantu, K. & Oni, A. A. 2021. Work-Life Experiences of Women in the Construction Industry: A Case of Women in Lagos Mainland, Nigeria. In: *Proceedings of the 14th Built Environment Conference - Technology, Transformation and Sustainable Construction -Association of Schools of Construction of Southern Africa (ASOCSA),* Durban, South Africa. 21-22 September 2020. T.C. Haupt (Ed). ASOCSA. pp. 1-11.

STAFF (2021)

Head of Department:
Prof K Kajimo-Shakantu

Associate Professor:
Prof K Kajimo-Shakantu

Senior Lecturers:
Dr C Amoah and Dr F Simpeh

Lecturers:
Ms T Bremer, Mr AH Deacon, Mr H du Plessis, Ms M-M Els, Ms C Ferreira, Mr PM Oosthuizen and Ms TL van Schalkwyk

Lecturers (Contract):
Mr D Huggett, Mr C Mukumba, Mr MT Ralile, Mr R Schaaf, Mr R Seedat, Mr C Skibbe, Dr L Spencer, Mr L Stott, Mr W Strydom, and Ms J Swartz

Programme Directors:
Mr H du Plessis and Ms C Ferreira

Affilliated Research Fellows:
Prof T Haupt, Dr K Ibrahim, Prof F Muleya and Dr A Opawole

Officers:
Mr A Beukes, Mr GT Moloi, Mr TH Mogorosi and Ms M Roux

Senior Assistant Officers:
Ms R Runkel and Ms M Sepheka

Secretary:
Ms E van der Walt

Messenger/Service Worker:
Ms N Mohapi

Department of URBAN AND REGIONAL PLANNING

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OVERVIEW OF 2021

During 2021, South Africa was still in varying levels of lockdown due to the COVID-19 pandemic. Since the Department of Urban and Regional Planning strives to provide support for students, both academically and personally, during the COVID-19 crisis we kept close track of every student who was significantly affected, and put special measures and initiatives in place. We made particular arrangements to ensure that students could access essential platforms. However, despite our best efforts, as a result of the impact of COVID-19, there may be students who withdrew from or did not register for studies due to the increased financial pressures.

A highlight of 2021 was the accreditation visit of the South African Council for Planners (SACPLAN) in May 2021. Positive feedback was received in the report back on 4 June. The final outcome communicated to us was that "The Master of Urban and Regional Planning (MURP) (BC470348 and 4762) complies with and in certain instances exceeds the minimum standards. The MURP (BC47034B and 4762) is therefore accredited".

ACHIEVEMENTS

Staff Achievements

Dr Kgosi Mocwagae was promoted from Lecturer to Senior Lecturer.

Dr Thuli Mphambukeli was invited by the National Committee for BRICS Research, Russia, and nominated by the South African BRICS Think Tank to present a lecture at the BRICS International School, held in Moscow from 28 June to 5 July 2021. Dr Mphambukeli was appointed as a co- editor of the *Journal of BRICS Studies*. By invitation from the Observer Research Foundation in New Delhi, India, Dr Mphambukeli published an article on the 'Expert Speak' platform of Urban Futures, a segment that aims at producing new knowledge for addressing emerging challenges in an urbanising world.

Dr Mphambukeli's and Prof Verna Nel's NRF C-ratings commenced in January 2021.

TEACHING AND LEARNING

2021 was still affected by the restrictions resulting from the COVID-19 pandemic and the various lockdown regulations. As part of our commitment to provide maximum support to all students, we couriered flash drives containing the relevant course content to assist students with limited internet access. Over and above the Faculty's efforts, we supplied students who had particular technological difficulties with a basic notepad to use in their studies. In addition, during the COVID-19 lockdown, the UFS arranged for key UFS sites, such as Blackboard and student email, to be zero-rated when accessed through Vodacom, MTN, CellC or Telkom Mobile. This meant that students were able to access these platforms and were not charged for the data.

At this time, our block week format enabled us to take time to consider the best way to proceed. Postgraduate students across the Faculty returned to the Campus in phases. The COVID-19 crisis necessitated a meeting with staff and class representatives to plan for moving to a blended teaching format. The representatives raised concerns that off-campus students would struggle with access to data and computers. This led to a full survey of all students, which provided essential information for shaping the Department's planning.

In a blended learning environment, flexibility is key. When students are able to learn in different ways at different times, they can benefit more from their courses. This has become particularly relevant during the COVID-19 crisis as distance education and remote teaching have increasingly been utilised to ensure that students still gain the maximum benefit from teaching. Due to COVID-19, the visiting staff have been limited. The Department has had outside experts comment on the mini-dissertations and dissertations.

Supervisors and students attending Master's students' presentations on research findings

Each year, the Honours students in Spatial Planning and Human Settlements visit informal settlements in Mangaung. Led by Mr Thomas Stewart and Dr Kgosi Mocwagae, the students must assess the spatial planning, or the absence thereof, and the social circumstances of the inhabitants of these settlements. In 2021, the visit was to the Phomolong informal settlement.

Dr Kgosi Mocwagae briefs the Honours students on the Phomolong informal settlement

Phomolong informal settlement

Honours in Human Settlements student, Ayodele Ige, during Phomolong site visit

RESEARCH AND INNOVATION

As with many universities offering a structured Master's degree, the non-completion of the mini-dissertation is one of the main reasons for the relatively low throughput rates. To increase the completion rate and hence the throughput, the Department has embarked on a number of strategies. One of these include that all Master's students must produce a substantial mini-dissertation that is evidence of the ability to undertake independent research. It is expected of the mini-dissertation students to present their draft literature reviews in April, their draft methodology chapters in August and their findings and proposals to all the supervisors for inputs in October.

Master's student, Malebona Makoetjie, presenting her research findings to the Department

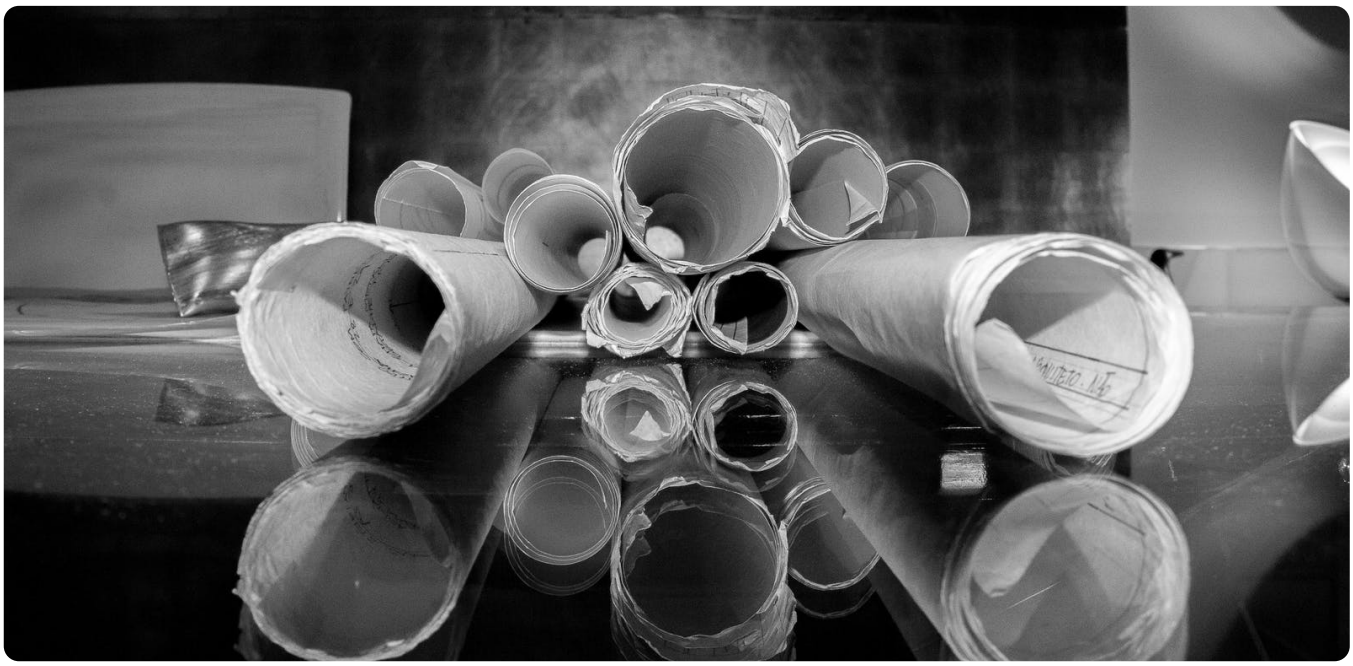
The Department was represented by a postgraduate student and staff delegation at the Human Settlements and Housing African Regional Student Conference, held in East London from 27 to 29 October, and hosted by the University of Fort Hare's Human Settlements Department in collaboration with the Institute of Human Settlement Practitioners South Africa. The conference was a multinational collaborative effort that focused on professional development, capacity building, resource development, advocacy, legislation and building principled partnerships to address the housing crisis and support sustainable development needs experienced by many African nations. The theme of the conference was 'Strengthening the Sector-Wide Capacity Development Efforts in a Pandemic – Opportunities for Young Professionals'.

The UFS delegation, which presented four papers, consisted of Mr Leemisa Matooane (Honours student), Mr Malefetsane (Human Settlements Lecturer), Ms Jennilee Kohima (PhD candidate), Mr Ige Ayodele (Honours student) and Ms Lucia Leboto-Khetsi (PhD candidate).

Prof Verna Nel arranged two writing retreats on the Bloemfontein Campus, which were attended by three staff members (Prof Verna Nel, Ms Abongile Mgwele and Dr Abraham Matamanda) and several PhD and Master's students. These writing retreats resulted in several submissions to conferences and book chapters.

Dr Thulisile Mphambukeli is a R500 000 grant recipient and principal investigator of the Joint NIHSS-CASS (National Institute of Humanities and Social Sciences-Chinese Academy of Social Sciences) research project, titled 'Exploring the Situated Political Ecology and Economy of Agricultural Land Policies in BRICS: A Case Study of China and South Africa'.

Prof Das Steÿn, a Research Fellow in the Department, is currently researching the role of the ports of South Africa in Regional Planning. In 2021 the World Bank published *The Container Port Performance Index 2020: A Comparable Assessment of Container Port Performance* of 351 ports all over the World. Four South African ports were in this list – Cape Town (No. 347), Port Elizabeth (No. 348), Durban (No. 349) and Ngqura (No. 351). In Regional Planning the concern is to improve the economic development of regions, mostly relating to the achievement of satisfactory relationship between people and jobs. South Africa is, for a large part, a supply region of raw materials and agricultural products to other regions, but is also an exporter of motor cars and other industrial products. In this, the eight ports serving the country plus the infrastructure serving these ports, are of major importance. This long-term study, which commenced in 2021, will seek to bring the different working parts together and to improve their efficiency from a regional planning perspective.



ENGAGED SCHOLARSHIP

Dr Kgosi Mocwagae regularly interacted with the industry as a specialist advisor and was re-appointed for a second term as a Deputy Chairperson of the Municipal Planning Tribunal of the Matjhabeng Local Municipality. He also served on the Executive Committee of the Free State branch of the South African Planning Institute. His experience as a Professional Planner in the private sector on land use applications and strategic plans, adds value to the students' learning experience.

Dr Thulisile Mphambukeli is a review editor and a topic editor for Governance and Cities for the *Frontiers in Sustainable Cities Journal*. Her research topic, titled 'Urban (In)Security and Social Justice in Post-Colonies' is currently published on the Frontiers website and researchers from all over the world will be contributing their articles in January 2022.

NATIONAL AND INTERNATIONAL COLLABORATION

Dr Mphambukeli was invited by His Excellency Dr Nirmal Kumar Bishokarma, Ambassador of Nepal to South Africa, to discuss potential collaboration between South Africa and Nepal.

Currently the Department has excellent linkages and collaboration, both nationally and internationally. These are summarised in the tables below.

Table 1: International Networks and Partnerships (2021)

Institution	Nature of Relationship
The National Institute for the Humanities and Social Sciences (NIHSS)	Dr Thulisile Mphambukeli is a member of the South African BRICS Think Tank, involving various countries.
International Union of Anthropological and Ethnological Sciences, Croatia	Dr Thulisile Mphambukeli is a member of the Commission of Marginalisation and Global Apartheid.
University College London, UK	Partner for the South African Planning Education Research (SAPER) project.
Malmö University, Sweden	Research Collaboration with Prof Nils Ekelund and Dr Per Schubert as part of the South Africa - Sweden University Forum (SASUF) projects on peri-urban areas.
Appalachian State University, USA	Partner university on joint international course in sustainability.
Newcastle University, UK	Dr Suzanne Speak is a research fellow with this Department.
Novosibirsk State University, Russia	Partner university on joint international course in sustainability.
University of Zimbabwe, Zimbabwe	Frequent research and teaching collaboration with Prof Innocent Chirisa, who is a research fellow with this Department.
Namibia University of Science and Technology (NUST), Namibia	Frequent research and teaching collaborator with Ms Jennilee Kohima, who is registered as a PhD student with this Department.
University of Lisbon, Portugal	Professor Verna Nel presented at and published in publications coordinated by Professor Carlos Nunes Silva.
The Social Science Research Council (SSRC), USA	Dr Mphambukeli is an Alumni of SSRC and is regularly invited to review the American Peacebuilding Network's Individual Research Fellowships grant applications.
University of Ghana, Ghana	Dr Mphambukeli collaborated with Dr Fidelia Dake on research proposal writing and attempted to secure research grants. Dr Dake also visited the UFS and presented her research at an international seminar hosted by the Department, BRICS-NIHSS.
Obafemi Awolowo University, Nigeria	Dr Mphambukeli collaborated with Prof Victor Okorie on various research projects that have generated income for our Department. Prof Okorie was also a Postdoctoral Fellow in the Department in 2017.
University of Kent, UK	Dr Mphambukeli disseminated her research findings at the Urban Ethnographies at the invitation of Prof Italo Pardo.
The Florida State University, USA	Dr Mphambukeli is a member of the Situated Urban Political Ecology (SUPE) research group, headed by Dr Mary Lawhon of the Department of Geography, Florida State University and Dr Henrik Ernstson of the Environmental Humanities at the Royal Institute of Technology (KTH) in Sweden and the KTH African Centre for Cities at University of Cape Town.

Table 2: National Networks and Partnerships (2021)

Institution	Nature of Relationship
Central University of Technology (CUT)	We have collaborated with the CUT through joint research projects. Through the 6th CUT/UFS Joint Research Grant, Dr Thuli Mphambukeli co-supervises a Master's dissertation with Professors O Ololade (UFS) and S Oke (CUT).
Centre for Scientific and Industrial Research (CSIR)	Through the SAPER project, we worked extensively with Dr Elsona van Huyssteen, who is based at the CSIR. The Department has also published two chapters on mining in the Bojanla district with colleagues from the CSIR.
Department of Agriculture, Land Reform and Rural Development (National and Free State)	We have presented at planning forums arranged by both the Free State and national branches. In addition, staff at the Free State branch have both taught and acted as examiners for our Department.
Free State Department of the Premier	Staff from the Premier's Department have taught components of our Professional Practice course.
Human Sciences Research Council (HSRC)	Our Department is part of the NRF Research Chair in City-Region Economies, held by Prof Ivan Turok, who holds a joint appointment with UFS and the HSRC.
Mangaung Metropolitan Municipality	Staff from Mangaung have both taught and presented to our students.
Institute of Human Settlements Practitioners of Southern Africa (IHSP –SA)	Four of our students attended a Regional Student Conference. Thomas Stewart has been appointed the interim chair of the Academics Forum of this Institute.
South African Local Government Association (SALGA)	We presented and facilitated at events arranged by both the Eastern Cape and Free State SALGA branches.
University of Pretoria (UP)	Professor Verna Nel frequently collaborates with Professors Mark Oranje and Karina Landman on various research projects, resulting in joint publications.
University of Witwatersrand (Wits)	Professor Nel and Dr Stuart Denoon-Stevens acted as external moderators for the Wits planning program and have contributed to a book edited by WITS university staff.
University of Johannesburg (UJ)	Dr Mphambukeli contributed a chapter to an upcoming book edited by Professor Zondi from the Department of Politics and International Relations at UJ.
University of Zululand (UniZulu)	Dr Mphambukeli collaborated with Dr IS Nojiyeza from the Department of Development Studies and Anthropology. Dr Mphambukeli externally examined dissertations from UniZulu.
University of Venda	Dr Mphambukeli had research interactions and performed external moderation of the Planning Programme modules with the University of Venda.
University of KwaZulu-Natal (UKZN)	Dr Mphambukeli had various research interactions with UKZN researchers namely, Prof Nirmala Gorpal, Prof Rozena Maart and Prof Chipungu.
North-West University (NWU)	Dr Mphambukeli collaborated and published with Prof Lere Amusan, Department of Political Studies and International Relations.

OTHER ACTIVITIES

Short Learning Programmes

The Department of Urban and Regional Planning has embarked on a mission to respond to an apparent gap in knowledge, skills and personal development for practitioners in the land use management, human settlements and socio-cultural planning disciplines, through Short Learning Programmes (SLPs). Mrs Lucia Leboto-Khetsi, a PhD candidate, was appointed as the SLP Coordinator to facilitate the process. While developing proposals and budgets that would bring to life the vision of the SLPs, she closely engaged with the Kovsie Phahamisa Academy (KPA), which oversees the management of SLPs at the broader institutional level. Through her assistance, four proposals and budgets were approved by the KPA. The scope of the SLPs are as follows:

- Principles of Land Use Management: Due to the promulgation of the Spatial Planning and Land Use Management Act 16 of 2013 (SPLUMA), development planning and land use management transformation

in South Africa necessitates first-hand knowledge for practitioners in the town planning, property development and real estate disciplines in order to align their daily operations to the new regulations. This SLP addresses an industrial demand to enhance the skills and knowledge of relevant practitioners to apply SPLUMA as per municipal requirements. In addition, the SLP looks to absorb a wide range of interested participants, by providing a bridge towards access to planning programmes.

- Introduction to Socio-Cultural Aspects: This programme aims to examine the relationship between indigenous knowledge systems and socio-cultural aspects of town planning. These relationships are often not easy to reconcile, but the programme strikes a balance between these two aspects of activity. In addition, the SLP deliberates on the importance of advocacy in planning, driven by probing social justice within the scope of environmental planning.
- Fundamentals for Human Settlements: The development of sustainable human settlements, as mandated by the Breaking New Ground (BNG) policy and international treaties such as the Sustainable Development Goals (SDGs) require knowledgeable and competent practitioners in the field. This short learning programme is designed to enhance capacity of practitioners working in the human settlements field. It supports the South African government's intent to fast-track housing provision and develop sustainable human settlements, while at the same time warranting institutional performance of local and provincial governments.
- Using GIS in Urban and Regional Planning: A big need exists in the Urban and Regional Planning fraternity to conduct evidence-based analysis to support the planning process. Spatial analysis using Geographic Information Systems (GIS) techniques and urban theories will enhance the planner's knowledge base and planning tools to ensure planning that is geographically sound and more relevant to people's needs. The purpose of the programme is to incorporate the use of GIS in urban theories that are imperative to the planning process. This SLP targets Urban and Regional Planning practitioners in the private, public, community and other sectors, Urban and Regional Planning students and users of GIS within the spatial planning fraternity.

Town and Regional Planning Journal

The Department is the custodian of the *Town and Regional Planning Journal*, which is a fully accredited Open Access scientific journal, listed in the Web of Science Core Collection: Emerging Sources Citation Index; SciELO SA indexed by the Web of Science; Norwegian list; Directory of Open Access Journals (DOAJ); and Ebsco Discovery Service. In 2021, the journal celebrated its 47th year and since 1974, 79 issues have been published – the latest was a special issue on the subject of access to the city by all people, irrespective of their age, class, race, gender and any other spatial consideration titled *Cities for All/The right to the City*. With 960 registered online readers from countries all over the world, this journal offers publication opportunities for independent, peer-reviewed articles by researchers in the fields of town, urban and regional planning. Articles are available at the journal's online archive:https://journals.ufs.ac.za/index.php/trp/issue/archive.

POSTGRADUATE STUDENTS

In 2021, the following postgraduate students were enrolled in the Department of Urban and Regional Planning:

- 41 in Spatial Planning Honours, and 8 in Honours specialising in Human Settlements
- Professional Master's: 25 in Urban and Regional Planning
- Research Master's: 5 in Urban and Regional Planning and 1 in Human Settlements
- PhD: 15 in Urban and Regional Planning

In 2021, a total of 20 students graduated with the Honours degree in Spatial Planning – Dane Buttner and Mareli Hugo graduated with distinction. Eight students graduated with the Specialisation in Human Settlements.

At Master's level, 29 students graduated with the Professional Master of Urban and Regional Planning – Ontebile Dube, Nonhlanhla Maphoso and Zukiswa Mdwane all graduated with distinction. One student graduated with the Research Master of Human Settlements.

In 2021 degrees were conferred upon the following four candidates who graduated with the Doctor of Philosophy majoring in Urban and Regional Planning:

Jacobus, Mischka

Thesis:	The experience of urban planners' practical training in South Africa
Supervisors:	Prof VJ Nel and Dr HS van den Berg

Denoon–Stevens, Stuart Paul

Thesis:	The role of land use management in promoting, or hindering, spatial transformation in South African urban areas
Supervisors:	Prof VJ Nel and Dr E van Huyssteen

Dube, Tilsetso

Thesis:	Exploring urban development and management in the informal economy – the case of Bulawayo, Zimbabwe
Supervisors:	Prof MM Campbell and Prof I Chirisa

Billawer Wilson

Thesis:	The indigenous knowledge systems, spatial planning and planning legislation: the case of Windhoek, Namibia
Supervisor:	Prof VJ Nel

RESEARCH FELLOWS

The Department has three Research Fellows, namely Prof Das Steÿn who was reappointed for another term, Prof Innocent Chirisa (since 2017) and Dr Stuart Denoon-Stevens (since 2021).

Thomas Stewart (let) and Prof Das Steÿn attending a lecture

STAFF MATTERS

Sadly, Dr Stuart Denoon-Stevens resigned from his position as Lecturer at the end of November 2021, to take up a position as Senior Lecturer at Nottingham Trent University in the UK, in January 2022. However, he was appointed as a Research Fellow in December 2021, so his resignation is considered to be more of a change in role.

Mrs Lucia Leboto-Khetsi, a PhD student and part-time Lecturer in the Department, was appointed as Coordinator for our SLPs.

RESEARCH OUTPUTS

Research Articles

Brand, A.D., Drewes, J.E. & Campbell, M. 2021. Differentiated outlook to portray secondary cities in South Africa. *AIMS Geosciences* 7(3): 457-477.

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Chirisa, I., Mavhima, B., Nyevera, T., Chigudu, A., Makochekanwa, A., Matai, J., Masunda, T., Chandaengerwa, E.K., Machingura, F., Moyo, S. and Chirisa, H. 2021. The impact and implications of COVID-19: Reflections on the Zimbabwean society. *Social Sciences & Humanities Open* 4(1): 100183.

Gbadegesin, J., Marais, L., Denoon-Stevens, S., Cloete, J., Venter, A., Rani, K., Lenka, M., Campbell, M. & Koetaan, Q. 2021. Studentification and governance in South Africa: Dependencies and conflicts. ***Land Use Policy*** 109:105639.

Marais, L., Nel, V., Rani, K., Van Rooyen, D., Sesele, K., Van der Watt, P. & du Plessis, L., 2021. Economic Transitions in South Africa's Secondary Cities: Governing Mine Closures. *Politics and Governance* 9(2). DOI: 10.17645/pag.v9i2.4032.

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Mphambukeli, T.N. 2021. Decolonising heritage sites in post-colonial-cum-apartheid cities: Experiences and suggestions from the Global South. *Urban Futures*. Online available at: https://www.orfonline.org/expert-speak/decolonising-heritage-sites-in-post-colonial-cum-apartheid-cities/

Sinxadi, L. & Campbell, M. 2021. Exploring the Influence of Community Participation by Planners on Sustainable Neighbourhood Performance: The case of Mangaung Metropolitan area. *IGLUS-Quarterly* 7(3) 12-20.

Books/Chapters in Books

Bandauko, E., Mutambisi, T., Toriro, P. & Chirisa, I. 2021. Urban Governance and the Political Economy of Livelihoods and Poverty in Harare, Zimbabwe. In: *Urban Geography in Postcolonial Zimbabwe*. A.T. Matamanda, V. Nel & I. Charisa (Eds). The Urban Book Series. Springer, Cham. pp. 77-92.

Campbell, M. 2021. Perceptions of the impact of extractive industries on local government: The case of the Rustenburg mining town. Chapter 6. In: *Mining and Community in the South African Platinum Belt: A Decade after Marikana.* L. Marais, M. Campbell, S.P. Denoon-Stevens & D. van Rooyen (Eds). Nova Science Publishers, Hauppauge NY.. ISBN: 978-1-53619-894-2 Pp 119-140.

Chirisa H., & Campbell M. 2021. Spatial Demography as the Shaper of Urban and Regional Planning Under the Impact of Rapid Urbanization. In: *The Palgrave Encyclopedia of Urban and Regional Futures.* R. Brears (Ed). Palgrave Macmillan, Cham. DOI: 10.1007/978-3-030-51812-7_96-1 ISBN 978-3-030-51812-7.

Chirisa, I., Gumbo, T., Mazongonda, S.S. & Marewo, M. 2021. Deviation, Transgression or Digression? The Informal City as the Dominant Phenomenon in the Zimbabwean Urban Economy. In: *Urban Geography in Postcolonial Zimbabwe.* A.T. Matamanda, V. Nel & I. Charisa (Eds). The Urban Book Series. Springer, Cham. pp. 119-140.

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Chivandire, C., Masunda, T. & Chirisa, I. 2021. Environmental Resilience – Food and the City. In: *Environmental Resilience.* A. Lemon, R. Donaldson & G. Visser (Eds). Springer, Singapore. pp. 1-16.

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Marais, L., Campbell, M., Denoon–Stevens, S. & Van Rooyen, D. Rustenburg: The Challenges of a Normalised Mining Town. Chapter 1. In: *Mining and Community in the South African Platinum Belt: A Decade after Marikana.* L. Marais, M. Campbell, S. Denoon-Stevens & Van Rooyen, D. (Eds). Nova Science Publishers, Hauppauge NY. pp1-12.

Marhulumba, T. & Nel, V. 2021. The Neglect of People with Disabilities in Integrated Development Planning in Ngangelizwe Township, Mthatha. In: *Urban Inclusivity in Southern Africa. R.* Matamanda, V. Nel & I. Chirisa (Eds). Springer, Cham. pp. 327-345.

Maritz, J., Oranje, M., Van Huyssteen, E. & Nel, V. 2021. Planning for a post-mining future in the Rustenburg region and the transition towards it? Chapter 6. In: *Mining and Community in the South African Platinum Belt: A Decade after Marikana.* L. Marais, M. Campbell, S.P. Denoon-Stevens & D. van Rooyen (Eds). Nova Science Publishers, Hauppauge NY. pp 63-82. ISBN: 978-1-53619-894-2.

Matamanda, A.R., Dube, T. & Campbell, M. 2021. Studentification and Its Interplay on Urban Form and Urban Policy: Reflection from Bulawayo, Zimbabwe. In: *Urban Geography in Postcolonial Zimbabwe.* A. Matamanda, V. Nel & I. Chirisa (Eds). Springer, Cham. pp. 57-75.

Matamanda, A.R. & Nel, V. 2021. (Un)Healthy Cities: Reflections on Urban Public Health in Poor Neighbourhoods. In: *Urban Geography in Postcolonial Zimbabwe.* A. Matamanda, V. Nel & I. Chirisa (Eds). Springer, Cham. pp. 93-118.

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Conference Contributions

Conference papers/Posters

Dunn, M. & Nel, V. 2021. *Advocating for socially-just municipal regulations: the case of Ashbury, Bloemfontein, South Africa.* Paper delivered at the International Geography Union (IGU) Conference, hosted by Istanbul University (Online). 17-21 August 2021.

Leboto-Khetsi, L. Matamanda, A., Nel, V. & Rwanqa, F. *Climate Policy and Local Governance in Lesotho.* Paper delivered at the International Geography Union (IGU) conference, hosted by Istanbul University (Online). 17-21 August 2021.

Matamanda, A.R., Kohima, J., Nel, V. & Chirisa, I. 2021. *Climate Change Adaptation and Planning Education in Southern Africa.* Paper delivered at the 5th Association of African Planning Schools Conference (Online), hosted by Technical University Dortmund, Germany. 18-20 November 2021.

Matamanda, A. & Nel, V. 2021. *The Public Transport and Land Use Planning Nexus: The Case Harare, Zimbabwe and Bloemfontein, South Africa.* Paper delivered at the International Geography Union (IGU) conference, hosted by Istanbul University (Online). 17-21 August 2021.

Minnie, S. & Nel, V. 2021. *Can the District Development Model Deliver Development?* Paper delivered at the International Geography Union (IGU) Geography of Governance Conference hosted by Adam Mickiewicz University, Poznań, Poland (Online). 23-24 June 2021.

Stewart, T. 2021. *The impact if Covid-19 on the prevalence of Guerilla Urbanism in the Mangaung Metro.* Paper delivered at the Human Settlements and Housing African Regional Conference (Online). 27-29 October 2021.

STAFF (2021)

Head of Department:

Prof MM Campbell

Professor:

Prof VJ Nel

Associated Professor:

Prof MM Campbell

Senior Lecturers:

Dr KS Mocwagae, Dr TN Mphambukeli and Mr T Stewart

Lecturers:

Dr HJ Booysen (Contract), Dr SP Denoon-Stevens, Mrs L Leboto-Khetsi (Contract), Ms A Mgwele and Mr MD Mokoena (Contract)

Programme Director:

Dr KS Mocwagae

Research Associates:

Prof I Chirisa, Dr SP Denoon-Stevens (from 1 December 2021) and Prof JJ Steÿn

Senior Assistant Officer:

Mrs S Rammile

Secretary:

Ms MC Hugo

NATURAL SCIENCES

Department of
CHEMISTRY

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OVERVIEW OF 2021

The Department of Chemistry continued to focus on the strategic priorities of the University of the Free State (UFS) and the Faculty of Natural and Agricultural Sciences. The Department is spread over the three UFS campuses, with the South Campus concentrating on the extended BSc programme, with 254 students in total. The Qwaqwa Campus caters for 230 local residential students and specialises in Polymer Science research, while the Bloemfontein Campus teaches approximately 700 undergraduate students and conducts research in all four classic divisions in Chemistry, namely Analytical, Inorganic, Organic and Physical Chemistry. In 2021, the postgraduate students on the Bloemfontein Campus included 11 Honours, 31 MSc and 31 PhD students, as well as 9 Postdoctoral associates from India, Nigeria, Sudan, Ethiopia, Morocco, Spain and Cameroon. The Qwaqwa Campus hosted 3 Honours, 13 MSc and 2 PhD students and 1 Postdoctoral associate.

The 2021 academic year was very challenging with all the restrictive measures due to the COVID-19 pandemic, compounded by student unrest at the beginning of both semesters, as well as the disruptive riots in the country. Limited face-to-face contact was maintained with the first- and second-year groups, while full contact sessions were held with the third-year and Honours students. All the second semester modules were formally assessed under controlled conditions, while between 90 and 100% of all the practical modules were successfully completed. The electronic teaching material was successfully utilised during the extended periods of student unrest, the riots as well as the ever-changing COVID lockdown levels. The impact of the blended teaching approach in 2020 was evident in the poor through-put rate of the students in 2021, clearly indicating a lack of knowledge and skills needed in the progressive nature of the Chemistry modules.

I would like to acknowledge our personnel for their sacrifice and their commitment, as well as loyalty which ensured the successful completion of the 2021 academic year. During this period, we also succeeded in producing 95 accepted publications in international accredited journals, while three PhD and ten MSc students graduated from the Department.

The continued contribution and support of all personnel in the Department of Chemistry, the Dean's Office and the Faculty are gratefully acknowledged.

ACHIEVEMENTS

Staff Achievements

In Inorganic Chemistry, during February 2021 both Alice Brink and Johan Venter were promoted to Associate Professor.

Prof Brink continued as a fellow of the South African Department of Higher Education and Training: Future Professors Programme (FPP). She was chosen from 130

nominations from all disciplines and 26 universities and was one of three from the UFS identified to participate during the first call in 2020. Prof Brink serves on the editorial board of Taylor & Francis Group for the journal *Crystallography Reviews*. She was invited to serve as a member of the South African National Committee for International Union of Crystallography (IUCr) and is an invited member of the Committee of Data (CommDat) for the IUCr. Prof Brink served as a Microsymposia Session Chair at the 25th General Assembly and Congress of the International Union of Crystallography held in Prague during 2021.

A visualisation image of the research publication of the Conradie research group was placed on an inside front cover of the journal *Dalton Transactions* (2021, 50:12843), and two papers from the Roodt group were reflected as front cover publications from the Royal Society of Chemistry journals *Dalton Transactions* (2021, 50: 1750), and *Inorganic Chemistry Frontiers* (2021, 8: 4313). A visualisation image of the research publication of Prof Elizabeth Erasmus and Dr Eleanor Müller was featured on the front cover of volume 204 of the journal *Polyhedron*.

Prof Jeanet Conradie and Prof Lyudmila Moskaleva organised the FreeStatePhyChem-2021 Symposium, held at the UFS on 28 October 2021.

Prof Karel von Eschwege received an NRF C-rating in 2021.

Student Achievements

Ms Hannah van Dyk, from the Inorganic Division, was awarded the James Moir Medal for 2021 by the South African Chemical Institute for being the best BSc Honours student in Chemistry during 2020 at the UFS. She was also awarded the Cambridge Crystallographic Data Centre Poster Prize for her presentation at the ePCCr: Pan African Conference on Crystallography in November 2021.

Five students from the Department of Chemistry participated in the South-African Academy for Science and Arts student symposium in Natural Sciences (Studentesimposium in die Natuurwetenskappe 2021). Ms Leandri Liebenberg and Mr Francois de Beer both won first place for the best oral presentation in their sessions, and Ms Melanie Visser was awarded second place for the oral presentation in her session. Mr Christo van Staden won second place for his presented talk at this symposium.

Refilwe Mogale (Langner group) received the second prize for best student speaker at the International FreeStatePhyChem-2021 Symposium.

Bathabile Makhathini (Marais group) won the Faculty of Natural and Agricultural Sciences Flash Fact Competition for MSc students, and Emmie Chiyindiko (Conradie group) won the PhD category and went on to win the prize for the University Flash Fact Competition. She was awarded second place in the 'Breakthrough of the year in the emerging talents category' at the Falling Walls Science Summit, held in Berlin from 7 to 9 November 2021, for her talk 'Breaking the walls of darkness'.

Participants at the South-African Academy for Science and Arts student symposium in Natural Sciences, from the left, Carla Jacobs, Leandri Liebenberg (first place), Francois de Beer (first place), Ursula Oosthuizen and Melanie Visser (second place)

TEACHING AND LEARNING

The lecturers in the Department of Chemistry successfully completed all 43 modules presented on the three campuses in 2021. The averages and pass rates for all the modules were lower than previous academic years, which can be attributed to the challenges of the COVID-19 pandemic, as well as student unrest in the previous academic years. Limited face-to-face contact was maintained with the first- and second-year groups, while full contact sessions were held with the third-year and Honours students. All the second semester modules were formally assessed under controlled conditions, while almost all of practical modules were successfully completed. The electronic teaching material was successfully utilised during the extended periods of student unrest and the riots, as well as the ever-changing COVID-19 levels.

During 2021, the teaching of Chemistry modules on the South Campus was managed by Dr Rina Meintjes, assisted by three fulltime facilitators, Dr Maretha du Plessis, Dr Bernadette van Tonder and Ms Christelle de Klerk. They also managed the Chemistry first-year Extended Programme teaching activities for 143 students on the Qwaqwa Campus. A total of 254 students enrolled at the beginning of 2021 for the first-year Chemistry modules for the BSc Extended Programme. Ms Lydia Siegert acted as laboratory manager of the multi-disciplinary laboratory on the South Campus and trained the South Campus students in the practical aspects of Chemistry.

Teaching on the Qwaqwa Campus involves the theory and practical aspects of all four classic Chemistry disciplines, from the first- to the third-year, for approximately 66 first-year students, 48 second-year students and 53 third-year students. At the beginning of 2021, 90 new students were enrolled for the first-year Chemistry modules for the BSc Extended Programme on the Qwaqwa Campus. The Honours

course had an enrolment of three students, which involved the teaching of subjects applicable to Polymer Science.

The Inorganic Chemistry Division is headed by Prof Deon Visser, the Physical Chemistry Division by Dr Ernie Langner, the Analytical Chemistry Division by Prof Karel von Eschwege and the Organic Chemistry Division by Dr Susanna Bonnet.

RESEARCH AND INNOVATION

Analytical Chemistry Division

Prof Karel von Eschwege (NRF C2-rating) continued his main field of research in aspects of photochromic and photo-catalytic compounds with potential applications in sensors of diverse kinds, and in the renewable energy sector where these dye compounds are used as, amongst others, photocatalysts in the electro-photoreduction of H_2O or CO_2 to H_2 or CO. In a related field, he started supervising a PhD project in collaboration with the University of Pretoria, investigating various aspects of pollution and greenhouse gases. In order to seek more affordable pharmaceuticals for both animal and human applications, his group did extensive syntheses of various anaesthetics and new related more potent derivatives.

Dr Rebotsamang Shago is involved in the synthesis of tetraphenylporphyrin-silicon conjugates for the removal of selected heavy metals in contaminated water.

The other part of the Analytical Chemistry Division is managed by ***Prof Walter Purcell***, under whose leadership the group focused on several analytical and hydrometallurgical projects. The analytical projects relate to method development and validation of analytical processes of target elements. The hydrometallurgical studies include the dissolution, quantification, separation and isolation of target elements of economic value and included minerals such as zircon, tantalite, ilmenite monazite and UG2 platinum group element (PGE) ores. These projects are conducted in collaboration with industrial partners, such as Kumba Iron Ore. The group also investigated the recovery of valuable elements from mine tailings, auto catalysts and, more recently, recovery of Co and Li from spent batteries.

Inorganic Chemistry Division

The Inorganic Chemistry Division consists of several research groups which are independently managed by Prof Deon Visser (C2-rated), Prof André Roodt (B2-rated), Prof Johan Venter, Prof Alice Brink (Y1-rated), Dr Marietjie Schutte-Smith (Y-rated) and Dr Dumisani Kama. The research is supported by Dr Pennie Mokolokolo as Chief Officer – Professional Services.

The ***Roodt Research Group*** focuses on Coordination Chemistry and the integrated investigation of 'reaction mechanisms' through the use of crystallography, spectroscopy, computational chemistry and reaction kinetics. Four sub-research thrusts probe the applications to medicine (radiopharmaceutical and chemotherapeutical), industrial reactions / homogeneous catalysis / applied process chemistry, the development of metal beneficiation technology, and coordination chemistry in the environment. This research was supported by grants under the Swiss-South Africa Joint Research Programme (SSAJRP) (2017-2021), NRF Competitive Programme for Rated Researchers (CPRR) and Unrated Researcher Programmes, and Sasol.

The ***Brink Research Group*** conducts research on radiopharmaceutical drug development, incorporating the interoperable usage of chemical and macromolecular crystallography, as well as research within the field of homogeneous catalysis. The research was supported by grants from Sasol, NRF and the UFS-CUT Interdisciplinary Grant in collaboration with the Central University of Technology (CUT). Students from the Brink group attended and presented research posters at the ***CCP4 Crystallographic School: Data Collection to Structure Refinement and Beyond*** (Digital Conference), at the University of Cape Town during February 2021. The research group was allocated four hours of synchrotron beam time at the DIAMOND Light Source, UK, for their research thrust.

Physical Chemistry Division

The Physical Chemistry division is divided into six distinct and separate research groups which are led by Prof Jannie Swarts, Prof Jeanet Conradie, Prof Lyudmila Moskaleva, Prof Lizette Erasmus, Dr Ernie Langner and Dr Eleanor Müller.

The ***Swarts Research Group*** researched gold-metallocene complexes intended for heterogeneous catalysis, in collaboration with Syngaschem BV at the Dutch Institute for Fundamental Energy Research (DIFFER), located at Eindhoven University of Technology in the Netherlands. Kinetic studies involving the reduction of nickel and copper tripeptides with complex cyanides of iron, tungsten and molybdenum, were conducted. Ferrocene-containing phthalocyanines with liquid crystalline properties and polymers with biomedical applications were studied. Prof Swarts received an international research award from Syngaschem BV and he also held an NRF Rated Researcher grant.

The ***Condradie Research Group*** consisted of two Postdoctoral Fellows, two PhD students and two MSc students. Their research focused on the synthesis, characterisation, computational chemistry, electrochemistry, kinetics etc. of ligands, transition metal complexes, transition states and reaction-intermediates for application in drugs, dye-sensitized solar cells (DSSC), catalysis etc.

Prof Moskaleva's research is focused on surface reactivity of solids at the atomic level using first-principles quantum-chemical methods, molecular dynamics, statistical theory, microkinetic modelling and thermodynamics. Currently,

computational studies are directed to chemocatalysis with two groups of heterogeneous catalysts, gold-based alloys and rare-earth oxides, and electrocatalysis (oxygen reduction reaction and CO_2 reduction). Recently, a new direction was started on the mechanistic studies and modelling of rate constants of combustion reactions. Prof Moskaleva received an NRF grant for 2021-2023 within the International Research Grant – South Africa / India joint Science and Technology Research Collaboration for her project 'Extremely Large-Scale Modelling of Elementary Processes in Hydrocarbon Combustion using High-Throughput Atomistic Simulations and Data Science', which will be undertaken in collaboration with the group of Prof R Ramakrishnan from Tata Institute of Fundamental Research in Hyderabad, India. Prof Moskaleva also continued a collaborative project within the Nonporous Gold Catalysts (NAGOCAT) Research Unit, funded by the German Research Foundation (DFG).

Prof Lizette Erasmus and her group focus their research on materials science and heterogeneous catalysis. In 2022, three main projects were conducted – on Grubb's catalyst investigations on stability, electrochemical characterisation, Morphology controlled nanocrystals as model heterogeneous catalysts, and Iron supported on nano-silica for fixation.

Dr Ernie Langner's research focused on two distinct series of Framework Materials. The Aluminium, Titanium- and Zirconium-based carboxylate metal organic frameworks were found to be photo catalytically active in the degradation of contaminant dyes in wastewater. The nano-sized Zn- and Co-based zeolitic imidazolate frameworks (ZIFs) were chemically altered to achieve record-high CO_2 adsorption. Some of these derivatives also showed high catalytic performance in the fixation of CO_2 to form cyclic carbonates. A series of metal exchanged ZIFs showed good photocatalytic activity in the adsorption and degradation of contaminant dyes in wastewater. Another ZIF derivate showed promising results as a drug-carrier.

Dr Eleanor Müller's research concentrates on anti-cancer agents and the synthesis of possible chemotherapeutic drugs. Possible anti-cancer drugs in the form of polymers, nano-particles and organometallic compounds have been newly synthesised. Her research also includes a cell-culture lab, and all newly synthesised compounds are tested in-house for anti-cancer activity. Cell-line testing is also performed for other researchers in the Department and the University.

Organic Chemistry Division

The Organic Chemistry division consists of three distinct research directions – Phytochemistry (Dr Susanna Bonnet and Dr Anke Wilhelm), Homogenous catalysis (Dr Charlene Marais), and supramolecular chemistry (Prof Vladimir Azov).

In the ***Phytochemistry Group,*** Dr Bonnet investigated the development of commercial drugs and phytomedicines from indigenous knowledge to treat and sedate patients suffering from psychotic diseases. Access to bioassays through ChanPharm, an Austrian pharmaceutical company, to identify GABA(A) modulators, continued to offer an ideal opportunity to investigate African traditional medicine used to treat psychosis, to provide scientific explanations for their efficacy, identify the active molecules involved, and develop phytomedicines and commercial antipsychotic drugs. In addition, investigations into groups of synthetic compounds with GABAergic and other biological activities, are in progress. In collaboration with the wattle industry, Dr Bonnet is also running projects on the investigation of black wattle bark extract (sulfomethylation, aminometylation, sulfitation, carboxylation, etc.).

Dr Wilhelm manages the zebrafish bioassay in the Department of Chemistry. Her main research focus is on the isolation of active GABAergic compounds utilising a larval zebrafish locomotor bioassay. The established collaboration with ChanPharm investigates the GABAergic activity of South African botanicals in the search of novel anti-epileptic drugs.

The ***Marais group*** focuses on homogeneous catalysis (e.g. olefin metathesis, transfer hydrogenation, the Sonogashira reaction, Heck reaction, carbonylation) in the synthesis of flavonoids, stilbenoids and other compounds with potential biological activities.

Projects of the group of ***Prof Azov*** cover the broad area of supramolecular chemistry, molecular self-organisation, and redox- and light-controllable molecular receptors, devices and materials. The current project involves the synthesis of redox-active tetrathiafulvalene derivatives and of non-canonical amino acids with donor and acceptor groups. Prof Azov is also involved in collaborative projects aimed at the study of weak interactions in molecular crystals, investigation of complex formation and gas phase reactivity using methods of mass spectrometry, and development of stereoselective heterogeneous catalysts.

Other Research Activities

Dr Linette Twigge, as Manager of the Nuclear Magnetic Resonance (NMR) facility, contributes to the research within all the groups in the Department of Chemistry by implementing new NMR techniques to advance their research. She assisted more than 20 postgraduate students from the different research groups with delicate and advanced multi-nuclear NMR experiments.

In August 2021 a new research group was established to concentrate on commercial projects. The unit is headed by Dr Anwar Noreljaleel and Dr Az-Eddine El Mansouri was appointed as a Postdoctoral Fellow. A collaboration with Insect Science in Tzaneen, Limpopo, was established.

ENGAGED SCHOLARSHIP

Most members of the Department acted as external reviewers for various chemistry journals and for the NRF, and served on Faculty and UFS committees, while others made their contributions as external examiners for several universities at undergraduate and postgraduate levels and represented the UFS on international research councils.

Dr Kama, supported by the Crystallographic Team (PhD student FJF Jacobs) presented the UFS Crystallographic Refinement School to postgraduate students from Chemistry and Biochemistry.

Prof Swarts acted as reviewer for articles in *Organometallics*, *Inorganic Chemistry* and *Inorganica Chimica Acta*.

Prof Purcell acted as reviewer for articles in *Hydrometallurgy*, *Arab Journal of Chemistry* and the *Journal of Minerals*. He also acted as external examiner for some Chemistry modules from the University of Fort Hare and Nelson Mandela University.

Dr Shago served on the NRF panel of reviewers for Chemistry and Material Sciences.

Prof Brink acted as a reviewer for *Acta Crystallographic A*, *Journal of Coordination Chemistry, and she serves on the Editorial Board for Crystallographic Reviews*. Prof Brink was invited by the NRF as a panel member reviewer for NRF-Thuthuka funding applications.

Prof Von Eschwege served as reviewer for various Elsevier and RSC journals, as external examiner of overseas PhD theses, and reviewed NRF funding applications for projects across the entire renewable energy domain. Due to his expertise, he serves in a constant advisory capacity to companies in the renewable energy sector.

Dr Langner was reviewer for NRF-rating applications. He also reviewed an article and acted as examiner for an MSc thesis.

Prof Swarts contributed to a book chapter on 'Fundamentals and applications in solution-phase electrochemistry and electrocatalysis' in *Applications of Porphyrinoids as Functional Materials*.

Prof Conradie acted as a reviewer for several international journals and served as the Physical Chemistry Editor for the *South African Journal of Chemistry*. She is also a member of the South African Chemical Institute (SACI), Academy of Science of South Africa (ASSAf), International Society of Electrochemistry (ISE) and Society of Porphyrins and Phthalocyanines (SPP). Prof Conradie also served as a reviewer for the NRF for student, funding and rating applications.

The Department of Chemistry held an International FreeStatePhyChem Symposium Online on 28 October 2021, organised by Prof Conradie and Prof Moskaleva. The symposium was aimed at fostering interest and engagement of students in physical chemistry research. The Physical Chemistry students and postdocs delivered several oral presentations, followed by lively discussions. The best presentations were honoured by award certificates. Also see the Symposium web page at fb.me/FreeStatePhyChem.

Students and staff from the Physical Chemistry Division during the FreeStatePhyChem Online Symposium

Prof Moskaleva acted as a reviewer for *Nano Research, ACS Omega, Chemical Engineering Science, ChemPhysChem, Physical Review Materials,* and *The Journal of Physical Chemistry*. She also serves on the Editorial Board of *Reports*.

Dr Müller acted as a reviewer for articles in *Inorganica Chimica Acta*, *Inorganic Chemistry*, *Transition Metal Chemistry* and *Journal of Electroanalytical chemistry*. She also made contributions as external examiner for other universities at postgraduate levels, and regularly acted as reviewer for NRF.

Prof Azov and Dr Marais organised the Virtual International Organic Chemistry Symposium, hosted by the UFS on 15 June 2021. Ten UFS postgraduate students and all staff members from the Organic Chemistry Division delivered oral presentations. Several renowned chemists from South Africa and abroad contributed to the symposium.

Prof Azov was also involved in the evaluation of several NRF rating and grant applications, and served on the editorial board of *Mendeleev Communications*

Dr Bonnet was selected as a member of the new SACI Organic Chemistry Committee.

Dr Wilhelm was invited by the NRF to act as a panel member in the five-year evaluation of a South African Research Chairs Initiative (SARChI) Chair.

Members of the Organic Chemistry Division acted as reviewers for the following internationally acclaimed journals: *Journal of Natural Products* (Prof Bezuidenhoudt, Dr Bonnet, Dr Wilhelm and Dr Marais), *Journal of Organic Chemistry* (Prof Azov and Prof Bezuidenhoudt), *Phytochemistry* (Dr Bonnet), *Phytochemistry Letters* (Dr Bonnet, Dr Marais and Dr Wilhelm), *Natural Product Communications* (Dr Wilhelm) *Chemistry – A European Journal* (Prof Azov), *Molecules* (Prof Azov), *International Journal of Mass Spectrometry* (Prof Azov), *Mendeleev Communications* (Prof Azov).

NATIONAL AND INTERNATIONAL COLLABORATION

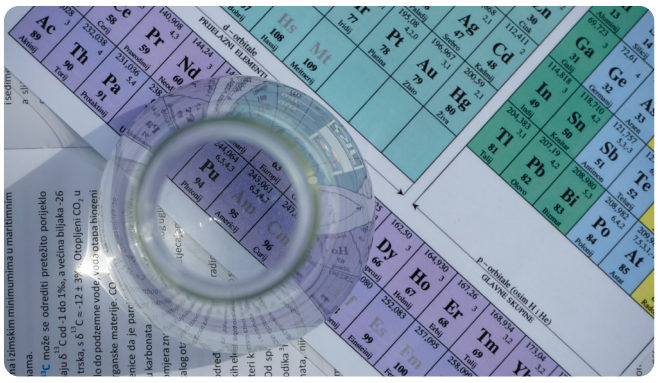
Prof Von Eschwege continued collaborating with the Laser Research Institute at the Physics Department at Stellenbosch University (femtosecond laser spectroscopy), Department of Chemistry at the University of Pretoria (Langmuir-Blodgett single molecular layer thin films) and their medical faculty (fine particulate matter in atmospheric pollution), together with universities in Sweden.

Prof Visser and Dr Schutte-Smith focus part of their research on the development of anti-cancer and anti-bacterial compounds involving metals such as gold, silver and rhenium. For this research they collaborate with Dr Gilles Gasser from ParisTech, France, Prof Justin Wilson, Cornel University, USA, Prof Tshepiso Makhafola of CUT, Bloemfontein, and Prof Olihile Sebolai, from the UFS Department of Microbiology and Biochemistry.

The Roodt Group's research on medical aspects of pharmaceutical model compounds, in collaboration with Prof Roger Alberto (University of Zürich, Switzerland) and Dr Gerdus Kemp (PET Laboratories and Klydon, South Africa) continued during 2021. Similarly, the group's collaboration on model homogeneous catalysts continued with Prof Vadim Boyarskiy from the State University of Saint Petersburg, Russia, and Dr Fanie Otto, from Sasol. In addition, the research on environmental chemistry, i.e. hydrogen generation and carbon dioxide utilisation, in collaboration with Prof Roger Alberto (University of Zürich, Switzerland), proceeded very well. Prof Roodt continued collaboration with Prof Houcine Naili from the University of Sfax in Tunisia, and with Prof Felix Zelder, from the University of Zürich, on reaction mechanisms on chemosensing, co-supervising a Swiss PhD student.

Prof Brink continued her long-standing collaboration with Prof John Helliwell from the University of Manchester. Additional collaborators involved in the research project include Dr Louise Natrajan (University of Manchester), Dr Simon Tanley (University of Manchester), Dr Colin Levy (Manchester Institute of Biotechnology), Prof Dirk Opperman (Biochemistry, UFS) and Prof Ted Kroon (Physics, UFS). A collaboration with the UFS Department of Pharmacology, the University of Pretoria and the University of Missouri, is ongoing as well as an interdisciplinary collaboration with Prof T Makhafola (CUT).

Prof Conradie collaborated nationally with Prof M Landman and Dr Maland (both of the University of Pretoria), Dr Gurthwin Bosman and Dr Christine M Steenkamp (Laser Research Institute, Stellenbosch University) and Dr CGCE van Sittert (North-West University). She also collaborated internationally with Prof Abhik Ghosh (Department of Chemistry and Centre for Theoretical and Computational Chemistry, University of Norway), Zachary Tonzetich (University of Texas at San Antonio, USA), Prof Penny Brothers (University of Auckland, New Zealand), Prof JH Potgieter (University of the Witwatersrand (Wits) and Manchester Metropolitan University, Manchester, UK), Karl M Kadish (University of Houston, USA), Carl Wamser (Portland State University, USA), Todd Harrop (University of Georgia, USA), Prof Elisa Tomat (University of Arizona, USA), Prof Sanjib Kar (National Institute of Science Education and Research and Homi Bhabha National Institute, India), Dr Jean Jules (Fifen University of Ngaoundere, Cameroon) and Prof Fridolin Nya Tchangnwa (University of Maroua, Cameroon).



Prof Moskaleva continued international collaboration with researchers from NAGOCAT. Joint online workshops were held in March, June, September and December 2021. She also started collaborative research with Prof R Ramakrishnan from Tata Institute of Fundamental Research in Hyderabad, India, funded jointly by NRF and DST (India), on combustion chemistry and data science.

Prof Erasmus collaborated with Prof Hans Niemandtsverdriet from Syngaschem BV at DIFFER (SynCat@DIFFER) in the Netherlands, working on Frustrated Lewis Pairs. Prof Swarts, Dr Müller and Dr Langner (on CO_2 adsorption) also collaborated with Prof Niemandtsverdriet. Dr Langner maintained a national collaboration with Dr Kobus van der Walt (CUT) on the development of polypropylene powders for laser sintering.

The Marais/Bezuidenhoudt group collaborated with Chemical Process Technologies, Pretoria, Wildlife Pharmaceuticals, Nelspruit, and with PETLabs Pharmaceuticals, on the analysis and synthesis of compounds with medical applications.

Dr Bonnet and Dr Wilhelm continued collaboration with Prof Steffen Hering from ChanPharm. They also collaborated with Dr Leon van Kralingen from the Wattle Industry, Pietermaritzburg, on projects involving the derivatisation of wattle tannin extracts for industrial applications, and with Dr Richard Burghoff from the Institute for Commercial Forestry Research, University of KwaZulu-Natal, through a grant received from the Forestry Sector Innovation Fund). Dr Bonnet and Dr Wilhelm also collaborated with Dr Chika Chukwuma from CUT, on anti-diabetic phytomedicines and synthetic molecules.

Prof Azov started a new collaboration with Prof Ulrich Hennecke of Vrije Universiteit Brussel in Belgium, funded by the joint NRF/FWO (Research Foundation – Flanders) grant, aimed at the synthesis of unnatural amino acids containing tetrathiafulvalene electron donors and various electron accepting groups for materials and biomedical applications. He also participated in a large international collaboration involving scientists from several universities (University of Leipzig, Purdue University, Pacific Northwest National Laboratory [PNNL]) related to the gas phase chemistry of dodecaborates, and with Dr M Zeller (Purdue University) / Prof Vande Velde (University of Antwerp) on crystallography of organic molecules.

Prof Purcell collaborated with Prof Herman Potgieter from the School of Chemical and Metallurgical Engineering at Wits, where he is also a visiting professor, and with Prof Hendrik Swart from the UFS Department of Physics, Ms Justine Magson, from the UFS Department of Geology, Kumba Iron Ore and various industrial partners.

Prof Purcell, Dr Alba Gómez-Arias (Postdoctoral Fellow) and Dr Julio Castillo Hernandez UFS (Microbiology and Biochemistry) successfully submitted an ERAMIN3 application to the European Commission (EU) Horizon Europe. The research, to extract REE from mine tailings using chemical and micro-biological processes, will be undertaken in collaboration with researchers from Chile, Spain and Portugal.

Members of the Organic Division and the Head of Department, Prof Purcell visited the headquarters of Insect Science in Tzaneen, on 8 and 9 November 2021. Insect Science is a research-oriented company developing and manufacturing innovative products for eco-friendly pest-management solutions, which allow the production of environmentally safe crops without harmful chemical residues. During the visit, research collaborations were discussed and established. As part of this collaborative agreement, Insect Science will sponsor three PhD bursaries at the UFS.

Visit to the headquarters of Insect Science in Tzaneen, Limpopo Province, from the left, Dr Anwar Noreljaleel (UFS), Dr Susan Bonnet (UFS), Dr Anke Wilhelm (UFS), Me Toffy (IS), Prof Walter Purcell (UFS), Mr Gerhard Booysen (IS), Mr Rudi Swart (UFS), Prof Vladimir Azov (UFS), Dr Az-Eddine El Mansouri (UFS), Dr Divan van Greunen (IS), Dr Marc Bouwer (IS) and Dr Charlene Marais (UFS)

OTHER ACTIVITIES

Prof Swarts oversaw the large equipment programme of the Faculty of Natural and Agricultural Sciences, a extensive task that he fulfilled with perseverance and commitment. For the Chemistry Department a new DSC and TGA were acquired.

The Inorganic Division named their X-ray diffraction laboratory after Prof Andreas Roodt to acknowledge his huge contributions in this field, both locally and internationally. A small function was held to abide by COVID-19 regulations. The X-ray diffractometer, obtained through funding from the NRF-NEP Research Grant, was successfully transferred from Prof Roodt to Prof Brink as grantholder. Dr Dumisani Kama manages the NRF-NEP X-ray Crystallographic facility.

The SA Precious Metal Permit is also managed by the Inorganic Division (Prof Brink) on behalf of the University.

Prof Roodt acted as session chair at the 25th General Assembly and Congress of the International Union of Crystallography, held in Prague in August 2021, and co-organised the virtual Swiss-SA meeting with Prof Roger Alberto during May 2021.

The dedication ceremony of the Roodt XRD Laboratory. From the left, Prof Danie Vermeulen (Dean), Prof Walter Purcell, Prof Andreas Roodt and Prof Hendrik Visser

POSTGRADUATE STUDENTS

Eleven (11) Honours, 31 MSc and 31 PhD students enrolled in the Department of Chemistry on the Bloemfontein Campus in 2021.

Nine MSc students graduated in 2021 – A Davies, J Kuhn, C van Staden, Z Xantini, L Parrot (Nanoscience), JTR Fiekkies (Nanoscience), GH Erasmus, NGS Mateyise (*cum laude*), KS Dhlamini (Nanoscience).

The PhD was conferred on the following students in 2021:

Muller, Kina Ann

Thesis:	A solid state and kinetic study of bidentate oxygen donor complexes of copper
Supervisor:	Prof A Roodt

Janardhana, Divya

Thesis:	Synthesis, characterization, luminescence and photocatalytic properties of undoped and rare earths doped Bi203
Co-Supervisor:	Prof W Purcell

Nkoe, Pheello Isaac

Thesis:	Photoluminescence and structural evaluation of O,O' and N,N' Bidentate Ligands and its Re(I) Tricarbonyl complexes
Supervisor:	Dr M Schutte-Smith

POSTDOCTORAL RESEARCH FELLOWS

The Department of Chemistry hosted seven Postdoctoral Fellows in 2021:

- Dr Orbett Alexander (South Africa)
- Dr Mohammed Abdelaziz Elkhidir Elmakki (Sudan)
- Dr Blener Buitendach (South Africa)
- Dr Okikiola Olaniyan (Nigeria)
- Dr Alhadji Malloum (Cameroon)
- Dr Kovo Akpomie (Nigeria)
- Dr Alba Gomez-Arias (Spain)
- Dr Dilip Rajak (India)
- Dr Az-eddine El Mansouri (Morocco)

Kovo Akpomie (from the Conradie group) won first prize for best student speaker at the International FreeStatePhyChem-2021 Symposium, hosted by the UFS on 28 October 2021.

STAFF MATTERS

Dr Orbett Alexander was appointed as Lecturer in Inorganic Chemistry and Dr Motshabi Sibeko as Lecturer in Analytical Chemistry at Qwaqwa Campus.

Ms Mpho Mathebula was appointed as Officer in the Analytical Department of the Bloemfontein Campus and Dr Anwar Noreljaleel as Researcher in the Organic Chemistry Division. Ms Lydia Siegert was appointed as Lab Manager on the South Campus.

Prof Andreas Roodt, Distinguished Professor in the Department of Chemistry, retired on 31 December 2021. In honour of his work of more than 35 years, the Inorganic Chemistry Division recently unveiled the Roodt Crystallographic Laboratory (Roodt XRD Lab). Prof Roodt has authored more than 330 research articles and supervised 54 MSc and 38 PhD students.

Prof Jannie Swarts and Prof Jeanet Conradie both retired at the end of 2021 after long years of service.

From the left, Prof Jannie Swarts, Prof Andreas Roodt and Prof Jeanet Conradie

Mrs Ina du Plessis retired at the end of February 2021. She was replaced as professional officer for Physical Chemistry by Dr Marianne Conradie.

Dr Linette Twigge, Lecturer on the Bloemfontein Campus, resigned in October 2021 and moved to FARMOVS, and Dr Mpondi Molefe, Lecturer at the Qwaqwa Campus, resigned in 2021 and moved to Rhodes University.

RESEARCH OUTPUTS

Research Articles

Abraha, Y.W., Tsai, C.W., Niemantsverdriet, J.W. & Langner, E.H.G. 2021. Optimized CO_2 Capture of the Zeolitic Imidazolate Framework ZIF_8 Modified by Solvent-Assisted Ligand Exchange. *ACS Omega* 6 (34): 21850-21860.

Adeleke, V.T., Adeniyi, A.A., Adeleke, M.A., Okpeku, M. & Lokhat, D. 2021. The Design of Multiepitope Vaccines from Plasmids of Diarrheagenic Escherichia Coli against Diarrhoea Infection: Immunoinformatics Approach. *Infect. Genet. Evol.* 91: 104803.

Adeleke, V.T., Adeniyi, A.A. & Lokhat, D. 2021. Coagulation of Organic Pollutants by Moringa Oleifera Protein Molecules: In Silico Approach. *Environ. Sci. Water Res. Technol.* 7: 1453-1464.

Adeniyi, A. & Conradie, J. 2021. Exploring substituents and solvent effects on the reduction potential and molecular properties of five derivatives of hydroxybenzophenone (HBP) in relation to their possible conformations and isomers. *Structural Chemistry* 32: 1299-1310.

Adeniyi, A., Conradie, J., Fukae, R., Yoshimura, M., Nishinari, K. & Lawal, O. S. 2021. Enhancing the loading and swelling capacity of cellulose crystal through difunctional and multifunctional epoxyl cross-linkers and the effects on the elasticity and plasticity: A computational study. *Journal of Molecular Structure* 1228: 129436.

Adeniyi, A.A., Landman, M. & Conradie, J. 2021. Mo Fischer carbene complexes: A DFT study on the prediction of redox potentials. *Journal of The Electrochemical Society* 168: 066523.

Adeniyi, J.N., Adeniyi, A.A., Moodley, R., Nlooto, M., Ngcobo, M., Gomo, E. & Conradie, J. 2021. Unravelling the drugability of MSI2 RNA recognition motif (RRM) protein and the prediction of their effective antileukemia inhibitors from traditional herb concoctions. *Journal of Biomolecular Structure & Dynamics* 40(6): 2516-2529.

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Amaku, J.F., Nnaji, J.C., Ogundare, S.A., Akpomie, K.G., Ngwu, C.M., Chukwuemeka-Okorie, H.O., Zubairu, S.M., Zubairu, S.M., Ugwu, B.I., Odoemelam, S.A. & Conradie, J. 2021. Chrysophyllum albidum stem bark extract coated tillite adsorbent for the uptake of Cr(VI): Thermodynamic, kinetic, isotherm and reusability. *Biomass Conversion and Biorefinery* (Online). DOI: 10.1007/s13399-021-01489-8.

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Amaku, J.F., Ogundare, S.A., Akpomie, K.G., Ngwu, C.M. & Conradie, J. 2021. Sequestered uptake of chromium (VI) by Irvingia gabonensis stem bark extract anchored silica gel. *Biomass Conversion and Biorefinery* (Online). DOI: 10.1007/s13399-021-01563-1.

Amaku, J.F., Ogundare, S.A., Akpomie, K.G. & Conradie, J. 2021. Pentaclethra macrophylla stem bark extract anchored on functionalized MWCNT-spent molecular sieve nanocomposite for the biosorption of hexavalent chromium. *International Journal of Phytoremediation* 24(3): 301-310.

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Akpomie, K. & Conradie, J. 2021. Ultrasonic aided sorption of oil from oil-in-water emulsion onto oleophilic natural organic-silver nanocomposite. *Chemical Engineering Research and Design* (Official journal of the European Federation of Chemical Engineering) Part A (165): 12-24.

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Akpomie, K.G., Ghosh, S., Gryzenhout, M. & Conradie, J. 2021. One-pot synthesis of zinc oxide nanoparticles via chemical precipitation for bromophenol blue adsorption and the antifungal activity against filamentous fungi. *Scientific Reports* 11: 8305.

Alemayehu, A.A., McCormick-McPherson, L.J., Conradie, J. & Ghosh, A. 2021. Rhenium Corrole Dimers: Electrochemical Insights into the Nature of the Metal–Metal Quadruple Bond. *Inorganic Chemistry* 60 (11): 8315-8321.

Alemayehu, A.B., Vazquez–Lima, H., Conradie, J., Martinsen, S.R. & Ghosh, A. 2021. Heavy-element-ligand covalence: ligand noninnocence in molybdenum and tungsten Viking-helmet Corroles†. *Dalton Transactions* 50:12843 [Inside front cover of journal].

Alexander, O.T., Alberto, R. & Roodt, A. 2021. The crystal structure of cis-diaqua-bis (N-butyl-N-(pyridin-2-yl) pyridin-2-amine-k^2N, N^1) cobalt (II)] dichloride trihydrate, $C_{28}H_{44}Cl_2N_6O_5Co$. *Z. Kristallogr. NCS* 236: 1065-1068.

Alexander, O., Duvenhage, M.M., Kroon, R.E., Brink, A. & Visser, H.G. 2021. Comparison of a Dimeric and a Monomeric Indium-Quinolinato Complex: Synthesis, Structure and Photoluminescence. *New J. Chem.* 45: 2132-2140.

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Braband, H., Benz, M., Spingler, B., Conradie, J., Alberto, R. & Ghosh, A. 2021. Relativity as a Synthesis Design Principle: A Comparative Study of (3 + 2) Cycloaddition of Technetium(VII)-and Rhenium(VII)-Trioxo Complexes with Olefins. *Inorganic Chemistry* 60 (15): 11090-11097.

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Dennis, R.C., Van Zyl, G.J., Fourie, E., Basson, S.S. & Swarts, J.C. 2021. A kinetic study of the oxidation of the tetrakisoxalatouranate(IV) ion by the hexacyanoferrate(III) ion in an oxalate buffer medium. *Reaction Kinetics, Mechanisms and Catalysis* 132: 599-615.

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Books/Chapters in Books

Swarts, P.J. & Swarts, J.C. 2021. Fundamentals and applications in solution-phase electrochemistry and electrocatalysis in *Applications of Porphyrinoids as Functional Materials*. Chapter 1.I n: *Applications of Porphyrinoids as Functional Materials. Smart Materials*. H. Lang & T. Rueffer (Eds). Royal Society of Chemistry. pp. 1-43.

Conference Contributions

Conference Papers/Posters

Abraha, Y.W., Tsai, C–W. & Langner, E.H.G. 2021. *Rapid gram–scale synthesis of mixed–linker (Zn) ZIFs and their application in CO2 adsorption and fixation.* Paper delivered at the International FreeStatePhyChem-2021 Symposium, University of the Free State, Bloemfontein, South Africa. 28 October 2021.

Akpomie, K.G. & Conradie, J. 2021. *Experimental and DFT investigations on the ultrasonic-aided adsorption of anionic and cationic dyes onto low-temperature derived biochar.* Paper delivered at the International FreeStatePhyChem-2021 Symposium, University of the Free State, Bloemfontein, South Africa, 28 October 2021. [1st place for best student speaker].

Akpomie, K.G., Ezeofor, C.C. & Conradie, J. 2021. *ZnO nanoparticle impregnated biomass sorbent for the adsorption of celestine blue: thermodynamics, isotherm, kinetics and reusability*. Paper delivered at the 4th African Nano Conference/Workshop – Applications of Nanotechnology to Energy, Environment, Agriculture and Health, University of Nigeria, Nsukka, Nigeria. 19 -23 July 2021.

Amaku, J.F., Ogundare, S., Akpomie, K.G., Ibeji, C.U. & Conradie, J. 2021. *MWCNTs-quartzite nanocomposite coated with Dacryodes edulis stem bark extract for the attenuation of hexavalent chromium*. Paper delivered at the 4th African Nano Conference/Workshop – Applications of Nanotechnology to Energy, Environment, Agriculture and Health, University of Nigeria, Nsukka, Nigeria. 19 -23 July 2021.

Azov, V.A., Hennecke, U., Ballet, S. & Martin, C. 2021. *P–STAC: Stabilizing peptide nanoStructures with tetraThiafulvalenebased donors and Acceptors.* Invited lecture delivered at the International Organic Chemistry Symposium, University of the Free State, Bloemfontein, South Africa (Virtual Symposium) 15 June 2021.

Blignaut, J., Visser, H.G. & Schutte–Smith, M. 2021. *Crystallographic characterization of Ru(II)–PC(n)P–Au(I) bimetallic complexes with varying PC(n)P–ligands.* Poster presented at ePCCr: Pan African Conference on Crystallography Online (Virtual) , hosted by X-Tech Lab, Cotonou, Benin. 15-19 November 2021.

Bonnet, S.L. & Wilhelm, A., (Invited lecture). 2021. *In vitro screening of South African plant extracts for GABAergic activity*. Invited lecture delivered at the International Organic Chemistry Symposium, University of the Free State, Bloemfontein, South Africa (Virtual Symposium). 15 June 2021.

Bosman, L., Kama, D. & Brink, A. 2021. *Halogenated rhodium(I) complexes as model catalysts for methanol carbonylation.* Poster presented at IUCr 2021: XXV General Assembly and Congress of the International Union of Crystallography, Prague, Czech Republic. 14-22 August 2021.

Bosman, L., Kama, D.V. & Brink, A. 2021. *Schiff-ting into a greener future utilizing Rh(I) N,O model catalysts.* Poster presented at the Joint meeting of the AfLS3-2021: African Light Source and the ePCCr: Pan-African Conference on Crystallography Online (Virtual), hosted by X-TechLab, Cotonou, Benin. 15-19 November 2021.

Bouba, M.O., Nya, F.T., Malloum, A. & Conradie, J. 2021. *DFT, TDDFT and CCSD(T) predictions of electronic structure and optical properties of large molecular structures: a huge challenge for the CHPC.* Micro-talk delivered at the CHPC National Conference 2021 (Online), South Africa. 1-3 December 2021.

Brink, A. 2021. *The harvesting of small molecule structure and dynamic data for macromolecular and catalytic usage.* Invited lecture delivered at the IUCr 2021: XXV General Assembly and Congress of the International Union of Crystallography, Prague, Czech Republic. 14-22 August 2021.

Carroll, L. & Moskaleva, L. 2021. *Studying the wet and dry CO oxidation of nanoporous Au using static DFT Computations.* Poster presented at the International Conference on Theoretical Aspects of Catalysis (ICTAC) (Online Scientific Meeting), Lyon, France. 14, 22, 30 June 2021.

Carroll, L. & Moskaleva, L. 2021. *Studying the wet and dry CO oxidation of nanoporous Au using static DFT Computations.* Pre-recorded Video Poster presented at the SACI YCS2021 National Conference (Online). 8-9 July 2021.

Carroll, L. & Moskaleva, L. 2021. *Studying the wet and dry CO oxidation of nanoporous Au using static DFT Computations.* Paper delivered at the FreeStatePhyChem Symposium, University of the Free State, Bloemfontein, South Africa. 28 October 2021.

Carroll, L. & Moskaleva, L. 2021. *Studying the wet and dry CO oxidation of nanoporous Au using static DFT Computations and AIMD simulations.* Micro-talk delivered at the CHPC National Conference 2021 (Online), South Africa. 1-3 December 2021.

Chiyindiko, E. 2021. *Breaking the walls of darkness.* Paper delivered at the Falling Walls Science Summit, Berlin, Germany. 7–9 Nov 2021. [2nd place for 'Breakthrough of the year in the emerging talents category].

Chiyindiko, E. & Conradie, J. 2021. *Practical Chemistry during a Pandemic: from lab to laptop.* Poster presented at the combined conference of the International Symposium of Microscale Chemistry (ISMC2021) and the RSC Secondary and Further Education Group Conference, Practical Chemistry during a Pandemic including a microscale approach. United Kingdom (Online). 13-14 July 2021.

Conradie, J., Brothers, P. & Ghosh, A. 2021. Invited oral, *Energetics of Exotic Porphyrinoid Systems.* Invited paper delivered at the 11th International Conference on Porphyrins and Phthalocyanines (ICPP-11) (Virtual). 26 June-2 July 2021.

Conradie, J. & Swarts, P.J. 2021. *Synthesis Electrochemical and DFT Study of an Electron Rich Subphthalocyanine.* Poster presented at the 11th International Conference on Porphyrins and Phthalocyanines (ICPP-11) (Virtual). 26 June-2 July 2021.

Conradie, J. & Von Eschwege, K.G. 2021. *DFT Studies of Redox Tendencies observed in a Phenyl-substituted Tetraphenylporphyrin Seriess.* Poster presented at the 11th International Conference on Porphyrins and Phthalocyanines (ICPP-11) (Virtual). 26 June-2 July 2021.

Da-yang, T.E., Fifen, J.J., Dhaouadi, Z., Nsangou, M. & Conradie, J. 2021. *Structures of the solvated copper (II) in methanol at various temperature.* Paper delivered at the Prochaines Journées Scientifiques de la Faculté des Sciences (Scientific Days of the Faculty of Sciences), Faculté des Sciences, Université de Maroua, Cameroon. 15-17 April 2021.

De Beer, F.J., Twigge, L. & Azov, V.A. 2021. *Synthesis of amino acids with donor and acceptor substituents.* Paper delivered at the International Organic Chemistry Symposium, University of the Free State, Bloemfontein South Africa (Virtual Symposium). 15 June 2021.

De Jager, K.M., Kuo, C-M., Bezuidenhoudt, B.C.B. & Marais, C. 2021. *Total synthesis of isomeric hydroxylated mono-methoxy homoisoflavanones.* Paper delivered at the International Organic Chemistry Symposium, University of the Free State, Bloemfontein South Africa (Virtual Symposium). 15 June 2021.

Faber, J., Marais, C. & Wilhelm, A. 2021. *Investigation of the C-glucosylated xanthone, mangiferin, under oxidative conditions.* Paper delivered at the International Organic Chemistry Symposium, University of the Free State, Bloemfontein South Africa (Virtual Symposium). 15 June 2021.

Foadina, C.S.T, Nya, F.T., Malloum, A. & Conradie, J. 2021. *Computational study of increasing absorption capacity, optical and non-linear optical properties of graphene oxide molecule.* Micro-talk delivered at the CHPC National Conference 2021 (Online), South Africa. 1-3 December 2021.

Gawe, S. & Langner, E.H.G. 2021. *Post-synthetic ligand exchange of ZIF-8 and ZIF-67 nanoparticles to act as Drug carriers.* Paper delivered at the International FreeStatePhyChem-2021 Symposium, University of the Free State, Bloemfontein, South Africa. 28 October 2021.

Jacobs, F.J.F. & Brink, A. 2021. *Bridging the gap between nature and industry: Fundamentals of capturing entering entities for industrial and medical applications.* Poster presented at RheManTec[III]: Solar Light-driven Homogeneous Catalysis for Greener Industrial Processes with H_2 as Energy Source and CO_2 as C1 Building Block – Joint virtual seminar between UFS and UZH, Swiss-South Africa Joint Research Programme (SSAJRP). 28 May 2021.

Jacobs, F.J.F. & Brink, A. 2021. *Functionalised nitrogen based ligands in dinuclear rhenium model radiopharmaceuticals with applications to protein coordination.* Poster presented at CCP4 Crystallographic School: Data Collection to Structure

Refinement and Beyond (Digital Conference), University of Cape Town, South Africa. 22 February-5 March 2021.

Jacobs, F.J.F. & Brink, A. 2021. *Structural and kinetic variations of rhenium tricarbonyl complexes for biological and catalytic evaluation.* Poster presented at the Joint virtual meeting of the AfLS3-2021: African Light Source and the ePCCr: Pan-African Conference on Crystallography (Online), hosted by X-TechLab, Cotonou, Benin. 15-19 November 2021.

Jacobs, F.J.F. & Brink, A. 2021. *Understanding small rhenium molecules kinetically and structurally in a macromolecular setting.* Poster presented at IUCr 2021: XXV General Assembly and Congress of the International Union of Crystallography, Prague, Czech Republic. 14-22 August 2021.

Kama, D., Brink, A. & Roodt, A. 2021. *Exploring Structural Implications of diphosphinamine ligands in Medicine and Catalysis.* Poster presented at IUCr 2021: XXV General Assembly and Congress of the International Union of Crystallography, Prague, Czech Republic. 14-22 August 2021.

Kapp, L., Visser, H.G. & Schutte-Smith, M. 2021. Structure activity relationship of imidazo[4,5-f] ligands and their Rhenium(I) complexes- photoluminescence and DNA intercalation. Poster presented at the 25th Congress of the International Union of Crystallography, IUCr 2021 (Hybrid congress), Prague Czech Republic. 14-22 August 2021.

Khokho, E.C.Y., Nya, F.T., Malloum, A. & Conradie, J. 2021. *Computational study of the electronic and nonlinear optical properties of the molecules diphenanthro [3,4,5,6-efghi:3',4',5',6'-uvabc] ovalene and tribenzo [jk. mn.pq] dibenzo [5.6:7,8] pentapheno [2,1,14,13,12-stuvabcd]: influence of potassium functionalization.* Micro-talk delivered at the CHPC National Conference 2021 (Online), South Africa. 1-3 December 2021.

Liebenberg, L., Visser, H.G. & Schutte-Smith, M. 2021. Renium(I) trikarbonielkomplekse van 1'-(alkielamino) aurone en amino-auroonimiene as potensiële chemoterapeutiese middels'. Paper delivered at the Student Symposium in Natural Sciences 2021 (Virtual), Potchefstroom, South Africa. 28-29 October 2021.

Maier, D.I.H., Bezuidenhoudt, B.C.B. & Marais, C. 2021. *New catalytic methodologies towards the synthesis of oxygenated dibenzo[b,f]azepines.* Paper delivered at the International Organic Chemistry Symposium (Virtual Symposium), University of the Free State, Bloemfontein, South Africa.15 June 2021.

Makhathini, B.T., Bezuidenhoudt, B.C.B. & Marais, C. 2021. *Strategies towards the synthesis of a stilbene-related substituted γ-butenolide natural product.* Paper delivered at the International Organic Chemistry Symposium (Virtual Symposium), University of the Free State, Bloemfontein, South Africa.15 June 2021.

Makhathini, B.T., Bezuidenhoudt, B.C.B., Marais, C. 2021. *Strategies towards the synthesis of a stilbene-related substituted γ-butenolide natural product.* Poster presented at the SACI YCS2021 National Conference (Online). 8-9 July 2021.

Makhathini, B.T., Bezuidenhoudt, B.C.B., Marais, C. 2021. *Strategies towards the synthesis of a stilbene-related substituted γ-butenolide natural product* (Oral Presentation) at the International Organic Chemistry Symposium, University of the Free State, Virtual Symposium, 15 June 2021.

Malloum, A. & Conradie, J. 2021. *DMSO Clusters: Non-Covalent Interactions and DFT Benchmarking.* Micro-talk delivered at the CHPC National Conference 2021 (Online), South Africa. 1-3 December 2021.

Malloum, A. & Conradie J. 2021. *Non-covalent interactions in thiophene clusters and furan clusters.* Paper delivered at the International FreeStatePhyChem-2021 Symposium, University of the Free State, Bloemfontein, South Africa. 28 October 2021.

Mateyise, N.G.S., Conradie, M.M. & Conradie, J. 2021. *Poster, DFT and kinetic study of the oligothiophene-containing rhodium model catalysts.* Poster presented at the SACI YCS2021 National Conference (Online). 8-9 July 2021.

Mncwangi, S.N. & Azov, V.A. 2021. *Synthesis of bis-tetrathiafulvalene derivatives with variable degree of π-conjugation.* Paper delivered at the International Organic Chemistry Symposium (Virtual), University of the Free State, Bloemfontein, South Africa. 15 June 2021.

Mogale, R., Akpomie K.G, Conradie J. & Langner, E. 2021. *Dye adsorption of aluminium- and zirconium-based metal organic frameworks with azobenzene dicarboxylate linkers.* Paper delivered at the International FreeStatePhyChem-2021 Symposium, University of the Free State, Bloemfontein, South Africa. 28 October 2021. [2nd place for best student speaker].

Molahloe, T.S, Zietsman, P.C., Wilhelm, A. & Bonnet, S.L. 2021. *Structure elucidation of iridoid glycosides from Aptosimum elongatum extracts.* Paper delivered at the International Organic Chemistry Symposium (Virtual), University of the Free State, Bloemfontein, South Africa. 15 June 2021.

Mokolokolo, P.P., Brink, A., Pretorius, C. & Roodt, A. 2021. *Structure and Reactivity of Rhodium(I) Carbonyl complexes as Model Nano-Wired Assemblies and Catalyst.* Poster presented at IUCr 2021: XXV General Assembly and Congress of the International Union of Crystallography. Prague, Czech Republic. 14-22 August 2021.

Mokolokolo, P.P., Schutte-Smith, M., Brink, A. & Roodt, A. 2021. *Structure and Reactivity of Rhodium(I) Carbonyl complexes as Model Nano-Wired Assemblies and Catalyst.* Poster presented at IUCr 2021: XXV General Assembly and Congress of the International Union of Crystallography (Virtual), Prague, Czech Republic. 14-22 August 2021.

Morerwa, Z.G., Roodt, A. & Brink, A. 2021. *Towards water soluble catalysts for CO/CO2 fixation and conversion.* Paper delivered at RheManTec[III]: Solar Light-driven Homogeneous

Catalysis for Greener Industrial Processes with H_2 as Energy Source and CO_2 as C1 Building Block – Joint virtual seminar between UFS and UZH, Swiss-South Africa Joint Research Programme (SSAJRP). 28 May 2021.

Morerwa, Z.G., Brink, A. & Roodt, A. 2021. *Environmentally Friendly Rhodium(I) Model Catalysts tailored by various bidentate and monodentate (water-soluble) ligand*. Poster presented IUCr 2021: XXV General Assembly and Congress of the International Union of Crystallography, Prague, Czech Republic. 14-22 August 2021.

Moskaleva, L., Li, Y., Li, S., Ivanova-Shor, E. & Bäumer, M. 2021. *Ceria nanoparticle supported on Au(111) as a model for inverse catalysts. An ab initio molecular dynamics study of the role of oxide-metal interface in catalytic reactions*. Paper delivered at the 31st Catalysis Society of South Africa (CATSA) Conference (Virtual). 7-10 November 2021.

Motente, M., Venter, J.A. & Brink, A. 2021. *Rhodium(I) (O,O'; N,O) Hydroxamic Acid Complexes As Model Catalysts*. Poster presented IUCr 2021: XXV General Assembly and Congress of the International Union of Crystallography, Prague, Czech Republic. 14-22 August 2021.

Mtshali, Z., von Eschwege, K. G., Conradie, J. 2021. *Functionalised polypridine manganese (II) complexes probed with DFT and cyclic voltammetry*. Poster presented at the SACI YCS2021 National Conference (Online). 8-9 July 2021.

Noreljaleel, A.E.M, Wilhelm, A., Van der Westhuizen, J.H. & Bonnet, S.L. 2021. *Synthesis and bioactivity of reduced chalcones containing sulphonamide side chains*. Paper delivered at the International Organic Chemistry Symposium (Virtual), University of the Free State, Bloemfontein, South Africa.15 June 2021.

Olaniyan, O. & Moskaleva, L. 2021. The reactivity of –O-Au-O- chain structures on the Au (321) surface with Ag impurities: a computational study. Paper delivered at the FreeStatePhyChem Symposium, University of the Free State, Bloemfontein, South Africa. 28 October2021.

Oosthuizen, U., Schutte-Smith, M. & Visser, H.G., 2021. Studie van Renium en Goud metaalverbindings as anti-kanker en anti-mikrobiale middels. Paper delivered at the Student Symposium in Natural Sciences (Virtual), Potchefstroom, South Africa. 28-29 October 2021.

Redgard, S., Roodt, A. & Venter, J.A. 2021. *CO2 fixation using 5-coordinate Pt and Pd complexes and its anomalies*. Paper delivered at RheManTec[III]: Solar Light-driven Homogeneous Catalysis for Greener Industrial Processes with H_2 as Energy Source and CO_2 as C1 Building Block – Joint virtual seminar between UFS and UZH, Swiss-South Africa Joint Research Programme (SSAJRP). 28 May 2021.

Roodt, A. 2021. And then there was AfCA (African Crystallographic Association). Invited lectcure delivered at the Joint virtual meeting of the AfLS3-2021: African Light Source and the ePCCr: Pan-African Conference on Crystallography Online, hosted by X-TechLab, Cotonou, Benin. 15-19 November 2021.

Swart, M.R., Twigge, L., Erasmus, E., Marais, C. & Bezuidenhoudt, B.C.B. 2021. *Alkene metathesis, p-Cresol and the Second-Generation Grubbs Catalyst: Fitting the Pieces.* Paper delivered/Poster presented at the Catalysis Science & Technology 10th Anniversary Symposium (Virtual event) United Kingdom. 16-17 November 2021.

Swart, M.R., Twigge, L., Erasmus, E., Marais, C. & Bezuidenhoudt, B.C.B. 2021. *The riddle of p-cresol and Grubbs second generation catalyst*. Paper delivered at the International Organic Chemistry Symposium (Virtual), University of the Free State, Bloemfontein, South Africa. 15 June 2021.

Teimouri, S., Potgieter, J.H. & Conradie, J. 2021. *DFT Modelled Deep Eutectic Solvent (DES) – Pyrite interactions*. Micro-talk delivered at the CHPC National Conference 2021 (Online), South Africa. 1-3 December 2021.

Twigge, L., Roodt, A., Alberto, R., Visser, H.G., Kirsten, L., Koen, R. & Schutte-Smith, M. 2021. *Structure of a rhenium(I) complex with 3-hydroxyflavone as O,O'-bidentate ligand and confirmation of π-stacking by solid-state NMR spectroscopy*. Paper delivered at the International Organic Chemistry Symposium (Virtual), University of the Free State, Bloemfontein, South Africa. 15 June 2021.

Van Dyk, H. & Brink, A. 2021. *Functionalised Schiff Base Ligands With Applications In Protein Crystallization Coordination, Catalysis And Luminescence*. Poster presented atCCP4 Crystallographic School: Data Collection to Structure Refinement and Beyond (Digital Conference), University of Cape Town, South Africa. 22 February-5 March 2021

Van Dyk, H., Jacobs, F.J.F. & Brink, A. 2021. *Catalytic development and medical application of transition metal complexes (Re, Co, Cu) containing novel Salicylidene Schiff bases*. Poster presented at IUCr 2021: XXV General Assembly and Congress of the International Union of Crystallography, Prague, Czech Republic. 14-22 August 2021.

Van Dyk, H., Jacobs, F.J.F., Mokolokolo, P.P. & Brink, A. 2021. *Application of functionalized salicylidene Schiff base ligands in catalysis, luminescence, and radiopharmacy*. Posterpresented at ePCCr: Pan African Conference on Crystallography Online held jointly with the African Physical Society (AfPS) and the African Light Source (AfLS) conferences. Hosted by X-TechLab, Cotonou, Benin. 15-19 November 2021.

Van Staden, C., Moskaleva, L.V., Kroon, R.E., Kama, D.V., Schutte-Smith, M. & Visser, H.G. 2021. *Journey to the structural optimisation of gold(I) complexes to investigate the experimental manipulation potential of aurophilic interactions by ligand design*. Paper delivered at Material Science and Beyond (Virtual). 2-3 December 2021.

Van Staden, C., Visser, H.G., Schutte-Smith, M., & Kama, D.V. 2021 *The structural comparison of dimeric Ag(I) and Au(I) complexes with bridging bidentate phosphine ligand systems*. Poster presented at ePCCr: Pan African Conference on Crystallography Online (Virtual) 15-19 November 2021.

Van Staden, C., Visser, H.G. & Schutte-Smith, M. 2021. The manipulation of metal-metal bonding distances by variation of the size of N-substituents on PNP ligand systems. Poster presented at IUCr 2021: XXV General Assembly and Congress of the International Union of Crystallography (Hybrid), Prague, Czech Republic. 14-22 August 2021.

Visser, M., Pieterse, T., Twigge, L., Marais, C. & Bezuidenhoudt, B.C.B. 2021. *Synthesis of flavonoids and benzo[b]furans*. Oral Presentation delivered at the International Organic Chemistry Symposium (Virtual), University of the Free State, Bloemfontein, South Africa. 15 June 2021.

Visser, M., Pieterse, T., Twigge, L., Marais, C., & Bezuidenhoudt, B.C.B. 2021. Synthesis of flavonoids and benzo[b]furans (Oral). Young Chemist's Symposium 2021 (SACI National), Virtual, 8 – 9 July 2021

Visser, M., Pieterse, T., Twigge, L., Marais, C. & Bezuidenhoudt, B.C.B. 2021. Universele metodiek vir die sintese van flavonoïede en benso[b]furane. Paper delivered at the Student Symposium in Natural Sciences (Virtual), Potchefstroom, South Africa. 28-29 October 2021. [2nd prize].

Wilhelm, A. 2021. *Larval zebrafish locomotor assay for the discovery of GABAA-receptor modulators*. Invited lecture presented at the International Organic Chemistry Symposium (Virtual), University of the Free State, Bloemfontein, South Africa. 15 June 2021.

STAFF (2021)

Head of Department:

Prof W Purcell

Bloemfontein Campus:

Distinguished Professor:

Prof A Roodt

Professors:

Prof VA Azov, Prof A Brink, Prof J Conradie, Prof E Erasmus, Prof L Moskaleva, Prof W Purcell, Prof JC Swarts, Prof JA Venter, Prof HG Visser and Prof KG von Eschwege

Senior Lecturers:

Dr S Bonnet, Dr DV Kama, Dr EHG Langner, Dr C Marais, Dr E Müller, Dr M Schutte-Smith and Dr A Wilhelm

Lecturers:

Dr RF Shago and Dr L Twigge (NMR Manager)

Junior Lecturer:

Mr L Nkabiti

Researcher/Assistant:

Dr A Noreljaleel

Research Associates:

Prof BCB Bezuidenhoudt and Prof KJ Swart

Programme Director:

Prof JA Venter (Physical Sciences)

Senior Officers – Professional Services:

Mr MP Coetzee, Ms T Swarts and Ms R Wales (Finances)

Officers – Professional Services:

Dr MM Conradie, Ms WC du Plessis (Marketing), Ms MW Mathebula, Ms M Meyburgh, Dr P PP Mokolokolo and Mr R Swart

Secretary:

Ms E Andrews

Technical Aid Assistants:

Mr ID Fish, Mr J Mafahle, Mr LP Maxhaka, Mr GI Nkotshana and Mr E Tau

Qwaqwa Campus:

Subject Head:

Dr M Mngomezulu (Acting)

Senior Lecturer:

Dr JP Mofokeng

Lecturers:

Dr OT Alexander, Ms MA Malimabe, Dr M Mngomezulu, Dr M Sibeko and Mr TA Tsotetsi

Junior Lecturers:

Mrs M Mbongo and Mr R Moji

Officers – Professional Services:

Ms CE Clarke-König, Ms P Leche and Mr MFT Mosoabisane

Senior Assistant Officer:

Mr MA Motsoeneng

South Campus:

Lecturer/Coordinator:

Dr R Meintjes

Facilitators:

Ms C de Klerk, Dr M du Plessis, Ms L Siegert and Ms B van Tonder

Laboratory Manager:

Ms L Siegert

Technical Aid Assistant:

Mr T Shago

Department of
COMPUTER SCIENCE AND INFORMATICS

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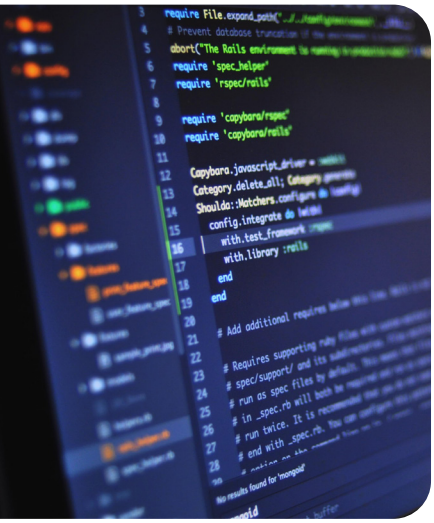

OVERVIEW OF 2021

The Department of Computer Science and Informatics (CSI) continued facing unique challenges due to the COVID-19 pandemic and lockdown, which meant we had to present modules face-to-face and online. We had to make changes to many of our modules, in particular the programming modules and the computer literacy modules, in order to present online lectures and carry out online assessments, as not all students returned to campus.

We are upgrading one of our departmental venues to be a computer laboratory in which 35 students can be seated. Since our student numbers have grown considerably over the last few years, we needed another computer laboratory to accommodate especially postgraduate students. The Department is also embarking on a project to install security gates at the offices of our staff members.

Two very successful Industry Advisory Board meetings were held in 2021, which provided much needed advice, interaction and discussion.

Our first Alumni newsletter was finalised and distributed in 2021.

ACHIEVEMENTS

Staff Achievements

Three staff members were promoted to Associate Professor, namely Eduan Kotzé, Lizette de Wet and Liezel Nel. Prof Kotzé achieved the NRF-rating (C3) in 2021.

Prof Eduan Kotzé

Dr Pakiso Khomokhoana was accepted in the UFS Learning and Teaching Fellowship programme.

Dr Pakiso Khomokhoana

He and Prof Liezel Nel received the Best Paper award at the 50th Annual Conference of the Southern African Computer Lecturers' Association (SACLA) for their paper titled 'Mapping the problem-solving strategies of novice programmers to Polya's framework: SWOT analysis as a bottleneck identification tool'.

Prof Liezel Nel

Prof Lizette de Wet was invited to be the guest speaker at the quarterly meeting of the South African Protea chapter of the Special Interest Group for Computer-Human Interaction (SIGCHI) of the Association for Computing Machinery (ACM). SIGCHI is the premier international society for professionals, academics and students who are interested in human-technology and human-computer interaction (HCI). The virtual presentation, titled 'Brain-computer – worth the effort in research or not?', took place on 2 June 2021.

Prof Lizette de Wet

Two staff members, Dr Pakiso Khomokhoana and Dr Wynand Nel, completed the Centre for Research on Evaluation, Science and Technology (CREST) Online Training Course for Supervisors of Doctoral Candidates at African Universities. Dr Nel passed with a distinction.

Student Achievements

Mr Bothma won a prize in a session at the Suid-Afrikaanse Akademie vir Wetenskap en Kuns, Studentesimposium in die Natuurwetenskappe 2021, held in Potchefstroom in October. His presentation titled *'n Ondersteunende stelsel vir die toets van konsensus-algoritmes* was based on his project which forms part of the Blockchain Technology research focus.

The Best Assignment project, headed up by the UFS Library and Information Services (LIS), is a collaborative flagship project between the LIS and the faculties of the UFS. The purpose of the project is to encourage research skills at an undergraduate level and to ensure that these skills are celebrated. Three students from the Department of Computer Science and Informatics were among the winners in the group assignment category in 2021 for their Software Engineering project, in the module presented by Mr Rouxan Fouché. The winners were Mr Shayne Hassett, Mr Tshegofasto Mochaki, and Ms Reba Phuthi. The project outlines the deliverables for the Requirements, Analysis and Design workflows of the Unified Process for the UFS COVID-19 Screening System, which serves to automate the process of screening campus staff, students and visitors for COVID-19 symptoms before they access the Bloemfontein Campus.

Winners of the Best Assignment project, from the left, Mr Shayne Hassett, Ms Reba Phuthi and Mr Tshegofasto Mochaki

TEACHING AND LEARNING

In response to the revised responses to the COVID-19 pandemic, all undergraduate and postgraduate module offerings were offered face-to-face during the first and second semesters of 2021.

The Electronic Computer Literacy Assessment (ECLA) program is used across the three UFS campuses to assess the first-year computer literacy modules. Usually, there are between four- and five thousand students registered for these modules in an academic year. As campus access was restricted due to the COVID-19 pandemic, the Department was required to update ECLA with functionality to enable lecturers to mark assessments submitted remotely.

This update also allowed the students in the University Access Programme (UAP) to make use of the software. Continuous expansions and updates are being applied to improve and expand functionality, and major updates included online assessments, submissions and automations.

RESEARCH AND INNOVATION

Blockchain Technology

The Blockchain Technology research area, which falls in the 4IR domain and is led by Dr Wynand Nel, continued its research on reducing the high energy consumption of the Bitcoin network. This project focuses on the Proof-of-Work consensus algorithm of Bitcoin and creating alternative algorithms that can dramatically reduce the energy requirement of the Bitcoin network. One PhD and two Honours students continued their work in this field.

The two Honours students, Mr Johandré Bothma and Mr Rudolph Myburg, presented their Honours projects at the Suid-Afrikaanse Akademie vir Wetenskap en Kuns Studentesimposium in die Natuurwetenskappe 2021. Mr Bothma developed a system that can analyse the Bitcoin blockchain and identify appropriate sections (blocks) that can be used to test newly developed blockchain consensus algorithms. Furthermore, his system can generate pseudo-random numbers utilising data within the Bitcoin blockchain that is then used with the non-linear Proof-of-Work algorithm developed earlier by the Department. Mr Myburg developed software that allows the researcher to run mining operations on an isolated Bitcoin network to compare the original Proof-of-Work consensus algorithm of Bitcoin with one of four newly developed non-linear Proof-of-Work algorithms. The data confirmed the findings of the simulations that were done previously – that the new algorithms can reduce the Bitcoin network's energy consumption.

Some members of the Blockchain Technology research group, from the left, Mr Johandré Bothma, Mr Rudolph Myburg, Dr Wynand Nel (Supervisor) and Mr Rouxan Fouché (Co-supervisor)

Computer Science Education

The Computer Science Education (CSE) research group, under the guidance of Prof Liezel Nel, continued its work on the 'decoding' Computer Science education and the unique challenges experienced by students in mastering discipline specific concepts. This long-term project focuses on the identification and evaluation of unique, discipline-specific strategies that could be utilised by instructors to improve the teaching and learning of various fundamental Computer Science concepts. Three PhD students are currently working on CSE related projects.

Data Science / Natural Language Processing

The Data Science / Natural Language Processing (NLP) research group, led by Prof Eduan Kotzé, continued work on the linguistic aspects of online hate speech, general text classification and stylometry (authorship), as well as conversational agents.

Eye-Tracking

Prof Tanya Stott continued the collaborative eye-tracking research aimed at identifying and categorising movements.

Human-Computer Interaction

The research interest of Prof Lizette de Wet falls within the discipline of Human-Computer Interaction (HCI). The focus is the evaluation of usability and user experience of applications in a variety of disciplines, using more traditional evaluation methods like observation, questionnaires and interviews, but also including physiological methods like brain-computer interfaces. Additionally, virtual reality (VR) was incorporated, creating VR environments as possible teaching methods, and subsequently evaluating the usability and user experience of these environments.

One of our alumni, Ms Kristina Tam, presented a paper on her Honours project in Virtual Reality with Prof Lizette de Wet, who was her project supervisor and Prof Liezel Nel as co-author. Ms Tam shared the departmental prize for Best Honours Project in 2020. She presented the paper virtually in December 2021 at the International Conference on Teaching, Assessment and Learning in the Digital Age (digiTAL2K). The paper, titled 'A potential catalyst to the next stage of the evolving pedagogy', was published in the conference proceedings.

Ms Kristina Tam

Internet of Things

Prof Paul Kogeda worked on Internet of Things (IoT) projects addressing various challenges that society is facing today, such as water resource management, sewerage and waste management, and health issues. He also does agricultural-, network- and home automation-related research. Prof Kogeda received funding for various projects, including a Kenya-South Africa collaborative research project and a Central University of Technology (CUT) and UFS joint research programme.

Mobile and Digital Technologies

Dr Pakiso Khomokhoana's research focuses on Mobile and Digital Technologies. Using these technologies, he aims to develop interventions/solutions to address topical challenges related to, amongst others, COVID-19 protocols, public transport, business activities/operations, etc. by incorporating other relevant technologies including IoT, mobile Internet, mobile edge and cloud computing.

Research on the Qwaqwa Campus

Mr Gavin Dollman developed a deep learning-based drone orthomosaic landcover classifier as part of the development of a deep learning predictive model for prospecting for new fossil sites from the Elliot Formation in South Africa. He presented his research findings at the Southern African Conference for Artificial Intelligence Research (SACAIR). The conference has a strong focus on growing a network of talented students working in AI from across Africa.

Mr Ben Mase is continuing with his PhD project focusing on exploring how the development of novices' basic programming skills can be advanced using a meta-cognitive scaffolding model.

Mr Adebola Musa is doing research on Information and Communications Technology (ICT) interventions in the transport sector. His other research interests include Recommender Systems, Machine Learning, and Artificial Neural Networks.

Dr Fani Radebe's research area was in Information Systems, focusing on mobile bullying, a subset of cyberbullying in which aggression is carried out through mobile phones.

Dr Ruth Wario's research focuses on HCI and educational technologies. One of her Master's students is developing an application to aid in sign language hand gesture recognition.

merSETA Grants

merSETA is currently funding two projects in the Department – the Research Capacity Building project for postgraduate students and the Blockchain project. The purpose of the funding for the first project (R7.4 million over three years) is to build the research capacity of the Department by expanding our postgraduate programme. We met all the deadlines and delivered our first commitment of ten Honours students and two Master's students at the end of 2021. For 2022, ten new Honours students will be registered and the two current Master's students will continue with their studies.

Dr Wynand Nel is the project leader of the second merSETA project (R4.8 million over two years), which concerns research in the area of 4IR, specifically focusing on smart resource trading. The funding will be used to build and grow Blockchain and 4IR research in the Department.

ENGAGED SCHOLARSHIP

Information Technology Service Learning (ITSL) Project

In the Information Technology Service-Learning module, second-year students in the Department of Computer Science and Informatics present computer literacy training to community members. This includes MS Word and MS Excel training in the form of registered short learning programmes (SLPs). The ITSL project is organised and presented annually by Mr Rouxan Fouché, assisted by four community partners, namely the Mangaung Concerned Residents Organization (MCR), the South African Red Cross Society, the Love Life Youth Development organisation and Bloem Shelter.

In 2021, the ITSL project could not be presented in its usual format due to the inaccessibility of the UFS computer laboratories as a result of COVID-19 regulations. A venue in Botshabelo was acquired after discussions with the Love Life leadership in the Free State, so the project could be successfully implemented at the Love Life Youth Development centre from August to December 2021. Students enrolled for the service-learning module at the UFS produced computer literacy training videos and assignments shared with the Botshabelo Love Life youth centre facilitators weekly.

Video recordings were used for training, since face-to-face contact was not allowed. The training videos and assignments were presented to the ITSL participants during their chosen sessions. The Love Life Youth Development centre facilitators, known as 'groundbreakers', provided onsite support in the

participants' home language and provided feedback for improving the training every week. After completing the ITSL project, 100 members of the Botshabelo community completed both the MS Word and MS Excel SLPs. They received certificates from the Department during the graduation ceremony in December 2021 for the two registered short courses. Bloemshelter was also included in the ITSL project and training was provided to four women who stayed there.

ITSL graduation ceremony in Botshabelo

NATIONAL AND INTERNATIONAL COLLABORATION

Prof Eduan Kotzé continued to work with Prof Walter Daelemans at the Computational Linguistics and Psycholinguistics (CLiPS) research centre at the University of Antwerp, Belgium. They are jointly working on natural language processing research projects, investigating methods and algorithms to automatically detect abusive language online in South Africa, as well as agents.

Dr Burgert Senekal and Dr Oluwafemi Oriola (from Nigeria) continued their fellowship with Prof Eduan Kotzé's research group, and Dr Christa van Staden continued her fellowship with Prof Liezel Nel's research group. Prof Kenneth Holmqvist, from Sweden, continued his fellowship with Prof Pieter Blignaut's eye-tracking research group.

Prof Paul Kogeda collaborated with Dr Vitalis Ozianyi from Strathmore University, Kenya, as part of a South Africa-Kenya joint science and technology research collaboration. This focused on the detection and prediction of water leakage to facilitate water resource management.

OTHER ACTIVITIES

Our industry Advisory Board provides a valuable platform to garner advice and suggestions, and for us to promote our activities. Two meetings were held during 2021. During the first meeting (7 May 2021), discussions and suggestions were made on the assessment of programming skills, and the possibility of a hackathon and industry contributions. In terms of the future of the computer literacy module, it was stressed that students must be equipped with relevant digital skills in order to cope with the demands of their first employment. Options to further develop our Honours degree were also discussed. As part of the meeting, Advocate Shirly Hyland, Director of the Kovsie Phahamisa Academy, made a presentation on short learning programmes (SLPs), which elicited interest from members of industry. This discussion was expanded to include work-integrated-learning (WIL) possibilities that the Department will investigate. Regarding the current mainstream curriculum, industry members made suggestions on topics that could be included.

At the second meeting (29 October 2021) industry members presented topics that, in their opinion, could be suitable for SLPs and identified possible WIL topics. Prof Eduan Kotzé gave feedback on how WIL is implemented at the Cape Peninsula University of Technology (CPUT) and North-West University (NWU). The possibility of internships was also discussed, particularly in terms of best fit for the Department and industry. Mr Rouxan Fouché presented on the ITSL. All these issues will be taken further with specific industry members.

POSTGRADUATE STUDENTS

Twenty-nine students enrolled as Honours students in 2021, with eight Masters and sixteen Doctoral students making up the postgraduate student cohort. Twelve Honours students completed their studies and received their degree certificates at the April 2022 graduation ceremony.

POSTDOCTORAL RESEARCH FELLOWS

Dr Andronicus Akinyelu, from Nigeria, continued his postdoctoral fellowship under the supervision of Prof Pieter

Blignaut. They are working on the use of machine-learning techniques to calibrate eye trackers.

Dr Aliyu Olubumni, also from Nigeria, commenced her postdoctoral fellowship in 2021 under the supervision of Prof Eduan Kotzé. They are working on personalised conversational agents.

STAFF MATTERS

Mr Thabiso Raleteng joined the Department as the Technical Assistant on the South Campus.

The Technical Assistant on the Bloemfontein Campus resigned and Mr Johandré Bothma was appointed on a contract basis to assist until the vacancy can be filled with a suitable appointment.

Dr Fani Radebe resigned and the Lecturer's vacancy on the Qwaqwa Campus has been advertised. Mr Ben Mase was elected as the new Subject Head on the Qwaqwa Campus in Dr Radebe's place.

RESEARCH OUTPUTS

Research Articles

Ahishakiye, E., Van Gijzen, M. B., Tumwiine, J., Wario, R. & Obungoloch, J. 2021. A survey on deep learning in medical image reconstruction. *Intelligent Medicine* 1(3): 118-127. DOI: 10.1016/j.imed.2021.03.003

Akinyelu, A.A. 2021. Advances in spam detection for social networks, microblogging websites, and emails: ML-based and nature-inspired-based techniques. *Journal of Computer Security* 2021: 473-529.

Atsa'am, D. D. & Wario, R. 2021. Classifier Selection for the Prediction of Dominant Transmission Mode of Coronavirus within Localities: Predicting COVID-19 Transmission Mode. *International Journal of E-Health and Medical Communications (IJEHMC)* 12(6): 1-12. DOI: 10.4018/IJEHMC.20211101.oa1.

Atsa'am, D.D. & Wario, R. 2021. Association rules on the COVID-19 variants of concern to guide choices of tourism destinations. *Current Issues in Tourism*. 1-5. DOI: 10.1080/13683500.2021.1951182.

Atsa'am, D.D., Oyelere, S.S., Balogun, O.S., Wario, R. & Blamah, N.V. 2021. K-means cluster analysis of the West African species of cereals based on nutritional value composition. *African Journal of Food, Agriculture, Nutrition and Development* 21(1): 17195-17212. DOI:10.18697/ajfand.96.19775.

Atsa'am, D.D. & Wario, R. 2021. Adopting the Divide-and-Conquer Strategy for Use of Terrorists in Counterterrorism through the Stag Hunt Game-Theoretic Environment. *Journal of Applied Security Research*. Online. DOI:10.1080/19361610.2021.1908814.

Atsa'am, D.D. & Wario, R. 2021. Knowledge extraction on the nexus between terrorism criteria and attacks on private citizens and property. *International Journal of Cyber Warfare and Terrorism (IJCWT)* 11(1): 20-30. DOI:10.4018/IJCWT.2021010102.

Atsa'am, D.D., Wario, R. & Alola, U.V. 2021. Why Do Terrorists Attack Other Terrorists? Knowledge Discovery from the Global Terrorism Database. *The International Journal of Intelligence, Security, and Public Affairs* 23(2): 125-138. DOI: 10.1080/23800992.2021.1953825.

Beelders, T. & Dollman, G. 2021. Virtual Prospecting in Paleontology Using a Drone-Based Orthomosaic Map: An Eye Movement Analysis. *International Society for Photogrammetry and Remote Sensing (ISPRS) International Journal of Geo-Information* 10(11): 753.

Botha, B. S., De Wet, L. & Botma, Y. 2021. Undergraduate Nursing Student experiences in Using Immersive Virtual Reality to Manage a Patient with a Foreign Object in the Right Lung. *Clinical Simulation in Nursing* 56: 76–83. DOI: 10.1016/j.ecns.2020.10.008.

Botha, B. S., De Wet, L. & Botma, Y. 2021. Experts' review of a virtual environment for virtual clinical simulation in South Africa. *Computer Animation and Virtual Worlds* 32(2): 1-13. DOI: 10.1002/cav.1983.

De Wet, L. 2021. Teaching human-computer interaction modules – and then came COVID-19. *Frontiers in Computer Science* 3. DOI: 10.3389/FCOMP.2021.793466.

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Conference Contributions

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STAFF (2021)

Head of Department:

Prof E Kotzé

Bloemfontein Campus:

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Mr R Fouché, Mr L Grobbelaar (Contract – Units)
Dr P Khomokhoana, Mr J Marais, Dr W Nel,
Ms TS Nkalai and Mr D Wium

Junior Lecturers:

Dr A Akinyelu (Contract – Units), Mr C Cilliers and
Mr J Pieterse (Contract – Units)

Programme Director:

Mr J Marais

Research Fellows:

Prof P Blignaut, Prof K Holmqvist, Dr O Oriola,
Dr B Senekal and Dr C van Staden

Senior Assistant Officers:

Mr S Radebe and Mr V van der Bank

Officer:

Ms S Opperman

Assistant Officers:

Ms S Mocwana and Ms R Smith

Technical Assistant:

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Messenger:

Mr W Baranye

Qwaqwa Campus:

Subject Head:

Dr F Radebe

Senior Lecturer:

Dr R Wario

Lecturers:

Mr G Dollman, Mr M Mase, Mr A Musa and Dr F Radebe

Junior Lecturers:

Mr T Lesesa and Mr B Sebastian

Assistant Officers:

Ms M Mahakoe and Mr M Makhanya

Secretary:

Ms P van der Merwe

South Campus:

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Department of
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OVERVIEW OF 2021

Engineering Sciences (EnSci) experienced 2021 as a good year with the addition of new lecturers to form a diversified staff complement. EnSci also expanded research activities to include green concrete and smart grids, micro grids and grid protection. All research activities are supported by existing research infrastructure that add security to a diverse portfolio of research strategies and third stream income projects.

Teaching benefited from the acquisition of cut-through equipment for practicals, and teaching moved to the successful use of blended learning methodology. Our methodology is fully supported and underpinned by digital citizenship and digital resilience.

ACHIEVEMENTS

Staff Achievements

Mr Louis Lagrange served on a number of international, national and provincial boards and committees, including as a National Board member of the South African Institute for Agricultural Engineers (SAIAE), Free State Branch chairman of the SAIAE, National Board member for training of the South African Energy Efficiency Confederation (SAEEC), International Board member representing Africa for the Certified Lighting Efficiency Professional (CLEP) training for the Association of Energy Engineers (AEE), and International Board member representing Africa for the Certified Business Efficiency Professional (BEP) training for the AEE.

Dr Jacques Maritz fulfilled an advisory (technical and management) role for the successful establishment of the UFS interdisciplinary Centre for Digital Futures (CDF) and successfully implemented the UFS smart grid and design process of the UFS microgrid for the Qwaqwa Campus.

TEACHING AND LEARNING

Students successfully returned to face-to-face (F2F) and blended learning and teaching and benefited from the training of lecturers to be skilled facilitators on blended learning methodologies. In addition, effort was applied to prepare for the new UFS digital skills graduate attribute of which several Engineering Sciences subjects were used as case studies.

The modules of Strength of Materials ran a Bridge Building Competition between classes through the construction and testing (until destruction) of bridges in front of all participants, which was a fun way to add to the theory and establish practical skills as well.

Dr Hossein Naghizadeh, with EnSci students Ms Valentia Mphuthi and Ms Lerato Kumalo, testing bridges for the annual Bridge Building Competition

The modules of Machine Design and Vacation Work added several cut-through models of vehicle components to their arsenal of practical equipment, including a cut-through of a complete motor car with moving parts. Studies culminated in the design, construction and competition of pedal cars.

EnSci students competing in the pedal car races

Students successfully completed their workshop practice (QWOR2520) at both SA Truck Bodies and the EnSci workshop. Through both these experiences the students were exposed to engineering tools and had the opportunity to use these tools themselves. The module also included a tea pot project, which entailed the design of a mechanism to pour tea out of a teapot into a teacup.

Mr Albert Dreyer and Ms Runé Edeling demonstrating the effectiveness of their tea pot designs

Final year design themes spanned most of the UFS needs within the energy engineering sphere, specifically focusing on renewable energy solutions and building demand management. All the projects presented are planned to be implemented within the UFS. Topics included:

- Wind solution for the Qwaqwa Campus to improve power availability
- Incineration plant for the Bloemfontein Campus using suitable waste
- Granular and multidimensional benchmarking approach of UFS student residences.

The module of Academic Literacy, Language and Communication incorporated a new strategic approach to focus lectures, group work activities and some assignments on the understanding and application of 'responsibility' and 'accountability'. The aim of this approach was to motivate students, not only during their first year of studies, but for the remainder of their studies. Towards the end of the semester, students were tasked with reflecting on their experiences and we received overwhelmingly positive feedback regarding the motivational drive they gained from this strategic approach.

A motivational method of cultivating an effective teaching and learning environment was implemented as an internal departmental award ceremony for both the students and staff. Award metrics included academic achievement, leadership and inspirational qualities. The following awards were obtained and celebrated at the event:

Dr A Naghizadeh receiving the award for Best EnSci Lecturer from Ms Meandri van Rheede van Oudtshoorn and Mr Louis Lagrange

Lisa Reblin receiving the Best EnSci first-year 'Super JumpStarter' trophy. From the left,from the left, Ms Lisa Reblin, Mr Zirke le Roux, Mr Louis Lagrange and Ms Meandri van Rheede van Oudtshoorn

Mr Louis Lagrange (right) presents the award for the Best EnSci second-year 'Yes I can' award to Ms Eleandri Crafford

The best EnSci third-year award award, won by JJ Esterhuizen. From the left, Mr Zirkus le Roux, Mr JJ Esterhuizen, Mr Louis Lagrange and Ms Meandri van Rheede van Outdshoorn

The EnSci staff also kept abreast of developments in educational methods through attending several EduCon (Educational Concepts) meetings in 2021, namely:

- Accountability and Reliability (UFS, Mr G le Roux and Ms M van Rheede van Oudtshoorn)
- The Tasking, Trusting Tending model (UFS, Mr L Lagrange)
- Learning styles, truth of myth? (YouTube) (Mr J Greene)
- Wacom Intuos Pro tablet use in class demonstration (Dr A Naghizadeh)
- Managing generational differences (Virtual) (Ms C Nieman)

RESEARCH AND INNOVATION

Engineering Sciences developed a new laboratory for the research projects in cement and concrete. The concrete lab will commence operating in January 2022. The laboratory has been designed and equipped based on the planned research projects on advanced concrete technology, focusing on green concrete and eco-friendly cementitious systems. The established laboratory facility will also be used in practical sessions for undergraduate students in civil subjects.

Ms Ntebaleng Lekhera, Mr Darmund de Klerk and Mr Leonel Tchadjie in the new green concrete testing laboratory

The merSETA-funded project on Data and Digital Engineering (CDDE) is anchored in the field of grid-related research and crystallises as a smart grid initiative that forms the core of the CDDE concept. The CDDE hosted a virtual mini symposium on the 3 September 2021 with emphasis on the role of the UFS grid-related research in industry and possible collaborations with other research groups. An innovative model of industry engagement via shared case studies and technical papers, with emphasis on local campus grids, was explored and discussed. One of the notable successes of the symposium was that it provided a platform for several research groups within in science, engineering and social sciences to synchronise with industry and showcase their expertise related to creating green and sustainable campus grids, The discussions during the symposium were aimed at future efforts that include working more closely with industry partners and leveraging internal collaborations in order to advance the digitalisation, optimisation, reliability and research-readiness associated with campus grids. The latter is also part of the mandate of the UFS Grid Related Research Group to build local research instruments that will serve a wider community of scientist and engineers

With this phase concluded, the merSETA-funded CDDE is entering its final year in 2022.

During the first semester of 2021, Dr Jacques Maritz successfully established the UFS Grid Related Research Group (UFS GRRG), with a strong research profile. The GRRG plans to generate several innovative niches, and build 'home grown' research instruments and data lakes to the benefit of the GGRG and its UFS operational dyad. The research approach is interdisciplinary and open sourced and welcomes collaborations. The envisaged core research fields will be:

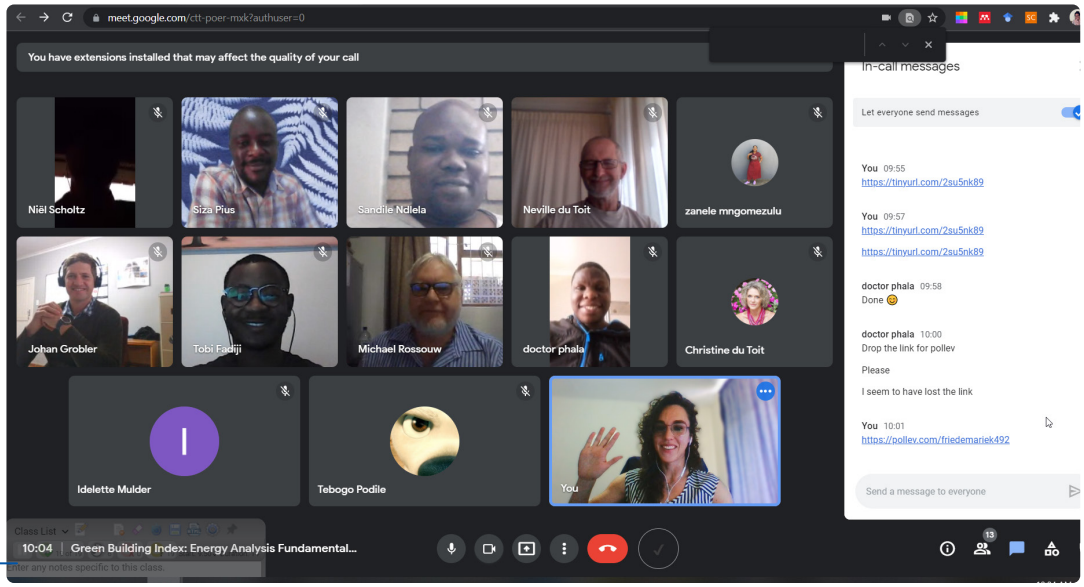
- Grid protection (transients, protection relays, energy reliability optimisation, mitigation strategies and power quality)
- Smart grids (tech integration, optimal design, energy optimisation, resource trading and cybersecurity)
- Microgrids (integration of hybrid renewables, resource optimisation and control)
- Research instrument (UFS smart grid + microgrids, open source digital twins, UFS Digital Backbone).

During the second semester of 2021, the GRRG successfully established the UFS smart grid and will also serve a stable platform for training interventions based on technology integration, green engineering, energy engineering, digital literacy and digital citizenship. In future the UFS smart grid will be integrated with the UFS digital backbone to enable the movement and processing of real-time grid data for other scientists and industry. The latter will encourage a stronger element of engaged scholarship from within the GRRG.

Experimental pods wired with data collection devices for the HPEM project

EnSci continued during 2021 with research and development on the Green Manufacturing Index (GMI) and High-Performance Engineering Materials (HPEM), funded by merSETA. The GMI project largely entailed the development of a GMI for the South African manufacturing industry. The research pods used to perform controlled testing for the HPEM project for the internal temperatures of various rooftop insulation materials, can be seen in the image below.

Four Green Building Index (GBI) virtual workshops were held during 2021, reaching a total of 35 students and engineers.



GBI Workshop participants

ENGAGED SCHOLARSHIP

As part of a sustainable engaged scholarship strategy, we aided the establishment of the UFS Centre for Digital Futures (CDF). The UFS CDF is a collaborative, co-creative space where social scientists, natural scientists, engineers, health scientists collaborate and interact with industry, private sector, government, and community partners to provide a unique eco-system, driving the digital future for the benefit of society, economic growth and prosperity. Within this optimal and modern ecosystem, projects were identified that will serve as sustainable counterparts for the UFS Grid Related Research Group.

Members of our staff were also individually involved in engaged scholarship activities. Mr Louis Lagrange was the co-author and examiner of the updated 2022 Certified Lighting Efficiency Professional (CLEP) training course material the Association of Energy Engineers (AEE), and the co-author of four chapters. of the 2022 Energy Audit Practitioner course for South African National Energy Development Institute (SANEDI)and the Institute of Energy Professionals Africa (IEPA). In addition, he was the co-author of three chapters of the 2022 Energy Audit Technician (EAT) course for the IEPA and author of the 2021 Fundamentals of Energy Management in Agriculture (FEMiA) course for the Pan-African Society of Agricultural Engineers (PASAE) in collaboration with the SAIAE.

Dr Abdolhossein Naghizadeh was the external examiner of three MEng dissertations from the University of Johannesburg.

NATIONAL AND INTERNATIONAL COLLABORATION

Engineering Sciences, through Dr Naghizadeh, is leading a collaboration of researchers from the University of Johannesburg, University of KwaZulu-Natal, Nelson Mandela University, Central University of Technology, and the University of Yaoundé (Cameroon) and Erzurum Technical University (Turkey), to formulate an eco-friendly construction material called 'green concrete. The project aims to reduce the impact of cement and cement production on the environment.

Dr Naghizadeh also collaborates in a research project on 3D printing additive technologies for sustainable human settlements in South Africa. The project is led by the University of Johannesburg, the Department of Science and Innovation (DSI) and other local and international partners from the industry.

An international academic collaboration was established with the Department of Electrical Engineering, Faculty of Khorramabad, Technical and Vocational University (TVU), in Iran.

The international industry Research and Development collaboration was reconfirmed with the Grid protection department of Schweitzer Engineering Labs (SEL) in the USA.

POSTGRADUATE STUDENTS

Mr Zirke le Roux is completing his MSc on work done in the field of smart grid protocols. He is supervised from within Engineering Sciences and the Department of Computer Science and Informatics. In a similar arrangement, PhD student, Riaan Bezuidenhout, is working in the field of blockchain.

RESEARCH OUTPUTS

Research Articles

Maritz, C.M., Maritz, J.M. & Salehi, M. 2021. A Travelling Wave-Based Fault Location Strategy Using the Concepts of Metric Dimension and Vertex Covers in a Graph. *IEEE Access* 155815-155825. DOI: 10.1109/ACCESS.2021.3129736.

Naghizadeh A. & Ekolu, S.O. 2021. Activator-related effects of sodium hydroxide storage solution in standard testing of fly ash geopolymer mortars for alkali – silica reaction. *Materials and Structures* 1-16. DOI: 10.1617/s11527-021-01875-8.

Conference Contributions

Conference Papers/Posters

Abolarin, S.M., Shitta, M.B., Emmanuel, M.A., Nwosu, B.P., Aninyem, M.C. & Lagrange, L.F. 2021. *An impact of solar PV specifications on module peak power and number of modules: A case study of a five-bedroom residential duplex.* Paper delivered at the 6th International Conference on Energy Engineering and Environmental Protection (EEEP2021), China (virtual). 16-17 November 2021.

Lagrange, L.F. 2021. *The Effect of Light on Humans.* Paper delivered at The 16th Annual South African Energy Efficiency Confederation Conference (Virtual). 3-5 November 2021.

Naghizadeh, A., Elolu, S. & Solomon, F. 2021. *Abandoned mine tailings and coal ash industrial wastes for sustainable production of geopolymer brick masonry: South African Case Study.* Paper delivered at the International Conference of Mechanics of Masonry Structures Strengthened with Composite Materials, Bologna, Italy. 24-26 November 2021.

Naghizadeh, A., Elolu, S. & Solomon, F. 2021. *Challenges and problems of geopolymer brick masonry: a review.* Paper delivered at the International Conference of Mechanics of Masonry Structures Strengthened with Composite Materials, Bologna, Italy. 24-26 November 2021.

Naghizadeh, A., Kawalu, N.P. & Mahachi, J. 2021. *A review of material specifications for 3D printing technologies and alkali activated materials contribution.* Paper delivered at The Young Concrete Researchers, Engineers and Technologist Symposium, Johannesburg, South Africa. 13-14 July 2021.

STAFF (2021)

Head of Department:

Mr LF Lagrange

Senior Lecturer:

Mr LF Lagrange

Lecturers:

Dr SM Abolarin, Dr JM Maritz and Dr A Naghizdeh

Affiliated Lecturers:

Mr CJB Bezuidenhout, Ms EP Boje, Mr JA Calitz, Mr SJ de Wet, Mr GH Ehlers, Mr JJ Haefele, Mr JC Potgieter and Mr RE Verburgt

Affiliated Junior Lecturers:

Mr GD le Roux, Mr IP Scott and Ms MM van Rheede van Oudtshoorn

Research Engineer:

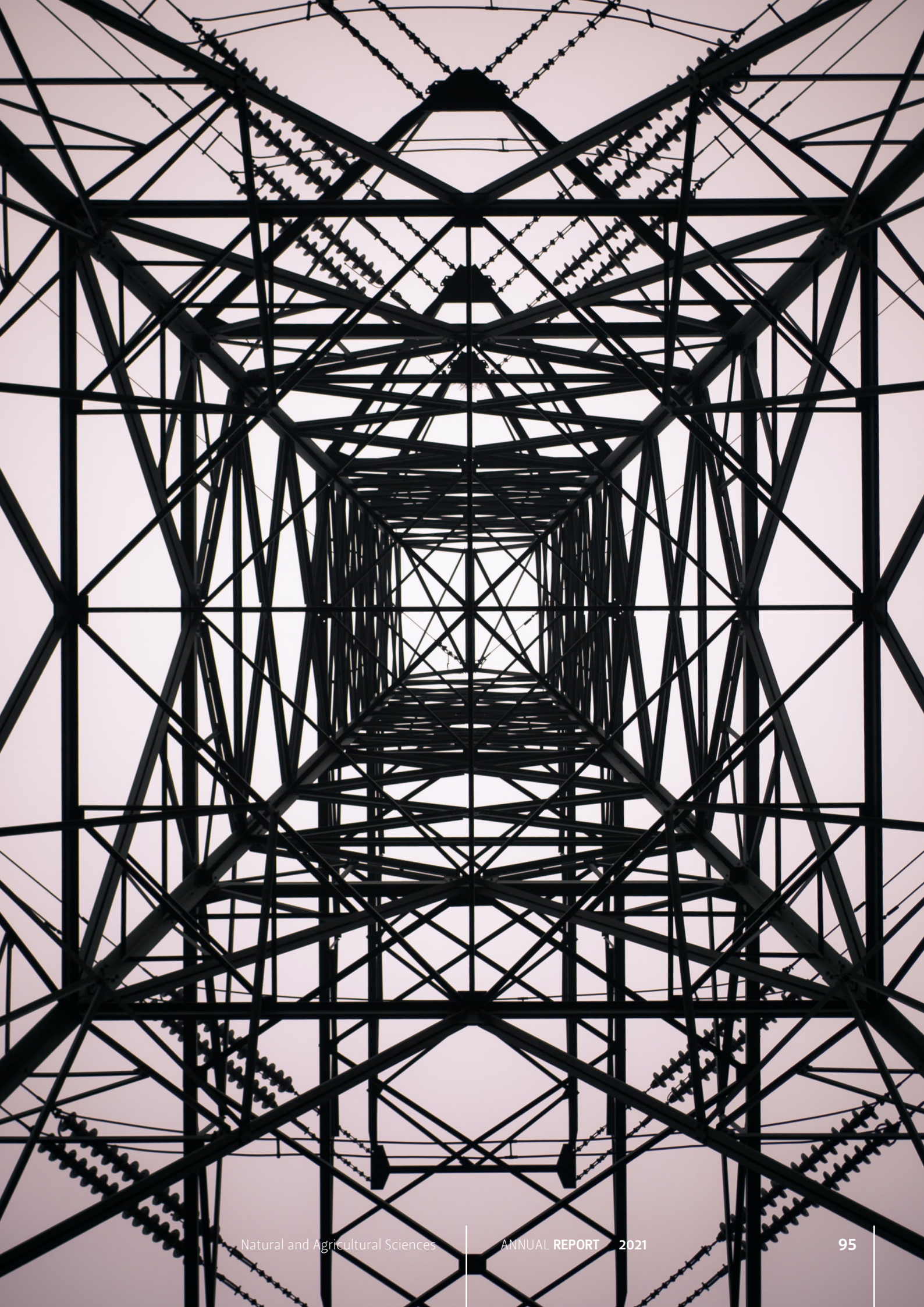
Mr SJ Erasmus (Contract)

Senior Assistant Officers:

Ms C du Toit and Ms ZV Mngomezulu

Senior Technician:

Mr HJD Lubbe



Department of
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OVERVIEW OF 2021

The Department of Genetics conducts training and research in the fields of Genetics and Forensics, with several sub-specialisations in each of these fields. Teaching and learning in the Department in 2021 was characterised by a continued high level of interest in our offerings, with undergraduate classes of 50 to 449 students, and 9 to 29 students in Honours modules.

The expertise of staff was evident in 2021 through service by a number of staff members on professional boards and journal editorial boards. Research was conducted in several specialisation areas.

Research involving animals and animal samples benefited when the Department received Biosafety Level 2 (BSL2) status for the research labs handling animal samples. This follows the decision by the National regulatory authority – the Department of Agriculture, Forestry and Fisheries (DAFF) – to require such accreditation for all facilities handling animal tissue. The Forensic Entomology research group started an extensive project based on field sites using pig carcasses to simulate crime victims, to study insect succession. The zebrafish unit is becoming well-established and will provide a very useful resource for current and planned projects. To support activities using the resource, a number of staff and postgraduate students received training in specific procedures during 2021 and received SA Veterinary Council (SAVC) authorisation to perform these procedures.

With the gradual lifting of COVID-related restrictions, some staff members were able to attend conferences in person again. At the same time, 2021 saw a rise in hybrid and fully online conferences, which in fact facilitated conference attendance by students who could not previously be exposed to international conferences.

Despite the many challenges presented to teaching and research by the COVID-19 pandemic, there were also opportunities. The Department became a hub for the South African Medical Research Council (SAMRC) programme to detect the signature of the virus from wastewater.

There was collaboration with national peers as well as researchers in the rest of Africa, Europe and the USA. Liaison with local stakeholders involved the ZZ2 group, the Jimmy Roos Special School and the Northern Cape Department of Environment and Nature Conservation. On campus, Prof Rebello ran a Next Generation Sequencing (NGS) Bioinformatics course offered by H3Abionet and Wellcome Genome Campus Advanced Courses and Scientific Conferences. Eight participants completed the course.

ACHIEVEMENTS

Staff Achievements

Dr Gerda Marx acted as chairperson for two sessions of the Society for Endocrinology Metabolism and Diabetes in South Africa (SEMDSA) Virtual Conference.

Dr Frank Maleka was selected to mentor an intern researcher, Ms Tsholofelo Modise. The internship position is funded by a joint programme from the Department of Science and Innovation (DSI) and Human Sciences Research (HSRC).

Prof Paul Grobler was invited to participate in a process to formulate management strategies for national

and international translocations of game, which will make recommendations to the National Department of Environmental Affairs and the Namibian Ministry of the Environment.

TEACHING AND LEARNING

During 2021, 14 modules were presented at undergraduate level and 18 at Honours level. The number of students enrolled in modules at undergraduate level ranged from 50 to 449, with 13 in one service module. The numbers for Genetics modules are now relatively stable, whereas most Forensics modules increased somewhat in size in 2021. The pass rate in these undergraduate modules ranged from 57 to100%.

Class sizes in Honours modules varied from 9 to 29, which is comparable to previous years. Pass rates were in the range of 88 to 100%, with reductions in some modules; however this mostly reflects a single student failing in Honours modules that previously had 100% pass rates.

A return to face-to-face lectures and practicals was experienced as a very positive development by the Department of Genetics. Lectures and practicals were adapted to ensure that COVID-19 regulations were adhered to. Where still implemented, the proficiency in online teaching and learning also continued to improve for both staff and students. Staff also became familiar with a blended approach to teaching and learning. It was found that self-sufficient students responded very well to the blended model of teaching. This should contribute to better postgraduate selection, as self-sufficiency is a favourable trait for postgraduate students to have.

RESEARCH AND INNOVATION

The number of research papers produced by the Department of Genetics in 2021 increased to 37 papers. Signs of an increase in research activity are also evident from the significant number of active projects listed by individual researchers and research groups, and evidence of high levels of activity in most of the research laboratories.

Details of the current research groups in the Department are summarised below, including those involved and current active projects. These fields and the associated members of staff are closely aligned to teaching at both undergraduate and postgraduate levels.

Conservation Genetics

Prof Paul Grobler, Dr Riël Coetzer and Ms Hesmari Bindeman

Research in this group is focused on the effects of isolation and fragmentation on game populations (gemsbok and red hartebeest populations on Northern Cape provincial game reserves), the genetic status of freshwater mussel populations from South Africa and Botswana, the genetic status of invasive marine mussels off the West Coast of South Africa, the use of zebrafish to model population genetic processes, the genetic management of small rhino populations, and assessing the biodiversity in a mountainous grassland site in the Winterberg Mountains, Eastern Cape using DNA barcoding and eDNA metabarcoding methods.

Highlights for 2021 were achieving Biosafety Level 2 (BSL2) status for the research laboratories, continued growth in expertise in handling zebrafish, several members of staff and students receiving SAVC accreditation to perform specific procedures, and several successful sampling excursions.

Human Genetics

Dr Gerda Marx, Ms Sue-Rica Schneider and Prof Renate Rebello

Projects underway in 2021 included the Haart to Heart HIV research project (Determining HIV related metabolic disorders), use of zebrafish to study human metabolic disorders, a project on pharmacogenetics and pharmacokinetics involving zebrafish in collaboration with the South African Doping Control Laboratory (SADoCoL) on the Bloemfontein Campus, and genetic determinants of schizophrenia and bipolar disorder.

Highlights in 2021 included the establishment of a zebrafish water tank (ZWT) method for compound and genetic testing.

Biosystematics

Dr Marieke Gryzenhout with two Postdoctoral research fellows

Projects undertaken in 2021 focused on psychedelic mushrooms, work on plant health in collaboration with the ZZ2 group, the biodiversity and systematics of macrofungi from South Africa, ethnomycology, and bioactive compounds from fungi and the linkage to nanoparticles.

In their project on the first-ever formal study on magic mushrooms in South Africa, Dr Gryzenhout and her research

group are helping amateur mycologists to verify identities of the various psychedelic mushroom species. She is the author of the newly published book, *Pocket Guide to Mushrooms of South Africa*.

The researchers helping amateur mycologists to verify the identities of psychedelic mushroom species, from the left, Zurika Murray, Onalerona Maloka (MSc student), Dr Marieka Gryzenhout and Dr Soumya Ghosh (Postdoc)

Highlights for 2021 were the completion of student projects and publication of resulting papers, with a number of manuscripts in various stages of review.

Plant Molecular Genetics and Genomics
Dr Frank Maleka

Much of the research in 2021 focused on Clivia, including the identification and characterisation of flower pigmentation genes, the development of microsatellite loci for the identification and differentiation of Clivia specimens, and the identification and characterisation of flower development genes in pendulous and non-pendulous Clivia species. Other research involved the development of microsatellite loci for cultivar delimitation in cactus pear.

Highlights for 2021 included the submission of manuscripts and receiving an internship position funded by a joint programme from the DSI and HSRC.

SARS from wastewater
Prof Paul Grobler, Dr Gerda Marx and Dr Frank Maleka

This project was launched in 2021 and involves wastewater surveillance of Severe Acute Respiratory Syndrome (SARS [COVID-19 causing]) gene copies and variants and is funded by the SAMRC. An initial highlight was staff receiving training from the SAMRC at their facilities in Cape Town.

Behavioural Genetics
Ms Zurika Murray

Projects focused on genetic variation of serotonin and related genes in a population of male juvenile delinquents, multiple sclerosis (MS) and neuromyelitis optica (NMO) etiology, and machine learning to use available genetic data to train a simulation to predict functional outcomes based on compacted genetic variation of genes within a neural system. A highlight for 2021 was our first paper from Psilocybin research being published.

Zurika Murray

Forensic Genetics
Dr Karen Ehlers and Ms Letecia Wessels

The research projects in 2021 focused on allelic frequencies of Y-STR markers in various African countries (Botswana, Zimbabwe and South Africa), determining the age of eggs and larvae on blowflies using gene expressions, allelic frequencies and statistical interpretation studies using short tandem repeats (STRs) to calculate parentage and mixture sample interpretation strategies, wildlife forensics (crane birds – interpretation strategies using STR markers), microbial DNA analysis of soil for improved post-mortem interval (PMI) estimation, fine-tuning the PMI clock using various methods, including gene expression, morphological and cuticular hydrocarbon analysis of forensically important insects, and DNA barcoding of forensically important insects.

Dr Karen Ehlers

Highlights for 2021 were the acceptance of a publication, conference presentations and completion of a very successful autumn sampling run for various projects. The latter was a significant achievement after an extended 14-month veterinary approval process.

Forensic Entomology
Dr Sonja Brink and Ms Letecia Wessels

Projects focused on biometric feature comparisons (also involving Anatomy students), a seasonal survey of flies of forensic importance, collection of life cycle data under natural conditions (as an alternative to an indoor climate-controlled insectarium), and the use of compound microscopy and potassium permanganate staining to identify the eggs of forensically important blow flies.

A highlight was the study of microbial and invertebrate dynamics associated with below-ground organisms in a carrion ecosystem.

Members of the Forensic Entomology group at a field site, from the left, Letecia Wessels, Mbo Zingisile (PhD student), William Lesaoane (Assistant), Dr Sonja Brink, Tshepiso Motlolo (PhD student) and Nosipho Sithole (MSc student)

As part of their research activities, several staff members and students from the Department of Genetics attended conferences, both in person and online. Dr Gerda Marx attended the SEMDSA Virtual Conference (25 to 28 March 2021), Dr Karen Ehlers and Ms Letecia Wessels attended the Forensic DNA symposium (Cape Town, 3 June), Dr Sonja Brink attended the 9th Face Science Symposium (Online, 3 November 2021), Prof Paul Grobler and one PhD student attended the annual symposium of the Southern African Wildlife Management Association (Kruger National Park, 5 to10 September 2021) and Prof Grobler and several postgraduate students participated in the online symposium of the Society for Conservation Biology (13 to 17 December 2021).

PhD student Heath Cronje (left) and Prof Paul Grobler at the annual symposium of the Southern African Wildlife Management Association, held at Berg-en-Dal, Kruger National Park

The virtual/online conference format of some of the conferences presented unique and very beneficial opportunities for delegates to participate at affordable prices.

ENGAGED SCHOLARSHIP

Dr Gryzenhout interacted with numerous citizen mycologists in South Africa; this collaboration contributes to some of her research projects.

Prof Grobler continued to serve on the editorial boards of two accredited journals – *Mammalian Biology* (Springer) and *African Journal of Aquatic Sciences* (Francis & Taylor).

Several staff members acted as external examiners for postgraduate students at other universities.

NATIONAL AND INTERNATIONAL COLLABORATION

Forensic Entomologist Dr Sonja Brink collaborated with Dr Zandre Smith, Forensic Pathologist from Stellenbosch University.

In the Biosystematics group, Dr Marieka Gryzenhout collaborated with Prof Ahmed Abdel-Azeem (Egypt), Prof André-Ledoux Njouonkou (University of Bamenda, Cameroon), Prof Tonjock Rosemary Kinge (University of Bamenda, Cameroon), Dr Joyce Jefwa (National Museums of Kenya) and Prof Leho Tedersoo (University of Tartu, Estonia).

In the field of Conservation Genetics, Prof Paul Grobler continued to collaborate closely with the Prof Antoinette Kotze from the National Zoological Garden (NZG) / South African National Biodiversity Institute (SANBI)I, and internationally with Prof Frank Zachos (Natural History Museum, Vienna) and Prof Jess Jones (Department of Fish and Wildlife Conservation, Virginia Tech University, USA).

POSTGRADUATE STUDENTS

In 2021, a total of 99 postgraduate students were registered in the Department of Genetics.

Of the 44 students registered for Honours, 18 were registered in Genetics, 4 in Behavioural Genetics, 10 in Forensic Genetics, 10 in Forensic Sciences and 2 in Forensic Chemistry.

At Master's level, 37 students were registered, of whom four graduated:

- Erasmus, JM: Genetics (Human Genetics)
- Jacobs, R: Genetics (Conservation Genetics)
- Magliolo, M: Genetics (Conservation Genetics)
- Williams, E: Forensic Science

Eighteen (18) students were registered for the PhD, one of whom graduated:

Pambuka, Gilmore

Thesis:	Characterization of the fungal microbiome of a cereal-legume intercrop system using Illumina sequencing
Supervisor:	Dr M Gryzenhout

POSTDOCTORAL RESEARCH FELLOWS

The Department of Genetics hosted two Postdoctoral Fellows in 2021 – both working with Dr Marieka Gryzenhout.

Dr Soumya Ghosh is conducting research on the biodiversity and functionalities of fungi, which includes possible applications enhanced by nanoparticles. Through his extensive international network, he published more than 20 papers in 2021.

Dr Sara Abdulla studies the biodiversity of mushrooms through DNA sequencing. Since the fungal biodiversity is poorly studied in South Africa, her research presented a number of first reports and novel species.

STAFF MATTERS

Dr Gerda Marx was appointed as the new Programme Director for the Genetics stream in the Department, taking over from Ms Zurika Murray who served in this capacity for terms.

Three staff members (Ms Z Raffie, Mr T Madisha and Ms H Bindeman) left the Department in 2021 to take up other positions.

Mr Mthe Manqana joined the Department as the new Senior Professional Officer, primarily tasked with running the genetic analyser.

At the end of 2021, the Department had 15 permanent members of staff and seven affiliated personnel.

RESEARCH OUTPUTS

Research Articles

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Geiser, D.M., Al–Hatmi, A.M.S., Aoki, T., Arie, T., Balmas, V., Barnes, I., Bergstrom, G.C., [...], Gryzenhout, M., et al. 2021. Phylogenomic analysis of a 55.1-kb 19-gene dataset resolves a monophyletic *Fusarium that includes the Fusarium*

solani species complex. *Phytopathology* 111(7): 1064-1079. DOI:10.1094/PHYTO-08-20-0330-LE.

Ghosh, S., Bornman, C. & Zafer, M.M. 2021. Antimicrobial resistance threats in the emerging COVID-19 pandemic: Where do we stand? *Journal of Infection and Public Health* 14: 555-560. DOI: 10.1016/j.jiph.2021.02.011.

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Hobern, D., Barik, S.K., [...], Zachos, F.E. & Bánki, O. 2021. Towards a global list of accepted species VI: The Catalogue of Life Checklist. *Organisms Diversity & Evolution* 21: 677-690. DOI: 10.1007/s13127-021-00516-w.

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Osagie, C., Othmani, A., Ghosh, S., Malloum, A., Esfahani, Z.K. & Ahmadi, S. 2021. Dyes adsorption from aqueous media through the nanotechnology: A review. *Journal of Materials Research and Technology* 14: 2195-2218. DOI: 10.1016/j.jmrt.2021.07.085.

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Vermeulen, M., Rothmann, L.A., Swart,W.J. & Gryzenhout, M. 2021. *Fusarium casha* sp. nov. and *F. curculicola* sp. nov. in the *Fusarium fujikuroi* species complex isolated from *Amaranthus cruentus* and three weevil species in South Africa. *Diversity* 13: 472. DOI: 10.3390/d13100472.

Williams, V.L., Coals, P.G., De Bruyn, M., Naude, V.N., Dalton, D.L. & Kotze, A. 2021. Monitoring compliance of CITES lion bone exports from South Africa. *PLoS ONE* 16(4): e0249306. DOI: 10.1371/journal.pone.0249306.

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Books/Chapters in Books

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Conference Contributions

Conference Papers/Posters

Ehlers, K. & Wessels, L. 2021. *Expanding capacity in forensic science laboratories via recognition of prior learning and part-time studies.* Paper delivered at the Forensic DNA symposium hosted by DNA for Africa, Cape Town, South Africa. 3 June 2021.

Marx, G.M., Nkonka, L. & Van der Vyver, M. 2021. The gene expression profile in type 2 diabetic patients, residing in central South Africa. Paper delivered at the SEMDSA Virtual Conference. 25-28 March 2021.

STAFF (2021)

Head of Department:

Prof JP Grobler

Professor:

Prof JP Grobler

Affiliated Professor:

Prof A Kotze (NZG-SANBI), Prof T Turner (USA) and Prof FE Zachos (Austria)

Associate Professor:

Prof R Rebello

Affiliated Associate Professor:

Prof BK Reilly (TUT)

Senior Lecturers:

Dr K Ehlers, Dr M Gryzenhout and Dr G Marx

Affiliated Senior Lecturers:

Lt Col A Lucassen (SAPS) and Dr E Mwenesongole (Botswana)

Lecturers:

Dr S Brink, Dr F Maleka, Ms Z Murray, Ms Z Raffie, Mr T Viljoen and Ms L Wessels

Programme Director:

Dr Karen Ehlers and Dr G Marx

Research Fellow:

Prof JJ Spies

Researcher:

Dr W Coetzer

Senior Professional Officer:

Mr M Manqana

Financial Officer:

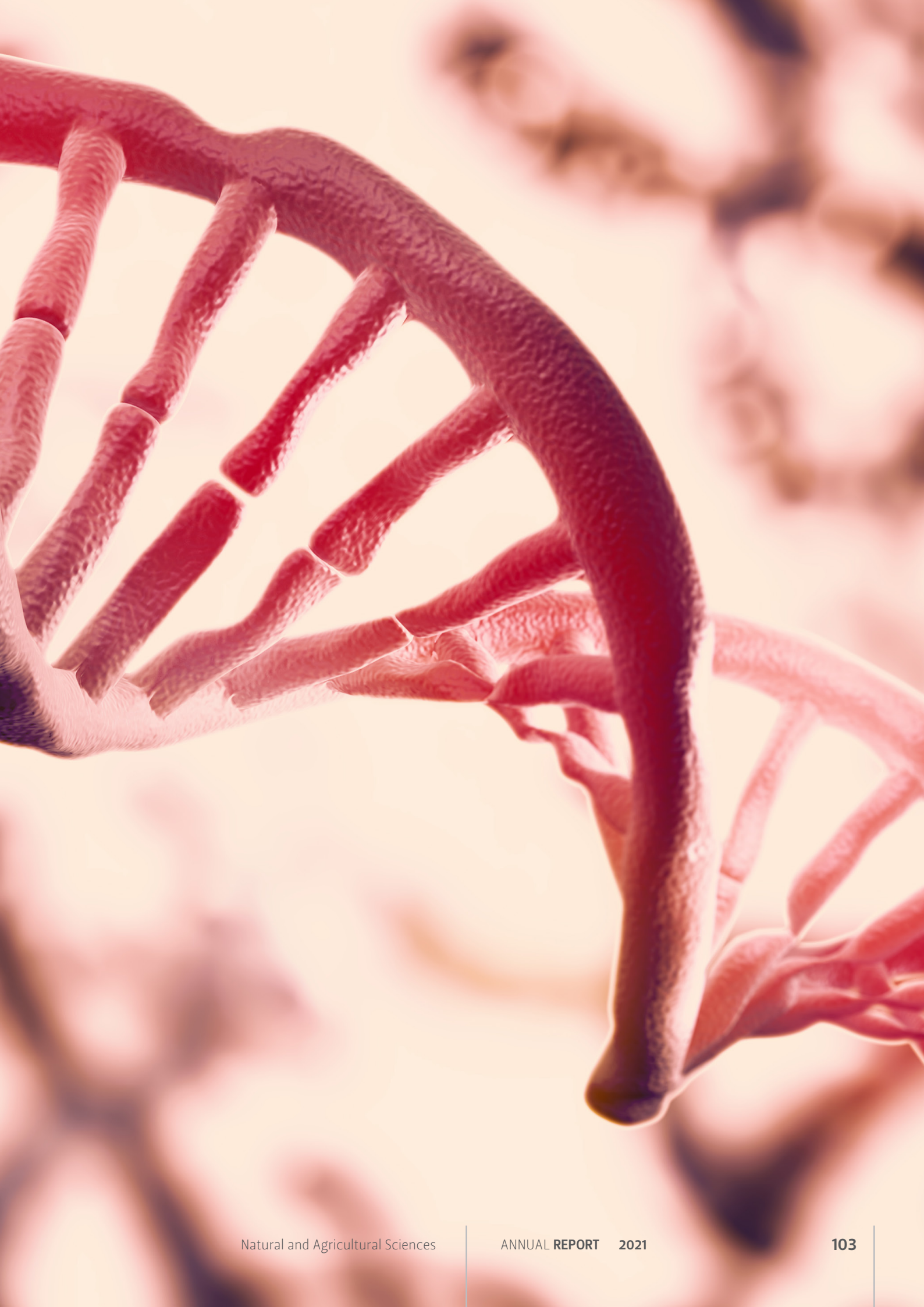
Ms B Henn

Secretary:

Ms B Segole

Lab Manager:

Ms B Radise



Department of
GEOGRAPHY

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OVERVIEW OF 2021

The Department of Geography performed well in 2021 with the easing of the COVID-19 restrictions as a result of the ongoing vaccination process. The stalling of research, teaching and learning and university services which were prevalent in 2020, has now been replaced with notable progress, which is a pleasing development.

2021 brought about two new appointments, a promotion, ongoing national and international collaborative research, an NRF-rated staff member and several publications.

ACHIEVEMENTS

Staff Achievements

Dr Abraham Matamanda received a Y2 NRF-rating in 2021, effective from January 2022.

Mischka Dunn obtained her PhD at the University of the Free State (UFS), for her thesis titled 'The experience of Urban Planners' practical training in South Africa'. The thesis developed a conceptual framework for the exploration of the experiences of Urban Planners' practical training.

Dr Elizabeth Rudolph and Mrs Marike Stander were elected as council members for the Southern African Association of Geomorphologists (SAAG) for the term 2021 to 2023. Dr Rudolph was voted in as the new President-elect of SAAG, to serve as President from 2024 to 2026.

Dr Rudolph was awarded first prize for the 'Best Paper Award' competition during the SSAG-SAAG 2021 biannual conference, an initiative led by the Society of South African Geographers (SSAG) Student and Young Professionals group, the Southern African Young Geomorphologists and the 'International Geographical Union Young and Early Career Geographers' Taskforce.

Dr Adriaan van der Walt was appointed as a member of the Editorial Board of the Springer journal *International Journal of Biometeorology* for the period 2021 to 2023. He was also included as one of the Afromontane Research Unit (ARU) research champions and is on the Steering Committee of the Alliance for Collaboration on Climate and Earth Science Systems (ACCESS) Global Climate Emerging Research Network (GCERN).

Dr Adriaan van der Walt, Dr Liezel Rudolph and Mrs Marike Stander

Prof Samuel Adelabu was invited as a visiting professor/scholar to the Department of Land Air and Water Resources at the University of California, Davies Campus. He will be visiting from April until May 2022.

Student Achievements

Two of Dr Sifiso Xulu's postgraduate students, Ms Boitumelo Chakana (Master's) and Ms Nosipho Ndima (Honours), received the South African National Space Agency (SANSA) Bursary Awards for 2021/2022. His other Honours student, Ms Fallon Kemp, submitted the paper from her Honours project for publication.

TEACHING AND LEARNING

In an initiative spearheaded by Mrs Tobeka Mehlomakhulu, the second-year Urban Geography students (GEOH2614) collaborated with the library staff to facilitate sessions on searching and citing references.

RESEARCH AND INNOVATION

Prof Geofrey Mukwada continued working with a Climate Research Group, which he founded in 2020, that is advancing research on climate change in the Drakensberg Mountains' region. One of its products is the weather stations that are currently being set up in the region using Wireless Sensor Network (WSN) technology.

Dr Melissa Hansen is coordinating the Japan Sustainability Science project, together with Prof Shogo Kudo from Akita International University. The project-based collaboration has sought to explore the relationship between migration, entrepreneurship and sustainable development in the rural mountain towns of Phuthaditjhaba, in the eastern Free State, and Gojome, in Akita Province in Japan. In addition, the project aims to contribute to the development of the Qwaqwa Campus as a Sustainability Science hub and to foster the development of inter- and transdisciplinary research. The project has sought to propose 'trans-local' learning – which connects different locations in order to learn from each case study – as a new approach in social learning for sustainability. The project also explored the relationship between migration and sustainable development, with a focus on the entrepreneurship of young migrants in the two different locations.

Dr Abraham Matamanda, Dr Mischka Dunn and Mrs Tobeka Mehlomakhulu obtained funding to spearhead a project titled 'The Geography of Informal Settlements in South Africa: insights from Caleb Motshabi, Bloemfontein'. The focus of this study is to explore the geography of informal settlements in South Africa using the case of Caleb Motsabi, an informal settlement in Bloemfontein. The study aims to explore the morphogenesis of the informal settlement, characterise the state of basic services provision and examine its liveability and propose strategies for effective informal settlement upgrading. Three Honours students were involved in project.

Dr Elizabeth Rudolph and Dr Jay le Roux, in collaboration with colleagues from the UFS Departments of Geology, Art History and Image Studies, Language Practice and the Centre for Environmental Management, were awarded a grant through the UFS' interdisciplinary funding call, to work on the interpretation, digitalisation and translation of landscapes.

in order to standardise Soil and Water Assessment Tool (SWAT) modelling efforts in South Africa, Dr le Roux established a national input database to run the SWAT model on a GIS, that is made available as an 'open-source' baseline. In collaboration with Texas A&M University (ArcSWAT model developer) and the Agricultural Research Council ([ARC] – the South African soil data custodian), the study provides geo-spatial input datasets in 'cloud storage', required as input by SWAT. This study, funded by the Water Research Commission (WRC), provides well-structured and geo-spatial input datasets, including digital elevation data, drainage networks, land cover codes, soil map and attribute tables, and weather statistics. The national input database to run the ArcSWAT model (on a GIS) is stored in the Water Research Observatory data portal of the WRC project, 'Development and application of a big data platform to improve agricultural water resources management in South Africa' https://www.waterresearchobservatory.org/data-and-resources/hydrological-data-and-modelling.

Dr Adriaan van der Walt is one of a consortium of collaborators and researchers who received funding from the National Research Foundation's (NRF) Earth Systems Science Research Programme (ESSRP) for a proposed project titled 'Application of knowledge for the management of Extreme Climate Events (APECX)'. Dr van der Walt will collaborate on two of six working groups (WG2 [Agriculture]: Assessment of intensification of extreme dry or wet events for improved prediction of crop production and losses and impact in three climate zones, and WP4 [Health]: Predictability extreme incidence [outbreaks] of selected infectious disease air quality incidents and heatwave impacts for early warning of risk exceedance and the long-term trends). One student will be funded by this project and supervised by Dr van der Walt to pursue a PhD in Geography at the UFS.

Prof Samuel Adelabu, Dr Sifiso Xulu and Dr Olusola (Postdoctoral Fellow) were awarded the tender by SANSA to conduct research on existing studies on AfriGEO and Degradation Neutrality in Africa. The tender award was in the region of R450 000.

ENGAGED SCHOLARSHIP

Prof Mukwada served as a member of the Thabo Mofutsanyane District Disaster Management Forum, a body whose primary function is to promote environmental management for purposes of averting disasters.

Dr Xulu is working on a project on GIS Training for Geography Educators in the King Cetshwayo and uMkhanyakude Districts in KwaZulu-Natal.

Dr le Roux co-convened an online Presenting Interactive Content (PICO) session at the European Geosciences Union (EGU) General Assembly on 30 April 2021. The PICO session was on 'Land degradation in savanna environments - assessments, dynamics and implications.'

Dr le Roux was invited to present at the Department of Water and Sanitation (DWS) - National Siltation Management Strategy for Dams Symposium held on 19 and 20 May 2021. The title of the presentation was 'Building Institutional Capacity: the importance of prevention and soil erodibility.' The initiative, hosted by DWS, was aimed at guiding the development of new training courses for future government officials to better address the situation of dams.

Dr le Roux was also closely involved in the SAAG post-conference excursion, which was based at the Golden Gate Highlands National Park (GGHNP). The excursion was organised and presented by Prof Paul Sumner (University of Fort Hare) and in collaboration with Dr le Roux, Prof Werner Nel (University of Fort Hare), Prof Heinz Beckedahl (University of Eswatini), Dr Piet-Louis Grundling (UFS) and Mike Loubser (University of Pretoria).

Tafoni weathering

The purpose of the excursion was to demonstrate the rich geomorphological diversity of the area, to provide insights into geomorphic processes and potential human impacts, and to facilitate further in-field discussions on the landscape in the area. Participants, one of whom was Ms Marike Stander, had the opportunity to explore the local wetlands and the rehabilitation interventions underway, under guidance of Dr Piet-Louis Grundling (Research Fellow at the UFS Centre for Environmental Management). Everyone was spoiled with the rich geological and geomorphological diversity in the area, including the many dolerite intrusions, tafoni and honeycomb weathering, soil development and movement, as well as 'vegetated islands'. The group also saw and learned more about needle ice, denudation as well as rainfall volume and intensity during the day excursion to the top of the Tugela Falls.

Striped sorted ground formed by cycles of needle ice freezing and thawing

One of Dr van der Walt's co-authored publications in the *South African Journal of Science,* titled 'Statistical classification of South African Seasonal Divisions on the Basis of Daily Temperature Data', received widespread media coverage with online articles in *Business Insider Travel* and *UFS News*, local and national newspaper articles in *Rapport*, *The Citizen*, and *Cape Argus*, radio interviews with SAFM, LotusFM and RSG Monitor, an article in *Landbouweekblad* magazine, and a podcast interview with *The Conversation Africa* on extreme temperatures in South Africa.

Prof Adelabu and Mrs Mehlomakhulu visited Mangaung Metropolitan Municipality to establish research collaborations, which will also include researchers from the Department of Urban and Regional Planning and the Centre for Development Support. The initial process to draw up a Memorandum of Understanding commenced in 2021 but was delayed due to protest action within the municipality.

Dr Rudolph presented a public talk on 27 May 2021 titled 'Earth science on Marion Island – a presentation'. Participation was open to the public and made possible via an online platform; a recording can be viewed at https://vimeo.com/559978699/b8b3e0b259.

Top of the Tugela Falls

NATIONAL AND INTERNATIONAL COLLABORATION

Dr Rudolph was invited, together with collaborators from a SANAP-NRF funded project, Prof W Nel (University of Fort Hare) and Prof DW Hedding (Unisa), to be part of a panel discussion during the University of Fort Hare's Virtual Research Week of Excellence, held online on 15 November 2021.

Dr Abraham Matamanda and Dr Thulisile Mphambukeli (from Urban and Regional Planning) are collaborating with researchers from China on the political ecology and economy of agricultural land policies in South Africa and China.

Dr Jay le Roux collaborated with Dr Althea Grundling at the ARC on a WRC-funded project titled 'Ecosystem resilience of headwater wetlands in two catchments, Eswatini and South Africa'. The project mapped different hydrogeomorphic wetland types and determined the relationships between the distribution of wetlands types, underlying geology and related processes, including hydrology and geomorphology, illustrated with conceptual hydrological/geomorphology response diagrams.

Dr le Roux continued his involvement in the South African Land Degradation Monitor (SALDi) project, in collaboration with Friedrich Schiller University Jena, in Germany, to explore a wide range of methodological approaches to assess land degradation and its dynamics over various spatial and temporal scales. In addition, he and Ms Marike Stander continued their collaboration with the Northwest Agricultural and Forestry University in China, focusing on fingerprinting techniques (to identify tracer(s) for erodible soils) and modelling of soil erosion processes in a research catchment near Ladybrand, within the Welbedacht Dam Catchment. The research includes identification of sediment sources by using composite fingerprinting technology, as well as the effects of changing soil erodibility on slope erosion using rainfall simulators.

The University Staff Development Programme (USDP) and Mountain-to-Mountain (M-2-M) Project, both coordinated by Prof Mukwada, registered commendable success in 2021. One USDP student, Moeketsi Dlamini, successfully completed his PhD, but unfortunately, he subsequently left the UFS. All except one of the USDP scholars are expected to complete their studies in 2022.

In the M-2-M Project, a notable development was the completion of the procurement of equipment for four weather stations, following the successful testing of the equipment. Another key development was the strengthening of collaboration with the Southern African Environmental Observation Network (SAEON), an organisation that is involved in climate change research in the Maloti-Drakensberg Mountains. SAEON had been a partner in the WSN foundation project funded by the NRF.

Dr Xulu is coordinating the Transport and Change of Aerosol and Ozone (TCHAO) in the UT-LS (upper troposphere - lower stratosphere) project, that resulted from long-term research networking. In addition to investigating important scientific questions in the context of significant changes in the most sensitive component of the climate (the atmosphere), the project aims to consolidate the SA-Reunion (France) cooperation and leadership in the field of atmospheric science in southern Africa and the southwest Indian Ocean basin. The project is a very important and critical transition layer, consisting of two balanced and complementary research work packages (WPs) conjointly coordinated by South African and French co-investigators. Most of the research actions planned in the project include young scientists and students and co-supervisors, with cross-mobility between South African universities (the University of Zululand, University of

KwaZulu-Natal, University of Pretoria, University of the Free State) and Reunion University.

Dr Xulu is also involved in the Gauteng Multi-Sensor Remote Sensing Campaign, coordinated by the Council for Scientific and Industrial Research (CSIR), with collaborators from several South African universities.

POSTGRADUATE STUDENTS

In 2021, fifty-six (56) students were enrolled for postgraduate studies in the Department of Geography – 18 for Honours, 21 for Master's and 17 for Doctoral studies.

Ms Eldalize Kruger, in collaboration with Ms Hanlie Stander from MDA Group (a locally based company providing Environmental Management services), established a mentorship programme for Honours students interested in working in the environmental field. In 2021, two students, Fébé Jansen van Vuuren and Emilhe Dodo, were selected for the programme. The students were taken to an active site where an Environmental Impact Assessment was being undertaken and asked to compile an Environmental Management Plan for the project as part of their training and exposure to real world experiences. The mentorship programme proved to be successful and will be initiated again in 2022 with two Honours students participating.

Inspecting the excavation, from the left, Fébé Jansen van Vuuren, Emihle Dodo and Eldalize Kruger

Two students graduated with the MSc in Environmental Geography (M Semela and P Nxumalo), and a further two with the MSc in Geography (BL Nkuna and L Chamane).

The PhD was conferred on one candidate in 2021:

Nyama, Vellim

Thesis:	An assessment of citizen participation in local development: The case of Murewa District in Zimbabwe
Supervisor:	Prof G Mukwada

Excavating a trench in order to lay a fibre cable along the N8 route.

POSTDOCTORAL RESEARCH FELLOWS

Prof Mukwada recruited three Postdoctoral Fellows, two of which are funded by the UFS while the third is funded through an NRF grant. They include Dr B Vilakazi from South Africa, Dr E Adagbasa from Nigeria and Dr H Zinhiva from Zimbabwe.

Prof Adelabu recruited two Postdoctoral Fellows Dr Olusola (Nigeria) and Dr Jombo (Zimbabwe) in 2021.

STAFF MATTERS

One promotion and three appointments were made in 2021, which will all become effective in 2022. Dr Adriaan van der Walt was promoted to Senior Lecturer, Mr Katlego Mashiane was appointed as Technician on the Bloemfontein Campus and Mr Solomon Zondo was appointed as Lecturer on the Qwaqwa Campus.

Dr Abraham Matamanda attended an online training course for supervisors of doctoral candidates at African universities, presented by the Centre for Research on Evaluation, Science and Technology (CREST) at Stellenbosch University, from 2 August to 31 December 2021.

RESEARCH OUTPUTS

Research Articles

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Mashingaidze, N., Chirisa, I., Mutambisi, T. & Matamanda, R.A. 2021. Paradoxes surrounding carbon credits and local area development: the case of Mbire district, Zimbabwe. *Local Environment* 26(10): 1175-1185.

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Matamanda, R.A., Chirisa, I. & Rammile, S. 2021. Elitist domination and its import: Survey of four decades of perpetuation of inequities in Zimbabwe. *Politikon* 48(3): 450-467.

Mazibuko, S.M., Mukwada, G. & Moeletsi, M.E. 2021. Assessing the frequency of drought/flood severity in the Luvuvhu River catchment, Limpopo Province, South Africa. *Water SA* 47(2): 172-184. DOI: 10.17159/wsa/2021.v47.i2.10913.

Mofokeng, D.O. & Adelabu, S.A. 2021. Modeling and assessing temporal distribution of anthropogenic factors in a protected area for fire danger assessment. *Journal of Geography and Natural Disasters* 11(8): 1-6.

Moyo, I. & Xulu, S. 2021. Public knowledge, perceptions and practices in the high-risk lightning zone of South Africa. *International Journal of Environmental Research and Public Health* 18: 7448.

Mukwada, G., Mazibuko, S.M., Moeletsi, M. & Robinson, G.M. 2021. Can Famine Be Averted? A Spatiotemporal Assessment of the Impact of Climate Change on Food Security in the Luvuvhu River Catchment of South Africa. *Land* 10(5): 527-544. DOI: 10.3390/land10050527.

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research opportunities. *South African Geographical Journal* 103(1): 65-81.

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Van der Walt, A.J. & Fitchett, J. 2021. Extreme Temperature Events (ETEs) in South Africa: a review. *South African Geographical Journal* (Online): 70-88.

Van der Walt, A.J. & Fitchett, J. 2021. Trend analysis of cold extremes in South Africa: 1960-2016. *International Journal of Climatology* 41(3): 2060-2081.

Xulu, S., Mbatha, N. & Peerbhay, K. 2021. Burned area mapping over the southern Cape Forestry Region, South Africa using Sentinel data within GEE cloud platform. *ISPRS International Journal of Geo-Information* 10: 511.

Xulu, S., Phungula, P., Mbatha, N. & Moyo, I. 2021. Multi-year mapping of disturbance and reclamation patterns over Tronox's Hillendale Mine, South Africa with DBEST and Google Earth Engine. *Land* 10: 760.

Zinhiva, H., Chitakira, M. and Mukwada, G., 2021. Factors associated with the utilisation of indigenous ecological knowledge in the planning and management of biotic resources in Masvingo Province, Zimbabwe. *Indilinga African Journal of Indigenous Knowledge Systems*, 20(1), pp.81-101.

Books/Chapters in Books

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Nel, V.J., Matamanda, R.A. & Chirisa, I. 2021. Social justice in spatial Governance. In: *Urban Geography in Postcolonial Zimbabwe*. A. Matamanda, V. Nel & I. Chirisa (Eds). Springer Nature Switzerland AG.

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Olusola, A.O., Onafeso, O., Fashae, O. & Adelabu, S.A. 2021. Geomorphological Analyses of third-order basins in Southwestern Nigeria. In: *Drainage Basin Dynamics*. P.K. Shit, B.K. Bera, A. Islam, S. Ghosh & G. Bhunia (Eds). Springer, Cham.

Conference Contributions

Conference Papers/Posters

Adelabu, S.A. & Olusola, A.O. 2021. *Remote sensing of night time light: progress, prospects and possibilities in Africa (2013-2021)*. Paper delivered at the IGARSS 2021 - 2021 IEEE International Geoscience and Remote Sensing Symposium, (Online) Brussels, Belgium. 12 -16 July 2021.

Baade, J., Le Roux, J.J., Morgenthal, T. & Nghiyalwa, H. 2021. *Land degradation in savanna environments – assessments,*

dynamics and implications. Paper delivered at the European Geosciences Union (EGU) General Assembly (Online), Vienna, Austria. 25-30 April 2021.

Dunn, M. & Nel, V.J. 2021. *Advocating for socially-just municipal regulations: The case of Ashbury, Bloemfontein, South Africa*. Paper delivered at the 34th International Geographical Congress: Geography Bridging the Continents (Online). 16-20 August 2021.

Gangathele, A.M., Grundling, A., Grundling, P.L. & Le Roux, J.J. 2021. *Peatland response to degradation: a case study of Waterval Peatland in Kgaswane Mountain Reserve*. Paper delivered at the Society of South African Geographers (SSAG) & Southern African Association of Geomorphologists (SAAG) 2021 Joint Biennial Conference (Online), Grahamstown, South Africa. 6-8 September 2021.

Jansen van Vuuren, F., Stander, M.H. & Van der Walt, A.J. 2021. *Heavy metal contamination in the sediment of Bloemspruit*, Paper delivered at the Biennial Conference of the Society of South African Geographers (SSAG) and Southern African Association of Geomorphologists (SAAG) (Online), Grahamstown, South Africa. 9-10 September 2021.

Kruger, J.A., Van der Walt, A.J. & Roffe, S.J. 2021. *Heatwave trend analysis across the Northern Cape, South Africa: 1980–2020*. Paper delivered at the Biennial Conference of the Society of South African Geographers (SSAG) and Southern African Association of Geomorphologists (SAAG) (Online), Grahamstown, South Africa. 9-10 September 2021.

Lefulebe, B.E., Van der Walt, A.J. & Xulu, S. 2021. *A literature review of mapping urban forests in Cape Town, South Africa using remote sensing and machine learning strategies*. Paper presented at the Biennial Conference of the Society of South African Geographers (SSAG) and Southern African Association of Geomorphologists (SAAG) (Online), Grahamstown South Africa, 6-8 September 2021.

Le Roux, J.J. 2021. *Building institutional capacity: the importance of prevention and soil erodibility*. Paper delivered at the NatSilt Symposium, Pretoria, South Africa. 19-20 May 2021.

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Manenzhe, A., Van der Walt, A.J. & Matamanda, R.A. 2021. *Investigating the influence of temperature and rainfall variability on groundwater resources in the Nzhelele region, Limpopo Province*. Paper delivered at the Society of South African Geography Student Conference (Online). 9-10 September 2021.

Matamanda, R.A., Kohima, J., Nel V. & Chirisa, I. 2021. *Climate change adaptation and planning education in southern Africa*. Paper delivered at the 5th African Association of Planning Schools Conference – Urban Africa in 21st Century (Online), Dar-es-Salam, Tanzania. 18-20 November 2021.

Matamanda, R.A. & Nel, V. 2021. *The Public Transport and Land Use Planning Nexus: The Case Harare, Zimbabwe and Bloemfontein, South Africa*. Paper delivered at the 34th International Geographical Congress, Geography: Bridging the Continents (Online), Istanbul, Turkey. 16-20 August 2021.

Olusola, A.O. & Adelabu, S.A. 20 21. *Estimating total precipitable water distribution across Free State Province, South Africa using remote sensing data and tools*. Paper delivered at IGARSS 2021 - 2021 IEEE International Geoscience and Remote Sensing Symposium (Online) Brussels, Belgium. 12 -16 July 2021.

Rudolph, E.M., Hedding, D. & Nel, W. 2021. *A spatial reconstruction of Marion Island's palaeo-ice extent*. Paper delivered at the SSAG-SAAG Joint Conference (Online), Makhanda, South Africa. 6-9 September 2021.

Summersgill, A.K. & Van der Walt, A.J. 2021. *Cellphone towers: Gaps in the coverage and a site suitability study of the area around the Intaba Ridge Secure Eco Estate, Mpumalanga Province*. Paper delivered at the Society of South African Geography Student Conference (Online) Bloemfontein, South Africa. 9-10 September 2021.

Van der Walt, A.J. & Fitchett, J. 2021. *Exploring extreme warm temperature trends in South Africa: 1960–2016*. Poster presented at the International Conference of Biometeorology (Online), Melbourne, Australia. 20-22 September 2021.

Van der Walt, A.J. & Fitchett, J. 2021. *Trend analysis of cold extremes in South Africa: 1960–2016*. Paper delivered at the Biennial Conference of the Society of South African Geographers (SSAG) and Southern African Association of Geomorphologists (SAAG) (Online), Grahamstown, South Africa. 6-8 September 2021.

Xulu, S. 2021. *Effects of drought on forest plantations in Zululand region of South Africa using MODIS and climate data*. Paper delivered at the Biennial SSAG (Society of South African Geographers) and SAAG (Southern African Association of Geomorphologists) Conference (Online), Grahamstown, South Africa. 6-8 September 2021.

STAFF (2021)

Head of Department:

Prof SA Adelabu

Bloemfontein Campus:

Associate Professor:

Prof SA Adelabu

Senior Lecturer:

Dr JJ le Roux

Lecturers:

Dr M Dunn, Ms E Kruger, Dr A Matamanda, Ms T Mehlomakhulu, Dr EM Rudolph, Ms M Stander and Dr AJ van der Walt

Programme Director:

Ms E Kruger

Senior Officer – Professional Services:

Ms N van Dyk

Officer – Professional Services:

Ms S Brits

Qwaqwa Campus:

Subject Head:

Dr M Hansen

Professor:

Prof G Mukwada

Lecturers:

Dr M Hansen, Dr P Mahasa, Dr M Pewa, Ms N Sekhele and Dr S Xulu

Senior Assistant Officer:

Ms M Lebeko

Department of
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OVERVIEW OF 2021

The Department of Geology is responsible for teaching and research in the geological sciences at the University of the Free State (UFS). The Department offers six undergraduate, three Honours and four MSc programmes (Geology, Geochemistry, Environmental Geology, and Mineral Resource Management [MRM]), as well as PhD by research. The Department offers 19 undergraduate modules, 10 Honours and 12 structured MSc (MRM) modules.

In 2021, the Department awarded a total of 50 degrees, which includes 18 BSc, 25 Honours, 6 MSc and one PhD. The Department enrolled 232 students – 140 undergraduate students, 27 Honours, 55 MSc (37 in MRM, 18 in Geology, Geochemistry and Environmental Geology), and seven PhD candidates.

The appointments of Dr Robert Muir (Senior Lecturer for Sedimentology) and Dr Martin Clark (Lecturer and Principal Investigator for the Merensky Group for Airborne Geological Image Classification [MAGIC] project) were significant highlights in the staff development strategy of the Department.

ACHIEVEMENTS

Staff Achievements

Dr Martin Clark was recognised as one of UFS's top collaborators in 2020/2021 due to the leading role he played in the formulation and securing of the collaboration with the Hans Merensky Foundation (HMF) in the form of the MAGIC project.

Ms Thendo Mapholi and Mr WJ Nel completed their MSc degrees – from Rhodes University and UFS, respectively.

Student Achievements

The Department of Geology annually recognises their best performing students by awarding prizes and financial incentives, sponsored by the Department and supporters. The best students in 2020 (who received their awards in 2021) were S Radebe (Best first-year student), M Ndlovu (Best second-year student) and S Madaka (Best third-year student).

Celebrating the top performers of the 2020 class

TEACHING AND LEARNING

The Department offers six undergraduate programmes for the BSc, majoring in Geology, Environmental Geology, Geochemistry, Geology and Geography, Geology and Chemistry, and Geology and Physics. The Department's Honours programmes offer specialisation degrees in Geology, Geochemistry and Environmental Geology.

The modules presented by the Department attempt to integrate theory, laboratory and geological field investigations, and most include visits to mines and mineral processing plants, geoscientific laboratories or research centres. At the undergraduate level, the first-, second- and third-year students visited various geological sites to study the different geological aspects pertinent to the modules.

Second-year students collecting data in the field

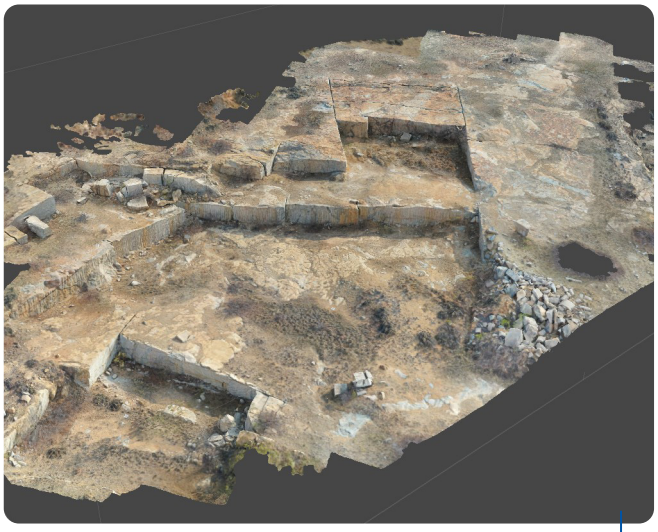
In line with the UFS Teaching and Learning guidelines and the Faculty of Natural and Agricultural Sciences' principles to manage the academic project in 2021, the Department of Geology implemented a blended learning approach – with more face-to-face (F2F) learning and less online learning. Blackboard Collaborate recordings have been used for all F2F contact sessions for second- and third-year students. A limited field excursion was conducted in line with the COVID-19 regulations.

RESEARCH AND INNOVATION

Prof Frederick Roelofse and Ms Justine Magson completed the logging of ~5730 m of drill core donated by Impala Platinum to the International Continental Scientific Drilling Programme (ICDP) project on the Bushveld Complex. The logging data was captured on the ICDP's drilling information management system (mDIS) that will be used to store the data generated over the course of the project. Dr Ilya Veksler, of the German Research Centre for Geosciences (GFZ – GeoForschungsZentrum), visited the Department's core storage facility during October and November to sample some of this core material for two projects funded by the German Research Foundation (DFG – Deutsche Forschungsgemeinschaft). One of these projects focuses on the petrogenesis of the Main Zone of the Bushveld Complex, while the other (with Dr Dieter Rammlmair of the Federal Institute for Geosciences and Natural Resources [BGR – Bundesanstalt für Geowissenschaften und Rohstoffe] as principal investigator), focuses on the application of various scanning technologies to improve our understanding of the formation of magnetitite layers within the Upper Zone of the Bushveld Complex. Prof Roelofse and two of his MSc students, Mr Mafete Malatji and Mr Thapelo Motaung (co-supervised with Ms Magson), attended the CIMERA annual colloquium on 18 and 19 November 2021. Both students presented their work at the colloquium.

The MAGIC project was successfully launched in September 2021 with the appointment of the Principal Investigator, Dr Martin Clark, as a member of the academic staff of the Department. MAGIC is a result of a significant funding agreement concluded in 2020 between the UFS and the HMF to launch a five-year project to perform focused research on the development of remote sensing technologies, using unmanned aerial vehicles (UAVs) and satellites, for application in the mining and groundwater exploration industries of South Africa and beyond. Specific areas being addressed include mineral exploration and extraction and remediation, as well as regional groundwater exploration and management. The proposed research to be funded by this research grant targets two field areas – the Barberton Greenstone Belt (Mpumalanga), and the Karoo. Remote sensing technologies being utilised aim to better characterise the structural architecture and history of the rocks in Mpumalanga and the Karoo, to identify ways to better manage near-surface groundwater resources. This collaboration project was identified as one of the top collaborations in the UFS in 2020/2021.

Dr Martin Clark operating his drone and guiding it in the collection of high-resolution geological data



3D image of a granite quarry generated using the high-resolution drone collected geological data

MAGIC Students learning geological mapping and interpretation skills

A collaborative project together with SAENSE (a former biochemistry platform funded by the Technology Innovation Agency [TIA] and located at UFS) to roll out water treatment technologies, was ongoing for several years and significant progress was made. The SAENSE platform is no longer in existence and together with the Biogeochemistry Research Infrastructure Platform (BIOGRIP) formed the Centre for Mineral Biogeochemistry (CMBG). The staff and projects have been absorbed into the CMBG. The UFS Council formally approved the establishment of the CMBG in March 2021. A project under the CMBG has resulted in a feasibility study to build an up-scale acid mine drainage (AMD) treatment plant at the South32 Union Coal Mine, Mpumalanga. Zutari engineers have been appointed to conduct the feasibility study with technical input from the CMBG team and the UFS Directorate Research Development (DRD).

Dr Robert Hansen, Director of CMBG, and his team also commenced a Welkom wetland impact study in 2020. The project has a broad scope with the long-term aim of understanding the biogeochemistry of the Welkom wetlands and determining the processes controlling the fate of pollutants in the wetland system. A reconnaissance study has been conducted and two Honours students and an MSc student are currently working on this project.

A compost-soil nutrient augmentation project was initiated as part of a collaboration between the UFS and ZZ2, a farming conglomerate headquartered in the Mooketsi area of Limpopo. The project is focused on answering questions such as how much of the compost material is immediately available for plant uptake, the nature of these nutrients (i.e. chemical composition) and at which rate nutrients are released.

Several other projects are ongoing under the leadership of Dr Robert Hansen. These include:

- Nitrogen and sulphur plumes related to platinum mining in the Bushveld complex and the impacts on surface water.
- Arsenic impacts on surface water from historic mining activities in Pilgrim's Rest.
- Geochemical modelling of coal mining mineral waste impacts on groundwater.
- Sorption of arsenic on montmorillonite – implications for remediation, biogeochemistry of carbon sequestration using burnt carbon sources in rural communities.
- Geochemical modelling of the Okiep Copper Tailings.
- Platinum tailings bioremediation.

Dr Robert Hansen, Director of CMBG

The Department continued to collaborate with the DSI-NRF Centre of Excellence for Integrated Mineral and Energy Resource Analysis (CIMERA), jointly hosted by the Department of Geology at the University of Johannesburg (UJ) and the School of Earth Sciences at the University of the Witwatersrand (Wits). Ms Keet's DSI-NRF CIMERA grant application for an MSc student under her supervision, titled 'In situ multiple sulphur isotope analysis by SIMS of pyrrhotite, pentlandite and chalcopyrite in the Flatreef, northern limb, Bushveld Complex', was successful.

Dr Hendrik Minnaar continued his research on the crust formation processes in the Paleoproterozoic Richterveld Magmatic Arc, from which he published a joint article on the lithostratigraphic description of the Vuurdood Subsuite, Northern Cape. Dr Minnaar has extended his research of the sub-suite in collaboration with Dave Reid (UCT) and Marlina Elburg (UJ) on a research topic titled 'Lu-Hf isotope and age characteristics of the Paleoproterozoic mafic-ultramafic Vuurdood Subsuite, Vioolsdrif Suite, Northern Cape Province'. This study has been funded by the Research, Education and Investment (REI) Fund of the Geological Society of South Africa (GSSA) since 2019. The findings of this research will be submitted for publication in 2022.

Ms Justine Magson continued with her PhD research on a project titled 'Probing magma dynamics and mineralization in the Bushveld Complex using high-resolution, multi-isotope (Sr-Nd) analysis across major compositional and mineralogical discontinuities'. In August 2021, she visited the Wits Isotope Geosciences Laboratory to complete the preparation of her samples for isotopic determinations. In November 2021, she visited the Laboratory of the Rhodes University to collect mineral chemistry data from her samples using the EMPA (Joel JXA 8230 Superprobe).

Ms Jarlen Keet continued with her doctoral research on deciphering the lateral and vertical variation of strontium, neodymium and sulphur isotopes of the Flatreef, in order to understand the implications for its formation and its correlation to the Merensky Reef in the remainder of the Bushveld Complex. Ms Keet's paper, titled 'A comparative study of sulfur isotope variations within the Flatreef and Merensky Reef of the Bushveld Complex, South Africa', was published in *The Canadian Mineralogist* in December 2021. Another paper, that focuses on the Nd isotopes of the Flatreef, is scheduled for submission early in 2022.

Mr Ernest Moitsi continued working on the mineralogical and metallurgical (process mineralogical assessment) of various UG2-ore types from Hossy, Rowland and Saffy Shafts of the Sibanye-Stillwater Marikana Operations, Northwest Province, Bushveld Complex. The proposed study aims to undertake detailed mineralogical and geological investigations, as well as the metallurgical response of UG2 Chromitite Layer at Hossy, Rowland and Saffy Shafts, including an evaluation of different ore mineralogy and texture types to flotation response, the identification of critical characteristics that influence flotation performances and PGE recovery. This will enable us to gain insight into factors that influence the geology, ore mineralogy, milling behaviour and flotation performances, as well as platinum group metals recovery of the UG2 Chromitite layer at the above-mentioned three shafts. As part of his ongoing PhD research, he visited the SPECTRUM, an analytical facility at UJ, to work on the Mineral Liberation Analyser (MLA) to perform several analyses, such as sulphides and platinum group mineral deportment, including PGM grain size distribution, association and abundances.

Ernest Moitsi undertaking his PhD research work using the MLA at the University of Johannesburg

As part of her PhD study, Ms Megan Welman-Purchase continued to research the stability of Prussian blue and Turnbull's blue with implications for Witwatersrand sulfidic Au-tailings environment, and on the behaviour of cyanide in Au-mine tailings. Her research includes a chemical experiment study in order to distinguish Prussian from Turnbull's blue, forming the basis for bioremediation research. She has completed DNA extraction and all analyses (XRD, XRF, XPS, FTIR, ICP-OES, UV-vis, 16S and metagenome analysis) and will soon embark on the final stage of her write-up.

Mr Justin Nel has completed his MSc dissertation on the structural geology of the Namaqualand Mobile Belt and is set to submit for examination early in 2022.

ENGAGED SCHOLARSHIP

Prof Frederick Roelofse continued to serve as chair of the Palaeoproterozoic Task Group of the South African Committee for Stratigraphy (SACS) and as regional member of council of the GSSA. Prof Roelofse was also elected by the Mineralogical Association of South Africa (MINSA) to be the representative on the International Mineralogical Association (IMA) Commission for Gem Materials. He was also nominated to serve on the National ICDP Committee, which was established under the auspices of the NRF with a responsibility to review project proposals submitted to the ICDP.

Dr Martin Clark was a founding convenor of a new centre of the UFS Interdisciplinary Centre for Digital Futures (ICDF), driven by the Rector, Prof Francis Petersen. His role is to provide strategic input towards the foundation of the Centre and establishment of its Digital Backbone.

Dr Clark also continued in his role as a guest editor for a special issue of the Multidisciplinary Digital Publishing Institute (MDPI) journal *Minerals*, titled 'Geochronology, Crystallography and Phase Transition in Shocked Minerals'.

Mr Ernest Moitsi continued to serve as the co-opted committee member of MINSA. He was also nominated as the UFS Overseer for the Bridge the Gap Geosciences Guidance Program (BTG).

NATIONAL AND INTERNATIONAL COLLABORATION

The Department has excellent relationships with industry, as illustrated by Minerals Education Trust Fund (METF) subventions to all our full-time academic staff members to date, and the increasing levels of collaboration. The feedback the Department received from mining companies on the quality of our graduates was very encouraging. As a result, student bursaries, research support such as access to mine facilities and provision of research materials, such as drill cores and samples, are improving. A number of Honours, MSc and PhD research projects are supported by the industry. Staff research and interaction with the industry have also improved significantly.

The collaboration agreement with De Beers which started in 2018, continued into 2021, resulting in generating three additional projects for Honours students. The research collaboration is aimed at expanding the understanding of mantle xenoliths from kimberlite pipes and generating significant number of mineral chemistry data sets using the electron microprobe analyser (EMPA) and LA-ICP-MS in De Beers Laboratory.

Prof Roelofse is collaborating with scientists at the University of the Witwatersrand (Prof Lew Ashwal and Prof Susan Webb) and the GFZ German Research Centre for Geosciences (Dr Robert Trumbull and Dr Ilya Veksler) on several projects forming part of the Bushveld Complex ICDP project.

The collaboration between the Department and DSI-NRF CIMERA, which has secured funding for MSc projects since 2019, continued into 2021.

Dr Clark has been invited to be part of an international collaboration based at UJ, under the leadership of Prof Dirk van Reenen, which will be studying the evolution of the Limpopo Complex.

Dr Martin Clark, Principal Investigator of the MAGIC project and new staff member in the Department of Geology

The staff of the Geology Department continue maintaining active collaboration and expanding their collaborative spheres with researchers from the following institutions:

- Albany Museum, South Africa
- Australian Nuclear Science and Technology (ANSTO)
- Beijing SHRIMP Center,China
- Berkeley Geochronology Center, California, USA
- CIMERA, South Africa
- Council for Geoscience, South Africa
- Freidrich-Alexander University, Germany
- German Research Centre for Geosciences – GFZ Potsdam, Germany
- James Cook University, Townsville, Australia
- Korzhinskii Institute of Experimental Mineralogy, Russia
- Louisiana State University, USA
- McGregor Museum, South Africa
- Museum of Natural History, Sweden
- Natural History Museum, London, UK
- Natural History Museum Vienna, Austria
- Polish Academy of Sciences, Poland
- Rhodes University, South Africa
- Sibanye-Stillwater Company, South Africa
- Universität Hamburg, Germany
- Université De Lille, France
- University of Cape Town, South Africa
- University of Exeter, UK
- University of Gothenburg, Sweden
- University of Johannesburg, South Africa
- University of Leoben, Austria
- University of Oslo, Norway
- University of Pretoria, South Africa
- University of the Witwatersrand, South Africa
- University of Tsukuba, Japan
- University of Vienna, Austria
- Zavaritsky Institute of Geology and Geochemistry, Russia

POSTGRADUATE STUDENTS

The Department of Geology offers a variety of postgraduate programmes, including Honours, four different MSc programmes (Geology, Geochemistry, Environmental Geology, and Mineral Resource Management [MRM]), and the PhD degree by research. In 2021, the Department enrolled 84 postgraduate students – 25 Honours, 52 MSc and 7 PhD candidates.

Twenty-five (25) Honours degrees, six Master's degrees and one PhD were awarded in 2021. Three students (JW Nel, MR Malatji and TS Motaung) successfully completed their MSc by

research and graduated. A further three students (CT Mapisa, JK Kgarume and JM Enslin) completed the two-year intensive modules and mini-dissertations required for the fulfillment of MRM MSc qualification, and obtained their degrees in 2021.

Dr Adriaan Odendaal was conferred with his doctoral degree after successfully completing his PhD thesis titled 'Sedimentary cycles in the Adelaide Subgroup, Southern Karoo – a new perspective'. His supervisor was Prof WA van der Westhuizen.

POSTDOCTORAL RESEARCH FELLOWS

Dr Emmylou Kotze has been a Postdoctoral Fellow of the Department since 2020. She is working in the Bushveld Research Group under the guidance of Prof Roelofse.

STAFF MATTERS

The Department welcomed Dr Robert Muir and Dr Martin Clark as academic staff in 2021 – the former as Senior Lecturer (Sedimentology), and the latter as Lecturer and principal investigator of the MAGIC Project. Both Dr Muir and Dr Clark had been postdocs – the former at UCT and the latter at UFS.

New staff member, Dr Robert Muir, Senior Lecturer in Sedimentology

Prof John Carranza was appointed as Professor of Economic Geology, and will join the Department in January 2022.

Dr Adriaan Odendaal resigned in March 2021, having served the Department for over 15 years.

Staff of the Department of Geology 2021

RESEARCH OUTPUTS

Research Articles

Archer, W. 2021. Carrying capacity, population density and the later Pleistocene expression of backed artefact manufacturing traditions in Africa. *Phil. Trans. R. Soc. B* 376: 20190716. DOI: 10.1098/rstb.2019.0716.

Archer, W., Djakovic. I., Brenet, M., Bourguignon, L., Presnyakova D., Schlager, S., Soressi, M., & McPherron, S. P. 2021. Quantifying differences in hominin flaking technologies with 3D shape analysis. *Journal of Human Evolution* 150: 102912. DOI: 10.1016/j.jhevol.2020.102912.

Beukes, J.J., Roelofse, F., Gauert, C.D.K., Grobler, D.F. & Ueckermann, H. 2021. Strontium isotope variations in the Flatreef on Macalacaskop, northern limb, Bushveld Complex: implications for the source of platinum-group elements in the Merensky Reef. *Mineralium Deposita*. 56: 45-57.

Cheweshe, T.T., Welman-Purchase, M. & Deysel, L-M. 2021. Extraction of Tungsten from Wolframite Sample Using Ammonium Phosphate Salt as Flux. *JOM* 74: 283-292. DOI: 10.1007/s11837-021-05021-1.

Cheweshe, T.T., Welman-Purchase, M. & Deysel, L-M. 2021. Fusion of chromite Ore using Sodium phosphate salt as flux and the effects of sodium ions in wet chemical analysis. *JOM* 73: 1344-1352. DOI: 10.1007/S11837-021-04632-Y.

Clark, M.D., Kovaleva, E., Huber, M.S., Fourie, F. & Harris C. 2021. Post-Impact Faulting of the Holfontein Granophyre Dike of the Vredefort Impact Structure, South Africa, Inferred from Remote Sensing, Geophysics, and Geochemistry. *Geosciences* 11(2): 96. DOI: 10.3390/geosciences11020096.

Cornell, D.H., Meintjes, P.G., Van der Westhuizen, W.A., Kristoffersen, M. & Frei, D. 2021. Dating detrital zircon from the gold-bearing Ventersdorp Contact Reef in the Ventersdorp Supergroup of South Africa. *Precambrian Research* 357: 106131. DOI: 10.1016/j.precamres.2021.106131.

Huber, M.S., Kovaleva, E., Clark, M.D., Ulrich, R. & Fourie, F.D. 2021. Evidence from the Vredefort Granophyre Dikes points to crustal relaxation following basin-size impact cratering. *Icarus* 374: 11482. DOI: 10.1016/j.icarus.2021.114812.

Keet, J.J., Roelofse, F., Gauert, C.D.K. Grobler, D. & Butler, M. 2021. A Comparative Study of Sulfur Isotope Variations within the Flatreef and Merensky Reef of the Bushveld Complex, South Africa. *The Canadian* Mineralogist 59(6): 1363-1380. DOI: 10.3749/canmin.2100028.

Krishnan, R., Menon, S., Lee E., Welman-Purchase, M. & Swart, H.C. 2021. Color tunable cathodoluminescence properties of RE2WO6:Ln3+ (RE, Ln = Er3+ and Tm3+) phosphor and its microscopic imaging. *Materials Research Bulletin* 134: 111114. DOI10.1016/j.materresbull.2020.111114.

McPherron, S.P., Archer W., Otárola-Castillo, E.R., Torquato, M.G. & Keevil, T. 2021. Machine learning, bootstrapping, null models, and why we are still not 100% sure which bone surface modifications were made by crocodiles. *Journal of Human Evolution* 164: 103071. DOI: 10.1016/j.jhevol.2021.103071

Reid, D.L. & Minnaar, H. 2021. Lithostratigraphy of the Vuurdood Subsuite, an early Mafic-Ultramafic phase of the Palaeoproterozoic Vioolsdrif Intrusive Suite, Richtersveld Magmatic Arc, Northern Cape Province. *South African Journal of Geology* 124(3): 805-814. DOI: 10.25131/sajg.124.0049.

Walter, B.F., Giebel, R.J., Steele-MacInnis, M., Marks, M.AW. Kolb, J. & Markl, G. 2021. Fluids associated with carbonatitic magmatism: A critical review and implications for carbonatite magma ascent. Earth-Science Reviews 215: 103509, DOI: 10.1016/j.earscirev.2021.103509.

Books/Chapters in Books

Huber, M.S., Kovaleva, E., Clark, M.D. & Prevec, S.A. 2021. Inhomogeneous distribution of lithic clasts within the Daskop granophyre dike, Vredefort impact structure: Implications for emplacement of impact melt in large impact structures. In: *Large Meteorite Impacts and Planetary Evolution VI*. GSA Special Papers Volume 550 W.U. Reimold & C. Koeberl (Eds).: Geological Society of America. DOI: 10.1130/2021.2550(10).

Huber, M.S., Roelofse, F., Koeberl, C. & Tredoux M.†. 2021. New field, geochemical, and petrographic evidence from the Bon Accord nickel body: Contamination of a komatiite by deep mantle or meteorite source? In: *Large Meteorite Impacts and Planetary Evolution VI*. GSA Special Papers Volume 550 W.U. Reimold & C. Koeberl (Eds).: Geological Society of America. DOI: 10.1130/2021.2550(10).

Conference Contributions

Conference Papers/Posters

Ibrahim, K.O., Yusuf, M.A. & Purchase, M.D. 2021. *Investigation of aquifer vulnerability and pollution index around industrial area in Ilorin, North-Central Nigeria, Ibadan, Nigeria.* Paper delivered at the GSSE. 7-11 September 2021.

Keet, J.J., Roelofse, F., Gauert, C.D.K. & Grobler, D. 2021. *Strontium and sulphur isotope variations in the Flatreef on Turfspruit and Macalakaskop, Northern Lobe, Bushveld Complex: correlation with the Upper Critical Zone – Main Zone transition.* Paper delivered at Goldschmidt 2021 (Virtual), Lyon, France. 4-9 July 2021.

Malatji, M., Roelofse, F. & Magson, J. 2021. *The strontium isotopic stratigraphy of the LCZ-UCZ transition in the Western Limb, Bushveld Complex.* CIMERA Annual Colloquium 2021 (Virtual), Johannesburg. 18-19 November 2021.

Motaung, T.S., Roelofse, F. & Magson, J. 2021. *The Sr-isotopic stratigraphy of the Eastern limb of the Bushveld Complex.* CIMERA Annual Colloquium 2021 (Virtual), Johannesburg. 18-19 November 2021.

STAFF (2021)

Head of Department:

Prof B Yibas

Professor:

Prof B Yibas

Associate Professor:

Prof F Roelofse

Affiliated Professors:

Prof DE Miller and Prof R Schemers

Affiliated Associate Professors:

Prof CD Gauert, Prof GJB Germs and Prof RP Schouwstra

Senior Lecturers:

Dr R Hansen, Dr H Minnaar and Dr R Muir

Lecturers:

Ms Jarlen Keet, Ms J Magson, Dr M Clark,
Ms M Dimmick-Touw (Contract), Ms R Makhadi and
Mr ME Moitsi

Junior Lecturers:

Ms T Mapholi and Mr J Nel

Affiliated Lecturers:

Mr E Bergh, Mr T Diale, Prof C Dohm, Dr DH Prinsloo,
Ms K van der Merwe, Mr A van Niekerk, Mr A Venter,
Mr P Viljoen, and Prof K Visser

Programme Directors:

Ms J Magson and Ms M Dimmick-Touw (MRM MSc)

Research Fellows:

Dr W Archer, Prof WP Colliston, Dr RJ Giebel,
Dr PG Meintjes, Dr L Nel, Ms HCF Pretorius, Dr M Sadeghi,
Dr MJ van der Merwe and Prof WA van der Westhuizen

Senior Assistant Officers:

Mr A Felix, Ms C van der Vyver and Ms R Zaal

Technical Officers:

Mr P Lehloenya, Ms M Purchase and Mr D Radikgomo

Department of
MATHEMATICAL STATISTICS AND ACTUARIAL SCIENCE

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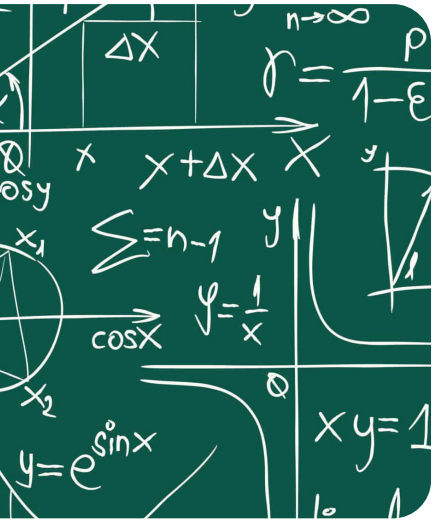


OVERVIEW OF 2021

The year of 2021 started with a much reduced intake in first-year students, mainly due to issues related to COVID-19 and the National Student Financial Aid Scheme (NSFAS). However, we managed to secure four new high quality researchers/lecturers, following the loss of two of our academic staff members in the previous year. Our programme remains strong in both research outputs, as well as student numbers and throughput rates.

The pandemic forced us into dual mode of lecturing, in which many classes were conducted online, and face-to-face classes are mostly conducted on BlackBoard Collaborate simultaneously, and recorded as well. This forced us into a blended approach in which online tuition and consultation became a part of what we do on a day-to-day basis, and likely to be with us into the future. Some of our staff members did contract COVID-19 during the year, but mostly with mild symptoms. This did not affect the delivery of the academic project in any way.

Our Department worked mostly from home, with about 25% occupation in office. The work from home was just as effective, if not more effective, with productivity levels remaining high. We expect some staff members to complete their PhDs soon, and 2021 saw two promotions – Sean van der Merwe to Senior Lecturer and Andrehette Verster to Associate Professor.

ACHIEVEMENTS

Staff Achievements

The following staff members received recognition for their excellent work in terms of student support and teaching and learning at the Learning and Teaching Awards held on 13 October 2021:

- Khothatsa Project 2021: Dr Michael von Maltitz
- Vice-Chancellor's Award (2nd place): Dr Michael von Maltitz
- UFS Learning & Teaching Awards - Assessment Category (2nd place): Zani Ludick

Celebrating the winners at the UFS Learning and Teaching Awards, from the left, Prof Danie Vermeulen (Dean), Zani Ludick (Mathematical Statistics and Actuarial Sciences), Christa Faber (Mathematics and Applied Mathematics, QwaQwa Campus]), Elzmarie Oosthuizen (Faculty Teaching and Learning Manager) and Michael von Maltitz (Mathematical Statistics and Actuarial Sciences)

Mr Frans Koning qualified as a Chartered Enterprise Risk Actuary (CERA).

Prof Maxim Finkelstein, distinguished Professor in the Department has been awarded the A-1 NRF-rating. For the second time (the first time being in 2015). He is the only researcher with an A1-rating in South Africa (in Probability, Statistics and Operations Research.

Student Achievements

The 2021 student awards were as follows:

- Best first-year student in Statistics:
  Ms S Laubscher and Ms B Ansley
- Best second-year student in Statistics:
  Mr MT Pheko
- Best third-year student in Statistics:
  Mr WJ le Roux
- Best first-year student in Business Calculations:
  Ms MV Thamae
- Best first-year student in Mathematical Statistics:
  Mr T Moshoma
- Best second-year student in Mathematical Statistics:
  Ms M le Roux
- Best third-year student in Mathematical Statistics:
  Mr F Marais

TEACHING AND LEARNING

Our Department presents degrees in Actuarial Science, Mathematical Statistics, Applied Statistics and Econometrics. No new courses were introduced in 2021.

RESEARCH AND INNOVATION

Our Department specialise in Extreme Value Theory (EVT), Bayesian Statistics, Multiple Imputation, and various financial types of research within Actuarial Science, as well as mortality analysis and improvements.

ENGAGED SCHOLARSHIP

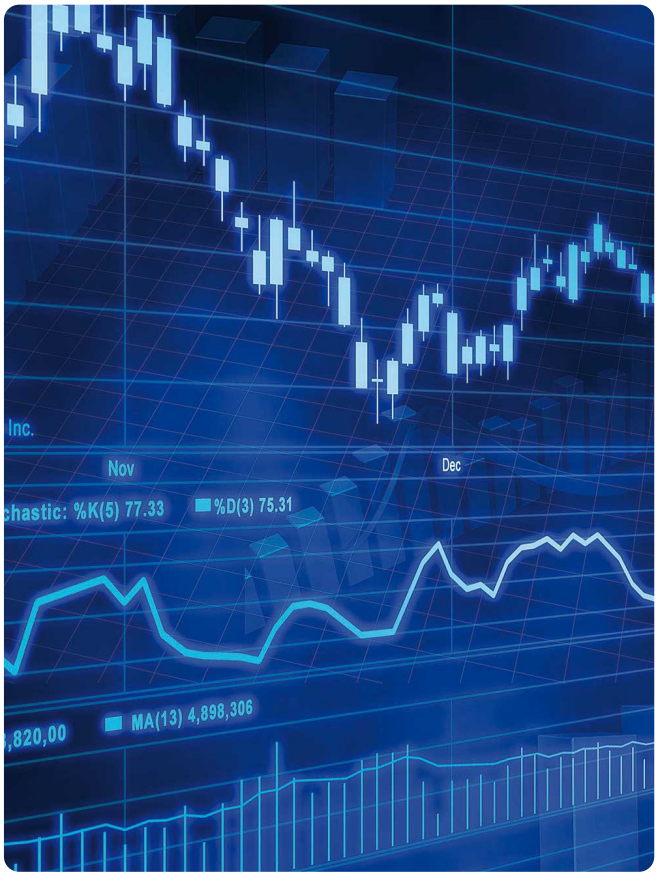
We continued to demonstrate very high involvement in engaged scholarship activities, such as serving as co-editor, reviewing articles for journals and books. Our interactions with especially the Actuarial Industry and professional sectors are good, with participation in several professional committees, such as the Microinsurance committee, Damages committee and some academic committees.

Some staff members are also involved in the professional actuarial examinations, as well in the marking thereof.

The statistical consultation unit is also growing and performing extremely well, providing a professional statistical service to the UFS research community.

NATIONAL AND INTERNATIONAL COLLABORATION

Prof Jan Beirlant from KU Leuven visits our Department on an annual basis and lectures the Extreme Value Theory Course. He also actively engages in research with our Department on the topic of EVT.



STAFF MATTERS

Dr Mandla Diko joined the statistical consultation unit, and also assisted with some teaching duties.

The appointment of Dr Niladri Chakraborty as Lecturer in the Department finally came to fruition when he joined the Department in February 2021. Two other new staff members started in 2921, Prof Charl Pretorius (as Professor) and Mr Sandile Shongwe (as Lecturer)

Two promotions that were applied for in 2020 realised, with the promotion of Dr Sean van der Merwe to Senior Lecturer and Dr Andrehette Verster to Associate Professor.

Sadly, Mr Dries Naude passed away on 8 January 2021.

RESEARCH OUTPUTS

Research Articles

Chikobvu, D. & Domingo, P. 2021.Using criterion-based model averaging in two-input MRSM problems: investigating cloning of an under-fitted response model. International Journal of Experimental Design and Process Optimization 6: 201-233.

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Conference Contributions

Conference Proceedings

Chong, Z.L., Chan, K.M., Wang, J., Malela-Majika, J-C. & Shongwe, S.C. 2021. Overall performance comparison of homogeneously weighted moving average and double homogeneously weighted moving average schemes. In: *International Conference of Industrial Engineering and Engineering Management*. Chai, K.H. & Moon, S.K. (Ed). Singapore City, Singapore, 13-16 December 2021. Universiti Tunku Abdul Rahman Press. pp. 1-5.

STAFF (2021)

Head of Department:

Mr FF Koning

Professors:

Prof MS Finkelstein (Contract), Prof C Pretorius, Prof R Schall (Contract)

Associate Professor:

Prof A Verster

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Mr J Blomerus, Dr N Chakraborty, Dr D Chikobvu, Mr F Koning, Dr M Diko, Dr L van der Merwe, Dr S van der Merwe and Dr M. von Maltitz

Lecturers:

Ms L da Silva, Ms E Girmay, Ms Z Ludick, Ms W Oosthuizen, Mr S Shongwe, Dr M Sjölander and Mr L Voges

Programme Director:

Dr M von Maltitz

Secretary:

Ms ME Mathee

Messenger:

Mr W Baranye

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OVERVIEW OF 2021

The Department of Mathematics and Applied Mathematics enjoyed a fruitful 2021, including the promotion of a staff member, promising research output and a number of staff members obtaining new qualifications. On the teaching and learning front, we were encouraged by being back on Campus in a fully face-to-face fashion, albeit still with some restrictions and adjustments due to social distancing requirements. Research travel and thus collaboration was also still hampered, although fortunately some compensation was achieved by means of virtual capabilities. This was exemplified in one highlight of the year, namely the hosting of the 64th Annual South African Mathematical Society (SAMS) congress, which was conducted fully online and yet was a great success. We look forward to expanding on virtual interactions in 2022, but will simultaneously wish to rekindle and even expand on the traditional modes with regard to student and staff engagement.

ACHIEVEMENTS

Staff Achievements

During the annual Flash-facts competition, Dr Elizabeth Maritz won the second prize in the Faculty with her talk, titled 'Travelling wave fault detection using graph theory'.

At the UFS Learning and Teaching Awards ceremony, Ms Christa Faber won first place in the 2021 Innovative Methods in Assessment Practices category. Ms Faber also obtained her MEd in Higher Education Studies in 2021.

Christa Faber

Mr Sello Mbambo obtained his MSc in Mathematics (Functional Analysis) in June 2021 at the University of

Pretoria; he subsequently started with his PhD studies. Two contract staff members, Mr Gerhard Venter and Ms Elize Swartz, also obtained new qualifications – an Honours in Mathematics and Applied Mathematics and an MSc in Mathematics, respectively.

Student Achievements

Ms Marinda le Roux received the CB van Wyk prize for the best second-year student in Mathematics and Applied Mathematics of 2020. This prize was officially awarded at the Faculty Awards Ceremony in May 2021.

TEACHING AND LEARNING

In 2021, all 23 undergraduate and 10 Honours modules, were offered in a face-to-face manner, albeit with some adjustments due to social distancing regulations, such as group sizes. Lecturers experienced being back in class as very positive, not only in terms of the interaction with students and among students, but also with respect to conveying difficult material and the immediate feedback that a class environment provides.

RESEARCH AND INNOVATION

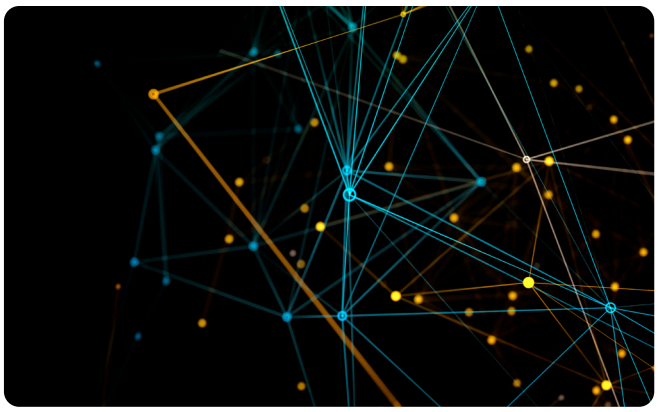
From 29 November to 1 December 2021, the Department hosted the 64th Annual Congress of the South African Mathematical Society (SAMS). The congress was conducted fully online over multiple streams, with special sessions on Lie symmetries and other approaches in solving nonlinear differential equations, functional analysis and operator theory, graph theory and combinatorics (a special session in honour of Izak Broere), category theory, algebra, topology, logic (a special session in honour of Hans-Peter Künzi), applied and numerical mathematics and finite groups and combinatorial structures. Prof Jeandrew Brink from our Department was a plenary speaker at the congress delivering an address titled 'Determining the geometry of strong field space-times in spite of tacitly assuming the answer during every measurement'. Prof Johan Meyer was the chair and driver of the local organising committee. The congress was a success with lively participation, despite being online.

In terms of our research activities during 2021, the field of graph theory continued its strong growth in the Department, with promising developments in the establishment of a graph theory research group.

Prof Tomas Vetrik again had a very productive year, (co) authoring 12 papers and collaborating with staff from the Department and also internationally. Prof Vetrik published a paper, together with Dr Elizabeth Maritz, on the partition dimension of directed circulant graphs. Furthermore, he supervised the Master's research of Ms Elize Swartz and completed prior research with Dr Selvaraj Balachandran, who finished his postdoctoral fellowship in the Department at the end of 2020.

Dr Elizabeth Maritz supervised the Honours research of Mr Gerhard Venter, who subsequently started with MSc studies and will continue with his graph theory research in 2022. Dr Maritz also extended her collaboration beyond the Department, continuing with an interdisciplinary study on the application of graph theory on travelling wave fault location detectors. Together with Dr Jacques Maritz, from the UFS Engineering Science, and Dr Moslem Salehi, from the Department of Electrical Engineering at Technical and Vocational University (TVU) in Tehran, Iran, a paper was published in IEEE Access. She presented an invited paper (virtually) at one of the mini-symposia of the Canadian Discrete and Algorithmic Mathematics Conference (CanaDAM) 2021, on 26 May, titled 'On the partition dimension of circulant graphs'. On 5 July, she also presented a paper (virtually) at the British Combinatorial Conference 2021, titled 'A note on the covering dimension of a graph'.

Dr Albert Kriel made good progress in his research on numerical analysis, specifically on numerical schemes, publishing two papers in high quality journals.



ENGAGED SCHOLARSHIP

Prof Johan Meyer continued in his role as vice-chairperson of the South African Mathematics Olympiad (SAMO) problems committee. Dr Renier Jansen and Dr Christiaan Venter were again involved with Nautilus Mathematics, which organises workshops in Olympiad-type mathematics for learners from the Free State and Northern Cape.

In 2021 staff from the Department acted as reviewers for various journals, such as:

- Dr Venter for *Pythagoras* and *Eurasia Journal of Mathematics, Science and Technology Education.*
- Dr Maritz for *Journal of Combinatorial Optimization and IEEE Access.*
- Prof Vetrik for *Ars Mathematica Contemporanea, Asian-European Journal of Mathematics, Discrete Applied Mathematics, Journal of Mathematics, Mathematical Problems in Engineering, Opuscula Mathematica, Symmetry, Transactions in Mathematical and*

Computational Sciences, Transactions on Combinatorics, TWMS Journal of Applied and Engineering Mathematics, and *U.P.B. Scientific Bulletin.*

- Dr Edgard Ngounda for *Computational Economics.*

Prof Vetrik also served on the editorial boards of *Discrete Mathematics Letters* and *Open Journal of Discrete Applied Mathematics,* and Dr Ngounda was a member of the review panel for the L'OREAL-UNESCO Woman in Science Fellowship.

Prof Jeandrew Brink continued to act as the South African representative on the International Pulsar Timing Array (IPTA) Steering Committee, and a member of the IPTA working groups for Education and Outreach.

NATIONAL AND INTERNATIONAL COLLABORATION

Prof Tomas Vetrik undertook research visits to Qatar and Slovakia, during which he collaborated with various researchers on aspects of graph theory.

Prof Tomas Vetrik (right) with collaborator, Prof Jaradat from the Univrsity of Doha, in Doha (November 2021)

Prof Johan Meyer continued a long-standing collaboration with Prof Carl Maxson from Texas A&M University, and together they published two papers in 2021.

Dr Ur Koumba collaborated with researchers from North-West University (NWU) and the University of Johannesburg (UJ) on research on the Mathematics of Finance and published a paper from this collaboration.

POSTGRADUATE STUDENTS

In 2021, three students were enrolled for BSc Honours in Mathematics and Applied Mathematics and all three obtained their degrees. One student enrolled for a Master's degree in Mathematics and will continue in 2022. One student continued with PhD studies in 2021.

A highlight of 2021 was our first MSc student who is enrolled for the full research Masters, not a structured Masters as in the past. More funding is available to students in this format and the hope is that this will attract more students and as such further assist in growing research in the Department.

POSTDOCTORAL RESEARCH FELLOWS

During 2021, the Department hosted one Postdoctoral Fellow, Dr Phillip Mafuta from Zimbabwe, who worked with Prof Tomas Vetrik on research in graph theory.

STAFF MATTERS

Ms Christa Faber was promoted from Junior Lecturer to Lecturer.

RESEARCH OUTPUTS

Research Articles

Alfuraidan, M.R., Balachandran, S. & Vetrik, T. 2021. General multiplicative Zagreb indices of unicyclic graphs. *Carpathian Journal of Mathematics* 37(1): 1-14. https://www.jstor.org/stable/27082077.

Alfuraidan, M.R., Das, K.C., Vetrik, T. & Balachandran, S. 2021. General sum-connectivity index of unicyclic graphs with given diameter. *Discrete Applied Mathematics* 295: 39-46. DOI: 10.1016/j.dam.2021.02.012.

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Deng, H., Vetrik, T. & Balachandran, S. 2021. On the harmonic index and the signless Laplacian spectral radius of graphs. *Kragujevac Journal of Mathematics* 45(2): 299-307.

Edelman, B., Rivera-Paleo, F.J., Merritt, J.D., Farr, B., Doctor, Z., Brink, J., Farr, W.M., Gair, J., Key, J.S., McIver, J. & Nielsen, A.B. 2021. Constraining unmodeled physics with compact binary mergers from GWTC-1. *Physical Review D* 103: 042004. DOI: 10.1103/PhysRevD.103.042004.

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Masre, M. & Vetrik, T. 2021. General degree-eccentricity index of trees. *Bulletin of the Malaysian Mathematical Sciences Society* 44: 2753-2772.

Masre, M. & Vetrik, T. 2021. On the general degree-eccentricity index of a graph. *Afrika Matematika* 32: 495-506. DOI: 10.1007/S40840-021-01086-Y.

Maxson, C.J. & Meyer, J.H. 2021 Obituary – John David Philip Meldrum : 1940 – 2018. *Bull. London Math. Soc.* 53: 1249-1262. DOI: 10.1112/blms.12535.

Maxson, C.J. & Meyer, J.H. 2021. Rings of congruence preserving functions, II. *Comm. Algebra* 49(2): 579-589. DOI: 10.1080/00927872.2020.1812619.

Mudzingiri, C. & Koumba, U. 2021. Eliciting risk preferences experimentally versus using a general risk question. Does financial literacy bridge the gap? *Risks* 9(8): 140. DOI: 10.3390/risks9080140.

Vetrik, T. 2021. Extended study of biological networks using graph theory. *Proyecciones Journal of Mathematics* 40(5): 1211-1225. DOI: 10.22199/issn.0717-6279-4580.

Vetrik, T. 2021. General degree distance of graphs. *Journal of Algebra Combinatorics Discrete Structures and Applications* 8(2): 107-118.

Vetrik, T. 2021. General eccentric distance sum of graphs. *Discrete Mathematics, Algorithms and Applications* 13(4): 2150046.

Vetrik, T. 2021. Study of generalized networks using graph theory. *Hacettepe Journal of Mathematics and Statistics* 50(5): 1491-1499. DOI: 10.15672/hujms.823694.

Conference Contributions

Conference Papers/Posters

Brink, J. 2021. *Determining the geometry of strong field space-times in spite of tacitly assuming the answer during every measurement*. Paper delivered at South African Mathematical Society (SAMS), Bloemfontein, South Africa. 29 November-1 December 2021.

Maritz, E.C.M. 2021. *A note on the covering dimension of a graph*. Paper delivered at the British Combinatorial Conference (BCC), Durham, England (Virtual). 5-9 July 2021.

Maritz, E.C.M. 2021. *On the partition dimension of circulant graphs*. Paper delivered at Canadian Discrete and Algorithmic Mathematics (CanaDAM), Winnipeg, Canada (Virtual). 25-28 May 2021.

Mbambo, S.P. 2021. *Ordered Banach spaces and cones with angle property*. Paper delivered at Topology, Algebra, Analysis, Geometry and Applications (TAAG-A), Gaborone, Botswana (Virtual). 27-29 September 2021.

STAFF (2021)

Head of Department:

Dr C Venter

Bloemfontein Campus:

Senior Professor:

Prof JH Meyer

Professor:

Prof T Vetrik

Associate Professor:

Prof J Brink

Lecturers:

Dr RS Jansen, Dr A Kriel, Dr ECM Maritz, Dr E Ngounda and Dr C Venter

Junior Lecturers:

Ms MJF Botha and Ms AE Swart

Temporary Lecturers:

Mr JB Smit, Ms E Swartz, Ms JS van Niekerk and Mr JG Venter

Programme Director:

Dr C Venter

Administrative Officer:

Ms SM Venter

Qwaqwa Campus:

Subject Head:

Dr UA Koumba

Senior Lecturer:

Dr UA Koumba

Lecturers:

Ms C Faber, Dr NR Loufouma Makala and Mr SP Mbambo

Department of MICROBIOLOGY AND BIOCHEMISTRY

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OVERVIEW OF 2021

The Department of Microbial, Biochemical and Food Biotechnology was, until the end of 2020, responsible for undergraduate teaching and postgraduate training in three subjects – Biochemistry, Microbiology and Food Science. At the end of 2020, reorganisation of the Faculty of Natural and Agricultural Sciences resulted in the closure of the Division of Food Science. The name of the Department thus changed to Microbiology and Biochemistry and the Department will in future only teach Microbiology and Biochemistry. Undergraduate modules in Food Science will be phased out by 2023. Research conducted in the Department will still find application in three main areas – production of safe and novel food products, biocatalytic production of chemicals or bioremediation of chemical pollution, and improvement of human and animal health.

Showing off the new name of the Department are, from the left, DAAD intern, Beness Partsch and PhD student, Corrinne Fourie

ACHIEVEMENTS

Staff Achievements

Prof Robert Bragg was a keynote speaker at the 3rd International Conference on Infectious Diseases and Nanomedicine.

Dr Julio Castillo delivered a keynote address on 'Biomining: new perspectives' at the Science Forum South Africa, held on 1 December in Cape Town and organised by the Association of Spanish Researchers in South Africa (ACE South Africa) and funded by the Embassy of Spain.

Dr Onele Gcilitshana was elected as the new treasurer of the South African Society for Microbiology.

Student Achievements

Abdullahi Jamiu received the Reliable Diagnostic Supplies prize for the best MSc dissertation in Microbiology/ Microbial Biotechnology.

Two Master's students from the Applied and Environmental Microbiology Group, Jameel Alom and Aoate Tsimatsima, were awarded A4U (Alliance 4 Universities) bursaries to stay for five months at the University Autonomous of Barcelona during the second semester of 2021. Ms Tsimatsima also became the first Tiny Earth Partner Instructor (TEPI) in South Africa, as part of Tiny Earth, an international student-sourcing antibiotic discovery network (https://tinyearth.wisc.edu/).

RESEARCH AND INNOVATION

The research undertaken within the Department can be clustered into three main themes, viz. safe and novel food products and processes; biocatalysis, bioremediation and bioprospecting; and improvement of human and animal health.

Safe and novel food products and processes

During 2021, Prof Celia Hugo and her research group continued their research on psychrotolerant bacteria in food, with an emphasis on the genus *Chryseobacterium/Kaistella*. These organisms produce keratinolytic enzymes that break down poultry feathers. The group also investigated the use of natural preservatives as replacement or partial replacement of sulphur dioxide in the production of Boerewors. Rooibos extract, green rooibos extract and protective cultures showed promising results. Prof Hugo was also contracted by MilkSA to investigate age gelation in ultra-high-temperature processing (UHT) milk to develop methods for detection of psychrotolerant bacteria and their enzymes. This work will be completed in 2022.

The research of Prof Garry Osthoff on milk composition of African non-dairy animals continues to add surprises to the knowledge of milk composition. The study on white rhinoceros' milk was completed and its composition was compared to that of other Perisodactyla species. This taxonomic order, which includes horses and zebras, seems to have the most conserved milk composition compared to all other taxa studied thus far. Although slow, progress was also made in the study of the metabolites in milk. As was experienced with the fats and proteins of milk, the elephant delivered very interesting data, specifically on the carbohydrate fraction. This fraction seems to be very complex and several more oligosaccharides were detected and will have to be identified.

Prof Osthoff and Prof Maryna de Wit have been investigating the composition of Opuntia (prickly pear plants) for several years, with the mucilage polysaccharides of the cladodes and fruit peels receiving attention. A PhD student, Brandon van Rooyen, is investigating the physical properties of the mucilage. This involves rheological tests on viscosity and gel formation, as well as tensile strength of dried cast gels. These properties are compared with other hydrocolloid carbohydrates that are employed in the food industry for texture purposes, such as pectin and alginates. It is anticipated that the mucilage could improve on certain of the physical properties of other hydrocolloid carbohydrates.

Prof Bennie Viljoen and his group continued their research on the medicinal and animal feed potential of exotic mushrooms. They primarily make use of industrial and agricultural waste as substrate for fungal cultivation, and use the mushroom spent for animal feed to establish a zero-waste business. They endeavoured to find alternative food security solutions in using selected mushrooms as biological decomposers of indigestible substances, such as lignocellulose and lignin, present in invasive encroaching wood species in South Africa. They established close collaborations with Carbon Fertilizer Technologies in the Eastern Cape using Wattle trees, and with Wintershoek Game Farm in the Northern Cape. Results from up-scaled experiments on both farms using wood-chips degraded by fungi as animal feed, indicated that ruminants from the experimental groups showed improved growth compared to the control groups. Consequently, a new opportunity emerged, not only in terms of saving water through the harvesting of invader tree species, but also the beneficiation of harvested agri-waste materials via microbial digestion – of particular value in drought affected areas.

Lentinus edodes (Shiitake mushrooms), with exceptional medicinal attributes, grown on invader wood types.

Based on a programme of the Research and Technology Fund of the Department of Agriculture, Forestry and Fisheries, the research was extended in 2021, in a collaboration with farmers in the Hartswater area, to include Peanut shells and Pecan nuts. This included an agreement with Groundnuts, a major company in Hartswater specialising in peanut and pecan nut shelling. The programme will primarily focus on the rural community and will be supported by Pecans Marketing (Pty) Ltd, a pecan nut distributor located in Vaalharts.

Different Pleurotus (Oyster) species, common edible mushrooms, grown on agri-waste material.

A highlight for 2021 was the establishment of a state-of-the-art facility to produce exotic mushroom in Botshabelo, in collaboration with the start-up company, Forever Mushrooms. The facility can harvest up to seven tonnes of mushrooms per month. The UFS signed an agreement of understanding to be responsible for training, development and the provision of spawn. Postgraduate students will have full access to the facility for research purposes.

Biocatalysis, Bioremediation and Bioprospecting

The ***Applied and Environmental Microbiology Group (AEMG)***, led by Dr Julio Castillo, apply the knowledge gained from their work in extreme environments to develop biotechnology strategies for the treatment of polluted water for various industries, recovery of metals of economic interest, and discovery of secondary metabolites with potential applications in the human and animal health sectors (i.e. antibiotic and anticancer compounds).

In a project funded by the Technology Innovation Agency (TIA), Dr Castillo and Master's student, Ms Martha Mogale, have characterised the bacterial diversity and chemical composition of several alkaline pit lakes. Their study proposes the use of a non-genetically modified microbial consortium in a natural desalinisation process for the remediation of mine drainage with high salt concentrations. This strategy might revolutionise the treatment of this type of contaminated water and might have a large socio-economic impact in a water stressed country like South Africa.

Dr Castillo and co-workers, Dr Alba Gomez and the Master's student, Jameel Alom, have also isolated bacteria from a hypersaline aquifer two billion years old at 3.5 km deep in Moab Khotsong mine. The untapped metabolisms hidden in these microorganisms will be explored using Nanoscale secondary ion mass spectrometry (NanoSIMS) and high-throughput next-generation sequencing. This project on the biogeochemical processes in subsurface hypersaline environments near the abiotic fringe, is carried out in collaboration with Princeton University and the New Mexico Institute of Mining and Technology.

Mr Jameel Alom (left) and Dr Julio Castillo (right) collecting water samples at 3.5 km depth in Moab Khotsong Mine in November 2021

The AEMG (Dr Julio Castillo, Ms Aoate Tsimatsima, and PhD student, Andisiwe Matu) are collaborating with the Single Cell Genomics Centre of the American Bigelow Laboratory for Ocean Sciences, to explore the genome of the endophytic microbial dark matter of a medicinal plant, the African potato. The group has developed a protocol which has revealed through next generation sequencing, for the first time, the microbial composition of the endophytic microorganisms (i.e. fungi and bacteria) that inhabit the African potato.

MSc candidate, Aoate Tsimatsima, collecting samples of African potato near Wepener in the Free State, for the project 'Endophytes in African potato as an alternative source of bioactive compounds'

In July 2021, the AEMG hosted a bioinformatics workshop, titled 'Introduction to Bioinformatic: R-studio and QIIME2', for its own students. The workshop was organised and presented by Dr Julio Castillo and Ms Andisiwe Matu.

The ***Biocatalysis and Structural Biology Group*** of Prof Dirk Opperman, Prof Martie Smit and Dr Carmien Tolmie have, for more than ten years, focused almost exclusively on novel biocatalytic systems for the introduction of oxygen into molecules and the further conversion of these hydroxylated products. Since their discovery of a cytochrome P450 (CYP) monooxygenase (with unique in-chain hydroxylase activity of *n*-alkanes and fatty alcohols and acids), the group has expanded on their work with this class of CYP. In 2021, the group published the X-ray crystal structure of only the third-ever fungal CYP class and are now exploring ways to engineer these enzymes for improved activity and selectivity.

The group has also started several projects on hydrogen peroxide-driven peroxygenases, exploring more industrially feasible routes to value-added products. In addition to Biocatalysis, the group has, under the guidance of Dr Carmien Tolmie, diversified into Structure-Based Drug Discovery. The first of these projects focuses on discovery of antifungal drugs and centres on developing novel drugs against metabolic enzymes, especially from the pathogens *Candida albicans* and *Aspergillus flavus*. A second project, on antiviral drug-discovery, is based on the reverse transcriptase-polymerase from the hepatitis B virus. These projects will use X-ray crystallographic fragment screening to develop lead compounds that can be developed into novel inhibitors using medicinal organic chemistry.

Improvement of human and animal health

The ***Molecular Virology Group*** of Prof Trudi O'Neill continued to investigate rotavirus strain diversity, specifically focusing on whole genome constellations of human field strains originating from Mozambique. The study was expanded to include various animal strains, including bovine and porcine from both Mozambique and South Africa. Two approaches for rotavirus vaccine development are also under investigation, namely a replication-deficient rotavirus vaccine through production of rotavirus proteins in yeast, and engineering of rotavirus reassortants making use of the rotavirus reverse genetics system. The latter is funded through a collaborative grant from the Deutsche Forschungsgemeinschaft (DFG). In a quest for a possible broad-spectrum antiviral, the role of lipids during rotavirus replication is also being investigated.

The work of the ***Clinical Biochemistry Group***, led by Dr Frans O'Neill, focuses on metabolism of selected sterols in various fauna and production of reproductive hormones. The former forms part of an interdisciplinary project in which a holistic approach to understanding rhinoceros biology and its interaction with the environment is investigated, while the latter has a specific focus on equine chorionic gonadotropin – an important hormone used in animal breeding.

Four academic staff members work together within the ***Pathogenic Yeast Research Group***. They are Prof Carlien Pohl-Albertyn (who holds the Research Chair in Pathogenic Yeasts under the National Research Foundation [NRF] South African Research Chair Initiative [SARChI]), Prof Koos Albertyn, Dr Olihile Sebolai and Dr Onele Gcilitshana. The group focuses on molecular mechanisms of virulence and the role of bioactive lipids in pathogenic yeasts, specifically *Cryptococcus neoformans* and several *Candida* species. They are also interested in the virulence of polymicrobial infections consisting of *Candida* spp. and the bacterium *Pseudomonas aeruginosa*. During 2021, four MSc students and one PhD student successfully completed their research and obtained their degrees.

The ***Veterinary Biotechnology Research Group*** of Prof Rob Bragg and Dr Charlotte Boucher (currently appointed as a research fellow), continued their work on the development of sub-unit vaccines against *Avibacterium paragallinarum* and SARS-CoV-2. They are also using the full genome sequence of *A. paragallinarum* to identify novel targets for sub-unit vaccine production. Work continued on phage display libraries for the development of antibody fragments and antiviral peptides to neutralise the Newcastle disease virus. As part of their research on resistance to disinfectants, the group sequenced the genome of a highly resistant bacterial strain and found genomic islands which contain a wide range of resistance genes, not only to disinfectants, but also antibiotics and heavy metals. This work opens the door to a very interesting new field investigating the link between disinfectant and antibiotic resistance. Transcriptomic analysis of the highly resistant strain was also completed and many genes were found to be substantially up- or downregulated. These include many efflux pump genes which were not previously regarded as playing a role in disinfectant resistance. Another exciting finding was the large number of hypothetical proteins, which could lead to the discovery of novel mechanisms of disinfectant resistance. During 2021, the efficacy of novel antimicrobial privacy curtains for use in hospitals, was also evaluated. It was demonstrated that these curtains were highly effective against a wide range of common nosocomial pathogens.

ENGAGED SCHOLARSHIP

Prof Pohl-Albertyn organised and chaired the 21st Biennial Conference of the South African Society for Microbiology. This was an online conference attended by local as well as international speakers. As always, the focus was on students and many of the students in the Department had the opportunity to present their research.

Dr Carmien Tolmie was the lead local organiser of an international workshop, co-organised with the University of Cape Town (UCT), on processing of X-ray crystallography data. The online workshop, CCP4 Crystallographic School in South Africa: Data Collection to Structure Refinement and Beyond, took place from 22 February to 5 March. It was the first CCP4 workshop to be hosted on the African continent and was attended by MSc, PhD and postdocs not only from the UFS and other South-African universities, but also from around the world. The lecturers were esteemed international scientists in crystallographic data processing. This workshop has already aided in the publication of two articles by researchers from the UFS.

NATIONAL AND INTERNATIONAL COLLABORATION

In 2021, the Department started an exciting new partnership with the South African National Biodiversity Institute (SANBI). Through this partnership, negotiated by Prof Carlien Pohl-Albertyn, the yeast culture collection facility was invited to become one of the core facilities of the Biobanks SA initiative. Prof Pohl-Albertyn was able to secure funding of more than one million rand to upgrade the infrastructure and equipment, and to appoint a new curator to standardise the processes and upgrade the digital database of the culture collection.

Prof Pohl-Albertyn was invited to present a talk on the Yeast Culture Collection, housed in the Department of Microbiology

and Biochemistry, at the Indigenous Microbial Diversity for Industrial Applications Virtual Workshop hosted by the CSIR on 9 November 2021. She highlighted the current holdings of this culture collection (the biggest yeast culture collection in Africa) as well as the exciting partnership with SANBI.

Despite the restrictions brought by COVID-19 since 2020, the Veterinary Biotechnology Group continued their collaborative projects with Dr Asgar, of Saife VetMed in India, on various potential commercial products. There was also continued collaboration with Dr Gavakar, of Ventri Biologicals, the largest poultry vaccine manufacturer in India, on the development of effective vaccines against infectious coryza.

Prof Dirk Opperman continued his ongoing collaborative projects with Prof Frank Hollmann and Dr Caroline Paul from Delft University of Technology (Netherlands). The groups bring together different expertise in the field of Biocatalysis, including protein structure determination, directed evolution and process development, and are currently focusing on the application of biocatalysts. Prof Opperman was also a co-investigator in the Global Challenges Research Fund – Synchrotron Techniques for African Science and Technology (GCRF-START) grant between the Diamond Light Source, UK, and various research groups in South Africa. Within GCRF-START, a collaborative project with Prof Albie van Dijk (North-West University) to determine the X-ray crystal structure of bovine glycine-N-acyltransferase (GLYAT) was continued. In 2021, together with research groups from Norway (University of Bergen and the Norwegian Research Centre [NORCE]), the United Kingdom (Exeter University), France (Alternative Energies and Atomic Energy Commission [CEA]) and Kenya (University of Nairobi), he secured funding via the ERA-NET Cofund on Food Systems and Climate (FOSC) to develop biotechnological routes to upcycle waste products and promote a circular economy.

Dr Carmien Tolmie continued a collaboration with Prof Frank von Delft, from the University of Oxford, and the XChem group at the Diamond Light Source, for structure-based drug discovery for novel antifungal drugs. Dr Tolmie and Dr Opperman collaborated with Dr Felix Ferroni from the Department of Physics at the Argentinian National Scientific and Technical Research Council (CONICET), , on the structural and functional characterisation of a copper nitrite reductase.

Prof Trudi O'Neill continued to collaborate with Dr Martin Blasco from the Centre for Biotechnology of the Argentinean National Institute of Industrial Technology (INTI) in Buenos Aires, and colleague, Prof Koos Albertyn, on rotavirus protein expression in yeast. She also continued her long-standing collaboration with Dr Nilsa de Deus, from the National Institute of Health, Maputo, Mozambique, on rotavirus diversity in Mozambique. Prof O'Neill also collaborated with Prof Martin Nyaga from the UFS Next Generation Sequencing (NGS) Unit and Dr Celeste Donato from the Enteric Diseases Group (Murdoch Children's Research Institute, Melbourne, Australia) on this topic. Second-phase funding of the DFG-funded project titled 'Antigens and reassortant strains for rotaviruses circulating in Africa (AfRota)', was approved late in 2021; AfRota-2 will commence in February 2022. The project utilises the rotavirus reverse genetics system and aims to generate chimeric viruses that can be used in next-generation rotavirus vaccine development. Collaboration with Prof Carlien Pohl-Albertyn on the role of bioactive lipids in infection was also continued.

Prof Trudi O'Neill hosted Vanessa Partsch, currently a Master's student at the University of Vienna, Austria, for eight weeks between July and September 2021, as part of the Research Internships in Science and Engineering (RISE) programme of the German Academic Exchange Service (DAAD). The internship was originally planned for 2020 but was cancelled due to the COVID-19 pandemic. Fortunately, DAAD re-offered the position for 2021.

Austrian student Vanessa Partsch in the Molecular Virology laboratory preparing a bioreactor for one of her experiments

The AEMG of Dr Julio Castillo signed a collaborative agreement with the University of Limpopo (Dr Kgabo Moganedi - Department of Biochemistry, Microbiology and Biotechnology) on a project titled 'Developing a bacterial consortium for improving the quality of mining-contaminated water'. The group has also established a collaboration with the University of Cadiz (Prof Alfonso Corzo) on a project which involves bioprecipitation of metallic copper from acid mine drainage in the Iberian Pyrite Belt. The AEMG will be responsible for the bioinformatics analysis.

Collaboration continued with Princeton University and New Mexico Tech on the project 'Biogeochemical Processes in a Subsurface Hypersaline Environment near the Abiotic Fringe Zone' and with Ritsumeikan University (Prof Hiroshi Ogasawara) on the project 'Drillhole investigations of earthquake physics and deep life in fault zones in South African mines. In addition, the AEMG still collaborates with Golders Associates analysing data collected from the pilot-barium carbonate ($BaCO_3$) dispersed alkaline substrate acid mine drainage treatment system, installed at Parys Mountain Mine and Cwm Rheidol Mine.

Dr Julio Castillo, together with Dr Alba Gomez-Arias and Prof Walter Purcell, both from the UFS Department of Chemistry, signed a collaboration agreement with a consortium which includes the University of Huelva (Dr Manuel Caraballo), the University of Aveiro (Prof Victor Ferreira), the Basque Centre for Materials (Dr Roberto Fernandez), the National University of Altiplano Puno (Dr Charango Munizaga-Rosas) and the Central University of Technology (Dr Maleke Maleke), for a project titled 'Mine tailings reprocessing, revalorization and risk reduction through sequential innovations in metal recovery, geopolymerization, ceramics and sealing processes'. The project is funded by the ERA-MIN3 programme supported by European Commission's Horizon 2020. Three PhD students are expected to graduate from this project.

Dr Frans O'Neill continued his collaboration with Prof David Marais (UCT) on phytosterols in selected South African fauna, and Dr Dee Blackhurst (UCT) on reactive oxygen species in rotavirus infected cells. The ongoing interdisciplinary collaborative effort centred on rhinoceros also includes other researchers from several departments within the Faculty of Natural and Agricultural Sciences, as well as the Faculty of Health Sciences.

Dr O'Neill is also part of an interdisciplinary project with Dr Angelique Lewies of the UFS Department of Cardiothoracic Surgery, looking at developing a cardiac organoid model for drug screening and disease modelling. He is also collaborating with Dr Fanie Steyn, of AniPharm (Pty) Ltd, on the production of equine chorionic gonadotropin, and with Dr Martin Blasco of the INTI Centre for Biotechnology (Argentina), on receptor-based assays.

Prof Carlien Pohl was appointed as visiting academic in the School of Physical Sciences at the University of Kent. This forms part of her collaboration with Dr Jennifer Hiscock on the development of novel antibiofilm compounds.

POSTGRADUATE STUDENTS

In 2021, there were 26 students enrolled with the Department for BSc Honours – 20 for Microbiology and six for Biochemistry. At the April 2021 virtual graduation 20 students from 2020 graduated with BScHons - three students majoring in Biochemistry and 17 students majoring in Microbiology.

In total, 38 students were registered in the Department for Master's degrees in 2021 – 27 in Microbiology and 11 in Biochemistry. During 2021 ten students were awarded Master's degrees, six with distinction:

- Andisiwe Matu with MSc in Biochemistry – with distinction
- Tarsisius Tichafunga Tiyani with MSc in Biochemistry – with distinction
- Sophia Soveij van der Schyff with MSc in Biochemistry
- Abdullahi Temitope Jamiu with MSc in Microbiology – with distinction
- Culien van der Merwe with MSc in Microbiology
- Mphumzi Songezo Gidaga with MSc in Biochemistry – with distinction
- Lynette Nel with MSc in Biochemistry – with distinction
- Mercy Ibukunoluwa Ogunyika with MSc in Biochemistry
- Jacobus Theunissen Rabie Brink, with MSc in Microbiology
- Nozethu Mjokane with MSc in Microbiology – with distinction

Thirteen (13) students were registered in 2021 in the Department for Doctoral degrees – six in Microbiology, three in Microbial Biotechnology and seven in Biochemistry. During 2021, five students were awarded Doctoral degrees:

PhD Biochemistry

Chen, Jou-An

Thesis: Scoping and quantification study of emerging contaminants in the free state: effects on microbial diversity

Supervisor: Prof A Valverde;
Co-supervisors: Dr J Castilo, Dr ED Cason & Dr G Kemp

Jacobs, Cheri Louise

Thesis: Structural and functional characterisation of new bacterial alkane hydroxylases

Supervisor: Prof DJ Opperman

PhD Microbial Biotechnology

Rothmann, Christopher

Thesis: Solid state fermentation of *Acacia mellifera* using mushrooms for value addition to animal feed

Supervisor: BC Viljoen

PhD Microbiology

Coetzee, Marisa

Thesis: A proteomic overview of *Avibacterium paragallinarum* serogroups with focus on immunogenic proteins

Supervisor: Dr CE Boucher-van Jaarsveld

Kgotle, Evodia Yolander

Thesis: Elucidating the biological role of 3-hydroxy fatty acid (3-OH C10:0) in the pathogenesis of *Pseudomonas aeruginosa*

Supervisor: Prof OM Sebolai

POSTDOCTORAL RESEARCH FELLOWS

The Department of Microbiology and Biochemistry hosted eight Postdoctoral Fellows during 2021. These were:

- Dr Ana Ebrecht (Argentina)
- Dr Obinna Ezeokoli (Nigeria)
- Dr Ntombikayise Nkomo (South Africa)
- Dr Olufemi Folorunso (Nigeria)
- Dr Rodolpho Aldo Machado (Brazil)
- Dr Adepemi Ogundeji (South Africa)
- Dr Roelof Coertze (South Africa)
- Dr Bonang Mochochoko (South Africa)

STAFF MATTERS

Ms Precious Letebele, who completed an MSc in 2020 supervised by Prof Carlien Pohl-Albertyn, started in April as Lecturer in Biochemistry. She is the Department's first appointment within the Government's New Generation of Academics Programme (nGAP).

Prof Koos Albertyn acted as Head of Department during the last four months of 2021, when Prof Martie Smit took long-leave. Prof Smit stepped down as Head of Department at the end of 2021 and Prof Albertyn was subsequently appointed as new Head of Department from the beginning 2022.

RESEARCH OUTPUTS

Research Articles

Adetunji, M.C., Ezeokoli, O.T., Ngoma L. & Mwanza, M. 2021. Phylogenetic diversity and prevalence of mycoflora in ready-to-eat supermarket and roadside-vended peanuts. *Mycologia* 113(1): 1-11. DOI: 10.1080/00275514.2020.1804235. Impact factor 2.149; Research field 1.06.

Akhtar S., Labuschagne M., Osthoff G., Mashingaidze K. & Hossain A. 2021. Xenia and deficit nitrogen influence the iron and zinc concentration in the grains of hybrid maize. *Agronomy* 11: 1388. DOI: 10.3390/agronomy11071388. Impact factor 3.34; Research field 1.06.

Alimi, A.A., Ezeokoli, O.T., Adeleke, R. & Moteetee, A. 2021. Arbuscular mycorrhizal fungal communities colonising the roots of indigenous legumes of South Africa as revealed by high-throughput DNA metabarcoding. *Rhizosphere* 19: 100405. DOI: 10.1016/j.rhisph.2021.100405. Impact factor 3.129; Research field 1.06.

Aschenbrenner, J.C., Ebrecht, A., Tolmie, C., Smit, M.S. & Opperman, D.J. 2021. Structure of the fungal hydroxylase, CYP505A30, and rational transfer of mutation data from CYP102A1 to alter regioselectivity. *Catalysis Science and Technology* 11: 7359-7367. DOI: 10.1039/d1cy01348c. Impact factor 6.119; Research field 1.06.

Baek, M., DiMaio, F., Anishchenko, I., Dauparas, J., Ovchinnikov, S., Lee, G.R., Wang, J., Cong, Q., Kinch, L.N., Dustin Schaeffer, R., Millán, C., Park, H., Adams, C., Glassman, C.R., DeGiovanni, A., Pereira, J.H., Rodrigues, A.V., Van Dijk, A.A., Ebrecht, A.C., Opperman, D.J., Sagmeister, T., Buhlheller, C., Pavkov-Keller, T., Rathinaswamy, M.K., Dalwadi, U., Yip, C.K., Burke, J.E., Christopher Garcia, K., Grishin, N.V., Adams, P.D., Read, R.J. & Baker, D. 2021 Accurate Prediction of Protein Structures and Interactions Using a Three-Track Neural Network. *Science* 373: 871-876. DOI:10.1126/science.abj8754. Impact factor 47.728; Research field 1.06.

Bello, S.A., Ayofe, T.A., Yakub, M.F. & Jamiu, A.T. 2021. Comparative analysis of the antimicrobial potential of stem and fruit extracts of *Calotropis procera*. *Pharmacognosy Research* 12: 368-374. DOI: 10.4103/pr.pr_58_20. Impact factor 0.00; Research field 1.06.

Boene, S.S., João, E.D., Strydom, A., Munlela, B., Chissaque, A., Bauhofer, A.F.L., Nabetse, E., Latifo, D., Cala, A., Mapaco, L., Chilaúle, J., O'Neill, H.G. & De Deus, N. 2021. Prevalence and genome characterization of porcine rotavirus A in southern Mozambique. *Infection, Genetics and Evolution* 87: 104637. DOI: 10.1016/j.meegid.2020.104637. Impact factor 2.773; Research Field 1.06.

Brink, J., Fourie, R., Sebolai, O., Albertyn, J. & Pohl, C.H. 2021. The role of lipid droplets in microbial pathogenesis. *Journal of Medical Microbiology* 70: 001383. DOI: 10.1099/jmm.0.001383. Impact factor 2.156; Research field 1.06.

Chibuzor-Onyema, I.E., Ezeokoli, O.T., Sulyok, M., Notununu, I., Petchkongkaew, A., Elliott, C.T., Adeleke, R.A., Krska, R. & Ezekiel, C.N. 2021. Metataxonomic analysis of bacterial communities and mycotoxin reduction during processing of three millet varieties into *ogi*, a fermented cereal beverage. *Food Research International* 143: 110241. DOI: 10.1016/j.foodres.2021.110241. Impact factor 4.97; Research field 1.06.

Coetzer, W.G., Coetzee, L.M., Cason, E.D., Grobler, J.P., Schneider, S.R. & Boucher, C.E. 2021. A peliminary assessment of skin microbiome diversity of zebrafish (*Danio rerio*): South African pet shop fish. *Indian Journal of Microbiology* 61: 81-84. DOI: 10.1007/s12088-020-00900-8. Impact factor 1.870; Research field 1.06.

De Wit, M. & Motsamai, V.K. Hugo, A. 2021. Cold-pressed cactus pear seed oil: Quality and stability. *Grasas Y Aceites* 72: e415. DOI: 10.3989/gya.0329201. Impact factor 1.650; Research field 1.06.

Ebrecht, A.C., Aschenbrenner, J.C., Smit, M.S. & Opperman, D.J. 2021. Biocatalytic synthesis of non-vicinal aliphatic diols. *Organic and Biomolecular Chemistry* 19: 439-445. DOI: 10.1039/d0ob02086a. Impact factor 3.876; Research field 1.06.

Ezeokoli, O.T., Gcilitshana, O. & Pohl, C.H. 2021. Risk factors for fungal co-infections in critically ill COVID-19 patients, with a focus on immunosuppressants. *Journal of Fungi* 7: 545. DOI: 10.3390/jof7070545. Impact factor 5.816; Research field 1.06.

Ezeokoli, O.T., Nuaila, V.N.A. Obieze, C.C., Muetanene, B.A., Fraga, I., Tesinde, M.N., Ndayiragije, A., Coutinho, J., Melo, A.M.P., Adeleke, R.A., Ribeiro-Barros, A.I. & Fangueiro, D. 2021. Assessing the impact of rice cultivation and off-season period on dynamics of soil enzyme activities and bacterial communities in two agro-ecological regions of Mozambique. *Agronomy* 11: 694. DOI: 10.3390/agronomy11040694. Impact factor 3.417; Research field 1.06.

Fourie, R., Albertyn, J., Sebolai, O., Gcilitshana, O. & Pohl, C.H. 2021. *Candida albicans SET3* plays a role in early biofilm formation, interaction with *Pseudomonas aeruginosa* and virulence in *Caenorhabditis elegans*. *Frontiers in Cellular and Infection Microbiology* 11: 680732. DOI: 10.3389/fcimb.2021.680732. Impact factor 4.123; Research field 1.06.

Fourie, R., Cason, E.D., Albertyn, J. & Pohl, C.H. 2021. Transcriptional response of *Candida albicans* to *Pseudomonas aeruginosa* in a polymicrobial biofilm. *G3 Genes, Genomes, Genetics* 11(4): jkab042. DOI: 10.1093/g3journal/jkab042. Impact factor 2.781; Research field 1.06.

Freitag, A., Cluff, M., Hitzeroth, A.C., Van Wyngaardt, L., Hugo, A. & Hugo, C.J. 2021. Community level physiological profiling of reduced or replaced salt fresh sausage inoculated with *Escherichia coli* ATCC 25922. *LWT - Food Science and Technology* 148: 111786. DOI: 10.1016/j.lwt.2021.111786. Impact factor 4.006; Research field 1.06.

Gómez-Arias, A., Yesares, L., Caraballo, M.A., MAleke, M., Vermeulen, D., Nieto, J.M., Van Heerden, E. & Castillo, J. 2021. Environmental and geochemical characterization of alkaline mine wastes from Phalaborwa (Palabora) Complex, South Africa. *Journal of Geochemical Exploration* 224: 106757. DOI: 10.1016/j.gexplo.2021.106757. Impact factor 3.352; Research field 1.05.

Gómez-Arias, A., Yesares, L., Díaz, J., Caraballo, M.A., Maleke, M., Sáez, R., Van Heerden, E., Vermeulen, D., Nieto, J.M. & Castillo, J. 2021. Mine waste from carbonatite deposits as potential rare earth resource: Insight into the Phalaborwa (Palabora) Complex. *Journal of Geochemical Exploration* 232: 106884. DOI: 10.1016/j.gexplo.2021.106884. Impact factor 3.352; Research field 1.05.

Hollmann, F., Opperman, D.J. & Paul, C.E. 2021. Biocatalytic reduction reactions from a chemist's perspective. *Angewandte Chemie International Edition* 60: 5644-5665. DOI: 10.1002/anie.202001876. Impact factor 15.336; Research field 1.06.

Jamiu, A.T., Albertyn, J. Sebolai, O.M., Gcilitshana, O. & Pohl, C.H. 2021. Polyunsaturated fatty acids potentiate the susceptibility of *Candida krusei* biofilms to fluconazole via disruption of membrane integrity and efflux pump activity. *Medical Mycology* 59: 1225-1237. DOI: 10.1093/mmy/myab055. Impact factor 4.076; Research field 1.06.

Jamiu, A.T., Albertyn, J. Sebolai, O.M. & Pohl, C.H. 2021. Update on *Candida krusei*, a potential multidrug-resistant pathogen. *Medical Mycology* 59: 14-30. DOI:10.1093/mmy/myaa031. Impact factor 4.076; Research field 1.06.

Kankam, G., Christians, B., Maliehe, M., Mjokane, N., Ogundeji, A.O., Folorunso, O.S., Pohl, C.H. & Sebolai, O.M. 2021. The first survey of cryptococcal cells in bird droppings across Bloemfontein, South Africa. *Veterinary World* 14: 2739-2744. DOI: 10.14202/vetworld.2021.2739-2744. Impact factor 1.547; Research field 1.06.

Lum Nde, A., Charimba, G., Hitzeroth, A, Oosthuizen, L., Steyn, L., Newman, J. & Hugo, C. 2021. *Chryseobacterium pennae* sp. nov., isolated from poultry feather waste. *International Journal of Systematic and Evolutionary Microbiology* 71: 004912. DOI: 10/1099/ijsem.0.004912. Impact factor 2.825; Research field 1.06.

Macdonald, J.F., Einkamerer, O.B., Hugo, A., Lepori, A., Josling, G.C. & Fair, M.D. 2021. Effects of fibre source on nutrient digestibility of diets for finishing lambs. *South African Journal of Animal Science* 51: 98-103. DOI: 10.4314/sajas.v51i1.11. Impact factor 0.847; Research field 1.06.

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Makinde, O., Adetunji, M., Ezeokoli, O., Odumosu, B., Ngoma, L., Mwanza, M. & Ezekiel, C. 2021. Bacterial contaminants and their antibiotic susceptibility patterns in ready-to-eat foods vended in Ogun state, Nigeria. *Letters in Applied Microbiology* 72: 187-195. DOI: 10.1111/lam.13407. Impact factor 2.858; Research field 1.06.

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Conference Contributions

Conference Papers/Posters

Aschenbrenner, J.C., Ebrecht, A.C., Tolmie, C., Smit, M.S. & Opperman, D.J. 2021. *Structural characterisation of a fungal hydroxylase from the CYP505 family and engineering of its regioselectivity by comparison with CYP102A1.* Poster presented at Biotrans, Graz, Austria (virtual). 19-22 July 2021.

Fourie, C., Ogunyinka, M.I., Legisa, D.M., Blasco, M., Albertyn, J. & O'Neill, H.G. 2021 *The effect of glycosylation on the secreted production of rotavirus VP6 by* Arxula adeninivorans *as subunit vaccine candidate*. Paper delivered at the South African Society of Microbiology Conference (SASM), Bloemfontein (virtual). 4-6 May 2021.

Gidaga, M.S., Ebrecht, A.C., Smit, M.S. & Opperman, D.J. 2021. *Characterization of fungal cytochrome P450 reductases to potentially expand class II cytochrome P450 catalysis*. Poster presented at Biotrans, Graz, Austria (virtual). 19-22 July 2021.

Kruger, M.W., Tolmie, C., Paul, C.E. & Opperman, D.J. 2021. *Revisiting the role of asparagine in the active site of "classical" Old Yellow Enzymes*. Poster presented at Biotrans, Graz, Austria (virtual). 19-22 July 2021.

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O'Neill, H.G., Strydom, A., Segone, N. & Strydom, M. 2021. *Whole genome characterization of porcine rotaviruses detected in the Western Cape province of South Africa between 2018 and 2020*. Poster presented at American Society of Virology 2021, USA (virtual), 19-23 July 2021.

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Wolder, A., Opperman, D.J. & Paul, C.E. 2021. *Scaling up asymmetric hydrogenation of substituted alkenes with a potential industrial workhorse: the thermostable Old Yellow Enzyme* Ts*OYE*. Poster presented at Biotrans, Graz, Austria (virtual). 19-22 July 2021.

Conference Proceedings

Roetting, T.S., La Touche, G.D., Hall, I., Siddorn, L., Stanley, P.C., Nieto Liñan, J.M., Suarez, F.M., Gómez Arias, A. & Castillo, J. 2021. Passive Mine Water Treatment Trials of Dispersed Alkaline Substrate at Two Emblematic Mine Sites in Wales. In: *Proceedings of the IMWA Conference. (online) – Mine Water Management for Future Generations. Cardiff, Wales.* P. Stanley, Ch. Wolersdorfer, and K. Wolkersdorfer (Eds). pp. 485.489.

STAFF (2021)

Head of Department:

Prof M Smit

Professors:

Prof J Albertyn, Prof R Bragg, Prof C Hugo, Prof G Osthoff, Prof T O'Neill, Prof C Pohl-Albertyn, Prof M Smit and Prof B Viljoen

Associate Professors:

Prof D Opperman and Prof O Sebolai

Affiliated Associated Professor:

Prof A Valverde Portal

Lecturers:

Dr O Gcilitshana, Ms P Letebele, Ms L Steyn and Dr C Tolmie

Senior Researchers:

Dr J Castillo-Hernandez and Dr G Kemp

Research Fellow:

Dr C Boucher

Programme Directors:

Prof J Albertyn and Dr F O'Neill

Senior Officer – Professional Services:

Mr S Marais

Officers – Professional Services:

Ms Y Makaum and Ms C van Rooyen

Officer:

Ms A van der Westhuizen

Senior Assistant Officer:

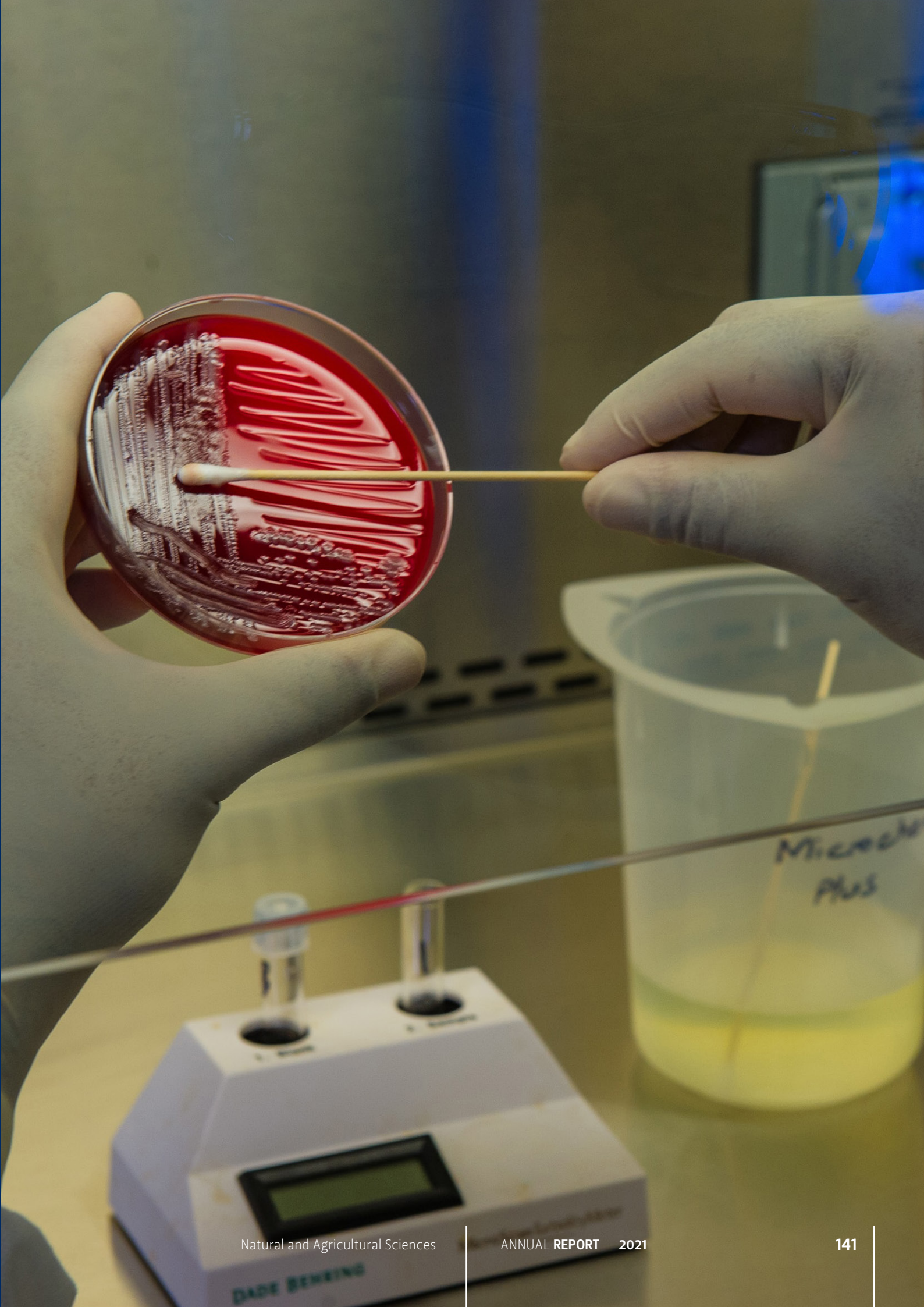
Ms E van den Heever

Storeman:

Ms M Mogopodi

Technical Help:

Mr K Mashuga, Ms L Mazwi, Mr P Mereko and Mr J Mvula



Department of
PHYSICS

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OVERVIEW OF 2021

2021 was similar to 2020 in terms of social distancing, sanitising and lockdown rules. The new normal was not so new anymore, and it proved to be another flourishing year for the Department of Physics at academic and research levels. The Department is recognised as one of the leading physics departments in the country, with research in astrophysics, phosphor - and solid-state physics that is internationally recognised. The Department boasts a well-equipped nano-surface characterisation laboratory (with state-of-the-art research infrastructure), an observatory (Boyden) with a 1.5 m telescope, and a digital planetarium. Most of the staff members are also involved with the Boyden Science Centre and the Naval Hill Planetarium, both of which are intensively involved in science engagement with local, provincial and national communities. The undergraduate and postgraduate programmes are challenging and well-balanced, and students exiting these programmes are of high quality and sought after by industry.

ACHIEVEMENTS

Staff Achievements

Brian van Soelen was selected for the Department of Higher Education and Training (DHET) Future Professors Programme.

Student Achievements

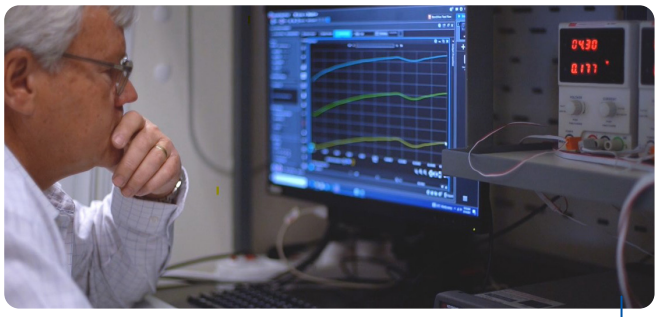
Our students excelled during 2021, with two postgraduate students receiving awards from the South African Institute of Physics (SAIP). The PhD Publication Award was awarded to LJB Erasmus for the 'Most Outstanding Work in the field of Condensed Matter Physics and/or Materials Science by a student, based on a Publication in a Scientific Journal originating from a Doctoral Thesis submitted at a South African Institution for Tertiary Education'. The paper, titled 'La2O2S:Eu3+ stability as temperature sensor' was authored by LJB. Erasmus, HC Swart and JJ Terblans, and published in *Applied Surface Science*.

Murendeni Nemufulwi won the MSc Publication Award for the 'Most Outstanding Work in the field of Condensed Matter Physics and/or Materials Science by a Student, based on a Publication in a Scientific Journal originating from a Master's Dissertation submitted at a South African Institution for Tertiary Education'. The paper, co-authored by MI Nemufulwi, HC Swart and G Mhlongo, was published in *Sensors and Actuators: B. Chemical.*

RESEARCH AND INNOVATION

There are clearly defined research groups in the Department, namely Solid-State Physics, Phosphor and Astrophysics.

Although South Africa remained on some level of lockdown due to the COVID-19 pandemic, 2021 was another successful year for the Department and the researchers continued to produce many ISI accredited journal papers, with the SARChI Chair on Solid State Luminescent and Advanced Materials, led by Prof Hendrik Swart, producing 71 publications in the year.



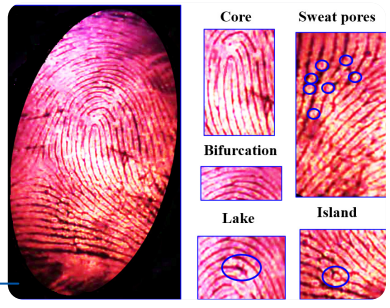
Prof Hendrik Swart, Head of the SARChI Chair

SARChI Chair on Solid State Luminescent and Advanced Materials

Some of the highlights from the SARChI Research Chair were in the areas of fingerprint detection, dosimetry phosphors and red component in white light-emitting diodes (wLEDs).

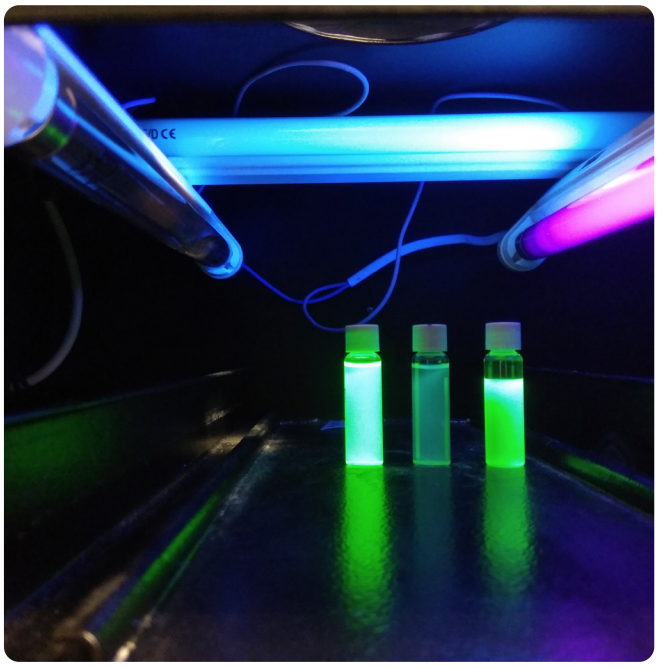
Fingerprint detection

Fingerprint patterns contain distinctive evidence about an individual and have been used for applications in forensic science and medical diagnostics. When a human touches any material surface, the fingerprint impression is transferred to the material through the pores, leading to an invisible ridge pattern. The ridges and traces of the impression hold a unique and indisputable pattern that helps to identify the fingerprint patterns accurately in a crime spot. Due to the invisible nature of the fingerprints to the naked eye under normal lighting conditions, they are referred to as latent fingerprints that require further chemical or physical treatments to improve the visualisation of their patterns. Powder dusting on the spot of the latent-fingerprint impression has proved to be a simple, efficient and ready-made process.



Fingerprint image and its components

Generally, black-coloured carbon powder is used for dusting on a light background and a white-coloured alumina powder is used for dusting on the metallic or dark background of the fingerprint impression, respectively. However, for coloured, shiny and transparent sites, the normal powder dusting method is not an optimum technique, Therefore, it was necessary to develop a phosphor material for the dusting process to obtain a simple, economic, and non-destructive technique to visualise the high contrast ridge patterns and to avoid the loss of other valuable information in a crime spot. As a marker for fingerprint detection, the phosphor material must exhibit the important characteristics, such as intense luminescence in the visible range, hydrophilic nature of the phosphor, non-toxic, high chemical stability, and high contrast bifurcation of ridge patterns. Hence, the choice of appropriate phosphor powder used for the dusting process is significant in achieving good colour contrast images to detect fingerprints. Real-time latent-fingerprint detection using Tm2WO6:Er3+ up conversion phosphor without using Yb3+ ion showed an excellent marking agent for applications in forensic science and medical diagnostics.



Dosimetry phosphors

In the past few years, a substantial amount of work has been carried out in search of new nanocrystalline phosphor materials with improved thermoluminescent sensitivity and dosimetry properties. Thermoluminescence properties of 60Co gamma irradiated Sm3+ doped Y2O3 nanophosphors were investigated for possible application for high dose gamma radiation dosimetry. Sm3+ doped Y2O3 nanophosphors were synthesised by the solution combustion method. The material obtained showed potential use for high dose gamma-radiation dosimetry.

Red component in white light-emitting diodes

Presently, the world is running towards the problem of a shortage of energy. To overcome this problem, solid-state lighting (SSL) offers a suitable method for light in terms of energy saving. Nowadays, light-emitting diodes (LEDs) using semiconductors are showing potential application in SSL and displays. The red component in wLEDs is still a matter of some concern. Therefore, near UV excited highly pure red light emitting Ca3B2O6:Eu3+phosphor was successfully synthesised via a solution combustion method. The phosphor proved to be a potential material as a red component for the wLEDs.

PHI Quantes Scanning Dual X-ray Photoelectron Microprobe

The arrival of the PHI Quantes Scanning Dual X-ray Photoelectron Microprobe during May 2021 was another highlight for the Department of Physics. This unique system, is the first-of-its-kind in Africa.

The Quantes is a combined XPS system that utilises soft and hard X-rays to probe sample surfaces. Data obtained with soft X-rays (from an Aluminum anode, Al Kα = 1486.6 eV) represents information from the first 10 nm, while from the hard X-rays (from a Chromium anode, Cr Kα = 5414.8 eV) information can be obtained up to 30 nm.

One of the major advantages of the use of hard X-rays is the increased information depth, which can allow for non-destructive analysis of the electronic structure of the buried interface of the thin films up to depths of more than 10 nm. Analogously, the chemical and electronic properties of bulk-like materials with varying surface properties can be probed without sputtering procedures. Due to the increased probing depth of HAXPES, the daily problematics of surface contamination like adventitious carbon and oxygen can also be overcome.

Prof Koos Terblans, with the new PHI Quantes XPS System

Boyden Observatory: Bootes 6 Developments

The construction of the Bootes 6 Robotic Telescope project was initiated when a Spanish team arrived on 16 November 2021. The telescope enclosure was erected before they had to leave South Africa when the Omicron variant was identified. The project will be completed when the crew fly out to South Africa later in 2022. This telescope will be used for the follow-up of transient sources.

The Bootes 6 Robotic telescope at Boyden Observatory

Bootes 6 Robotic Telescope enclosure at Boyden Observatory

Dr Brian van Soelen purchased a new imaging camera for the Boyden 1.5-m telescope. It is a KL4040 scientific CMOS camera from Finger Lake Instruments (USA). This will be used for image projects on the Boyden 1.5 m telescope. The new camera will have a wider field of view and very fast read out, which will allow us to undertake more projects, improving the capabilities on the telescope.

ENGAGED SCHOLARSHIP

Two Observatories Project

The Two Observatories Project at the UFS consists of the Boyden Observatory (approximately 28 km from Bloemfontein) and the old Lamont-Hussey Observatory on Naval Hill in the centre of Bloemfontein, which was converted into a digital planetarium. The Department of Physics is responsible for

both observatories, which work in synergy to educate and inform citizens about the natural sciences. The observatories are also important for the display and communication of South Africa's astronomical heritage. In addition to offering planetarium shows, including full dome films, the venue is also attractive for public lectures, concerts, corporate events, and larger functions The site also offers a large hall adjacent to the facility that is ideal for educational and corporate events and larger functions. Collectively all these facilities operate under the banner of the Free State Centre for Earth and Space.

The activities of the Two Observatories Project are coordinated by a small cohort of personnel from the Department of Physics with the assistance of volunteers, presenters, and student assistants.

A major development during this period was the establishment of an education partnership with colleagues at the University of Athens and two Greek observatories after a visit to the Boyden Observatory by the Greek Consul General in November 2020. The partnership developed into two major exciting online events across hemispheres. One was to observe the great conjunction of Jupiter and Saturn on 22 December 2020, and the other was to replicate Eratosthenes' historic experiment to calculate the circumference of the Earth in March 2021. This experiment was conducted online in real time.

Over the entire period, there were limitations due to lockdown requirements, which affected school activities and public events. Planning for ongoing education activities were constrained by uncertainties over changing regulations. Thus, though weekly public events were presented, the pragmatic solution was to concentrate on site upgrades. Most site upgrades were implemented at Boyden Observatory. These included the extension of the Education Walk, the refurbishment of an old telescope building to house a new robotic telescope for a team from the Czech Republic, a new pier and foundations for the Boötes robotic telescope and improving and expanding fire breaks around the perimeter and around buildings.

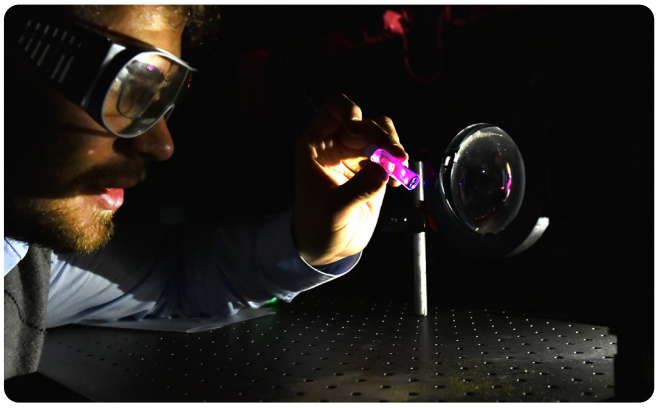
Members of the Two Observatories team made a substantial contribution to science communication through the printed and broadcast media. Prof Matie Hoffman was a regular guest on RSG channel. This provides a useful platform for informing a large audience about the activities at Boyden Observatory and the Planetarium.

The Community Service Module

This is a special elective module for third-year science students aimed at addressing scarce skills in teaching science and mathematics at schools through special workshops. These workshops are hosted by the Department of Physics at Boyden Observatory.

. The Boyden Heritage and Museum Project

After the cataloguing of more the 5 000 books and Star Atlases in the Boyden Library, curator, Dawid van Jaarsveldt selected documents and books to exhibit. The emphasis is on the History of Boyden Observatory and the Harvard College Observatory, as well as the other two South African Observatories, the Cape of Good Hope Observatory, and the Union Observatory. The Star Atlases will be displayed in exhibit cases which have been commissioned, but which have been delayed due to the COVID-19 pandemic. The exhibit will include several posters of the astronomers associated with Boyden.



NATIONAL AND INTERNATIONAL COLLABORATION

The Department of Physics have a number of valuable ongoing collaborations, but due to the ongoing COVID-19 pandemic, travel was very limited during 2021.

Strong collaboration between the SARCHI Research Chair and colleagues from Shantou University, China, Nagpure University India, Ghent University, Belgium, and Karlsruhe Institute of Technology, Germany, is ongoing and strengths.

In Astrophysics, Prof Pieter Meintjes and Prof Brian van Soelen are part of the Higher Energy Stereoscopic (H.E.S.S.) and Cherenkov Telescope Array (CTA) Gamma-ray projects, which involve collaboration between different countries on Gamma ray astronomy. They also represent the UFS on SA-Gamma, which is a collaboration between various universities and institutions in southern Africa to promote gamma-ray and multi wavelength astronomy. They are both also co-investigators on the project 'Observing the Transient Universe with SALT', a collaboration of various national and international research groups, working together with the South African Astronomical Observatory (SAAO).

Other ongoing collaborations are with University College of Dublin (related to the Watcher Robotic Telescope at Boyden Observatory, Appalachian State University (regarding the Spectropolarimeter 1.5 m telescope at Boyden Observatory), the Institute of Astrophysics of Andalusia (on the Bootes 6 Robotic telescope network) and Masaryk University in the Czech Republic (regarding the development of the 14 inch robotic telescope that will be installed in 2022).

POSTGRADUATE STUDENTS

During 2021, the Department delivered four PhD and seven MSc graduates.

On the Bloemfontein Campus, V Makumbane (Nanoscience), SP Lara (Solid State), B Bisschoff (Astrophysics), ST Madzime (Astrophysics), MJ Mphuthi (Solid State), EH Onah (Solid State) and Q. Kaplan (Astrophysics) graduated with an MSc degree.

The PhD graduates were:

Abdelrehman, MHM

Thesis:	Luminescence properties of Gd2O3:Bi3+ co-doped Ln3+ as powder and thin films phosphor for solar cell application
Supervisors:	Prof HC Swart and Prof RE Kroon

Mabuea, BP

Thesis:	Synthesis and characterization of transition metal carbides as electrocatalysts for clean Hydrogen production
Supervisors:	Prof HC Swart and Prof E Erasmus

Janardhana, D

Thesis:	Synthesis, characterization, luminescence and photocatalytic properties of rare-earths doped Bi2O3
Supervisors:	Prof HC Swart and W Purcell

Jabraldar, BMJ

Thesis:	Effect of host anion or cation substitution on the luminescence and stability of lanthanum oxide-based phosphors doped with bismuth.
Supervisors:	Prof RE Kroon and HC Swart

POSTDOCTORAL RESEARCH FELLOWS

During 2021, the Department of Physics hosted fifteen Postdoctoral Fellows – thirteen involved in Solid-state Physics, and two in Astrophysics. They were:

- Dr P Kumar, from India (Solid-state Physics)
- Dr NJ Shivaramu, from India (Solid-state Physics)
- Dr SN Ogugua, from Nigeria (Solid-state Physics)
- Dr GB Nair, from India (Solid-state Physics)
- Dr MYB Yagoub, from Sudan (Solid-state Physics)
- Dr K Rajagopalan, from India (Solid-state Physics)
- Dr DN Oosthuizen, from South Africa (Solid-state Physics)
- Dr F Ramamonjisoa, from Madagascar (Astrophysics)
- Dr KK Singh, from India (Astrophysics)
- Dr EHH Hasabeldaim, from Sudan (Solid-State Physics)
- Dr NA Mustafa, from Sudan (Solid-State Physics)
- Dr PP Sukul, from India (Solid-State Physics)
- Dr RG Motsoeneng, from South Africa (Solid-State Physics)
- Dr ZP Tshabalala, from South Africa (Solid-State Physics)
- Dr SJ Panchu, from India (Solid-state Physics)

Dr NA Mustafa, Dr RG Motsoeneng and Dr ZP Tshabalala joined the Solid-State Physics group as new postdocs, bringing new ideas and research to our laboratories.

STAFF MATTERS

Prof David Motaung joined the Department of Physics during 2021 and Prof Francis Dejene left the Department on the Qwaqwa Campus.

RESEARCH OUTPUTS

Research Articles

Abdalla, H., Meintjes, P.J., Van Soelen, B., et al. 2021. Evidence of 100 TeV γ-ray emission from HESS J1702-420: A new PeVatron candidate. *Astronomy and Astrophysics* 653: A152. DOI: 10.1051/0004-6361/202140962.

Abdalla, H., Meintjes, P.J., Van Soelen, B., et al. 2021. H.E.S.S. and MAGIC observations of a sudden cessation of a very-high-energy γ-ray flare in PKS 1510-089 in May 2016. *Astronomy and Astrophysics* 648: A23. DOI: 10.1051/0004-6361/202038949.

Abdalla, H., Meintjes, P.J., Van Soelen, B., et al. 2021. Revealing x-ray and gamma ray temporal and spectral similarities in the GRB 190829A afterglow. *Science* 372: 1081-1085. DOI: 10.1126/science.abe8560.

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Abdalla, H., Meintjes, P.J., Van Soelen, B., et al. 2021. Searching for TeV Gamma-ray emission from SGR 1935+2154 during its 202 X-ray and radio bursting phase. *The Astrophysical Journal* 919: 106. DOI: 10.3847/1538-4357/ac0fel.

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Charak, I., Manhas, M., Bedyal, A.K., Singh, S., Srivastava, A., Swart, H.C. & Kumar, V. 2021. Structural and spectral studies of highly pure red-emitting $Ca_3B_2O_6:Eu^{3+}$ phosphors for white light emitting diodes. *Journal of Alloys and Compounds* 869: 159363. DOI: 10.1016/j.jallcom.2021.159363.

Charak, I., Manhas, M., Khajuria, P., Bedyal, A.K., Swart, H.C. & Kumar, V. 2021. Investigation of thermoluminescence response and kinetic parameters of $CaMgB_2O_5:Tb^{3+}$ phosphor against UV-C radiation for dosimetric application. *Journal of Materials Science: Materials in Electronics* 32: 17418-17426. DOI: 10.1007/s10854-021-06273-y.

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Egbosiuba, T.C., Abdulkareeem, A.S., Kovo, A.S., Afolabi, E.A., Tijani, J.O., Bankole, M.T., Bo, S. & Roos, W.D. 2021. Adsorption of Cr(VI), Ni(II), Fe(II) and Cd(II) ions by KIAgNPs decorated MWCNTs in a batch and fixed bed process. *Scientific Reports* 11: 75. DOI: 10.1038/s41598-020-79857-z.

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Hile, D.D., Swart, H.C., Motloung, S.V., Motaung, T.E., Kroon, R.E., Egbo, K.O., Pawade, V.B. & Koao, L.F. 2021. Synthesis and characterization of europium doped zinc selenide thin films prepared by photo-assisted chemical bath technique for luminescence application. *Materials Chemistry and Physics* 262: 124303. DOI: 10.1016/j.matchemphys.2021.124303.

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Prof E Coetzee-Hugo and Prof MJH Hoffman

Affiliated Associate Professors:

Prof KT Hillie and Prof G Mhlongo

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OVERVIEW OF 2021

The Department of Plant Sciences is a dynamic department contributing towards research, teaching and learning, community service and entrepreneurial development. The Department has three divisions – Botany (both Bloemfontein and Qwaqwa Campuses), Plant Breeding and Plant Pathology. The year of 2021 saw both support and academic staff of the Department returning to campus full-time, amid strict COVID-19 regulations. This clearly showed the commitment of all staff members to the 2021 academic project, ensuring that both under- and postgraduate students received face-to-face learning and teaching, as well as research supervision. In spite of international travel restrictions, academic staff showed their commitment towards research by attending virtual conferences, some even contributing towards keynote lectures. During 2021, 14 Honours, 11 Master's and 2 Doctoral students obtained their degrees.

ACHIEVEMENTS

Staff Achievements

Dr Sandy-Lynn Steenhuisen won the staff component of the 2021 Natural and Agricultural Sciences (NAS) Faculty Flash Fact Competition, with a three-minute presentation on 'The cheesy side of flowers – Interactions between microbes, pollinators and Proteas'. Dr Mpho Mafa won the third prize in the competition with his presentation on 'Unravelling the protective role of carbohydrates in plants exposed to abiotic and biotic stress'.

Dr Lisa Rothmann was selected to participate in the short learning programme at the University of Stellenbosch: Centre for Research on Evaluation, Science and Technology (CREST) on 'Supervisors of Doctoral Candidates at African Universities'.

Dr Ntombokulunga Mbuma was awarded a certificate of reviewing in October 2021, in recognition of participation in the peer review process for the *African Journal of Food, Agriculture, Nutrition and Development* (AJFAND) as Senior Reviewer.

Mr Ngaka Mzizi, an Officer: Professional Services in the Department (Qwaqwa Campus), received his Master's degree in Botany.

Student Achievements

A number of students from Plant Breeding won prizes from the Southern African Plant Breeders' Association (SAPBA). Wills du Preez and Tumo Makhetha received the award for

best second-year students in Plant Breeding, Jenna Vos for best third-year student in Plant Breeding, and Henry Basson for the best fourth-year student in Plant Breeding, while St Raphael Banda won the prize for best MSc student in Plant Breeding and Dr André du Toit the prize for best PhD student in Plant Breeding.

Henry Basson

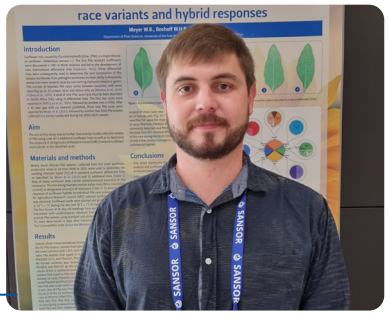
Botany students who were awarded prizes at the Faculty's prize giving function were Robyn Liebenberg, Jo Cobbold and Isabella du Toit, who received Botanical Society of South Africa (Free State Branch) prizes for the best second-year, third-year and Honours students in Botany, respectively. Wilku Meyer received the EM van Zinderen Bakker prize for a student with an outstanding MSc study in Botany.

Jo Cobbold

In Plant Pathology, Tumo Makhetha received the incentive prize for Plant Pathology and Kevin Chandler received the award for the best final-year student in Plant Pathology.

Postgraduate students participated in the Annual Postgraduate Student Symposium hosted by the Department of Botany and Plant Biotechnology at the University of Johannesburg that was held virtually from 9-12 November 2021. Jo Cobbold won the first prize for her Honours project presentation titled 'To Bee or not to Bee'. Her supervisors were Dr Lize Joubert and Dr Rothmann. Henry Basson won the third prize in the MSc category for his talk 'A pre-breeding approach towards soybean sudden death syndrome resistance in South African soybeans', for which his supervisors were Dr Adré Minnaar-Ontong and Dr Rouxlene van der Merwe. Finally, Wilku Meyer was awarded the second prize in the PhD category with a talk 'An overview of virulence and genotypic assessment of South African *Puccinia helianthi* isolates'. His supervisors were Prof Willem Boshoff, Dr Minnaar-Ontong and Prof Botma Visser.

Wilku Meyer was also the co-recipient of the Junior Captain Scott Memorial Medal awarded by the South African Academy for Science and Arts for the best MSc dissertation in Botany awarded at a South African university. The title of his dissertation was 'Phenotypic and genotypic variation of *Puccinia helianthi* in South Africa'.



Wilku Meyer

TEACHING AND LEARNING

From 16 to 26 February 2021, Dr Joubert and Dr Andri van Aardt led the third-year Botany excursion for 39 students. Due to lockdown regulations and COVID-19, the excursion was held in the Free State, with daily field trips to different field sites, including the Seven Dams Conservancy and the Free State National Botanical Garden in Bloemfontein, Golden Gate Highlands National Park (GGHNP) and De Krantz Wildlife Reserve. During the excursion, the third-year Botany students were trained in several vegetation survey, plant identification, research and specimen collection techniques.

On 12 August, postgraduate students from the Department of Plant Sciences participated in the launch of ShareScreen Africa, a training initiative by Leadership for Conservation in Africa.

On 15 October, postgraduate students from the Taxonomy and Pollination Laboratory visited Kovsie alumnus, Mr Andy Khuo, at Hsiang Chun Orchid Garden, to learn about the business side of growing orchids.

Visiting the Orchid Garden, from the left, Mr Andy Khuo, Mr Charl Cillé, s Emma Ferreira, Mr Goitseone Sedimo and Ms Hantie Grobler

On 29 October, Dr van der Merwe, Dr Minnaar-Ontong and Dr Angeline van Biljon led the combined second- and third-year Plant Breeding excursion to an onion production farm close to Petrusburg. During the excursion, the students were exposed to onion cultivar variety trials that are performed by industry in collaboration with local farmers. Students had to complete a questionnaire based on the production, marketing and economic value, and need for breeding, of the different varieties that were illustrated during the excursion.

Students on the excursion to an onion production farm

Prof Boshoff presented an invited lecture titled 'Stem rust in wheat – the Southern African perspective', as part of an on-line seminar to MSc students taking the Plant Breeding and Protection for Sustainable Production course in the Department of Plant Protection Biology at the Swedish University of Agricultural Sciences. As part of the same online seminar, Dr van Biljon presented an invited lecture titled 'Nutritional improvement through biofortification', and Prof Visser an invited lecture titled 'Out of Africa to down under: a study on the proposed inter-continental movement of wheat stem rust'.

RESEARCH AND INNOVATION

SARChI Chair in Disease Resistance and Quality of Field Crops

The National Research Foundation (NRF) South African Research Chairs Initiative (SARChI) Chair in Disease Resistance and Quality in Field Crops, headed by Prof Maryke Labuschagne, will continue until 2025. The wheat quality research of the Chair delivered a PhD thesis on the influence of abiotic stress conditions on durum wheat gluten protein composition and quality. Another PhD study on the influence of abiotic stress conditions on bread making quality and gluten protein composition is almost completed. Three MSc projects on wheat quality were in progress in 2021, of which one on the influence of stripe resistance genes on gluten protein composition and selected baking quality characteristics, has been completed. Another on the *wbm* (wheat bread-making) gene in selected South African wheat cultivars has led to three backcross generations. A project on resistant starch in South African wheat cultivars has already tested molecular markers for the presence of resistance starch genes, and the evaluation of starch, amylopectin and amylose has completed.

In terms of crop biofortification, a project on stacking of genes for iron, zinc, provitamin A and essential amino acids has culminated in the completion of a PhD thesis. Another PhD project on quality protein maize in Ethiopia, and breeding for climate resilience in this maize, is almost complete. Two new PhD projects on sorghum nutritional value started in 2021, one in South Africa and one in Ethiopia. In terms of legumes, four cowpea projects are underway, the first on the influence of drought stress on cowpea nutritional quality, one PhD study in South Africa on heritability and expression of nutritional value, and an MSc project on genetic diversity in a mutant cowpea collection. A genetic diversity PhD project in a West-African cowpea collection is underway in Nigeria and Ghana. A PhD study on genetic diversity in a southern African bambara groundnut collection was completed. This Chair's research has culminated in 11 accredited papers being published in 2021, as well as three oral and two poster presentations at international conferences.

In the research on disease resistance, an MSc student completed her dissertation on barley leaf rust (*cum laude*). Research highlights from the rust programme for the report period include the acceptance of nine research papers in peer reviewed journals. Two of these papers resulted from contributions made by UFS staff to international studies in the control of wheat stem rust and were published in *Theoretical and Applied Genetics* and *Nature Communications*. The other papers reported on breeding for rust resistance as well as on the occurrence and pathogenic variation of different *Puccinia* species. Through the UFS rust programme, one new wheat leaf rust race and one stem rust race were described. The impact of these new races on wheat cultivar responses has been determined and the data was made available for inclusion in the wheat production guidelines of the Agricultural Research Council-Small Grain (ARC-SG). Data was also made available to wheat producers through the popular media in a recent paper published in *Wheat Focus* titled 'Increased incidence of wheat stem rust in the south-eastern production areas of the Western Cape during the 2020-season'. Another contribution made in the popular media was a paper titled 'Stripe rust 25 years later: Collaboration turned hysteria around', which presented a historic review since the first report of this disease in 1996 in South Africa.

Botany: Plant physiology/biochemistry and molecular biology

Dr Arun Gokul identified five different endophytic isolates that had significant biocontrol activity against *Fusarium oxysporum* in laboratory trials. Currently research is being conducted to determine their efficacy in controlling phytopathogens in maize plants.

Dr Mpho Mafa's research is based on two pillars – the Carbohydrates and Carbohydrate-Active enZYmes (CAZymes) in plant health and the application of CAZymes in the bio-refinery sector. Plant defence responses against a pathogen, pest and environmental stress include morphological, physiological and biochemical changes. In his laboratory, the defensive functions of both structural and non-structural carbohydrates during plant-biotic or plant-abiotic interactions, are being investigated. For instance, carbohydrates (soluble sugars) are involved in plant osmoregulation (osmolytes) during drought. In the biorefinery sector, CAZymes are used to hydrolyse agricultural residue into value-added chemicals such as biofuels. The use of the CAZymes is vital in the biorefinery sector, and the rapid increase of the sector's products validates their importance. In addition, understanding these enzymes hold answers to more environmentally friendly products and chemicals. Hence, the focus includes CAZyme physicochemical characterisation, substrate specificity, kinetics and synergistic application.

Dr Rudo Ngara was awarded an NRF-Thuthuka grant for the period 2021 to 2023 on a new abscisic acid signalling and root transcriptomics project of drought-stressed sorghum. She also continued with her research on the complex responses of sorghum and maize to a range of abiotic stress factors.

Dr Rudo Ngara

Prof Botma Visser, in collaboration with Prof Willem Boshoff (Plant Pathology), studies the genetic relationships between races and isolates of fungi that cause rust diseases of cereal crops. During 2021, microsatellite markers were used to describe the genetic structure of *Puccinia graminis* f. sp. *tritici* (causing stem rust of wheat), *Puccinia triticina* (causing leaf rust of wheat), *Puccinia hordei* (causing leaf rust in barley) and *Puccinia sorghi* (causing leaf rust in maize). A protein kinase encoding gene involved in the adult plant resistance response of wheat against stem rust, was characterised, while a single nucleotide deletion was identified in the avrSr50 effector protein encoding gene of South African *P. graminis* f. sp. *tritici*, which could lead to *Sr50* virulence in the near future. Phylogenetic studies in collaboration with Prof Zakkie Pretorius, Dr Cathy Aime and Dr Alan Wood, were also used to identify rust pathogens occurring on different *Solanum* species, finger grass and fig trees, as well as a variety of ornamental and native shrubs and grasses.

Dr Makoena Moloi's research focuses on plant-environment interactions – particularly abiotic stress physiology and ecophysiology. Her current research involves the physiological, biochemical and morphological responses of edamame and cowpea to drought and high temperature stress. Another project involves the use of natural bio-stimulants/bio-fertilisers to mitigate drought stress in edamame and spinach. This research is of great importance as it provides solutions for crop production under changing climatic conditions.

Dr Lintle Mohase

Dr Lintle Mohase and her research team investigate plant defence mechanisms in wheat infested by the Russian wheat

aphid (RWA), *Duiraphis noxia*. She collaborates internally with a biochemist (Dr Mafa), molecular biologist (Prof Visser) and plant pathologist (Prof Boshoff) from the UFS, and externally with entomologists at ARC-SG, Bethlehem (Dr A Jankielsohn) and the Lesotho Agricultural Research Unit (Wheat germplasm in Lesotho). Her research concentrates on wheat defence mechanisms to aphids, exploring tolerance mechanisms in various wheat germplasm, including landraces from Lesotho. The influence of environmental factors such as drought on the resistance response to aphids is also investigated. In addition, the team explores plant protection strategies by investigating the role of inorganic nutrients, such as selenium and silicon, signalling molecules (salicylic acid) and leaf rust isolates, in mitigating drought and aphid stress on wheat.

Botany: Phytomedicine and ethnobotany

Prof Anofi Ashafa and his group is continuing with the evaluation of Basotho medicinal plants to cure and/or ameliorate both infectious and non-infectious diseases. During the 2021 research year, the group developed four herbal remedies into capsules to ease administration and consumption for constipation, diabetes and high blood pressure. In the near future, they will be collaborating with both local and international collaborators to work on neglected tropical diseases, using medicinal plants.

Botany: Plant taxonomy and molecular systematics

Dr Lize Joubert collaborated with Prof Carlien Pohl-Albertyn (UFS Department of Microbiology and Biochemistry) in an application for a NRF-National equipment plan (NEP) grant, which funded the purchase of a new Zeiss LSM900 confocal microscope for the UFS Centre for Microscopy.

Dr Joubert and one of her Honours students, Ms Jo Cobbold, conducted a pollination efficiency assessment of macadamia cultivars in South Africa, in a study funded by Macadamias South Africa (SAMAC). This study highlighted the value of using managed beehives to supplement pollination in macadamia orchards, as well as the role cultivar selection plays in pollination efficiency and yield.

Macadamia nuts

Dr Joubert continued collaboration with Dr Mariëtte Jackson, Dr Andri van Aardt (UFS) and Mr Pieter Bester from the South African National Biodiversity Institute (SANBI) on the study of flower structure and diversification of the genus *Nemesia* (Scrophulariaceae). This project explores the intersection between the fields of plant systematics, ecology, pollination biology and evolutionary development to gain a better understanding of the origins of South Africa's most diverse plant groups. Progress has been made on compiling a complete taxonomic revision and phylogenetic analysis of the genus. The research results have also elucidated the developmental mechanisms that control aspects of floral structure, and potential diversification, in *Nemesia*.

The Cape jewel – Nemesia strumosa

Dr Jackson is heading the Molecular Systematics Research group. An initial project has been completed in a new field of research which investigated the retrieval of genetic data from fossil soil sediments from the fossil pollen collection of Prof Louis Scott. Dr Jackson was also involved in an MSc Plant Pathology project, with Dr Lisa Rothmann, in which fungi within sorghum kernels were identified using molecular techniques. Dr Jackson also collaborates with Dr Joubert on her *Nemesia* project.

Botany: Palaeo-botany and ecology

Prof Scott is the co-editor and co-author of chapters in the book *Quaternary Vegetation Dynamics – The African Pollen Database*, an open access publication available online since November 2021. Prof Scott's research on palaeoenvironments derived from alluvial deposits in the western Cape at Uniondale, appeared in *Palaeogeography, Palaeoclimatology, Palaeoecology*. He was also involved in a publication in *Ambio* of the work of Kenyan student, Veronica Muiruri.

Dr van Aardt's research focused on terrestrial and aquatic studies in the GGHNP in the Free State. She also started to collaborate with SANBI on the VegMap programme on

vegetation type mapping and ground truthing in the Free State. Research on palaeoenvironments in the Grassland and Savanna biomes is ongoing. She also collaborated on a research paper on food plants in the Cradle of Humankind.

Dr Sandy Steenhuisen continued collaborations with University of KwaZulu-Natal (UKZN) through two Honours projects, co-supervised with Dr Ruth Cozien, on the effect of variation in plant gender on reproductive success in the lizard-pollinated plant, *Guthriea capensis*, and the pollination ecology of the rare subalpine endemic, *Nerine bowdenii* subspecies *wellsii,* on the slopes of Sentinel Mountain in the northern Drakensberg. Her research group's focus on invasive plant species continues to grow with the start of two MSc projects and co-supervision of a PhD student working on the reproductive ecology and invasion potential of alien Rosaceae (*Cotoneaster* sp., *Rosa* sp.), an MSc project on the effectiveness of the Working for Water Programme in the Blyde River catchment (Department of Forestry and Fisheries, Mpumulanga), and a near completed PhD on the impacts of invasive *Nassella* species on montane grasslands. A new co-supervised PhD project on the generic definition and pollination ecology of the genus *Galtonia,* with Prof Glynis Goodman-Cron (University of the Witwatersrand) commenced in October. Experiments were set up with a large international team investigating the effects of climate change on biodiversity and ecology of range-expanding plant species in alpine ecosystems. This BiodivERsA project (RangeX) is funded by a European Union Horizon2020 grant and involves a comparative experimental setup in South Africa, Switzerland and Norway, with plans to expand to China, Canada and Sweden. This is led by Dr Jake Alexander (University of Zurich) and Dr Ralph Clark (Afromontane Research Unit [ARU]). Dr Steenhuisen is a South African co-principal investigator responsible for investigating the effects of climate change (warming) on pollinators and reproductive success of focal species in the study sites, using phenological patterns and observations from time-lapse camera footage. Through this project, they aim to establish the first alpine research station in South Africa, located on the Amphitheatre plateau in the Maluti-Drakensberg mountains.

Inspecting the RangeX project at the open top chambers on the Maloti-Drakensberg, from the left, Evelin Iseli, Dr Onalenna Gwate, Dr Sandy Steenhuisen, Dr Stephanie Payne and Dr Ralph Clark

Apart from plant-focused research, Dr Steenhuisen also conducts research on the soundscape of Afromontane wetlands using sound recorders to assess avian diversity in wetlands in the GGHNP, surrounding mountains and into Lesotho, through a collaboration with the ARU, BirdLifeSA, National University of Lesotho (NUL), SANParks and the Department of Entomology and Zoology (UFS Qwaqwa).

Plant Breeding: Molecular plant breeding

Dr Ansori Maré collaborated with Prof Liezel Herselman and Prof Boshoff (Plant Pathology) to identify new rust resistance sources in wheat, using molecular markers and phenotypic evaluations to evaluate mapping populations. Selected wheat cultivars/lines, from three different breeding backgrounds, have been identified with unknown rust resistance. The three breeding backgrounds include the International Maize and Wheat Improvement Center (CIMMYT) rust resistant nursery, Morden Research and Development Centre – Agriculture and Agri-Food Canada and CM-82036/AvocetS. This research is funded by the NRF-Thuthuka and Winter Cereal Trust (WCT). Further progress has been made with cross breeding and application of molecular markers to enhance rust and Fusarium head blight (FHB) resistant wheat lines with a higher number of resistance genes to ensure durable resistance in wheat.

Dr Rouxlene van der Merwe's research is focused on breeding for resistance to pod shattering in vegetable-type soybean (in collaboration with the Northeast Institute of Geography and Agroecology, Chinese Academy of Sciences). This research continued to make progress towards the development of an improved South African vegetable type soybean cultivar that shows resistance to pod shattering. This project is undertaken in collaboration with Dr Adré Minnaar-Ontong and Dr Maré, who assist with marker-assisted selection of progenies grown in field trials. An MSc student, Kelvin Hlatswayo, works on this project.

Edamame – a vegetable type soybean

Dr Minnaar-Ontong's research focus is on breeding for resistance against fungal diseases across multiple crops with specialisation on resistance breeding against: *Sclerotinia sclerotiorum* diseases in both sunflower and soybean, soybean sudden death syndrome (SDS) and associated phytotoxins and mycotoxins produced by FHB causal pathogens. The South African economically important crops (soybeans, sunflowers and wheat) are evaluated for resistance to these different dieases (sclerotinia diseases; soybean SDS and associated phytotoxins; FHB and associated mycotoxins), to promote the improvement of disease control strategies.

The NRF-Thuthuka as well as GrainSA fund the Sclerotinia resistance research. This research also forms part of the South African Sclerotinia Research Network (SASRN) and includes the maintenance of a *Sclerotinia sclerotiorum* culture collection, derived from a population genetics study on >1000 isolates collected from eight of the nine South African provinces, across multiple crops. Dr Minnaar-Ontong and her team (Dr Chrisna Steyn, postgraduate students and collaborators) drive this research. Part of the population genetic study was completed as an MSc study. The culture collection expands continuously as more Sclerotinia infections are reported every season.

The soybean SDS resistance research includes the evaluation of the South African commercial soybean as well as edamame germplasm for potential resistance to this destructive disease. *Fusarium virguliforme* was identified and concluded as the causal pathogen of SDS as part of a successfully completed MSc study. A pre-breeding programme for SDS resistance was initiated using marker-assisted breeding approaches. The outcome of both projects will contribute signficantly to soybean production in South Africa.

Breeding for resistance against the mycotoxins associated with FHB causal species, was funded by the SARChI Chair in Disease Resistance and Quality of Field Crops. Several *Fusarium* species associated with FHB were identified, but *F. graminearum* was identified as the predominant causal species. The mycotoxins involved, deoxynivalenol (DON) and nivalenol (NIV), pose a threat to both human health and food security; therefore resistance breeding against these secondary metabolites should be prioritised. A part of this research was completed successfully as Honours and PhD studies. Knowledge gained from analyses will assist with the development of effective control strategies for resistance breeding against FHB and the associated mycotoxins. This will provide an incentive to farmers to plant wheat, thus improving wheat production in South Africa.

Plant Breeding: Conventional breeding

In her research, Dr van der Merwe's focus is on breeding for tolerance to drought and heat stress in vegetable-type soybean (in collaboration with the Edamame Development Program [EDP]). This research continued to make progress on the characterisation of vegetable-type soybean cultivars in terms of drought and heat stress tolerance. The project is undertaken in collaboration with Dr van Biljon, who assisted with sugar analysis, Dr Arno Hugo, who assisted with fatty acid analysis, and Dr Moloi, who assisted with physiological response analyses. The project has been funded since 2021 by the NRF-Competitive Support for Unrated Researchers. One MSc student (Drikus Coertzen) is enrolled for his degree on this project, while one final year BSc Agric student (Jenna Vos) performed heat stress screening activities as part of her research project.

Leaf sample collection on vegetable-type soybean plants exposed to a drought stress treatment under field conditions

A project on the impact of water-limited-stress (WLS) on the morphology, physiology and nutritional quality of dry bean, commenced in 2021 and aims to characterise dry bean cultivars in terms of drought stress tolerance and nutritional quality. This project is done in collaboration with Dr van Biljon who assists with nutritional quality analysis and Dr Moloi who assists with physiological response analyses. One MSc student (Lesole Sefume) is enrolled for his degree on this project.

Drikus Coertzen showing the root system of a vegetable-type soybean seedling after exposure to drought stress in the glasshouse

Plant Breeding: Wheat–quality and crop–nutritional value research

The PhD project on the influence of heat and drought stress on durum wheat quality and gluten protein was completed, under supervision of Prof Labuschagne and Dr van Biljon. The research on the influence of abiotic stress conditions on bread wheat quality and gluten protein composition continued, under supervision of Dr van Biljon and Prof Labuschagne and Prof Garry Osthoff (UFS Department of Microbiology and Biochemistry). A joint project with the division of Plant Pathology (Prof Labuschagne, Prof Boshoff and Dr van Biljon) on the influence of stripe rust resistance genes on gluten protein composition and some baking quality characteristics, was completed as part of a completed MSc dissertation. A project on the influence of the bread-making gene in South African wheat cultivars in terms of protein composition and quality, has progressed well and backcrosses are in progress (under supervision of Dr Maré, Dr van Biljon and Prof Labuschagne). They also supervised the project on resistant starch in South African wheat, which included testing for starch, amylose and amylopectin in wheat, and testing of molecular markers on the material.

A project with CIMMYT, Harare, on biofortification of maize with iron, zinc, lysine and tryptophan, and provitamin A through gene-stacking, was completed as part of a PhD thesis. Another project is underway on biofortified maize in Ethiopia, and on improving abiotic stress resilience of this material (supervised by Prof Labuschagne and Dr van Biljon). A PhD project on genetic diversity in bambara groundnut germplasm in southern Africa was completed as part of a doctoral study. Two PhD projects are underway on genetic diversity, and enhancement of nutritional value of cowpea germplasm in southern and West Africa, and students are in the process of doing field trials. An MSc project on cowpea mutants is also in the field trial stage. Another MSc project on genotype and environmental effects on maize grain yield, nutritional value, and milling quality has progressed well (supervised by Dr Mbuma and Prof Labuschagne). Two PhD projects, supervised by Prof Labuschagne, Prof Herselman and Dr van Biljon, on nutritional value of sorghum in South Africa and Ethiopia are underway, using both conventional and molecular breeding.

Dr Ntombokulunga Mbuma and Prof Labuschagne collaborated with researchers from the ARC on a project that focuses on the development and improvement of high yielding cowpea genotypes/cultivars with improved protein content and mineral elements, in combination with good agronomic performances through bio-fortification breeding techniques. The research aims at understanding the adaptability and stability of cowpea varieties under South African conditions, as well as on improving cowpea genotypes for nutritional value under abiotic stresses, such as drought and heat.

Dr Mbuma and Prof Labuschagne also collaborated with researchers from Bayer – focusing on the development and improvement of high yielding maize genotypes/cultivars with improved nutritional value and milling quality. The research also involves understanding the adaptability and stability of maize varieties under South African conditions.

Dr van der Merwe also investigates green pod yield and nutritional content of large-seeded (vegetable-type) soybean in collaboration with the EDP. This research is making progress towards the development of an improved South African vegetable-type soybean cultivar that shows high yield potential and with improved nutritional value. Promising cultivars are being evaluated on agronomic performance and consumer acceptability in order to be promoted for production by small-scale farmers. This project is done in collaboration with Dr van Biljon, who assists with sugar analysis, and Dr Hugo, who assists with fatty acid analysis. From this project, one MSc student (Jacques van der Merwe) obtained his qualification in 2021.

Plant Pathology: Cereal rust diseases

Prof Willem Boshoff was involved in the WCT project 'Evaluation of wheat cultivars and lines for genetic resistance to rust disease', carried out annually by the UFS rust pathologists. This research involves annual greenhouse and field screening with selected races of the three rust pathogens of wheat. During 2021 field trials were carried out in the Western Cape, with the support of Syngenta staff; cereal varieties were rated with the assistance of Prof Pretorius. Field trials were planted near Greytown, KwaZulu-Natal with support from Corteva. Data from these trials is annually included in the national wheat production guidelines of ARC-SG.

From the left, Prof Zakkie Pretorius (UFS), Dr Renée Prins (CenGen) and Prof Willem Boshoff (UFS) during a visit to field trials planted in collaboration with Corteva

Newly initiated projects include a study of the maize rust pathogen, *Puccinia sorghi*, a collaborative project with Prof Visser and researchers at Forestry and Agricultural Biotechnology Institute (FABI) at the University of Pretoria and funded by the Maize Trust.

Plant Pathology: Soil microbial ecology

Prof Wynand Swart's research broadly focuses on adopting a 'total systems approach' to plant health management by utilising the functional diversity of fungi and bacteria, above- and below ground, as bio-indicators of soil and plant health. This involves understanding multi-trophic interactions that occur in agroecosystems, with particular attention to the phytobiome, and in particular the rhizosphere microbiome. In so doing, innovative crop production and protection strategies can be developed with particular emphasis on beneficial microbes that influence both plant and soil health.

Plant Pathology: Mycology

After the lockdowns of 2020 due to COVID-19, Dr Gert Marais and the Pecan Research Group resumed their regular field trips to all the pecan production areas in South Africa in 2021. These areas ranged from Orania along the Orange River to Upington, Vaalharts, Schweizer-Reneke, Jacobsdal, and a number of areas in Limpopo, Mpumalanga, Kwazulu-Natal, Eastern Cape and North West. Farmer's days were kept to a minimum to limit large gatherings, but student research projects in the field were still conducted. Currently, six MSc and two PhD projects are studying the role of fungal pathogens in causing diseases, such as overall decline, Alternaria black spot, die-back, black blotch and scab on pecans. In addition, the resistance of pecan cultivars based on the metabolites they produce, is being investigated in a separate study. Three MSc students graduated in 2021. One project showing that the scab disease in pecans in South Africa is associated with as many as 12 different species of *Cladosporium*. The second project confirmed that *Neofusicoccum parvum* is the causative agent of dieback in pecans; although other fungal species of *Botryosphaeria*, *Dothiorella* and *Lasiodiplodia* were also isolated from dieback trees. The third project concluded a study that evaluated essential oils as potential to control crown and root rot in maize.

Plant Pathology: Epidemiology

Dr Lisa Rothmann leads the McLab Epidemiology Group, which focuses on diseases associated with summer grain crops – sorghum, soybean and sunflower. In an internal collaboration with Dr Jackson (Botany), Mr Thabiso Masisi, supported by the Sorghum Trust, completed his MSc Agric degree in 2021, titled 'Assessing the effect of decortication on sorghum grain mold fungi and concomitant mycotoxins'. Under the supervision of both Dr Rothmann and Prof Neal McLaren, Ms Marlese Meiring submitted her PhD titled '*Sclerotinia sclerotiorum* disease potential and management responses in soybean and sunflower'. This research was supported by the Department of Science and Innovation (DSI), the Oil and Protein Seeds Development Trust (OPDT), Sasol Agricultural Trust, and Winfield United South Africa, as well as GrainSA. The project to evaluate soybean and sunflower cultivars for escape resistance towards *Sclerotinia sclerotiorum,* is ongoing in collaboration with Dr Derick van Staden (Agronomy Info Services, Mpumalanga) and Mr Koos Strydom (producer in the Free State). In 2021, a project was initiated to identify and assess soybean seed borne diseases, in order to improve seed health through reducing prevalent fungal pathogens.

ENGAGED SCHOLARSHIP

Prof Labuschagne served as Speciality Chief Editor of *Frontiers in Sustainable Food Systems*, and Associate Editor of *Cereal Chemistry* and *Journal of Cereal Science*. She is also a member of the Academy of Science of South Africa (ASSAF) and the Expert Working Group (gluten proteins) of the International Wheat Initiative.

Dr Joubert and Dr van Aardt are working with the UFS Department of Otorhinolaryngology and the Lung Institute at the University of Cape Town on monitoring pollen in in the atmosphere to provide pollen counts on a weekly basis, that are posted on the website: https://pollencount.co.za/ to inform allergy sufferers about the current risk.

Dr Steenhuisen was involved in mentoring emerging women researchers through the Mountain-to-Mountain Mentorship Programme run through UFS and Appalachian State University. She also serves on the Faculty's Institutional Audit Committee and was selected by the Rectorate as one of twelve academics on a panel to develop the future trajectory of the UFS through

the UFS Vision2030 project. Dr Steenhuisen continues to serve as an executive member and Treasurer for the South African Association of Botanists (SAAB). She has been promoted to Review Board Editor for the *South African Journal of Botany*, and is an Associate Editor for the *American Journal of Botany*. She also is the external moderator for undergraduate and Honours modules at UKZN (School of Life Sciences, Pietermaritzburg) and Rhodes University (Department of Botany).

Dr Rothmann's research forms part of the official Memorandum of Understanding (MoU) between GrainSA and the UFS Department of Plant Sciences, for administrating the SASRN, The SASRN has continued their website and social media activities since the launch in September 2019. This Network provides a platform for South African researchers, industry, and producers to work together towards a management solution for Sclerotinia diseases in South Africa. Ms Marlese Meiring (PhD student in Plant Pathology) and Dr Rothmann led one virtual farmer's day and three information sessions on Sclerotinia diseases with industry partners under the auspices of the SASRN, supported by GrainSA. These sessions, which have been conducted chiefly in the Free State and Mpumalanga, are aimed not only at connecting producers with the current research, but also to hear from the producers what their needs from academia and industry are. The focus of the interaction with producers is to develop and communicate practical management strategies for diseases caused by Sclerotinia for local producers. Dr Rothmann and Marlese Meiring also contributed popular articles to *SA Grain* and *Oilseed Focus* magazines, on topics related to Sclerotinia cultivar evaluations and potential interventions of diseases associated with *Sclerotinia sclerotiorum*.

Dr Rothmann was invited by the OPDT and Oilseed Advisory Committee to deliver a presentation at the Soybean for Human Consumption Symposium in September 2021. Her presentation was titled 'Jack and the (soy)beanstalk: slaying disease giants'.

Dr Joubert presented a talk and a guided walk for the Friends of Seven Dams Conservancy, as well as an online talk for the Leadership for Conservation in Africa weekly seminar series.

The Geo Potts Herbarium completed barcoding all specimens in the main collection, while 3 415 specimens have been digitised in a project funded by the International Association of Plant Taxonomists. This project will lead to the more efficient management of the collection and make the digitised specimen records available online for use by the international scientific community.

Dr Mafa worked with Parr Farm, investigating the extraction, quantification and partial characterisation of peroxidase from horseradish (*Armoracia rusticana*) root tissue and also wrote a technical report for Parr Farm.

Dr Mbuma served as Senior Reviewer of the *African Journal of Food, Agriculture, Nutrition and Development*.

Dr van der Merwe was a panellist in the online webinar section, 'Investigations of water deficit interactions with heat and elevated carbon dioxide in wheat (*Triticum aestivum*)', that was held by the University of Fort Hare as part of their Research Week of Excellence, held from 15 to 18 November 2021.

Dr Minnaar-Ontong participated as reviewer for NRF student project funding applications. She reviewed industrial research project reports on Maize Trust projects on *Fusarium* and the impact of these fungi on maize, and reviewed articles for international journals, such as *Molecular Diversity* and the *European Journal of Plant Pathology*.

Prof Swart, in his capacity as President of the Southern African Society for Plant Pathology, was invited to present and interact as Chairperson with an international audience at the National Science and Technology Forum (NSTF) discussion forum on 'Plant Health – threats to biosecurity, biodiversity and food security', hosted virtually on 10 and 11 June 2021. The NSTF is a non-profit stakeholder forum representing the science, engineering and technology (SET) and innovation community in South Africa, representing 120 organisations ranging from research institutions, universities and state entities to business, professional societies (proSET) and civil society. The title of his presentation was 'Whither (or wither) Plant Pathology in the next 50 years' in which he outlined the vision for Plant Pathology. The presentation can be viewed at: http://www.nstf.org.za/discussion-forum/plant-health-in-south-africa-threats-to-biosecurity-biodiversity-and-food-security/.

Prof Boshoff was also invited to present a talk titled 'Disease resistance in small grain cereals: The South African approach' as part of the discussion forum.

The H3ABioNet Next Generation Sequencing Bioinformatics course for 2021 (presented by the UFS Department of Genetics) adopted a distance-based learning approach and brought together hundreds of participants from over 30 institutes in Africa. The teaching assistants for the course were Postdoctoral Fellow, Dr Castelyn, and PhD student, Wilku Meyer.

NATIONAL AND INTERNATIONAL COLLABORATION

Prof Labuschagne collaborated with Dr Carlos Guzman, Cordoba University, Spain, on durum and bread wheat gluten composition and quality under heat and drought stress conditions. Dr Guzman co-supervised two PhD students in 2021. Prof Labuschagne also collaborated with Dr Dennis Eriksson, Agricultural University of Sweden on the AgriFoSe (Agriculture for Food Security) project on adoption rates of newly bred staple crop varieties in Africa. Collaborators from CIMMYT included Dr Itria Ibba (Mexico) on durum wheat quality, Dr Thoko Ndhlela (Harare) on biofortification of maize in Africa and Dr Dagne Wegary (Harare) on maize breeding. She also continued collaboration with ARC-Pretoria on cowpea and Bambara groundnut breeding, ARC-Bethlehem on wheat quality and ARC-Potchefstroom on maize and

cowpea breeding. Together with Dr Mbuma she collaborated with Dr Abe Gerrano and Dr Alina Mofokeng from the ARC on cowpea projects, and with Dr Sanesh Ramburan, from Bayer South Africa, on maize breeding.

After the African Pollen Database (APD) was discontinued in 2007 due to lack of funds, and after an October 2019 meeting in Paris attended by Dr van Aardt, it resumed its activities recently. It is a tool used in long-term global environmental simulation of climate change, in collaboration with international databases Neotoma (USA), Pangaea (Denmark) and the Institut Pierre Simon Laplace (France). The APD was started in 1996 in Paris by a group which included Prof Scott, in cooperation with its European counterpart, the European Pollen Database (EPD) and the Global Pollen Database hosted at the National Oceanic and Atmospheric Administration (NOAA) Paleoclimatology Database. As part of the re-launch of the APD, during 2021 Prof Scott revised, updated and submitted new fossil and modern pollen data sets from numerous southern African and Southern Ocean sites, which have been accumulated at the Palynology Laboratory in the Plant Sciences Department since the 1960s

Dr van Aardt and Prof Scott were invited to collaborate on a Spanish project 'Paleo-biodiversity and climatic fluctuations in the northern (Spain) and southern (South Africa and Argentina) Hemispheres: 150 000 years of change' by principle investigator Dr Yolanda Fernandez-Jalvo, of the National Museum of Natural Sciences in Madrid.

Dr van Aardt collaborated with Prof Marlize Lombard, Professor in Stone Age Archaeology at the University of Johannesburg on a project about the foodplants growing in the Cradle of Humankind Fossil Hominin Site. She was also invited by Anisha Dayaram from SANBI to collaborate on the VegMap for the Free State Province.

Dr Marais collaborated with the South African Pecan Nut Producers Association (SAPPA) and FABI (Prof Bernard Slippers and Prof Wilhelm de Beer) to study diseases in the pecan industry in South Africa.

Dr Steenhuisen collaborated nationally and regionally with Dr Cozien (UKZN), Department of Forestry and Fisheries (Mpumulanga), Prof Aliza Le Roux (UFS Department of Zoology and Entomology), Dr Grant Martin (Centre for Biological Control, Rhodes University and Research affiliate with the Department of Entomology and Zoology, UFS Qwaqwa), Dr Ralph Clark (Director, ARU), Dr Kim Canavan (Centre for Biological Control, Rhodes University), Prof David Richardson (Centre for Invasion Biology, Stellenbosch University), Prof Colleen Downs (SARChI Chair in Ecosystem health and biodiversity, UKZN), Dr Peter Chatanga (NUL), and Prof Glynis Goodman-Cron (University of the Witwatersrand). Her international collaborators include Dr Jake Alexander (University of Zurich, Switzerland), Dr Jamie Alison and Toke Thomas Høye (Aarhus University, Denmark), Dr Rachel Prunier (University of California, USA), Prof Robert Raguso (Cornell University, USA), and Dr Clara de Vega (University of Seville, Spain).

Dr Gokul maintains national collaboration with Prof Marshall Keyster (Environmental Biotechnology Laboratory) and Prof Ashwil Klein (Plant Omics Laboratory at the University of the Western Cape) on the project 'The isolation and exploitation of endo-symbionts to enhance plant growth, health and biocontrol'. The collaboration has resulted in the graduation of two MSc students as well as five articles in high impact factor journals.

Dr Rothmann and Ms Meiring are in collaboration with AgriSeed/DMS Genetics in Delmas. Soybean and sunflower field trials on the experimental farm are aimed at cultivar and fungicide evaluations. Dr Rothmann is also part of an official MoU between the UFS and the Universidade Federal de Viçosa, Minas Gerais, Brazil. This MoU facilitates research collaboration and potential future exchange opportunities.

Dr Joubert collaborated with Mr Pieter Bester from SANBI, Prof Beverley Glover from the Department of Plant Sciences at the University of Cambridge and Dr Mario Fernandes-

Mazuecos from the Autonomous University of Madrid, on the project 'The role of flower structure in the diversification of the genus Nemesia (Scrophulariaceae)'. The collaborators provide expertise on the taxonomy of Scrophulariaceae, floral evolutionary development and molecular systematics respectively. Dr Fernandes-Mazuecos presented an online talk on his research on the genus *Linaria* from the Mediterranean region. Dr Joubert also collaborated with Dr Victoria Ruiz-Hernández from Universidad Politécnica de Cartagena in Spain on a project focusing on the relationship between human, bumblebee and thrips preferences for floral characters in *Antirrhinum*. This collaboration resulted in the publication of a research paper in 2021.

Dr Mafa and Prof Pletschke Brett (Biochemistry and Microbiology, Rhodes University) collaborated on the Enzyme Science Programme (ESP) with Dr Samkelo Malgas, the principal investigator based at the Department of Biochemistry, Genetics and Microbiology, University of Pretoria. The research included biorefinery projects in which they investigated the synergistic application of glycoside hydrolase and carbohydrate esterase enzymes for the effective hydrolysis of agricultural residues.

Dr Moloi collaborated with Prof Ned Bowden from the University of Iowa, USA, on a project involving the use of dithiophosphates on the improvement of drought tolerance in crops of agricultural importance. They are currently co-supervising an MSc student on the project. Dr Moloi also collaborated with Prof Brigitta Tóth of the University of Debrecen, Hungary on crop physiology and improvement and their work produced five publications in peer reviewed journals.

Dr Rudo Ngara initiated new collaborative links with Dr Dirk Swanevelder from the ARC-Biotechnology Platform, Onderstepoort for the transcriptomics analysis of sorghum under drought stress. She also continued working with Dr Nemera Shargie, ARC-Grain Crops, Potchefstroom and Dr Stephen Chivasa, Durham University, UK, on stress biology projects of cereals.

Nationally, Dr van der Merwe continued her collaboration with the EDP, based at Mariannhill in KwaZulu-Natal, on germplasm maintenance of introduced varieties, base seed multiplication, research and training of students, pre-breeding and new cultivar development for South African growing conditions. She also established a research collaboration with TransfOrmus to evaluate the effect of enOrmus and Soil Life Combo on plant biomass and yield of vegetable-type soybean and maize cultivars under field conditions. This project is also done in collaboration with Dr Elmarie van der Watt at Agronomy (UFS).

On international level, Dr van der Merwe and Dr Minnaar-Ontong continued their collaboration with Prof Qiuying Zhang from the Northeast Institute of Geography and Agroecology, Chinese Academy of Sciences. The project focuses on breeding for resistance to pod shattering in vegetable-type soybean.

Dr Minnaar-Ontong also collaborated with Syngenta (together with Dr Rothmann) on breeding for resistance to Sclerotinia diseases in both soybean and sunflowers, with breeding companies from industry, and researchers from the University of Manitoba, Canada and the University of Nebraska and the United States Department of Agriculture (USDA) in the USA.

Prof Boshoff collaborated with researchers from the Kingdom of Saudi Arabia (King Abdullah University of Science and Technology), the United Kingdom (John Innes Centre), Australia (Commonwealth Scientific and Industrial Research Organisation [CSIRO] Agriculture and Food), and China (Institute of Genetics and Developmental Biology, Chinese Academy of Sciences). Two peer-reviewed papers were published during 2021 from these collaborations and one is under review. Locally Prof Boshoff collaborated with Dr Renée Prins from CenGen, Dr Tarekegn Terefe at ARC-SG and researchers at Stark Ayres and Syngenta.

Prof Visser collaborated with Dr Les Szabo (University of Minnesota, USA) and Dr Cathie Aime (Purdue University, USA), which resulted in two papers that were accepted for publication. Nationally, he collaborated with Dr Alan Wood (ARC-Plant Health & Protection, Stellenbosch) and Dr Terefe (ARC-SG, Bethlehem).

Dr Mohase collaborated with Dr Jankielsohn (ARC-SG, Bethlehem) on projects involving RWA phenotyping under greenhouse conditions and aphid diversity in South Africa and Lesotho. Additionally, she collaborated with the Lesotho Agricultural Research Unit, which provided wheat germplasm in Lesotho.

Prof Ashafa maintained his international collaboration with Dr TO Ojuromi (Department of Zoology and Environmental Studies, Lagos State University, Nigeria) on the molecular characterisation of livestock ticks from Southwest and

Northern Nigeria. Nationally, he collaborated with Prof David N''Da (Centre of Excellence for Pharmaceutical Sciences, North-West University) on a project titled 'Antileishmanial activity of selected South African medicinal plants against *L. donovani* and *L. minor*'. Other collaborations were with Prof MMO Thekisoe (School of Biological Sciences, North-West University) on a project 'Acaricidal activity of *Artemisia afra, Eucalyptus globulus* and *Tagetes minuta* against cattle ticks in Qwaqwa area, Maluti-A-Phofung' and with Dr S Sabiu (Department of Biotechnology and Food Technology, Durban University of Technology) on *in silico* studies on the antiviral activities of selected South African medicinal aromatic plants.

POSTGRADUATE STUDENTS

During 2021, 20 Honours, 55 Master's and 46 Doctoral students were enrolled for postgraduate studies in the Department of Plant Sciences.

At the 2021 graduations, 14 students graduated with the BSc Hons majoring in Botany (10 on the Bloemfontein Campus and four on the Qwaqwa Campus).

Four students graduated with an MSc (Agriculture):

- Carmen Meyer (Plant Breeding)
- Eunica Semu (Plant Pathology)
- Thabiso Masisi (Plant Pathology)
- Zizipho Spelman (Plant Pathology – with distinction)

A further seven students graduated with an MSc:

- Donald Adams (Botany, Qwaqwa Campus)
- Grace Mochologi (Botany, Qwaqwa Campus)
- Lebohang Moloi (Botany, Qwaqwa Campus)
- Mawethu Ndiki (Botany, Bloemfontein Campus)
- Jacques van der Merwe (Plant Breeding)
- Bongani Mahlangu (Plant Pathology)
- Ngaka Mzizi (Botany, Qwaqwa Campus)

Two candidates from the Department of Plant Sciences graduated with a PhD in Plant Breeding in 2021:

Matova, Prince
Thesis: Breeding of maize for fall armyworm resistance in Southern Africa

Supervisors: Prof MT Labuschagne, Dr C Magorokosho and Dr C Kamutando

Phakela, Keneuoe
Thesis: Influence of specific abiotic stress factors on durum wheat gluten proteins and their relation with pasta quality

Supervisors: Prof MT Labuschagne, Dr A van Biljon, Dr B Wentzel and Dr C Guzman

POSTDOCTORAL RESEARCH FELLOWS

Dr Neila Abdi (Tunisia) continued with her postdoctoral fellowship at Plant Breeding during 2021, while Dr Tesfaye Mekonnen (Ethiopia) was appointed as a new Postdoctoral Fellow at Plant Breeding in 2021, both working on projects within the SARChI Chair.

Dr Howard Castelyn (South Africa) was appointed as a Postdoctoral Fellow in the laboratory of Prof Visser for a final year, to continue with the bio-informatics analysis of the adult wheat-stem rust interaction. He provided guidance for an MSc study on the characterisation of the adult plant resistance response of wheat after stem rust infection, as well as unravelling the role of carbohydrates and carbohydrate active enzymes towards leaf rust resistance in wheat.

STAFF MATTERS

Prof Liezel Herselman was promoted to full Professor in the Department, and Dr Willem Boshoff was promoted to Associate Professor.

Dr Andri van Aardt was promoted to Senior Lecturer and Dr Ansori Maré to Lecturer.

Dr Lisa Rothman was appointed as Lecturer in Plant Pathology and Dr Dimitri Veldkornet as Lecturer in Botany.

Mr Petrus Chakane was permanently appointed as Technical Aid to assist in the Palynology Laboratory and the Geo Potts Herbarium.

Ms Grace Mochologi was appointed as Academic Facilitator for Botany on the Qwaqwa Campus.

Prof Scott continued to act as mentor in the Department of Plant Sciences.

RESEARCH OUTPUTS

Research Articles

Abdi, N., Labuschagne, M., Ullah, A., Hemissi, I., Van Biljon, A., Hachana, A. & Sifi, B. 2021. Legume-rhizobia symbiosis under abiotic constraints: performance system. *Agrosciencia* 55(2): 37-61.

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Labuschagne, M.T., Phakela, K., Wentzel, B., Guzman, C. & Van Biljon, A. 2021. *Proteomic analysis of durum glutenin protein under heat and drought stress.* Poster presented at the 4th Conference of the International Plant Proteomics Organization (online conference). 9-11 March 2021.

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Meyer, W.B., Boshoff, W.H.P., Minnaar-Ontong, A. & Visser, B. 2021. *An overview of virulence and genotypic assessment of South African Puccinia helianthi isolates.* Paper delivered at the Annual post-graduate symposium of the Department of Botany and Plant Biotechnology at University of Johannesburg (virtual). 9-12 November 2021.

Meyer, W.B., Boshoff, W.H.P. & Visser, B. 2021. *Race diversity of Puccinia helianthi in South Africa* (presented in Afrikaans). Paper delivered at the 20ste Studentesimposium in die Natuurwetenskappe deur die Suid-Afrikaanse Akademie vir Wetenskap en Kuns (SAAWK), Noordwes Universiteit, SAAWK Studentesimposium (virtual). 28-29 October 2021.

Nienaber, K., Van Aardt, A.C. & Van Tol, J.J. 2021. *Phytosociological classification of wetland vegetation in the Golden Gate Highlands National Park, Free State Province, South Africa.* Paper delivered at the National Wetland Indaba (virtual). 20-21 October 2021.

Spelman, Z., Visser, B. & Boshoff, W.H.P. 2021. *Phenotypic and genotypic variation of Puccinia hordei in South Africa.* Paper delivered at the Annual post-graduate symposium of the Department of Botany and Plant Biotechnology at the University of Johannesburg (virtual). 9-12 November 2021.

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Van der Merwe, R. 2021. *Drought tolerance indices and their correlation with seed yield in vegetable-type soybean.* Paper delivered at the Meeting of the Working Group Seed Science and Certification (GPZ/GPW) & Section IV Seeds (VDLUFA). Topic of the Scientific Seed Symposium: "Seed Production in Times of Climate Change" (virtual). 9-11 March 2021.

Vos, J., Van der Merwe, R. & Moloi, M. 2021. *The impact of heat stress during flowering on the physiological and yield traits of vegetable-type soybean*. Paper delivered at the Annual post-graduate symposium of the Department of Botany and Plant Biotechnology at the University of Johannesburg (virtual). 9-12 November 2021.

Research Reports

Boshoff, W.H.P. 2021. Evaluation of wheat cultivars and lines for genetic resistance to rust diseases. Report delivered at the Wheat Trust, Pretoria, South Africa.

Boshoff, W.H.P. 2021. Project: #3768 Genomics for Resistance. Report delivered to KAUST, Saudi Arabia.

Mafa, M.S., Moloi, J. & Mohase, L. 2021. Extraction, quantification, and partial characterization of peroxidase from horseradish (*Armoracia rusticana*) root tissue. Report delivered to Parr Farm.

Yilmaz, N., Visagie, C.M., Visser, B. & Boshoff, W.H.P. 2021. Survey of fungal pathogens affecting maize production in the eastern Cape. Report delivered to the Maize Trust, Pretoria, South Africa.

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OVERVIEW OF 2021

On the Bloemfontein Campus staff and students tried their utmost best to cope under the extremely challenging circumstances COVID-19 has presented. Field trips were undertaken, when possible. This included day trips with the third-year Zoology students as part of their practicals, and a Biodiversity excursion with the Honours class. Most of these trips were possible due to our collaboration with Dr Leon Barkhuizen from the Free State Department of Economic, Small Business Development, Tourism and Environmental Affairs (FSDESTEA), who is also a Research Fellow in the Department. Staff and postgraduate students attended several conferences, some online, and on one or two occasions even face-to-face.

Gerhard de Jager, a PhD student of Prof Linda Basson, left South Africa at the beginning of September 2021 as a secondee of the Horizon 2020 Project that started two years previously, but could not kick off officially due to COVID-19. Hennie Butler, Adriaan Jordaan and Christiaan Steenkamp undertook a 10-day survey during March 2021 as part of a biomonitoring project for Anglo America (Kolomela Mine, Postmasburg). This forms part of a larger project which will develop a first of its kind biomonitoring baseline for the mine industry.

The year 2021 was a rather successful one for the Department of Zoology and Entomology at the Qwaqwa Campus, considering that the COVID-19 pandemic has altered our way of life for more than two years. Part of that success reflects the positive impact that Prof Peter Taylor (who joined the Department in January 2021) and Dr Grant Martin (appointed Research Fellow in 2021) have already had on the Department. Prof Taylor also received a number of national and international accolades, which have further elevated the standing of our Department and that of the UFS as a whole.

ACHIEVEMENTS

Staff Achievements

Prof Charles Haddad received his C1-rating from the National Research Foundation (NRF).

Ms Lindi Heyns obtained her Master of Environmental Management degree during the December 2021 graduation and Prof Daryl Codron obtained his BSc Honours degree in Applied Statistics (*cum laude*). Ms Nontsasa Mokhethi (Office Manager) completed her MA in Governance and Political Transformation and will be graduating in April 2022.

Dr Nontembeko Dube was appointed as a member of the Advisory Committee of the Prince Edward Islands in January 2021, by the Department of Forestry and Fisheries and the Environment. The main purpose of the committee is to evaluate proposals and research activities associated with the islands.

In January 2021, Prof Taylor was elected a Fellow of the Linnean Society of London, the world's oldest active biological society. In October 2021, he was inaugurated as member of

the Academy of Science of South Africa (ASSAf). His NRF-rating improved from B3 to B2; this will become official from January 2022.

Prof Peter Taylor

Prof Aliza le Roux became an inaugural member of the Steering Committee of the Scientific Advisory Group on Emergencies (SAGE). This body, hosted within ASSAf, responds rapidly to emergencies with up-to-date scientific advice and seeks to advance our responses to ongoing crises, through actions such as workshops, webinar series and engagement with government.

Student Achievements

Aneke Kruger, Anke de Smidt and Runé van der Merwe (MSc students) all received the 'Afrikaanse SkryfGoed 6' software prize (in collaboration with CTexT-Centre for Text-technology) at the student symposium in Natural Sciences of the South African Academy of Science and Arts, which was held online from 28 to 29 October 2021.

Jade Hastings (MSc student in Aquatic Parasitology) attended the online African Inclusive Microscopy: Student Microscopy Symposium from 29 November to 2 December 2021, at which he was awarded second-place for best light microscopy presentation.

Gerhard de Jager achieved third place in the Faculty's annual Flash Fact competition in the category for PhD students.

Ngitheni Nyoka (PhD student) was appointed as Academic Facilitator and Coordinator of the Extended Programme on the Qwaqwa Campus.

Sphindile Dlamini (MSc) was appointed as one of the five 'Developers' tasked with organising an international online Summer School on Surface Water Monitoring. The Summer School, which will take place from 24 to 28 January 2022, will be jointly hosted by the UFS, Cape Peninsula University of Technology (CPUT) and the Technical University of Dresden (Germany).

TEACHING AND LEARNING

The annual third-year Zoology Marine and Freshwater Ecology Excursion could not take place due to COVID-19 restrictions. Instead, students undertook three half-day field trips to Soetdoring Nature Reserve (including Krugersdrift Dam) during the middle of the first semester in 2021. Dr Leon Barkhuizen (FSDESTEA) assisted with access to this reserve and presented a hands-on fish practical to the students on the first day. Students had to measure water quality for the remaining two days and collect plankton and other aquatic organisms associated with the Soetdoring Pan and Krugersdrift Dam. At the end of the semester, students had to submit a written article and present a poster on the ecological assessment of these two waterbodies.

Dr Leon Barkhuizen explaining fyke nets to Honours students in Soetdoring Nature Reserve

During the first week of October 2021, Prof Liesl van As, Dr Candice Jansen van Rensburg, Mr Luthando Bopheka and eight Honours students were accompanied by Dr Leon Barkhuizen to Soetdoring Nature Reserve. This formed part of the Biodiversity and Evolution course and included a number of activities, i.e. fish collections using various techniques such as fyke nets, gill and sein nets, identification and dissections, collection and identification of plankton and water invertebrates, an informative nature walk, as well as collecting data from camera traps. Data and information collected were analysed and presented to the lecturers in the form of a mini-symposium.

Honours students setting up camera traps in Soetdoring Nature Reserve

To promote a better understanding of shark science and conservation, the second-year Zoology students in the Vertebrate Life and Evolution module participated in a video conference with The South African Shark Conservancy (SASC). Through a novel application of Zoom video meetings, we could bring the SASC Shark Lab in Hermanus into the classroom in Bloemfontein, as students joined staff and interns for close-up demonstrations with several shark species. With the addition of comments and live questions, an engaging, in-the-moment learning experience was created for the second-year Zoology students.

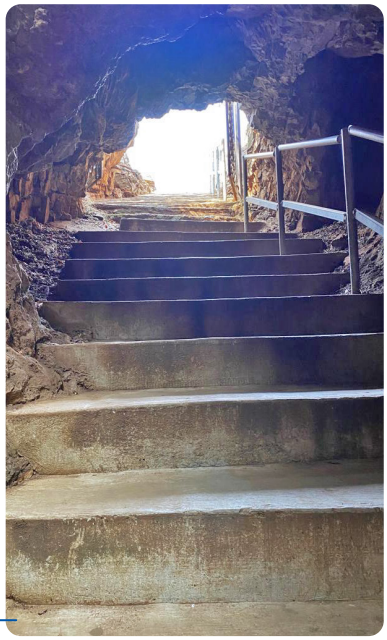
Dr Nontembeko Dube introduced Biological Control as an additional topic in the Ecophysiology of Insects module for the second-year Entomology students. In October, Dr Dube accompanied three undergraduate Entomology students to the Weed Biocontrol (Plant Health and Protection) and Insect Ecology Laboratories at the Agricultural Research Council (ARC)l Roodeplaat, Pretoria.

Visiting ARC Plant Health and Protection, from the left, Lancelot Malpe, Bongani Nyanzane and Thabo Moabi

Anthony King (ARC) with students in the Weed Control laboratory at ARC Plant Health and Protection nursery

During this visit, students were briefed about the designs of the nursery and quarantine facilities. They were shown activities on various weed biocontrol programmes using insects, such as plant culturing, insect culturing and host range testing, which demonstrated the applications of the topics covered in class.

After a hiatus in 2020, the annual excursion of the Qwaqwa third-year Zoology students to the Cradle of Humankind resumed in 2021. During the two-day trip, the students visited the Sterkfontein Caves and the Maropeng Visitor Centre near Krugersdorp, where they learned more about human evolution, under the guidance of Dr Mpho Ramoejane and Dr Patricks Voua Otomo.



Entrance to the Sterkfontein Caves

Qwaqwa third-year Zoology students underground in Sterkfontein Caves

RESEARCH AND INNOVATION

Bloemfontein Campus Research Groups

Aquatic Ecology / Parasitology

As a secondee of the Horizon 2020 Project, Gerhard de Jager (PhD student of Prof Linda Basson), finally left to take up his secondment in September 2021. Secondments usually last for 12 months, but due to COVID-19 travel restrictions, Gerhard completed the first six months of his 12-month Marie Curie Scholarship online, as part of the Next Generation Taxonomy (NGTax) H2020-MSCA-RISE project. He then spent three months (to the end of December 2021) at the University of Pisa in the Department of Zoology and Comparative Anatomy as part of the ciliate research group, under the leadership of Prof Giulio Petroni. The remainder of the time was spent at the Max Planck Institute of Developmental Biology in Tübingen, Germany, as part of the Swart research group, led by the esteemed Dr Estienne Swart, who specialises in Bioinformatics.

Gerhard de Jager at the Max Planck Institute of Development Biology, Tübingen, Germany

In August 2021, in preparation for his departure to Italy, Gerhard and Prof Linda Basson travelled to Reebok to collect material for him to take to Europe. During his time visit in Italy, he received training in traditional and specialised ciliate staining techniques and whole genome amplification, resulting in the first sequencing of the complete DNA genome in the ciliate group Mobilida and the first set of annotations for the mitochondrion and ribosomal operon of the ciliate genus *Leiotrocha*.

Field trip to Orbetello, from the left, Dr Leandro Gammuto, Prof Sergei Fokin, Alessandro Allevi, Dr Joachim Langeneck and Gerhard de Jager

Material for Jade Hastings (MSc student) was collected during a field trip to De Hoop Nature Reserve (two weeks in November). Jade's project concentrates on three ciliate groups from two intertidal molluscs. Dr Joaquín Verdú Ricoy, a Postdoctoral Fellow from Spain, joined this trip, providing indispensable expertise in molecular techniques.

Jade Hastings at De Hoop Nature Reserve with the homemade fume cabinet

Prof Liesl van As and her PhD student, Luthando Bopheka, visited colleagues at North-West University (NWU) to work on his 'Morphology, molecular analysis and life cycle of trypanosomes found in fish species from the Orange River System, Free State Province'. Precious Aywei, a PhD student from NWU co-supervised by Prof van As, visited the Aquatic Parasitology lab during September. All the scanning electron microscopy preparation of the specific specimens was completed in the Aquatic Parasitology lab, after which four days were spent analysing the specimens on the new JEOL scanning electron microscope (SEM) that was installed in 2021 at the UFS Centre for Microscopy.

Applied Agricultural Entomology

De Villiers Fourie continued his research investigating pyrethroid resistance developing in the stinkbug complex that is damaging sub-tropical fruit and nuts in the Nelspruit region of Mpumalanga. This is an ongoing project undertaken in collaboration with the ARC in Nelspruit.

Several ongoing studies by one MSc and two Honours students are being conducted at Rotondo Walnuts, in the Free State, to establish a holistic Integrated Pest Management plan focusing on the natural enemies targeting the armoured scale complex in these orchards.

Arachnology

Prof Charles Haddad and his team sampled spiders and other arachnids along a latitudinal transect in the western interior of South Africa. The project aimed to determine whether spider biodiversity was correlated with aridity gradients. A standardised protocol was used to sample arachnids in

four biotopes (riparian vegetation, open plains, eastern and western slopes of mountains), using three methods (leaf litter searching, rock searching and beating). More than 6 000 spiders were collected, representing over 300 species. As part of the project, leg tissues were prepared and submitted for sequencing to the Canadian Centre for DNA barcoding (CCDB). More than 800 specimens were sequenced, making a significant contribution to the Spiders of South Africa (SPIZA) Project.

Prof Charles Haddad and PhD student Ruan Booysen, Honours student Adriaan Stander and Reginald Christiaan of SANParks, undertook a field trip to survey five degree squares along the western interior of South Africa. The transect extended from the Richtersveld National Park in the north to the Tankwa Karoo National Park in the south. The study aimed to document the patterns in spider faunal diversity in the arid Desert and Succulent Karoo Biomes of South Africa, and was funded through a NRF grant in the Foundational Biodiversity Information Programme (FBIP).

From the left, Adriaan Stander, Reginald Christiaan Charles Haddad and Ruan Booysen at the Namaqua National Park

A paper was published in *Biodiversity and Conservation* that documented the contribution of third-year Entomology student excursions to the discovery and sampling of spiders on the farm Bankfontein, in the western Free State. Over five years of excursions, student groups sampled almost two-thirds of the spiders known from the farm, underlying the importance of excursions as a source of biodiversity data for South Africa's fauna.

Charles Haddad was also an invited speaker for a symposium in honour of two legendary British arachnologists, John Murphy and Michael Roberts, who both passed away in 2021. They co-authored many significant books on spider morphology and taxonomy, for which Murphy wrote the text and Roberts provided excellent scientific illustrations. Charles presented a paper on the gnaphosid genera *Leptodrassex* and *Leptopilos*, which have been recorded from southern Africa for the first time, including the description of seven new species. This work was completed together with PhD candidate, Ruan Booysen.

Etho-ecology

Under the supervision of Hennie Butler, the etho-ecology group was involved in a number of diverse projects. As part of her MSc, Klinette Sutherland continued to monitor the feeding preferences of various antelope species by means of camera traps. The objective of this study is to determine the response of South African game species to flavoured feed formulations. The findings might assist with passive capturing of game species, which will not only save costs but will also lower the risk of injuries to animals during capture procedures.

Another MSc student, Kristen Darker, investigated enzootic geophagy by elephants (*Loxodonta africana*) in relation to the geochemical composition of mineral licks in the Addo Elephant National Park. Daily and seasonal data of elephants consuming soil at lick sites was captured by means of camera traps. Soil samples were also collected to determine the chemical composition of the, and dung was collected to calculate the amount of soil that elephants consume.

Alida Jordaan, as part of her BSc Honours degree, investigated the conservation value of inselbergs in the Free State, using small mammal density as an indicator.

Environmental Entomology and Dipterology

The research group led by Dr Vaughn Swart included PhD projects by Burgert Muller, on the systematics of Afrotropical water snipe flies (Diptera: Athericidae), and De Villiers Fourie, on pyrethroid resistance in two-spotted stinkbug, *Bathycoelia distincta* (Hemiptera: Pentatomidae).

For his MSc study Gary Edwards investigated the ecological aspects of arthropod soil meso-fauna in nut orchards in the Free State and the Eastern Cape.

Liezl Whitehead completed her MSc (*cum laude*) based on the phylogenetic analysis of South African *Aedes* Meigen, *Anopheles* Meigen and *Culex* L. (Culicidae) based on COI, ITS2 and ND4 sequences, which coincide with optimising DNA profiling techniques for the identification of mosquito species in the Free State.

Herpetology

As part of James Kidd's MSc project, the group undertook several visits to the Ditsong Museum of Natural History in Pretoria in order to collect comprehensive morphometric data from the preserved specimens of the lizard subspecies *Agama aculeata aculeata* in its holdings. The data collected comprised measurements of the head, body, limbs and tail of adult, subadult and hatchling specimens. The tails of all specimens were also checked for signs of injury, potentially caused by interactions with predators. A visit for the same purpose was also undertaken to the Iziko South African Museum in Cape Town.

Tamson Foster's PhD research focuses on ecological data of the tortoise species, *Homopus femoralis*. To assist her during fieldwork, she was accompanied on a number of field trips to the Trompsburg area by two Postdoctoral Fellows, Dr Joaquin Verdu-Ricoy and Dr Zhongning Zhao, and on a few occasions also by James Kidd. Prof Neil Heideman joined the group on the November field trip. The data collected comprised movement patterns of males and females fitted with radio transmitters, their utilisation of habitat, monitoring changes in their body mass, and the reproductive condition in females.

Insect Physiological Ecology/biocontrol

In collaboration with the ARC and the University of KwaZulu Natal, Dr Nontembeko Dube led a project on the biological control of the invasive alien shrub, *Chromolaena odorata*, originating in the Caribbean. This research examined the impact of the gall-forming tephritid, *Polymorphomyia basilica*, on its growth and reproductive potential, and its preference for different morphotypes of *Chromolaena odorata* and other Asteraceae in the laboratory.

Nematology

One field trip was undertaken in early 2021 to Erfenis Dam Nature Reserve for the collection of soil samples for nematodes. This work forms part of a project mapping the biodiversity of free-living and plant-parasitic nematodes from nature reserves in the Free State. Anke de Smidt's study for her PhD focuses on the systematics and taxonomy of the Cephaloboidea (Nematoda) from the Free State. Dr Candice Jansen van Rensburg and Anke also participated in the 23rd Biannual Symposium of the Nematological Society of Southern Africa (19 to 23 September 2021), during which Dr Jansen van Rensburg delivered a paper.

Ms De Smidt also presented papers at two online conferences – the Student Symposium in Natural Sciences of the South African Academy of Science and Arts and the South African Society of Aquatic Sciences Conference.

Participants at the 23rd Biannual Symposium of the Nematological Society of Southern Africa in Tulbagh

Terrestrial Ecology

Dr Aileen van der Mescht (Postdoctoral Fellow), Runé van der Merwe (MSc student) and Chanel Lewis (MSc student) undertook two field trips to Tswalu Kalahari Reserve for sampling of orthopteran soundscapes, habitats and biodiversity. They and Prof Daryl Codron presented papers at the International Conference of Zoology (online), with Runé and Chanel also presenting papers at the annual conference of the Southern African Wildlife Society.

Eleven journal articles were published by the group, including a contribution to a special issue of *Quaternary International*, describing both mathematical and (to our knowledge the first) empirical evidence for the evolution of clumped, rather than partitioned ecological, niches across species in animal communities, presenting a new mechanism for the evolution of modern large mammal herbivore systems.

Based on analysis of katydid (bush cricket) soundscapes in the Kalahari, Dr van der Mescht discovered a non-circadian (from midday to midnight) pattern of orthopteran mate signalling.

Through her MSc study, Runé van der Merwe has shown that body size, a fundamental life history trait, cannot explain the variance in intrapopulation trophic structure of mammalian herbivores, while through her project, Chanel Lewis found that populations of mammalian carnivores show consistently more ecological niche partitioning across individuals than do herbivores.

Tick Research Unit

The main focus of research in this group continued to be the testing of tick acaricide resistance in order to construct tick resistance profiles of tick collections received from commercial farms in South Africa. A total of 10 profiles were compiled for different commercial companies and, although this number was lower than previous years, it still enabled the ongoing monitoring of the state of acaricide resistance in South Africa. At the same time, the occurrence of the alien species, *Rhipicephalus microplus*, was evaluated to enable the tracking of this invasion on commercial farms. The lower number of tick collections received was due to the effects of COVID-19 and the financial implications thereof.

Two Honours students accompanied Dr Ellie van Dalen to a farm in the Eastern Cape for tick collections, as part of an ongoing study, started in 2010, to evaluate a commercial farming unit and its tick populations, as well as its changing resistance profile over time. Blue ticks were also collected on this farm as part of Grethe Campher's Honours project to test an alternative, less labour-intensive method to indicate resistance development of field strains in the laboratory.

Grethe Campher collecting ticks from cattle on a farm in the Eastern Cape

Looking at resistance from another angle, Elizna Terblans undertook a monthly collection of ticks from three different cattle breeds on farms close to Bloemfontein, in order to determine the difference in host resistance to ticks. In contrast to other crossbreeds, she found that the Afrigus, the crossbreed of the Afrikaner and Angus breeds, did not display a stronger resistance to ticks than the Afrikaner breed (*Bos indicus*), but was less susceptible to tick infestations than the European Angus breed (*Bos taurus*).

A third Honours student, Aiden Wolmarans, investigated the seasonal occurrence of different tick species on the greater padloper tortoise (*Homopus femoralis*) on a farm near Trompsburg. She was accompanied by Dr Joaquin Verdu-Ricoy on several field trips to collect data for her research project.

Tinotenda Nemaungwe (MSc) investigated the increased occurrence of theileriosis in cattle from Zimbabwe and a possible link to climate change, that might cause a wider distribution of the vector tick, *Rhipicephalus appendiculatus*. Resistance of this tick species to acaricides, forms part of the investigation.

Qwaqwa Campus Research Groups

Kokonyana (Applied Entomology)

Dr Bredenhand participated in the first leg of Witsieshoek Bioblitz project under the leadership of Prof Peter Taylor. This project is being done in collaboration with 12 researchers from various fields in Zoology and Botany, namely Prof Peter Taylor, Prof Ara Monadjem, Dr Andrinajoro Rakotoarivelo, Dr Sandy-Lynn Steenhuisen, Dr Caswell Munyai, Dr Emile Bredenhand, Dewald Kleynhans, Nokubonga Thabethe, Luyanda Shabalala, Veli Mdluli, Alexander Howard and Toka Mosikidi. Bioblitz will contribute to the building of a photo library of invertebrate species found in the eastern Free State More detail can be found on the following YouTube link: https://www.youtube.com/watch?v=PSRGE7bbPcg.

Ecotoxicology

Ngitheni Nyoka (PhD student), Nduduzo Kubheka (MSc student) and Dr Patricks Voua Otomo participated in two sampling campaigns with Dr Marinda Avenant (UFS Centre for Environmental Management) and Prof Beatrice Opeolu (CPUT), as part of a joint project, sponsored by the Water Research Commission, titled 'Threats of extreme weather events: improving the resilience of Qwaqwa to the multiple risks of climate change'.

Ngitheni Nyoka measuring water physico-chemical parameters at one of the sampling sites

Mammal Cognition

After struggling with regular fieldwork due to COVID-19 restrictions in 2020, students were able to conduct significantly more fieldwork in 2021. This included Sphindile Dlamini's research on water quality in the Upper Tugela catchment and bi-weekly deployments of passive acoustic recording equipment in the Klasiesriver Wetland in the Golden Gate Highlands National Park (GGHNP). Due to heavy rains, some equipment was lost to the floods. Some of the most exciting results of this ongoing study includes novel bird species that were discovered – the pallid harrier *Circus macrourus* and wattled crane *Bugeranus carunculatus*, which are both vulnerable species. These species have never been seen in GGHNP before, and the identifications were confirmed by Toka Mosikidi, who has been trained as an expert bird watcher.

We have also been publishing research on jackal behaviour in the mountains, highlighting previously unknown aspects of their behaviour, such as responses to moonlight. As this group, led by Prof Aliza le Roux, is expanding its behavioural research to include non-mammalian species, we are working on a name change for 2022.

Vertebrate Haemoparasite Biology

This research group focuses mainly on the blood parasites and biology of reptiles and mammals, with a specific focus on malaria-like parasites, vector interactions, life cycle biology and ecotoxicological effects of parasite burdens. New species, yet unknown to the scientific world, are being described, and we explore other health aspects of the vertebrate hosts involved.

Animal Molecular Genetics

The research group of Dr Mpho Ramoejane, which was officially started in 2021, focuses primarily on montane small mammals, but also includes reptiles and fish. Only one Honours student, who graduated at the end of 2021, was recruited, and Njabulo Ntombela's research focused on the identification of rodent species in the GGHNP (natural) and the UFS Qwaqwa Campus. The research lab managed to acquire a new PCR machine from the Faculty which aided the research. Mr Ntombela is willing to do his Master's with the group in 2022, and we are expecting at least two more Honours students in the new year.

Parasitology

The research group of Dr Nthatisi Nyembe focuses on documenting and finding possible treatments for parasitic diseases caused by protozoans and helminths in the Maluti-A-Phofung Municipality and beyond. In 2021, two Honours students (Thlohonolofatso Sefojane and Engelinah Macamo) successfully completed their degrees in the field of parasitology. They have both applied to study for their MSc in the same field.

Mountain Bats

With the arrival of Prof Peter Taylor, together with two new PhD students (Monday Veli Mdluli and Alexandra Howard) and a Postdoctoral Fellow (Dr Sina Weier), the Mountain Bat Lab was launched in 2021. The aim will be to conduct research, with community engagement, on the ecosystem services of bats in agricultural and natural ecosystems in the eastern Free State. Funded by a UFS Interdisciplinary Grant (in collaboration with the Faculty of Education), Monday has already visited four schools in Qwaqwa to present educational talks and install artificial bat houses. This is all in the hope of enlightening learners on the positive ecological role of bats and involving them as citizen scientists in his PhD research project.

Different species of Horseshoe bats are found in the mountains of Qwaqwa – one of which could be a new (mountain) species
Photo credit: Piotr Nasrecki

ENGAGED SCHOLARSHIP

Academics from the Department were involved in reviewing articles for a range of scientific publications, including, *inter alia*:

- Prof Liesl van As processed articles as journal sub-editor of the *African Journal of Aquatic Sciences*.
- Prof Linda Basson reviewed several manuscripts for *Aquaculture* and *Parasitology International*, and processed manuscripts for *Acta Amazonica*, as a member of the editorial board. She also serves on the editorial boards of *Acta Prozoologica* and *European Journal of Protistology*.
- Dr Candice Jansen van Rensburg reviewed nematology articles for *Global Ecology & Conservation Journal*
- Prof Charles Haddad processed 12 articles as associate editor for *Zootaxa*, and reviewed 12 manuscripts for seven journals.
- Dr Mpho Ramoejane was invited to review an article submitted to *Journal of Fish Biology*. He was also involved in the review process of the NRF Competitive Programme for Rated Researchers (CPRR) and the Thuthuka Agricultural Science review panels.

- Dr Nthatisi Nyembe was invited to review an article in the *Acta Tropica* journal.

During 2021, Prof Liesl van As continued to be involved in Unlocking Nature webinars, under the auspices of Leadership for Conservation in Africa (LCA). This initiative resulted in another project, ShareScreen Africa (SSA), whose aim is to become a Pan-African conservation-based tutorial platform to the benefit of conservation departments and agencies, training institutions, universities, colleges, schools, tutors, as well as traditional leaders, to freely share knowledge and broaden skillsets and create a Pan-African conservation-based student programme for learning, practicals and career opportunities.

Dr Candice Jansen van Rensburg accompanied Prof Liesl van As to the Academy for Environmental Leadership SA near Upington, to present lectures and practical sessions to the students on various themes in Freshwater Ecology.

Dr Candice Jansen van Rensburg (left) with students from the Academy of Environmental Leadership SA, busy with water quality readings.

Prof Charles Haddad identified spiders for members of the public, as well as for three postgraduate student projects from other universities.

Prof Linda Basson was invited by the Free State Honorary Rangers to present an talk on her research visit to Antarctica. The talk, presented online in February, was well-received and she was subsequently invited to present a similar talk to the National Honorary Rangers annual meeting held in September.

Dr Aileen van der Mescht, a Postdoctoral Fellow in Prof Codron's lab, was interviewed by *The Conversation*, providing an audio in which she had opportunity to explain, in layman's terms, the ecological idiosyncrasies of orthopteran calling patterns.

Dr Mpho Ramoejane served on two NRF committees, as well as the GGHNP committee. He was also invited to be a member of Maluti-A-Phofung Municipality's environmental forum, in particular for the portfolio of research.

Prof Aliza le Roux co-hosted the webinar series for SAGE on 'Why environmental management must become the new normal'. She also co-authored scientific advisories on the subject. Aliza is also leading a new Women's Mentorship Program as part of the Mountain-to-Mountain Partnership with Appalachian State University, and continues to act as vice-president of the Zoological Society of Southern Africa. In addition to reviewing article submissions for several international journals, Prof le Roux serves on the editorial board of *Scientific Reports* and *Behavioural Ecology*. She is a trustee of the Kalahari Research Trust, together with researchers from Cambridge, Zurich and Stellenbosch universities.

Dr Patricks Voua Otomo contributed commentaries to two online articles by *Mail & Guardian* (Decolonising environmentalism and climate change - https://mg.co.za/environment/2021-05-22-decolonising-environmentalism-and-climate-change/) and *Daily Maverick* (Water shortages in parts of Free State drastically affecting health services and healthcare workers - https://www.dailymaverick.co.za/article/2021-09-23-water-shortages-in-parts-of-free-state-drastically-affecting-health-services-and-healthcare-workers/). Furthermore, Patricks served as Co-Chair of the Scientific Committee of the first Southern African Mountain Conference (SAMC2022) organised by the Afromontane Research Unit (ARU), to be held in March 2022. He and Dr Nthatisi Nyembe reviewed abstracts for SAMC2022.

Prof Peter Taylor and his students collaborated with Dr Bekithemba Dube and his students from the Faculty of Education on the Qwaqwa Campus, to conduct ongoing outreach activities on the ecosystem services of bats and biodiversity at schools in Phuthaditjhaba. The main focus has been school teachers and Grade 7 and 8 learners at two secondary and two primary schools in the area. The group has been in touch with the Engaged Scholarship team at UFS, and Prof Taylor has become an 'Engaged Scholarship champion'.

NATIONAL AND INTERNATIONAL COLLABORATION

National Collaboration

For a number of years, Prof Linda Basson and Prof Liesl van As from the Aquatic Parasitology Research Group have collaborated on the basis of Memoranda of Understanding (MOUs) with CapeNature and the South African Institute of Biodiversity (SAIAB).

Prof Louis du Preez and two of his postgraduate students from NWU visited Prof Linda Basson, for training in preparation techniques for light and scanning electron microscopy of the rectum ciliates of amphibians, which is the focus of one on the MSc students who visited.

Dr Candice Jansen van Rensburg was invited by Prof Driekie Fourie from NWU to assist and be part of a larger project titled

'Long-term crop rotation and tillage', which is led by Dr Gert Ceronio of the UFS and funded by GrainSA. Prof Fourie and Dr Jansen van Rensburg, together with their PhD student from NWU, will assess and monitor root and soil health under different crop rotation sequences and tillage practices, using nematodes (plant-parasitic and beneficial) and other bio-indicators.

Prof Neil Heideman and the Herpetology Research Group continued to collaborate with herpetology curators at the following museums: Dr Mike Bates (National Museum, Bloemfontein), Mr Lemmy Mashinini (Ditsong Museum of Natural History, Pretoria) and Jofred Opperman (Iziko Museum, Cape Town). Their research projects focus on the phylogeny, taxonomy and ecology of various reptile groups (frogs, tortoises and lizards).

Prof Charles Haddad signed an MOU with Dr Danilo Harms (Leibnitz Institute for the Analysis of Biodiversity Change, Hamburg) and Prof Stefan Foord (University of Venda), which includes participation from other local and international arachnologists, for an investigation into South Africa as an example of an old, climatically buffered, infertile landscape (OCBIL). The focus of this study will be on the arachnofauna of the Fynbos Biome. He is also collaborating with Prof Foord and Prof Ansie Dippenaar-Schoeman (University of Venda) on a project investigating spider diversity patterns in arid western South Africa.

De Villiers Fourie, from the Applied Agriculture Entomology group, continued research and collaboration with ARC-ITSC (Agricultural Research Council – Institute for Tropical and Sub-tropical Crops) and SAMAC (South African Macadamia Growers' Association).

Dr Mpho Ramoejane collaborated with Dr Albert Chakona from SAIAB and Ms Dewidine van der Colff, from the South African National Biodiversity Institute (SANBI), on a new project, known as 'Refreshed'.

Dr Patricks Voua Otomo is actively involved in the project titled 'Threats of extreme weather events: improving the resilience of Qwaqwa to the multiple risks of climate change, with Dr Marinda Avenant (Centre for Environmental Management, Bloemfontein Campus) and Prof Beatrice Opeolu (CPUT).

Prof Aliza le Roux collaborated with Birdlife South Africa and the National University of Lesotho (NUL) on wetland health projects. She continues to work with several national and international institutions on the Snapshot South Africa project.

Dr Nthatisi Nyembe is in an ongoing collaboration with the NWU, co-supervising two PhD students and two MSc students.

International Collaboration

Prof Linda Basson forms part of a project of the European Union (Research and Innovation Staff Exchange (RISE) Call: H2020-MSCA-RISE-2019), titled 'Next Generation Taxonomy: Ciliophora and their bacterial symbionts as a proof of concept (NGTax)'. The project commenced at the end of 2019, with the official launch planned for June 2020 in Italy. Due to delays as a result of COVID-19 regulations, the project officially got off the ground in 2021, and Prof Basson could send her first secondee (PhD student Gerhard De Jager) to Europe. The hosting institution in Italy was the University of Pisa (September-December 2021), while the Max Planck Institute (Tübingen) will be the host in Germany from January-March 2022.

Prof Liesl van As (Aquatic Parasitology) continued to collaborate with the Okavango Research Institute (ORI) of the University of Botswana in Maun.

Prof Daryl Codron continued long-standing collaborations with Profs Marcus Clauss (University of Zurich, Switzerland), Matt Sponheimer (University of Colorado at Boulder, USA) and Dr Liora Horwitz (Hebrew University of Jerusalem, Israel). Dr Michael Toffolo (presently Bordeaux University, France, but set to change soon) was successful with a five-year grant application to the European Research Commission, for which Prof Codron is co-PI; the project, is due to commence late in 2022.

Prof Codron was invited to deliver an online lecture, titled 'Competition drives the evolution of emergent neutrality in the dietary niches of mammalian herbivores' as part of the Colloquium on the Biology of Populations for the Department of Ecology and Evolutionary Biology at Princeton University, USA. During the week following the seminar, Prof Codron attended one-on-one meetings with Prof Rosemary Grant, Prof Jonathan Levin, Prof Robert Pringle and Prof Shane Campbell-Staton, as well as a doctoral student from Prof Pringle's lab, and participated in both a breakfast and lunch session with the Princeton postgraduate ecology group. This seminar not only showcased UFS Zoology research to an Ivy League university audience, but also fostered both two-way learning and future collaborations.

Ms Runé van der Merwe, an MSc student, was recently awarded a bilateral NRF-NUFFIC scholarship for her forthcoming PhD, which will formalise a new research collaboration with Prof Han Olff of the University of Groningen, Netherlands.

Prof Charles Haddad continued collaborating with Prof Wanda Wesołowska (Wrocław University, Poland) and Dr Galina Azarkina (Siberian Branch of the Russian Academy of

Sciences, Russia) on the systematics of Afrotropical jumping spiders. Another continuing research collaboration includes studies on predatory specialist and myrmecomorphic spiders with Prof Stano Pekár (Masaryk University, Czechia).

Dr Patricks Voua Otomo initiated a collaboration with Prof Alain Souza of the Université des Sciences et Techniques de Masuku in Gabon.

Prof Aliza le Roux continued her international collaborations on the Snapshot South Africa project, as well as her links with the University of Zürich (Prof Dr Marta Manser) and Okinawa Institute of Science and Technology (Dr Nick Friedman).

Prof Peter Taylor continued his active involvement in two international projects funded by the German Federal Government's SPACES II programme (South African Limpopo Landscapes Network) and the African Union and European Union (EcoRodMan) project. He also actively collaborates (including student co-supervision) on small mammals with researchers at the University of Montpellier in France and the University of Eswatini.

POSTGRADUATE STUDENTS

In 2021 53 postgraduate students were enrolled in the Department of Zoology and Entomology:

- Honours: Five in Zoology and three Entomology on the Bloemfontein Campus, and four in Zoology on the Qwaqwa Campus
- MSc: Nine in Zoology and four in Entomology on the Bloemfontein Campus, with a further eight in Zoology on the Qwaqwa Campus
- PhD: Eight in Zoology and six in Entomology on the Bloemfontein Campus, and nine in Zoology on the Qwaqwa Campus

Ten students graduated with the Honours degree on the Bloemfontein Campus (six in Zoology and four in Entomology), and three students graduated with an Honours in Zoology on the Qwaqwa Campus.

At Masters level, Lugusani Mulaudzi graduated on the Bloemfontein Campus (*cum laude* in Entomology), while Letsema Molete (MSc), who was enrolled at the University of the Witwatersrand and co-supervised by Prof Aliza le Roux, graduated in 2021.

Three students graduated with PhD from the Bloemfontein Campus:

Van Dalen, Ellie

Thesis:	Evolution of acaricide resistance status and ecological competition of two *Rhipicephalus (Boophilus)* species on commercial farms in South Africa. (Zoology)
Supervisor:	Dr C Jansen van Rensburg

Wardjomto, Maliki

Thesis:	Prevalence of avian haemosporidian parasites in the lowveld region of South Africa. (Zoology)
Supervisor:	Dr M Ndlovu;
Co-supervisor:	Dr T Nangammbi

Chikowore, Gerald

Thesis:	Biological control pre-release studies on the ecological impacts and biotic interactions of *Robinia pseudoacacia* L. (black locust) with indigenous fauna and flora in South Africa. (Entomology)
Supervisor:	Dr F Chidawanyika;
Co-supervisor:	Dr GD Martin

POSTDOCTORAL RESEARCH FELLOWS

The Department of Zoology and Entomology hosted six Postdoctoral Fellows in 2021 (five in Bloemfontein and one in Qwaqwa):

- Dr Joaquin Verdu Ricoy, from Spain, supervised by Prof Heideman (ended August 2021)
- Dr Zhongning Zhao, from China, supervised by Prof Heideman
- Dr Reyard Mutamiswa, from Zimbabwe, supervised by Dr Chidawanyika (ended November 2021)
- Dr Aileen van der Mescht, from South Africa, supervised by Prof Codron (ongoing)
- Dr Michael Vickers, from USA, supervised by Prof Haddad
- Dr Sina Weier from Germany, supervised by Prof Taylor

STAFF MATTERS

On the Bloemfontein Campus, Dr Nontembeko (Ntemsie) Dube was appointed as Senior Lecturer in Entomology in April 2021. She had previously worked at the ARC as a researcher since 2009. Dr Dube's experience in biological invasions, insect-plant interactions, as well as chemical ecology, will be a benefit yo the newly established Insect Physiological Ecology and Biocontrol research group in the Department.

Prof Neil Heideman retired at the end of December 2021. He started his association with 'us' in 1998 as head of Zoology at Qwaqwa, when that Campus was still part of the University of the North and he was subsequently Deputy Dean of Science for two years. From 2003, Prof Heideman was Programme Head for Natural and Agricultural Sciences, when the Qwaqwa

Campus became part of the UFS. During his career with UFS, he was Vice-Dean, Acting Dean, and finally Dean of the Faculty of Natural Agricultural Sciences (2010-2015), and in 2015 he became part of the academic staff of the Department of Zoology and Entomology on the Bloemfontein Campus.

In January 2021 Prof Peter Taylor was appointed as Professor on the Qwaqwa Campus and Dr Grant Martin was appointed Research Fellow with the Department on the Qwaqwa Campus.

RESEARCH OUTPUTS

Research Articles

Ackermans, N.L., Martin, L.F., Codron, D., Kircher, P.R., Clauss, M. & Hatt, J-M. 2021. Confirmation of a wear-compensation mechanism in dental roots of ruminants. *The Anatomical Record* 304: 425-436.

Akinnuoye-Adelabu, D., Bredenhand, E., Van der Merwe, S. & Franke, A.C. 2021. Soil fertilization synergistically enhances the impact of pollination services in increasing seed yield of sunflower under dryland conditions. *Journal of Agricultural Science* 159: 258-271.

Ávila Herrera, I.M., Král, J., Pastuchová, M., Forman, M., Musilová, J., Kořínková, T., Šťáhlavský, F., Zrzavá, M., Nguyen, P., Just, P., Haddad, C.R., Hiřman, M., Koubová, M., Sadílek, D. & Huber, B.A. 2021. Evolutionary pattern of karyotypes and meiosis in pholcid spiders (Araneae: Pholcidae): implications for reconstructing chromosome evolution of araneomorph spiders. *BMC Evolutionary Biology* 21(#75): 1-38.

Berg, P., Berg, R. & Heideman, N.J.L. 2021. *Agama planiceps* (Namib rock agama). Attempted cannibalism. *Herpetological Review* 52: 851-852.

Booysen, R. & Haddad, C.R. 2021. Revision and molecular phylogeny of the spider genus *Micaria* Westring, 1851 (Araneae: Gnaphosidae) in the Afrotropical Region. *Zootaxa* 4940: 1-82.

Booysen, R. & Haddad, C.R. 2021. Season determines the efficiency of a rapid sampling protocol for non-acarine arachnids (Chelicerata: Arachnida) in Afrotemperate grassland biotopes. *Austral Entomology* 60: 682-697.

Byrne, M.J., Mayonde, S., Venter, N., Chidawanyika, F., Zachariades, C. & Martin, G.D. 2021. Three New Biological Control Programmes for South Africa: Brazilian Pepper, Tamarix and Tradescantia. *African Entomology* 29: 965-982.

Canavan, K., Canavan, S., Clark, V.R., Gwate, O., Richardson, D.M. & Martin, G.D. 2021. The alien plants that threaten South Africa's Mountain ecosystems. *Land* 10: 1393. DOI: 10.3390/land10121393.

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Cheruiyot, D., Chiriboga, X., Chidawanyika, F., Bruce, T.J.A. & Khan, Z.R. 2021. Potential roles of selected forage grasses in management of fall armyworm (*Spodoptera frugiperda*) through companion cropping. *Entomologia Experimentalis et Applicata* 169: 966-974.

Chikowore, G., Martin, G.D. & Chidawanyika, F. 2021. An assessment of the invasive alien tree, *Robinia pseudoacacia* canopy traits and its effect on grassland microclimates and subsequent arthropod assemblages. *Journal of Insect Conservation* 25: 429-439.

Chikowore, G., Mutamiswa, R., Sutton, G.F., Chidawanyika, F. & Martin, G.D. 2021. Reduction of grazing index in high elevation grasslands following Black locust invasion in South Africa. Rangeland *Ecology and Management* 76: 109-117.

Chikowore, G., Steenhuisen, S.-L., Mutamiswa, R., Martin, G.D. & Chidawanyika, F. 2021. Integration of invasive tree, Black locust, into agro-ecological flower visitor networks induces competition for pollination services. *Arthropod Plant Interactions*. *Arthropod Plant Interactions* 15: 787-796.

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Elseb, S.J., Taylor, P.J., Zeller, U., Denys, C. & Nicolas, V. 2021. Peripatric speciation linked with drainage evolution in a rare African rodent, *Mastomys shortridgei* (Rodentia: Muridae). *Journal of Zoological Systematics and Evolutionary Research* 2020:1-21. DOI: 10.1111/jzs.12441.

Ermilov, S.G., Hugo-Coetzee, E.A. & Behan-Pelletier, V.M. 2021. *Hogsbackia africaensis* gen. nov., sp. nov. (Acari, Oribatida, Ceratozetoidea, Punctoribatidae), from an Afromontane Forest of South Africa. *Zootaxa* 4963: 530-544. DOI: 10.11646/zootaxa.4963.3.7.

Ermilov, S.G, Hugo-Coetzee, E.A. & Khaustov, A.A. 2021. A new species of Scheloribates (Acari, Oribatida, Scheloribatidae) from South Africa. *Ecologica Montenegrina* 39: 86-91. DOI: 10.37828/em.2021.39.10.

Ermilov, S.G., Hugo-Coetzee, E.A. & Khaustov, A.A. 2021. Contribution to the knowledge of *Geminoppia* (Acari, Oribatida, Oppiidae) with description of a new species from South Africa. *Acta Zoologica Academiae Scientarum Hungaricae* 67: 211-222. DOI: 10.17109/AZH.67.3.211.2021.

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Ermilov, S.G., Hugo-Coetzee, E.A., Khaustov, A.A. & Khaustov, V.A. 2021. A new species of *Malgacheliodes* (Acari, Oribatida, Licnodamaeidae) from South Africa. *Zootaxa* 4984: 357-367. DOI: 10.11646/zootaxa.4984.1.26.

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Holt, S., Kolska Horwitz, L, Wilson, B. & Codron, D. 2021. Leopard tortoise *Stigmochelys pardalis* (Bell, 1928) mortality caused by electrified fences in central South Africa and its impact on tortoise demography. *African Journal of Herpetology* 70: 32-52.

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Jäger, P., Arnedo, M.A., Azevedo, G.H.F., Baehr, B., Bonaldo, A.B., Haddad, C.R., Harms, D., Hormiga, G., Labarque, F.M., Muster, C., Ramírez, M.J. & Santos, A. 2021. Twenty years, eight legs, one concept: describing spider biodiversity in Zootaxa (Arachnida: Araneae). *Zootaxa* 4979: 131-146.

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Books/Chapters in Books

Botha, J. & Huttenlocker, A.K. 2021. Non-mammalian synapsid. In: *Comparative skeletal histology and paleohistology*. V. de

Buffrénil, A. de Ricqlès, L. Zylberberg & K. Padian (Eds). Boca Raton: CRC Press, Taylor and Francis. pp. 550-563.

McCleery, R., Monadjem, A., Conner, L.M., Austin, J. & Taylor, P.J. 2021. *Methods for ecological research on terrestrial small mammals*. Baltimore, USA: John Hopkins University Press.

Reynolds, C., Byrne, M.J., Chamberlain, D.E., Howes, C.G., Seymour, C.L. Sumasgutner, P. & Taylor, P.J. 2021. Urban Animal Diversity in the Global South. In: *Urban Ecology in the Global South*. C.M. Shackleton, S.S. Cilliers, E. Davoren & M.J. du Toit (Eds). Cities and Nature. Springer, Cham. pp 169-202.

Conference Contributions

Conference Papers/Posters

Ayawei, P.P., Smit, N.J., Van As, L.L. & Hadfield, K.A. 2021. *First molecular characterisation of Lamproglena from Africa*. Poster presented at 58th Society of Aquatic Sciences Annual Congress (SASAqS) (Online).1-3 November 2021.

Ayawei, P.P., Smit, N.J., Van As, L.L & Hadfield, K.A. 2021. *Molecular and morphological characterisation of Argulus japonicus (Japanese fish louse) from the Orange-Vaal River system*. Paper delivered at the 49th Annual Conference of the Parasitological Society of Southern Africa (PARSA) (Online). 14-15 September 2021.

Chazan, M., Bank, C., Codron, D., Horwitz, L., Lukich, V., Matmon, A., Miller, M., Mohale, N., Morris, D. & Porat, N. 2021. *The role of the Kalahari in hominin evolution: a perspective from the open-air sites of the Kathu Complex*. Paper delivered at the Society of Africanist Archaeologists Meeting (Online), Oxford University, UK. 14 August- 28 September 2021.

Codron, D., Malindie, S. & Buschke, F. 2021. *Partitioning of stable isotope niches in mammal herbivores reveals a clustered pattern sufficient for coexistence*. Paper delivered at the 23rd International Congress of Zoology (Online). Cape Town, South Africa. 22-24 November 2021.

Codron, D., Zietsman, P.C. & Barnes, S. 2021. *If eternity should fail: Boscia, carbon isotopes, and warming in the southern Kalahari*. Paper delivered at the Kolomela Mine Biodiversity Symposium, Postmasburg, South Africa. 6-7 October 2021.

Cory Toussaint, D., Taylor, P.J. & Barnhoorn, I. 2021. *The potential of bats as bioindicators for opencast mining within the Vhembe Biosphere Reserve, Limpopo*. Paper delivered at the 23rd International Congress of Zoology (Online). Cape Town, South Africa. 22-24 November 2021.

De Smidt, A. Jansen van Rensburg, C. & Van As, L.L. 2021. *Aalwurm-opname in twee natuurreservate van die Vrystaat Provinsie, Suid Afrika*. Paper delivered at the Student Symposium in Natural Sciences of the South African Academy of Science and Arts (Online), Potchefstroom, South Africa. 28-29 October 2021.

De Smidt, A., Jansen van Rensburg, C. & Van As, L.L. 2021. *Nematode survey of aquatic habitats in two reserves in the Free State Province*. Paper delivered at the 58th Society of Aquatic Sciences Annual Congress (SASAqS) (Online). 1-3 November 2021.

Grobbelaar, A., Basson, L. & Van As, L.L. 2021. *A planned taxonomical study and a twenty-year period, statistical overview of Sessilida Kahl, 1933 (Oligohymenophorea: Peritrichia) found on chiton species along the South African coastline*. Paper delivered at the 49th Annual Conference of the Parasitological Society of Southern Africa (PARSA) (Online). 14-15 September 2021.

Haddad, C.R. & Booysen, R. 2021. *Revision of the gnaphosid genera* Leptodrassex *Murphy, 2007 and* Leptopilos *Levy, 2009 in southern Africa*. Paper delivered at the John Murphy and Mike Roberts Memorial Symposium (Online). 3 December 2021.

Hastings, J., Basson, L. & De Jager, G.P. 2021. *Possible new symbiont species on South African endemic marine fish*. Paper delivered at African Inclusive Microscopy: Student Microscopy Symposium organised as part of the Microscopy Society of southern Africa, (MMSA) (Online). 29 November-2 December 2021.

Howard, A., Taylor, P.J., Richards, L., Weier, S. Markotter, W. Teeling, E & the BAT1K Consortium. 2021. *Unlocking the secrets: a call to sequence the genome of African bats*. Poster presented at the 23rd International Congress of Zoology (Online). Cape Town, South Africa. 22-24 November 2021.

Jansen van Rensburg, C. 2021. *Nematodes collected from leaf litter from the Jonkershoek Nature Reserve, Stellenbosch*. Paper delivered at the 23rd Symposium of the Nematological Society of Southern Africa, Tulbagh, South Africa. 19-23 September 2021.

Jordaan, A., Butler, H.J.B. & Steenkamp, J.C. 2021. *The importance of repeated sampling for monitoring reptiles*. Paper delivered at the Kolomela Mine Biodiversity Symposium, Postmasburg, South Africa. 6-7 October 2021.

Kruger, A.X., Jansen van Rensburg, C. & Van As, L.L. 2021. *Oorsig van die superorder Cladocera (Branchipoda) in die Vrystaat Provinsie*. Paper delivered at the Student Symposium in Natural Sciences of the South African Academy of Science and Arts (Online), Potchefstroom, South Africa. 28-29 October 2021.

Kruger, A.X., Jansen van Rensburg, C. & Van As, L.L. 2021. *Survey of cladoceran species present in Allemanskraal Dam, South Africa*. Paper delivered at 58th Society of Aquatic Sciences Annual Congress (SASAqS) (Online). 1-3 November 2021.

Le Roux, A., Mathibane, N. & Nowak, K. 2021. *On the urban edge: a small primate's landscape of fear in an anthropogenic habitat*. Paper delivered at the 23rd International Congress of Zoology (Online). Cape Town, South Africa. 22-24 November 2021.

Le Roux, A. 2021. *Rapid responses of wildlife to climate change: the limits and possibilities.* Keynote presentation delivered at the International E-conference on Climate Nexus Perspectives (I2CNP2021). 5 June 2021.

Lewis, C., Van der Merwe, R., Radloff, F.G.T., Beukes, M., Beukes, O. & Codron, D. 2021. *Trophic effects in the niche variation hypothesis: disparate niche individualization between carnivores and herbivores.* Paper delivered at the 23rd International Congress of Zoology (Online). Cape Town, South Africa. 22-24 November 2021.

Linden, B., Foord, S.H., Horta-Lacueva, Q., Taylor, P.J & Collinson-Jonker, W. 2021. *Primates and linear infrastructure in South Africa: mortality and mitigation.* Paper delivered at the 23rd International Congress of Zoology (Online). Cape Town, South Africa. 22-24 November 2021.

Lewis, C., Van Der Merwe, R., Radloff, F.G.T., Beukes, M., Beukes, O. & Codron, D. 2021 *Integrating trophic level with the niche variation hypothesis A comparison of individual niche variation between mammal herbivore and carnivore populations.* Paper delivered at the Annual Conference of the Southern African Wildlife Management Association, Kruger National Park, South Africa 4-9 September 2021.

Mahlobo, T., Dube, N., Zachariades, C., & Munyai, T.C. 2021 *Polymorphomyia basilica (Snow) (Diptera: Tephritidae): Preference for, and performance on, different morphotypes of Chromolaena odorata (Asteraceae) in the laboratory.* Paper delivered at the 22nd Congress of the Entomological Society of Southern Africa (Online). 28 June-1 July 2021.

Martin, G.D. 2021. *Southern African Mountain Weeds Working Group.* Paper delivered at the Invasive Species Symposium (Online). 23 March 2021

Rogers, D. Coetzee, J.A. & Martin, G.D. 2021 *Biology and host specificity of Listronotus frontalis a potential biological control agent for Sagittaria platyphylla (Alismataceae).* Paper delivered at the Invasive Species Symposium (Online). 23 March 2021.

Salgado, S. & Martin, G.D. 2021. *Megabruchidius tonkineus* (Coleoptera: Chrysomelidae: Bruchinae) *a potential new association biological control option for the invasive Gleditsia triacanthos L. (Fabaceae) in South Africa* Paper delivered at Entomology 2021, Denver, Colorado, USA. 31 October-1 November 2021.

Salgado, S. & Martin, G.D. 2021. Biol*ogical control options for Gleditsia triacanthos in South Africa.* Paper delivered at the 22nd Congress of the Entomological Society of Southern Africa (Entsoc), 28 June - 1 July 2021 (online).

Steenkamp, J.C, Butler, H.J.B. & Jordaan, A. 2021. Fra*gile frogs as environmental health indicators – Are they as good as the canaries in the coal mine?* Paper delivered at the Kolomela Mine Biodiversity Symposium, Postmasburg, South Africa. 6-7 October 2021.

Swanepoel, P.J., Barkhuizen, L.M. & Van As, L.L. 2021 *Accessing the value of using long line fishing for small-scale fisheries in South Africa's largest impoundment, Lake Gariep.* Paper delivered at Virtual Conference of Fisheries Society of British Isles, 5-8 July 2021.

Swanepoel, P.J., Barkhuizen, L.M, Van As, L.L. & Ellender, B. 2021. *Biological characterises pf the African sharptooth catfish Clarias gariepinus in South Africa's largest impoundment.* Paper delivered at Virtual World Fisheries Congress. 20-24 September 2021.

Taylor, P.J. 2021. *To split or not to split: Evolutionary classification of small mammals highlights the conservation plight of Afromontane habitats.* Paper delivered at The Conservation Symposium, South Africa (Online). 1-5 November 2021.

Van Der Merwe, P.J. & Fourie, DeV. 2021. *Investigation into armoured scale insects (Hemiptera: Diaspididae) affecting South African walnut production and biological control focused management strategies.* Paper delivered at the 22nd Congress of the Entomological Society of Southern Africa (Entsoc) (Online). 28 June-1 July 2021.

Van Der Merwe, R. & Codron, D. 2021. *Die rol van liggaamsgrootte as 'n faktor wat nisvariasie binne herbivoorbevolkings beïnvloed.* Paper delivered at the Student Symposium in Natural Sciences of the South African Academy of Science and Arts (Online), Potchefstroom, South Africa. 28-29 October 2021.

Van Der Merwe, R., Lewis, C. & Codron, D. 2021. *The role of body size as a life-history trait influencing within-population niche variation in herbivorous mammals.* Paper delivered at Annual Conference of the Southern African Wildlife Management Association, Kruger National Park, South Africa. 4-9 September 2021.

Van der Mescht, A.C. & Codron, D. 2021. *Bush cricket responses to ecological gradients.* Paper delivered at the 23rd International Congress of Zoology (Online). Cape Town, South Africa. 22-24 November 2021.

Voua Otomo, P. & Dlamini, N.P. 2021. *High rates of biochar soil amendment cause increased incidences of neurotoxic and oxidative stress in* Eisenia fetida *(Oligochaeta) exposed to glyphosate.* Paper delivered at the Virtual Symposium of the Biochemistry and Molecular Biology Society of Zimbabwe, Harare, Zimbabwe (Online). 15 December 2021.

Weier, S., Taylor. P.J., Linden, V, Hammer, A., Grass, I. & Tscharntke, T. 2021. *Land use affects bat communities and their ecosystem services in agro-ecosystems in Limpopo, South Africa.* Paper delivered at 23rd International Congress of Zoology (Online). Cape Town, South Africa. 22-24 November 2021.

Weier, S., Linden, V., Hammer, A., Grass, I. Tscharntke, T. & Taylor, P.J. 2021. Bat guilds respond differently to habitat loss and fragmentation in macadamia orchards, South Africa.

Paper delivered at The Conservation Symposium, South Africa (Online). 1-5 November 2021.

Wolmarans, A., Paterson, I. & Martin, G.D. 2021. *Biological control options for Robinia pseudoacacia.* Paper delivered at the 22nd Congress of the Entomological Society of Southern Africa (Entsoc). Online. 28 June-1 July 2021

Conference Proceedings

Madiope, K.W., Keeping, M.G. & Fourie, DeV. 2021. Quantifying yield loss to yellow sugarcane aphid in potted sugarcane. In: *Proceedings of the South African Sugar Technologists' Association (SASTA)* 93: 145-148. 94th SASTA Congress, ICC, Durban. 16 -18 August 2021.

STAFF (2021)

Head of Department:

Prof LL van As

Bloemfontein Campus:

Professors:

Prof L Basson and Prof NJL Heideman

Distinguished Professor:

Prof LJ Fourie (Affiliated)

Associate Professors:

Prof D Codron, Prof CR Haddad and Prof LL van As

Senior Lecturers:

Dr N Dube and Dr VR Swart

Lecturers:

Mr HJB Butler, Ms I Heyns, Dr C Jansen van Rensburg and Dr EMP van Dalen

Junior Lecturers:

Mr G Janse van Rensburg and Miss JW Paulse

Programme Director:

Dr C Jansen van Rensburg

Research Associate (Affiliated):

Dr Y Marusik

Research Fellows (Affiliated):

Dr LM Barkhuizen Dr M Bates, Dr J Botha, Dr F Chidawanyika, Dr EA Hugo-Coetzee

Technicians:

Mr TW Lesaona and Mr PK Mohasi

Senior Assistant Officer:

Ms B Maasdorp

Officers – Professional Services:

Mr L Bopheka and Ms NW Mokhethipelwa

Qwaqwa Campus:

Subject Head:

Dr P Voua Otomo

Professor:

Prof P Taylor

Associate Professor:

Prof A le Roux

Senior Lecturers:

Dr E Bredenkamp and Dr P Voua Otomo

Lecturers:

Dr N Nyembe, Dr M Ramoejane, Dr J van As and Dr M van As

Research Fellow (Affiliated):

Dr G Martin

Officers – Professional Services:

Dr N Kheswa and Ms MP Sithole

ACADEMIC CENTRES

Centre for
ENVIRONMENTAL MANAGEMENT

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OVERVIEW OF 2021

The year 2021 was accompanied with much success for the Centre for Environmental Management (CEM), in spite of the ongoing global pandemic. Research outputs have grown steadily over more than a decade – the eight research reports and two accredited articles produced in 2005 have increased to 152 research reports, 65 book chapters and 415 articles in accredited journals by the end of 2021, of which five book chapters and 79 accredited articles were produced during 2021. Even though the CEM's initial mandate was to coordinate the Masters of Environmental Management programme, it was important to develop our own research profile – not only to serve the wider community of environmental managers, but also to support and ensure quality postgraduate training. By continuing to develop our research profile alongside our postgraduate degree programmes, the CEM aims to establish itself as the thought-leader in southern African environmental and water management. This will create a hub where the best and brightest post-graduate students can come together to begin solving tomorrow's environmental problems.

This year marked the second year of the two new Master of Science degrees. Both are structured and were presented both online and face-to-face due to the ongoing pandemic. The CEM is currently presenting the following programmes:

Environmental Management:

- Master of Science majoring in Environmental Management
- PhD in Environmental Management

- Integrated Water Management:
- Postgraduate Diploma in Integrated Water Resource Management
- Master of Science majoring in Integrated Water Resource Management
- PhD in Integrated Water Resource Management

The CEM Advisory Board was constituted, and includes the following members: Prof Paul Oberholster (UFS Centre for Environmental Management), Dr Inge Jacobs-Mata (International Water Management Institute Southern Africa), Dr Nick King (Consultant), Prof Janine Adams (Nelson Mandela University), Mr Xolisa Ngwadla (Council for Scientific and Industrial Research [CSIR]) and Associate Prof Johan van Niekerk (UFS Sustainable Food Systems and Development).

ACHIEVEMENTS

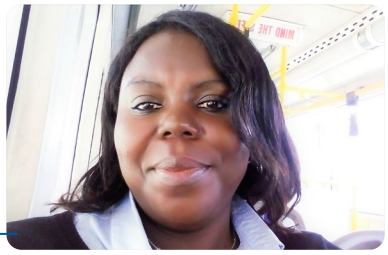
Staff Achievements

Dr Marinda Avenant received her PhD degree in April 2021 for her thesis titled 'The role of fish in a suite of indicators for assessing environmental water requirements in non-perennial rivers in the Orange River system'. Her supervisors were Dr SA Mitchell and Prof MT Seaman (both affiliated to the UFS). She was also appointed as curriculum advisor by the Southern African Regional Universities Association (SARUA) for the curriculum review of their Master's in Climate Change and Sustainable Development.

Prof Paul Oberholster was nominated for the 2020/2021 National Science and Technology Forum (NSTF)-South32 Awards (Science Oscars) in the category NSTF-Water Research Commission Award. He subsequently received the award for his contribution to water resource management in South Africa over the last five years, on 30 September 2021 in Cape Town.

Prof Olusola Ololade received an NRF C2-rating in November 2021. She was invited to deliver a Keynote Address at the University of Johannesburg (UJ) Department of Chemical

Sciences' internal postgraduate student seminar on 30 July 2021. The presentation was titled 'Unravelling the interlinkages of the Water-Energy-Food Nexus towards achieving security in the three sectors. She was also accepted as a Lifetime Fellow Member by the International Society for Development and Sustainability (ISDS) in Japan in August 2021, based on her research contribution to environmental sustainability. Prof Ololade presented in the Science Advisory Group on Emergencies (SAGE) webinar series 'Why environmental management must become the new normal' on 5 August 2021. The title of her talk was 'Pathway towards climate mitigation and resilience requires a transdisciplinary approach'. Prof Ololade participated as a panellist for The Water Show Africa for the session on 'Navigating the threats of climate on water in mining' held from 23 to 25 August 2021 (online).



Prof Shola Ololade

Dr Surina Esterhuyse received an NRF C2-rating during November 2021.

Dr Piet-Louis Grundling was the Coordinating Lead Author for the Global Peatlands Initiative (GPI) Global Peatlands *Assessment report*, led by the United Nations Environment Programme (UNEP), and is a Main Board Member of the International Mire Conservation Group. Dr Grundling also received an honourable mention in the book *Rietvlei: where nature, history and conservation meet* (Wohlitz, 2021) for his work on wetlands.

Student Achievements

Ms Beatrice Otunola's presentation on 'Assisted phytoremediation of heavy metals contaminated soil using attapulgite and bentonite: Effects on growth and metal accumulation in Vetiver grass', was adjudged as Outstanding at the Next Generation Thought Leaders (Next G) Conference on Environment and Sustainability, held at the University of Ghana (and online), on 28 and 29 July 2021.

Ms Beatrice Otunola, PhD student in the Centre for Environmental Management

Ms Yolandi Schoeman's presentation on 'Ontwerpbeginsels vir drywende vleilande' won the section prize at the annual *Studentesimposium in die Natuurwetenskappe* 2021, held in Potchefstroom on 28 and 29 October 2021).

RESEARCH AND INNOVATION

Through Prof Paul Oberholster, the UFS is involved in a collaborative project with the CSIR and four Southern African Development Community (SADC) countries, titled 'Alternative low cost solution to rural sewage wastewater treatment using phycoremediation'. The aim of the study is to reduce the health risks that Waste Water Treatment Works (WWTWs) pose to communities and to reduce poverty through innovation. The project involves participation of local communities to assess and reduce health risks, and cooperation with local governments to assess and implement options. The objectives also include improving the operational efficiency of pond-based WWTWs, implementing biotic cultures to pond systems to reduce pathogens and nutrients. Developing operational guidelines and procedures for roll-out to other WWTW's in SADC countries and building local capacity to support local entrepreneurs and local government capacity.

Prof Paul Oberholster

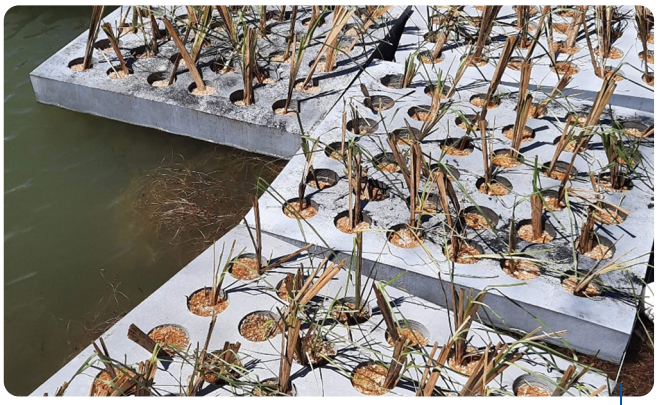
In a related long-standing collaboration, started in 2016 and scheduled for completion in 2022, Prof Oberholster is the principal investigator and project leader of the African Development Bank and African Climate Technology Centre (ACTC) (financed by the Global Environment Facility [GEF]), project, which is examining phycoremediation as an adaptation measure for climate change vulnerability at rural wastewater treatment plans in the SADC countries. With locations and actions in Botswana (Gaborone), Malawi (Zomba) and South Africa (Mossel Bay), the principal objective of the project is to facilitate efficient reduction of nutrients (nitrates and phosphates) and certain pathogens (protozoa, helminths, bacteria and viruses) that have increased due to climate change in effluents of the identified WWTWs, thereby reducing human health risks and improving water resource quality for reclamation, to be re-used in irrigation.

A collaborative project between the CSIR, UFS (CEM – Prof Oberholster), Sasol Group Technology and Sasol Mining,

focusing on determining source, pathway and receptors of a mixture of pollution, examines the source of water seepage to the Leeuspruit stream, wetlands and Rietspruit stream at Sasol's defunct Sigma Coal Mine at Sasolburg.

Another collaboration with Coaltech in which Prof Oberholster is involved, aims at accessing different supporting organic materials for the enhancement of anaerobic microorganisms in sub-surface constructed wetlands receiving acid mine drainage. He is also principal investigator of a new project started in 2021, in collaboration with De Beers, which is assessing ecosystem services before and after installation of floating wetlands in the post-mining pit lake of Voorspoed Mine, Kroonstad.

Mr Mbuyiselwa Moloi, PhD student in the CEM, sampling surface water of the Leeuspruit near SASOL



Drifting wetlands

A new project was initiated in 2021 on Management aquifer recharge in South Africa (MARSA). This project, for which Prof Oberholster is the project leader, is a collaborative effort involving the Geological Survey of Denmark and Greenland (GEUS), the Department of Water Affairs and Sanitation, a the University of the Western Cape (UWC). The primary aim of MARSA is to develop management aquifer recharge (MAR) technologies that allow for a broader span of water resources to be used for MAR, including storm water, river water, saline water and even reclaimed water (treated wastewater). The research includes development of new monitoring strategies for the technologies and an assessment of the water saving achieved by implementing MAR on a larger scale in South Africa, with the focus on the West Coast District Municipality.

Prof Shola Ololade is the coordinator and lead investigator of a research project titled 'Assessment of the ecological and environmental degradation and possible restoration in the Welkom mining area. She is also the coordinator and lead investigator of the research project titled 'Assessment of the Water-Energy-Food Nexus Agenda within sectoral departments and policies in South Africa, funded by the Energy Water Sector Education Training Authority (EWSETA) skills training fund.

A collaborative project with the Central University of Technology (CUT) on 'Impacts of urban development on environmental sustainability: case study of Mangaung Metropolitan Municipality', for which Dr Oloade is the co-project leader, is funded by the UFS-CUT Collaboration Fund.

The CEM, in collaboration with the Disaster Management Training and Education Centre for Africa (DiMTEC), the Department of Zoology on the Qwaqwa Campus, the Cape Peninsula University of Technology (CPUT), and the Technical University of Dresden, received funding from the Water Research Commission (WRC) to conduct a study titled 'Threats of extreme weather events: improving the resilience of QwaQwa to the multiple risks of climate change'. The project, led by Dr Marinda Avenant, investigates the potential risks associated with extreme weather events on service delivery in Qwaqwa and seeks to develop a risk reduction strategy for the area.

Water sampling at the Metsi-Matsho River, upstream of Phuthaditjhaba

Dr Falko Buschke led the second year of the bilateral project 'Socio-Ecological Resilience in Agricultural Landscapes' (SERIAL) between UFS and the Vrije Universiteit Brussels (VUB) in Belgium. The project, which focuses on the Rooiberge-Riemland Key Biodiversity Area in the eastern Free State, is funded by the Flemish Interuniversity Council and includes collaboration the Conservation NGO Birdlife South Africa.

ENGAGED SCHOLARSHIP

Dr Tascha Vos and the postgraduate students based at CEM continued the long-term monitoring of the water quality of the urban impoundment, Loch Logan, which is the central focus of Bloemfontein's Waterfront development. The information gathered was shared with the Mangaung Local Municipality and the owners of the Waterfront development, for use in the management of the lake. Dr Vos appeared with Dr Stephanie Cawood (Centre for Africa Studies, UFS) in a feature article 'Testing the waters: how water quality could be used at informal heritage sites', on UFS *News Archive*, on 4 January 2021.

Dr Tascha de Vos and colleagues testing water quality

Prof Anthony Turton participated as a panellist on the webinar 'Is South Africa falling apart – where to from here?' presented by the UFS on 24 August 2021 as part of the Free State Literature Festival's online initiative, VrySpraak-digitaal. He was also involved four interviews in the South African media on various topics – 'The origins of our water provision and of the degradation of our systems', an interview with Sara Gon on Chai FM (101.9) Podcasts. 25 March 2021; 'There is a growing water crisis in SA', an interview on Newzroom Africa on 1 June 2021; 'Cabinet Reshuffle - Department of Water and Sanitation challenges', an interview on SABC News on 10 August 2021; and 'South Africa's Water Crisis: Gauteng experiencing water cuts', an interview on ENCA on 7 September 2021.

Dr Falko Buschke served on the Scientific Committee for the International Congress on Conservation Biology (ICCB), the biennial conference of the Society for Conservation Biology. The conference was scheduled to take place in Rwanda in December 2021, but was changed to a virtual format, and held from 13 to 17 December 2021. He is a member of the Reviewer College of the British Ecological Society, a committee that reviews grant applications for the Society, and also a member of the International Union for the Conservation of Nature's (IUCN) Commission on Ecosystem Management, specifically for the Impact Mitigation and Ecological Compensation (IMEC) working group. Dr Buschke is on the editorial board of the *Conservation Biology,* the journal of the international Society for Conservation Biology.

Dr Melusi Thwala is a guest editor for *Springer Nature: Applied Sciences* and Dr Surina Esterhuyse was invited as a guest editor for the special mentoring issue on water resources of *Water International*.

Dr Pieter Zietsman served on the editorial board, and as a referee and co-worker on the book *Flowering Plants of Africa* volume 67 published by the South African National Biodiversity Institute(SANBI).

NATIONAL AND INTERNATIONAL COLLABORATION

Over and above the collaborative research projects reported above in which Prof Paul Oberholster is actively involved, he is also a collaborator on the USA-South Africa University Partnership (sponsored by the USA Embassy). The project focuses on increasing science, technology, engineering and mathematics (STEM) capacity, as well as improving knowledge and skills in university administration in South Africa.

At a national level, Prof Shola Ololade collaborated with Dr Julio Castillo Hernandez (UFS Department of Microbiology and Biochemistry), Dr Makhosazana Aghoghovwia (UFS Department of Soil and Crop Sciences), Dr Melusi Thwala (CSIR, Pretoria) and Dr Saheed Oke (Department of Civil and Environmental Engineering, CUT). Internationally, she worked with Dr Bethany O'Shea from the Department of Ocean and Environmental Resources, University of San Diego, California, and Dr Amy Quandt from the Department of Geography, at the same university.

Dr Falko Buschke completed a project with researchers from Gothenburg University, Sweden, and Sapienza University of Rome, Italy. The project was a virtual collaboration started in 2020 on global biodiversity indicators. He also continued his long-term collaboration with KU Leuven and VUB, in Belgium. More recently this collaboration was expanded to include Universidade Eduardo Mondlane, Mozambique. As this work was conducted remotely due to COVID-19 restrictions, they have not had the opportunity to meet in person since early 2020.

Dr Surina Esterhuyse worked with researchers from Belgium and Brazil on a book chapter on the impact of hydrocarbon extraction on freshwater resources for the *Encyclopedia of Inland Waters*. She is also involved in the Petroleum Agency SA (PASA) project, 'Development and design of a regional groundwater monitoring network for the Central Karoo', on which she is working together with the Institute for Groundwater Studies (IGS).

Dr Surina Esterhuyse

Dr Marinda Avenant worked with Prof Beatrice Opeolu, Faculty of Applied Sciences, CPUT, Dr Dirk Jungmann, the Chair of Limnology in the Institute of Hydrobiology, Technical University of Dresden, and Dr Hilmar Boernick from the Institute of Water Chemistry at the same university.

POSTGRADUATE STUDENTS

n 2021, a total of 21 students were registered for the Postgraduate Diploma in Integrated Water Management, and 34 for the Master of Environmental Management. Nine candidates were registered for the PhD in Environmental Management and one for the PhD in Integrated Water Management.

Fourteen (14) students were registered for the two new structured Master of Science degrees – five for the MSc majoring in Environmental Management and nine for the MSc majoring in Integrated Water Management. A further five students were registered for the full MSc – three majoring in Environmental Management and two majoring in Integrated Water Management.

POSTDOCTORAL RESEARCH FELLOWS

The CEM hosted four Postdoctoral Fellows during 2021 – Dr Israel Orimoloye (from Nigeria), Dr Ernestine Atangana (from Cameroon), Dr Nicolette Vermaak (from South Africa), and Dr Gladys Belle (from Congo).

STAFF MATTERS

Dr Falko Buschke resigned at the end of 2021 in order to take up employment with an international company.

The Centre for Environmental Management bid farewell to Dr Falko Buschke, after seven years with the Centre

RESEARCH OUTPUTS

Research Articles

Adetoro, A.A., Ngidi, M., Nyam, Y.S. & Orimoloye, I.R. 2021. Temporal evaluation of global trends in water footprint, water sustainability and water productivity research. *Scientific African* 12: 1-15 (Article # e00732). DOI: 10.1016/j.sciaf.2021.e00732

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Conference Contributions

Conference Papers/Posters

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Botha, P.L, Grundling, P. & Brown, L. 2021. *Contribution of a small sloping spring mire in preventing gulley erosion in the mountainous Waterberg, Limpopo, South Africa.* Paper delivered at The National Wetland Indaba (Online), South Africa. 20-21 October 2021.

Buschke, F.T. 2021. *How a cohort of early-career environmental professionals prioritise the principles in the National Environmental Management Act.* Paper delivered at the International Association for Impact Assessment (IAIAsa) National Conference (Online), South Africa. 17-19 August 2021.

Buschke, F.T. 2021. *The effect of ecological stochasticity on global biodiversity indicators.* Paper delivered at the 30th International Congress for Conservation Biology. Kigali, Rwanda (Online). 13-17 December 2021.

Buschke, F.T. & Codron, D. 2021. *The macroecology of modern coexistence theory.* Paper delivered at the International Biogeography Society & Early Career Biogeographers Conference, Amsterdam, The Netherlands (Online). 22-24 October 2021.

Gangathele, A.M., Grundling, A.T., Grundling, P. & Le Roux, J.J. 2021. *Peatland response to degradation: a case study of Waterval Peatland in Kgaswane Mountain Reserve.* Paper delivered at the Society of South African Geographers (SSAG) & Southern African Association of Geomorphologists (SAAG) 2021 Joint Biennial Conference (Online), South Africa. 6-8 September 2021.

Gangathele, A.M., Grundling, A.T., Grundling, P. & Le Roux, J.J. 2021. *Peatland response to degradation: A case study of the Waterval peatland in the Kgaswane Mountain Reserve.* Poster presented at the 8th annual Land Rehabilitation Society of Southern Africa (LaRSSA) Conference 2021, Pretoria & Virtual (Online), South Africa. 13-16 September 2021.

Gangathele, A., Grundling, A.T., Grundling, P., Le Roux, J.P. & Hannekom, C. 2021. *Socio-economic impacts of peat fires: a case of Molopo Peatland and Muzi Swamp.* Paper delivered at The National Wetland Indaba (Online), South Africa. 20-21 October 2021.

Grundling, A.T., Grundling, P., Van Deventer, H. & Le Roux, J.P. 2021. *Pressures and protection of South African peatlands – Situation analysis.* Paper delivered at The National Wetland Indaba,(Online), South Africa. 20-21 October 2021.

Grundling, P. 2021. *Wetland specialist studies: ethics in the bog – our contribution to wetland degradation in South Africa.* Paper delivered at The National Wetland Indaba (Online), South Africa. 20-21 October 2021.

Grundling, P.L., Botha, P.L. & Grundling, A.T. 2021. *Hillslope wetland restoration in granitic landscapes – Contributing to landscape scale conservation.* Paper delivered at the 8th annual Land Rehabilitation Society of Southern Africa (LaRSSA) Conference 2021, Pretoria & Virtual (Online), South Africa. 13-16 September 2021.

Henschel, J.R. 2021. *Namib tenebrionid beetles reveal complex pulse-reserve dynamics.* Paper delivered at the annual Arid Zone Ecology Forum (AZEF) 2021 Conference (Online), South Africa. 11-15 October 2021.

Khosa, D.S., Grundling, P.L. & Brown, L. 2021. *Characterising the diversity of selected wetlands in the Marakele National Park in Limpopo Province, South Africa.* Poster presented at The National Wetland Indaba (Online), South Africa. 20-21 October 2021.

Le Roux, J.P., Grundling, A.T. & Grundling, P. 2021. *Changing weather: a trigger for peat weathering?* Paper delivered at the Society of South African Geographers (SSAG) & Southern African Association of Geomorphologists (SAAG) 2021 Joint Biennial Conference (Online), South Africa. 6-8 September 2021.

Le Roux, J.P., Grundling, A.T. & Grundling, P. 2021. *The restoration of burnt peatlands: Lessons to be learnt concerning potholes, sinkholes and ash-holes.* Paper delivered at the 8th Annual Land Rehabilitation Society of Southern Africa (LaRSSA) Conference 2021, Pretoria & Virtual (Online), South Africa. 13-16 September 2021.

Le Roux, J.P., Grundling, A.T., Grundling, P., Gangathele, A. & Hannekom, C. 2021. *Towards understanding the hydrology and hydrodynamics of the Muzi Swamp.* Paper delivered at The National Wetland Indaba (Online), South Africa. 20-21 October 2021.

Mokgawa, M.P, Luus-Powell, W.J., Sara, R.R., Oberholster, P.J. & Smit, W.J. 2021 *The health and survival of Oreochromis mossambicus exposed to domestic wastewater from Motetema wastewater treatment plant, Sekhukhune District.* Paper delivered at the 23rd International Congress of Zoology, Cape Town, South Africa. 21-26 November 2021.

Moloi, M.S., Lehutso, R.F., Erasmus, M., Oberholster, P.J. & Thwala M. 2021. *Exposure and toxicity effects of engineered nanomaterials released from nano-enabled products: A review.* Paper delivered at the SETAC Africa 10th Biennial Conference 2021 (Online), USA. 20-22 September 2021.

Mudau, R, Oke, S. & Ololade, O.O. 2021. *Impact of nickel mine tailings storage facility on surface and groundwater quality at Onverwacht Farm, Mpumalanga, South Africa.* Paper delivered at the 3rd Euro-Mediterranean Conference for

Environmental Integration (EMCEI-2021), Sousse, Tunisia, & Online. 10-13 June 2021.

Musengi, K, Henschel, J.R. & Van der Merwe, H. 2021. *Testing remotely sensed soil moisture product and its relationship with long-term variability of rainfall, temperature and humidity at two sites in the Karoo, South Africa*. Paper delivered at the annual Arid Zone Ecology Forum (AZEF) 2021 Conference (Online), South Africa. 11-15 October 2021.

Oberholster, PJ. 2021. *Long term monitoring of the Zaalklapspruit Wetland*. Paper delivered at the South African Colliery Environmental Safety Health Association (SACESHA) Conference (Part 2/2) (Online), South Africa. 18 August 2021.

Oberholster PJ. 2021. *Using low cost technology to reduce the risk of eutrophication in the Olifants River catchment, South Africa*. Invited guest speaker at Technische Universität Dresden, Institute of Hydrobiology, Germany. 21 January 2021

Orimoloye, I.R. & Ololade, O.O. 2021. *Drought disaster risk reduction and its environmental benefits*. Paper delivered at the 3rd Euro-Mediterranean Conference for Environmental Integration (EMCEI-2021). Sousse, Tunisia & Online. 10-13 June 2021.

Orimoloye, I.R., Olusola, A., Belle, J.A. & Ololade, O.O. 2021. *Climate Change and Drought Drivers: Identification of drought drivers and climate extreme using regression-based algorithms*. Paper delivered at the AGU 2021 Fall Meeting, New Orleans, USA & Online. 13-17 December 2021.

Otunola, B.O., Aghoghovwia, M., Thwala, M., Gómez-Arias, A., Jordan, R., Hernandez, J.C. & Ololade, O.O. 2021. *Assisted phytoremediation of heavy metals contaminated soil using attapulgite and bentonite: Effects on growth and metal accumulation in Vetiver grass*. Paper delivered at the Next Generation Thought Leaders (Next G) Conference on Environment and Sustainability. Legon, Ghana & Online. 28-29 July 2021.

Otunola, B.O., Aghoghovwia, M., Thwala, M., Gómez-Arias, A., Jordan, R., Hernandez, J.C., Ololade, O.O. 2021. *Effects of attapulgite clay on the phytoremediation capacity of Indian mustard and Vetiver grass in Al and Mn contaminated water*. Paper delivered at the 2nd International Conference on Environmental Science and Applications (ICESA'21) (Online), Canada. 21-23 November 2021

Schoeman, Y. 2021. *Ecological engineering education towards a low carbon economy: case studies in ecological engineering, South Africa*. Paper delivered at the annual International Association for Impact Assessment South Africa (IAIAsa) 2021 National Conference (Online). 17-19 August 2021.

Schoeman, Y. & Oberholster, P. 2021. *Ontwerpbeginsels vir drywende vleilande*. Paper delivered at the annual Studentesimposium in die Natuurwetenskappe 2021, Potchefstroom, South Africa (Online). 28-29 October 2021.

Schoeman, Y., Oberholster, P. & Somerset, V. 2021. *A zero-waste multi-criteria decision-support model for the iron and steel industry in developing countries: a case study*. Paper delivered at the Annual International Association for Impact Assessment South Africa (IAIAsa) 2021 National Conference (Online), South Africa. 17-19 August 2021.

Schoeman, Y., Oberholster, P. & Somerset, V. 2021. *Hierarchical prioritization of industrial waste management system components for the iron and steel industry in developing African economies*. Paper delivered at the Next Generation Thought Leaders (Next G) Conference on Environment and Sustainability, Legon, Ghana (Online). 28-29 July 2021.

Sirunda, J., Oberholster, P., Wolfaardt, G, Botes, M., & Truter, C. 2021. *Assessment of microbiological quality of the water produced at the Von Bach treatment plant, in Namibia*. Paper delivered at the Next Generation Thought Leaders (Next G) Conference on Environment and Sustainability, Legon, Ghana (Online). 28-29 July 2021.

Thoré, E., Brendonck, L. & Pinceel, T. 2021. *Turquoise killifish on antidepressants: towards understanding the ecological risks of neurochemical pollution*. Paper delivered at the 4th Nothobranchius Symposium, Czech Republic (Online). 3-4 June 2021.

Turton, A. 2021. *Geopolitical Background to the War in Angola 1975 – 1989: An Intelligence Officer's Strategic Perspective (Understanding the Battle of Cuito Cuanavale in its Strategic Context)*. Paper delivered at the 2nd Watercourse History Festival, Plettenberg Bay, South Africa. 25-26 February 2021.

STAFF (2021)

Director:

Prof PJ Oberholster

Professor:

Prof PJ Oberholster

Associate Professor:

Prof OO Ololade

Affiliated Professors:

Prof NA Kgabi and Prof A Turton

Senior Lecturers:

Dr FT Buschke

Lecturers:

Dr MF Avenant and Dr S Esterhuyse

Research Fellows:

Dr NL Avenant, Dr NB Collins, Dr PL Gründling, Dr JR Henschel, Dr E Milne, Dr TWD Pinceel, Prof MT Seaman, Dr M Thwala, Dr DF Toerien, Prof BJ Vanschoenwinkel and Dr PC Zietsman.

Senior Officer – Professional Services:

Mrs ME Kemp

Officer – Professional Services:

Dr AT Vos

Researcher:

Dr Ernestine Atangana

Course Coordinator:

Mrs V Padayachee

Senior Assistant Officer:

Mrs DM Kolesky

Messenger:

Mr PS Thibiri

Centre for
MICROSCOPY

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OVERVIEW OF 2021

The Centre for Microscopy is a faculty research facility that supports researchers in gathering structural information using various microscopes, such as the scanning electron microscope (SEM), transmission electron microscope (TEM), confocal laser scanning microscope (CLSM) and stereo light microscopes. While the Centre primarily supports the University of the Free State (UFS), other local and international institutes outside the UFS also utilise the available facilities.

In the first quarter of 2021, the Centre took delivery of multiple pieces of new research equipment. This was an exciting time for those who had been involved in the large equipment drive at the UFS, which started in 2020. The new research equipment includes a JEOL high-resolution transmission electron microscope (HRTEM), a JEOL focused ion beam (FIB), JEOL SEM and a Zeiss CLSM,

In 2021 there was a significant increase in total hours spent on the microscopes. This progress was welcomed by the staff and indicates that research in the Faculty is recovering from 2020.

ACTIVITIES

User Support

Users and usage hours

In 2021, our staff supported 62 researchers and students covering a range of disciplines involving microscopy research. The combined hours spent on all the microscopes totalled 655 hours, an increase from 2020, however still significantly lower than pre-pandemic years. The Philips CM100 TEM was offline for 2021 due to a required filament replacement, which was completed in the last quarter of 2021. No research hours could therefore be logged for the system.

The following table summarises the microscope usage hours by various users in 2021.

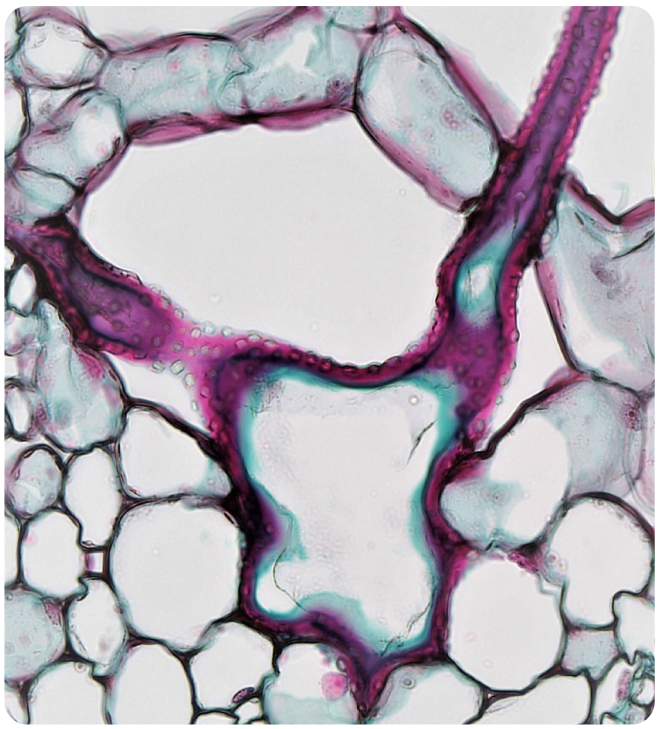


Table 1: Microscope usage per user (2021)

UFS Department	Usage hours		
	SEM	CLSM	Total
Chemistry	142	-	142
Consumer Science	21	-	21
Microbiology and Biochemistry	45	14	59
Pharmacology	5	3	8
Physics	273	5	278
Plant Sciences	33	4	37
Zoology & Entomology	90	-	90
External researchers/projects			
Central University of Technology (CUT)	20	-	20
Total Usage	**629**	**26**	**655**

The user numbers and hours spent on the microscopes during the past four years is shown in the table below,

Table 2: Total number of users and hours (2018 – 2021):

	2018	2019	2020	2021
Users	51	86	55	62
Hours	750	1 179	391	655

Sample preparation

In addition to operating the microscopes, the Centre staff also handle the necessary sample preparation requirements for each microscope, which are prearranged with the researchers. This allows the Centre to keep stock basic for more specialised chemicals and supplies used for microscopic preparations. Having all the necessary supplies available, saves researchers both time and funds, allowing them to conduct smaller projects, as some supplies can be costly and with a limited shelf life. This overall support service approach forms an integral part of the support service provided by the Centre and has proved to be very successful, as it provides researchers with an economically viable route to incorporate microscopy in their research.

New equipment

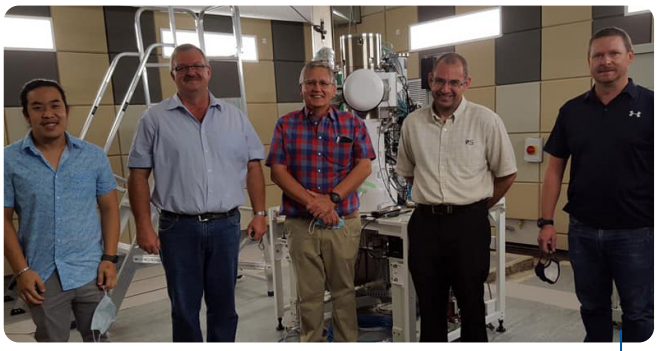
Arrival and Installation

With the renovations of 2020 completed, the start of 2021 was an exciting period for both the Centre and the University as we took delivery of the new research equipment.

Taking delivery of the JEOL microscopes, from the left, Ms Hanlie Grobler, Mr Edward Lee, Prof Koos Terblans and Ms Nonkululeko Phili

The new equipment items and their key features are:

- JEOL F200 HRTEM: Featuring a field emission electron source that would provide a higher spatial resolution and analytical performance than the current Philips CM100 at the Centre.

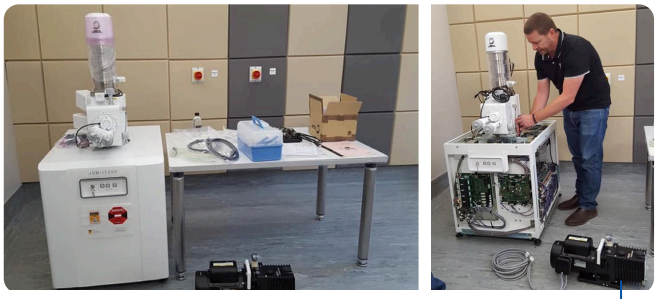


Early stages of installation of the JEOL F200 HRTEM, from the left Mr Edward Lee, Prof Koos Terblans, Prof Danie Vermeulen, Mr James Troup and Mr Roy Taylor

- JEOL JIP-4000PLUS FIB: Has the ability to mill and image the specimen using a focused ion beam. The system enables the preparation of cross-sections of thin-film specimens for TEM imaging.

JEOL JIB-4000PLUS FIB installation by Mr Edward Lee and Mr Roy Taylor

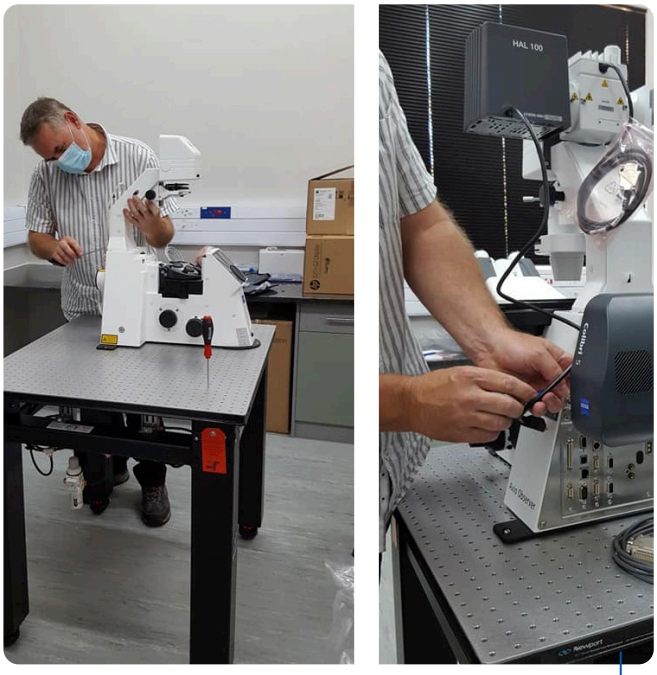
- JEOL IT200 SEM: An easy-to-use SEM will work alongside the current JEOL JSM 7800F SEM at the Centre for imaging specimens that do not require high magnification.



Installation of JEOL IT 200 SEM by Mr Roy Taylor

- Zeiss LSM 900 with Airyscan 2 CLSM: Capable of obtaining confocal images of living or fixed biological specimens with improved signal to noise and resolution without sample bleaching.

Arrival of the Zeiss LSM 900 with Airyscan 2 CLSM

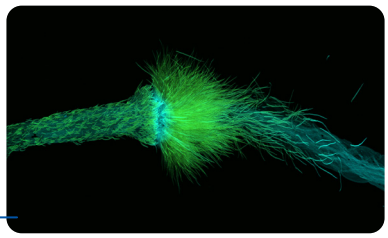


Mr R Granville busy with installation of the Zeiss LSM 900 CLSM

Training

In August 2021, online training at the Centre on the Zeiss LSM 900 CLSM was presented by Dr Jasmina Dikic, of Global Application Support Team from Zeiss Microscopy. The training focused primarily on the essential operation of the microscope. A second more specialised training is scheduled for 2022.

Ms Nonkululeko Phili and Ms Thandokuhle Khumalo receiving training on the Zeiss LSM 900 CLSM

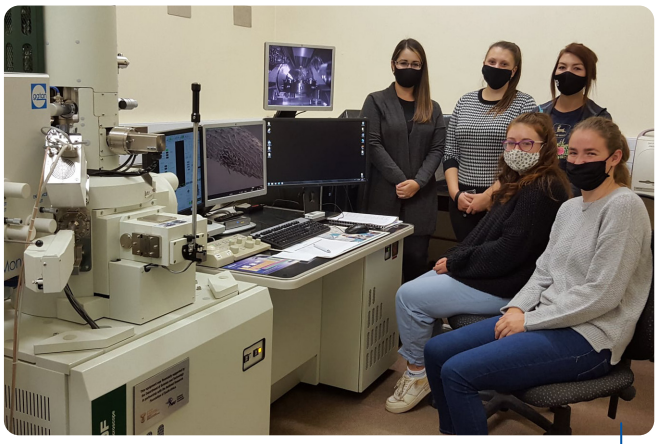


Confocal image of a Macadamia nut ovary stained with Aniline Blue captured on the Zeiss LSM 900 CLSM, of a specimen collected and stained by Ms Jo Cobbold, Department of Plant Sciences

TEACHING AND LEARNING

The Centre's staff are also involved in presenting practical sessions upon request for different departments in the Faculty of Natural and Agricultural Sciences. These sessions typically consist of a tour through the Centre, during which the staff show the researchers and/or students all the equipment available at the facility. The tour also includes a basic demonstration on how the equipment works, what information one would expect to obtain, and the sample preparation required for each piece of equipment.

An example of such a practical session is the annual practical SEM session for the Honours students from the Department of Zoology and Entomology, requested by Prof Linda Basson. The students are required to collect and prepare their own specimens, after which they are shown how to operate the SEM in order for them to examine the specimens they have collected. This provides the students with the experience of how to use an electron microscope, and for some this will be a once in a lifetime experience and for others a first introduction to many more possible SEM sessions as they continue with further studies.



Zoology and Entomology Honours students at the JEOL JSM-7800F SEM. Back row from the left, Ms H Grobler, Ms A Jordaan and Ms G Campher, and in the front, Ms A Wolmarans and Ms E Terblans

STAFF (2021)

Director:

Prof JJ Terblans

Junior Lecturer/Researcher

Mr E Lee

Senior Officer:

Ms H Grobler

Assistant Officer:

Ms Nonkululeko Phili

DISASTER MANAGEMENT TRAINING AND EDUCATION CENTRE FOR AFRICA (DiMTEC)

CONTACT DETAILS

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OVERVIEW OF 2021

The Disaster Management Training and Education Centre for Africa (DiMTEC) — the largest Disaster Management Training Centre in Africa – undertakes Disaster Management education, training and research. DiMTEC has three postgraduate programmes – the Post Graduate Diploma in Disaster Management, the Master of Disaster Management (MDM) and the PhD in Disaster Management,. The DiMTEC programmes are multidisciplinary, and are very high in demand, attracting students from throughout Africa and beyond. The number of students for all the programmes increased compared to 2020.

The importance of disaster risk management was again highlighted by the ongoing COVID-19 global pandemic and the 2021 academic year was once again challenged by COVID-19 and the various levels of national lockdown. This challenge put DiMTEC and the whole University to the test, and DiMTEC staff and students again proved their resilience and potential to adapt to external shocks.

DiMTEC is proud to report that the 2021 academic year was completed without any major hiccup and did very well in all four pillars of engagement. Teaching and learning were improved with changes in the content of most modules and the pass rate slightly increased. The research output increased sharply with all permanent academic staff publishing more than two articles in accredited journals. The DiMTEC staff were engaged in many community services, both within and out of South Africa.

Prof Belle continued piloting the activities of DiMTEC as the Acting Head of Department in 2021. Prof Abodiun Ogundeji was appointed as the new Director, to assume duties in March 2022.

At DiMTEC we can proudly and confidently say that 2021 was a more successful academic year than 2020 and the trend can only continue in 2022.

ACHIEVEMENTS

Staff Achievements

Dr Johanes Belle was appointed by the United Nations (UN) as part of the international team of 16 members for thematic theme 4 on Nature-based Solutions (NbS) to organise the Global Platform (GP) for Disaster Risk Reduction scheduled, to take place in Bali, Indonesia in May 2022. GP2022 is the highest platform constituted by the UN to evaluate and advise on the commitment of Nation States on disaster risk reduction issues. Dr Belle is the only member from Africa.

Dr Johannes Belle

Dr Alice Ncube, was invited to present a paper on the 'Importance of Risk Assessment and Disaster Risk Reduction as the world navigates the Agenda 2030 and the African Union Agenda 2063' at the United Nations World Cities Day held on 31 October, as part of Urban October 2021, under the theme 'Adapting Cities for Climate Resilience'. The eThekwini Municipality partnered with the UN Habitat to host the online event.

Student Achievements

For the first time, DiMTEC participated in the Academic Awards Ceremony of the Faculty of Natural and Agricultural Sciences, held virtually on the 26 May 2021. The Best Student in the Postgraduate Diploma in Disaster Management (named in honour of the late Jonty Ndlazi), was awarded to Ms Lindiwe Nhlamba.

Ms Thobile Makhubu was awarded the DiMTEC prize for the Best Master's Student in Disaster Management.

Ms Thobile Makhubu

TEACHING AND LEARNING

In response to the challenges of the COVID-19 pandemic, DiMTEC continued the blended method of learning and teaching.

The first contact session for the Post Graduate Diploma was held face-to-face to give the students that important exposure to the UFS environment and also for the students to meet and know their lecturers.

ENGAGED SCHOLARSHIP

Dr Belle was invited to be a panellist on the webinar of the Global Network of Civil Society Organisations (GNDR), the largest international network of civil society organisations working together to strengthen the resilience of communities most at risk of disasters. The theme of the webinar, held on 13 July, was 'Responding to Climate Change Impacts and Conflicts in Africa: Local Experiences of Resilience Building to Accelerate Sustainable Development Goals 13 and 16'. The main task for the panellists was to establish the link between climate change and conflicts in Africa and to suggest pathways for researchers and local communities to work together to find sustainable solutions.

Dr Olivia Kunguma and Dr Alice Ncube as Sphere trainers on minimum standards in humanitarian response, were invited to attend and contribute to the online training pack for working with National Disaster Management Agencies (NDMAs). The workshop was held virtually on 16 December 2021. The training pack, intended for NDMAs as well as other humanitarian agencies, was to be finalised at the end of 2021.

Prof Johannes Belle, Dr Alice Ncube and Dr Tlou Raphela were invited as guest lecturers for a refresher course on 'Making Southern African cities greener in a time of climate change: Strategies to reduce water and food production vulnerabilities caused by water extremes', organised by the Ministry of Foreign Affairs through Nuffic, the Dutch organisation for internationalisation in education, and held virtually from 26 October to 5 November 2021. The course forms part of the Global Development Program, under the topic 'Strategies to Reduce Food Insecurity in Times of Climate Change in South Africa: Focus on Poor and Indigenous Communities'.

Dr Alice Ncube was an invited panellist on the Dialogue for Women in Disaster Management, organised and hosted by the Gauteng Provincial Disaster Management Centre (PDMC), in partnership with the South African Local Government Association (SALGA). The Dialogue, held online on 30 August 2021, focused on issues affecting or relating to women in disaster management, exploration of women's perspectives and experiences in disaster risk reduction, challenges and opportunities for active participation in various areas of the disaster management and scenarios that will design the women agenda for disaster management in Gauteng. In her talk, Dr Ncube reflected on the significant inroads that women had made in the disaster management profession – from there being no women in the field before the dawn of democracy, to the current situation where many women are educated, employed and occupy positions in disaster management.

Dr Alice Ncube

NATIONAL AND INTERNATIONAL COLLABORATION

Dr Johannes Belle continued to coordinate the Intra-Africa Academic Mobility Scheme. The programme aims to improve the skills and competence of students through enhanced mobility between African countries. It also aims to promote

cooperation between African countries and reduce poverty by increasing qualified professionals in Africa. The programme is also intended to increase inter-cultural exchange in Africa and prepare the background for eventual regional integration in Africa. The UFS is a partner institution of the Fostering Research and Intra-African Knowledge Transfer through Mobility and Education (FRAME) Project, and DiMTEC as the local coordinating partner invited applications for the postgraduate programmes in Disaster Management.

POSTGRADUATE STUDENTS

In 2021, a total of 140 students were enrolled in the three postgraduate programmes offed by DiMTEC. At PGDip level, 50 students were enrolled, with 74 enrolled for the MDM, and 16 for the PhD.

The first cohort of students under the Intra-Africa Mobility Scholarship project sponsored by the European Union (EU) in partnership with the African Union (AU) were received from March 2021. They included two students from Cameroon, two from Ghana, one from Botswana and one from Namibia. These students were included in two departments within the Faculty of Natural and Agricultural Sciences, viz. DiMTEC and Agricultural Economics. Selection for the second cohort of students will include a student for the Department of Soil, Crop and Climate Sciences. Prof Belle continues to coordinate this very important project.

Out of the six students in the first cohort who were awarded the scholarships at the UFS, two were accepted to do their PhD in Disaster Management.

In 2021, 27 students graduated with the PGDip in Disaster Management and 25 with the MDM. This was an increase from 2020. Some MDM students who finished their studies in 2021, will graduate in early 2022.

Some of the DiMTEC students, from left, Ms Trudy Jose (PhD in Disaster Management); Mr Tevin Selelo, Ms Lum Sonita (PhD in Disaster Management) and Ms Blessing Eyong-Manyo

The writing workshop that was organised by DiMTEC and sponsored by the UFS Postgraduate School encouraged and enabled many DiMTEC students to complete the write-up of their mini dissertations, and for staff and students to write articles.

Sebastian Nyam obtained his PhD in 2021. The title of his thesis was 'Modelling sustainable agricultural water resources management in South Africa using applied system dynamics, and he was supervised by Prof Andries Jordaan and Prof Abiodun Ogundeji.

STAFF MATTERS

Prof Belle continued serve as Acting Head of Department for 2021 and Dr Ncube was appointed as Programme Director in January 2021.

RESEARCH OUTPUTS

Research Articles

Belle, J.A. 2021. A critical appraisal of the legal and institutional arrangement for wetlands management in South Africa. *Research Square* (Online Preprint). DOI: 10.21203/rs.3.rs-430245/v1.

Danso-Abbeam, G., Ojo, T.)., Ehiakpor, D.S. Ogundeji, A.A., Belle, J.A. & Ngidi, M.S.C. 2021. Measuring producciton performance of Moringa oleifera. *International Journal of Vegetable Science* 27(5): 472-479. DOI: 10.1080/19315260.2020.18582.17.

Kunguma, O. 2021, COVID-19 home remedies and myths becoming a hazardous health infodemic? *Jàmbá: Journal of Disaster Risk Studies* 13(1): a1115. DOI: 10.4102/jamba.v13i1.1115.

Kunguma, O., Mokhele, M.O. & Coetzee, M. 2021. Investigating the prevention and mitigatory role of risk communication in the COVID-19 pandemic: A case study of Bloemfontein, South Africa. *Jàmbá: Journal of Disaster Risk Studies* 13(1):a1130. DOI: 10.4102/jamba.v13i1.1130.

Kunguma, O., Ncube, A. & Mokhele, M.O. 2021. COVID-19 disaster response: South African disaster managers' faith in mandating legislation tested?. *Jàmbá: Journal of Disaster Risk Studies* 13(1): a1099. DOI: 10.4102/jamba.v13i1.1099.

Ncube, A. & Bahta, Y.T. 2021. Meeting Adversity with Resilience: Survival of Zimbabwean Migrant Women in South Africa. *Journal of International Migration & Integration (JIMI)*. DOI: 10.1007/s12134-021-00878-22.

Ndlovu, T., Belle, J.A. & Silengo, M. 2021. Participation of communal cattle farmers in drought risk reduction in Southern Zimbabwe. *Jàmbá: Journal of Disaster Risk Studies* 13(1): a982. DOI: 10.4102/jamba.v13i1.982.

Nyam, Y.S., Ojo, T.O., Belle, J.A., Ogundeji, A.A. & Adetero, A.A. 2021. Determinants of profit efficiency among smallholder sheep farmers in South Africa. *African Journal of Science, Technology, Innovation and Development* 14(3): 620-629. DOI: 10.1080/20421338.2021.1879510.

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Conference Contributions

Conference Papers/Posters

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Belle, J.A. 2021. Wetlands and disaster risk reduction in South Africa. Keynote address delivered at the Weblands Webinar, Free State Province (Online). 24 February 2021.

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STAFF (2021)

Director (Acting):
Dr JA Belle

Professor:
Prof AJ Jordaan

Affiliated Professors:
Prof R Bragg (UFS), Prof B Grové (UFS), Prof A Ogundeji (UFS), Prof A Ozuno, Prof F Renaud and Prof J Szarzynski

Senior Lecturers:
Dr JA Belle, Dr M Coetzee and Dr A Ncube

Lecturer:
Ms O Kunguma

Junior Lecturers:
Mrs D Banyane, Ms M Joubert and Ms Z Poto

Affiliated Senior Lecturers:
Dr C Barker, Dr H Booysen (UFS) Dr E du Plessis (UFS), Dr B Falko (UFS), Dr T Kama (UFS), Dr M Khangale and Dr M Tesfuhuney (UFS)

Affiliated Lecturers:
Ms L de Wet(UFS), Mr W RIlis (UFS), Dr N Matthews (UFS) and Mr M Serekoane (UFS)

Affiliated Junior Lecturers:
Ms L Nogabe and Mr M Procter

Programme Director:
Dr Alice Ncube

Senior Assistant Officer:
Dr A van Straten

Officer:
Ms G van Coppenhagen

Research Assistant:
Mr YS Nyam

Auxiliary Staff:
Ms CS Mkhafu

Institute for
GROUNDWATER STUDIES

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OVERVIEW OF 2021

The 2021 academic year presented many unique challenges due to the ongoing COVID-19 pandemic. The impact of the pandemic forced the Institute of Groundwater Studies (IGS) to present classes online, meetings where held via Blackboard and international travel was limited. The IGS soon adjusted to the adapted teaching method and it became normal to us. Nonetheless, it has been a difficult year for our students and staff. The additional work related to lecturing online, placed a great deal of pressure on all staff members. Some of our students had to withdraw from studies due to increased financial pressures.

Despite all the challenges and difficulties, there was also one big highlight. The IGS water research laboratory recently obtained ISO 17025 accreditation from the South African National Accreditation System (SANAS) for all methods used in the IGS. This accreditation indicates that the laboratory adheres to all the conditions and requirements as stipulated by the body via the international standard. ISO 17025 is complementary to the generic quality management system standard ISO 9001. The International Organization for Standardization (ISO), based in Switzerland, created the industrial standards, and ISO 9001, a quality management system used in all industries – small and large – is by far the most successful and most widely recognised standard. According to Dr Lore-Mari Deysel, Deputy Director of the Laboratory, if laboratories comply with ISO 17025 requirements, they will operate a quality management system that also meets the principles of ISO 9001.

IGS Laboratory staff – back row, from the left, Dr Tania Hill, Masego Letebele, Vanessa Koagile, Bonolo Moruri, and front row, from the left, Dr Trevor Chiweshe, Thobeka Ntshingila, Dr Lore-Mari Deysel (Head) and Wanda Geyer (Absent: Xanele Adoons)

ACHIEVEMENTS

Student Achievements

The IGS Dux Prize for the Best MSc student in Geohydrology was awarded to Mr MG Khoza with a final mark of 85%. The title of his dissertation was 'Modelling of Groundwater flow within a leaky aquifer with fractal-fractional differential operators'. The prize-giving took place online.

TEACHING AND LEARNING

The lecturers in the IGS successfully completed all seven Honours modules. The averages and pass rates for all the modules were lower than previous academic years, probably as a result of the online classes via Blackboard and all the challenges of the COVID-19 pandemic.

RESEARCH AND INNOVATION

Despite the disruptions as a result of the pandemic, the IGS still managed to deliver a high number of research outputs for 2021.

To stay on the forefront of Geohydrology is a necessity for all lecturing personnel at the IGS, and the only way to achieve this is through research. Research at the IS can be divided into two major streams, namely public- and private sector research, depending on the origin of the funding.

All research projects, big or small, are used for capacity building and many form part of Master's or PhD studies. The topics of research projects are diverse; over the past few years, projects have been undertaken on the following topics. part of an MSc

- Water Supply
- Surface water – Groundwater interaction
- Recharge studies
- Fracking
- Acid mine drainage / Acid rock drainage
- Contamination studies
- Groundwater and Geochemical modelling
- Impact of mine water irrigation on groundwater
- Mine water volume calculations (Water balances / Stage curves / Mine dewatering / Mine decanting)

OTHER ACTIVITIES

An Advisory Board was established in April 2021 The members of the Board are Dr Eelco Lukas (Chairperson: IGS), Dr Shafick Adams (Water Research Commission), Dr Koos Vivier (Consultant), Mr Gawie van Dyk (Department of Water and Sanitation), Mr Julian Conrad (GEOSS South Africa) and Ms Anneke Rossouw (IGS). The main focus of the Advisory Board is to determine if IGS is on the right track with regard to the training of our students.

POSTGRADUATE STUDENTS

In 2021, a total of 30 students were enrolled for the BSc Honours degree, 46 for MSc studies and 24 for PhD studies. We awarded a total of 33 degrees, with 18 students receiving BSc Honours degrees, 12 MSc degrees, and 2 PhD degrees. Five Master's students passed with distinctions – Michael Holloway, Phuti Mabotja, Siphokazi Mandu, Mulalo Mashamba and Heinrich Schreuder.

The PhD was conferred on two candidates from the IGS in 2021:

Makhutla, Mokete

Thesis: Evaluation of DNAPL presence in fractured-rock aquifers using innovative field screening and conventional sampling techniques

Supervisor: Prof M Gomo

Vermaak, Nicolette

Thesis: Management strategies for the Lower Berg River Aquifer System, Western Cape

Supervisor: Prof PD Vermeulen

STAFF MATTERS

Ms Sinegugu Ntshingila was appointed as Quality Manager in the IGS Laboratory. Born in Ladysmith, KwaZulu-Natal, where she completed her secondary school education, Sinegugu is a graduate from the University of Pretoria with a BSc in Chemistry. She has vast experience within the environmental laboratory testing sector, having started her career at the CSIR as an intern under the Consulting and Analytical Services Laboratory, and then as a Laboratory Analyst and later a Quality Coordinator at Element Materials Technology South Africa, where she was responsible for the organisation's accreditation and compliance to ISO 17025.

Sinegugu Ntshingila

RESEARCH OUTPUTS

Research Articles

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STAFF (2021)

Director:
Dr E Lukas

Professor:
Prof A Atangana

Associate Professor:
Prof M Gomo

Affiliated Associate Professor:
Prof KT Witthüser

Senior Lecturer:
Dr FD Fourie

Lecturers:
Dr AJ Allwright, Dr SS de Lange and Mr PJH Lourens

Programme Director:
Dr AJ Allwright

Affiliated Researcher:
Prof JF Botha

Chief Officer:
Ms L Rust (Financial Manager)

Officer – Professional Services:
Ms AB Rossouw

Assistant Officers:
Mr M Smit (Contract) and Mr T Viljoen (Contract)

Messenger/Cleaner:
Ms TP Mosala

<u>IGS Laboratory</u>

Deputy Director:
Dr L-M Deysel

Quality Manager:
Ms S Ntshingila

Analyst:
Dr T Chiweshe (Contract)

Junior Quality Analyst:
Ms B Moruristian

Junior Assistant Analyst:
Dr T Hill (Contract)

Senior Officers:
Ms W Geyer and Ms N Koagile

Officer:
Ms T Letebele

Cleaner:
Ms X Adoons

UFS EXPERIMENTAL FARM

CONTACT DETAILS

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OVERVIEW OF 2021

The purpose of the UFS Experimental Farm is to provide a vehicle where all the departments of the University of the Free State can be involved in teaching, learning, research and service delivery. Currently eight departments from three different faculties are involved in different projects at the UFS Experimental Farm.

Developments at the Experimental Farm are slowly reaching the point where the farm can be a showcase for the University. The Dairy Processing Unit was completed during 2021 and is currently producing excellent cheese and yoghurt will soon follow. This Unit forms part of a larger project that involves the already completed Wood Processing Unit and the Kovsie Brewery that will be completely installed in early 2022. The purpose of these developments is to expose the students to the full value chain in agriculture and to provide the larger farming community with training opportunities.

The Department of Animal Science acquired two automated feeding systems for both small and large stock on the Experimental Farm. The ratio-frequency identification (RFID) automated feeder system is used for measuring individual voluntary feed intake of small stock, while the GrowSafe™ system not only focuses on measuring the voluntary feed intake of cattle and dairy cattle, but also feeding behaviour, live weight and water intake in a more commercial setting, with no stress to the animals.

The crop production area has expanded by 105 hectares to increase fodder production for our growing animal numbers. A tractor, baler, haymaker and power rake were procured to increase the capacity for fodder production.

The beef cattle enterprise had an impressive conception rate of 95% while the heifers in the dairy herd reached a respectable 82%. Unfortunately, the conception rate of the sheep fell to 75% due to the high parasite load – a result of the excellent rainfall during the 2021 season.

The central part of the country was again plagued with devastating veld fires. With the help of the Koppieskraal Farmer Society and BKB, 528 round bales that were produced on the farm were made available to the farmers who lost everything in the fires. The CAPSTONE Seed Company, sponsored the seed to be planted in the enlarge area on the experimental farm for the establishment of a fodder bank in case this should happen again.

The Experimental Farm donated 428 bales of animal feed to farmers who lost veld in the Fauresmith and Tierpoort districts

The Experimental Farm hosted and presented several successful training workshops and farmers' days. These included:

- Lucerne production (crop for cultivated pastures)
- Pig production
- Branding of animals
- Agricultural engineering (irrigation systems)

- Feed catalogue (various feeds and supplying companies)
- Animal health week and handling

Through these initiatives, the Experimental Farm remains fully committed to community service and training. The training has also been extended in the form of short courses, to the wider community that includes school groups and emerging farmers. These groups are taught about production systems, vaccination techniques, branding and marking of animals, as well as other various farming related topics.

Students learning about Simbra cattle

RESEARCH AND INNOVATION

Various research trials are conducted on the Experimental Farm in 2021.

Collection of data on the Afrikaner cattle breed

The data collected on this herd includes the normal performance testing data as well as a project in which the rumen flora are genomically evaluated and correlated with the performance of the animals. As part of the National Afrikaners Breeders Society, DNA is also collected from all the animals that are born on the farm, to help establish a reference population for the breed with genomic breeding values as an end goal. A portion of the Afrikaner cows were crossbred to Angus, Simmentaler and Simbra bulls, in order to increases the weaning weight and provide an alternative market for selling weaners to feedlots. The main herd is selectively bred to excellent stud bulls to ensure optimal animal production from well-adapted animals.

Collection of data on the dairy herd

The state-of-the-art equipment in the dairy enables easy data collection on almost all economically important traits in the herd. All milk produced is processed in the dairy processing unit on the farm and the resulting cheese and yoghurts are available to the public.

Feeding trials on cattle and sheep

Several feeding trials that involve both cattle and sheep are run on an ongoing basis on the farm. Research is conducted on different types of feed in different feeding scenarios, both in an intensive and extensive setting. Several feeding companies are involved in this research that investigates both the production levels of the animals as well as the economic viability of the supplementation.

Crop production trials

Various species of perennial grasses are cultivated on the Experimental Farm to research the production potential under both irrigation and dry land production. The research includes the testing of these grasses as a method of improving the natural veld fodder flow. This research includes dry land production of teff, sorghum, oats and wheat for effective fodder production under various plant population densities.

STAFF (2021)

Farm Manager:

Mr J Barnard

Lecturers:

Mr L Krűger and Dr A Hattingh

Junior Lecturer:

Mr J Neser

Senior Assistant Officer:

Ms AM Smith

Research Assistants:

Mr B Madyibi, Mr OM Mavhungu and Mr NN Mkhonza

Dairy Assistants:

Ms EL Mosala, Mr ZR Timbela and Mr FT Pitso

Farm Workers:

Mr RD Khoele, Mrs MM Kantoane, Ms MA Kubheka,
Mr TF Kubheka, Mr LE Magala, Mr YS Motswari,
Mr RS Papa, Mr KP Ramatekoane, Mr KH Salamane,
Mr J Soato, Mr BNL Matevise and Mr PM Somi

ACADEMIC SUPPORT
DIVISIONS

ELECTRONICS DIVISION

CONTACT DETAILS

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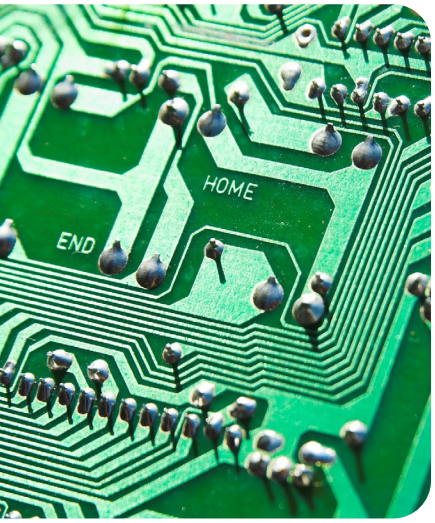

OVERVIEW OF 2021

Despite all the COVID-19 regulations, 2021 got off to a good start and the trend continued throughout the year. The Division was able to complete the year in a normal way, although personnel had to isolate from time to time, without losing too many hours. Two new positions were granted to our Division by the Dean, to be filled early in 2022. With this added capacity, workflow will improve greatly and our Division will be able to vastly improve our service and turnaround time to the different departments. All the personnel have always strived to deliver the best work possible, however, in the last couple of years the workload increased dramatically. We are thankful for the new staff and we are looking forward to deliver an even better service in the future.

WORK ACTIVITIES

A total of 424 work requisitions were received in 2021, representing 734 pieces of apparatus. Eighteen (18) of these requisitions were for development and installation projects. Some were new and others were extensions of existing systems, as well as the upgrading of older systems. Of the possible 6 512 working hours (based on 7.5 hours per day per person present), 6 435 were actively used (i.e. 98.8%).

Our Technical Assistant, Denver de Koker, working on the Servicing boom

Table 1 below illustrates the time spent on work for the 50 departments, divisions and others, that made use of the services of the Electronics Division in 2021.

Table 1: Use made of the Electronics Division by departments and divisions (2021)

Client	Total Time Spent (Hours)	% Time Spent
Physics	1 087	16.89%
Internal Administration	635	9.91%
Animal, Wildlife and Grassland Sciences	603	9.37%
Chemistry	544	8.45%
Animal Sciences	527	8.19%
Centre for Microscopy	355	5.52%
Electronics Division	303	4.70%
Biotechnology	298	4.63%
Plant Sciences	281	4.37%
Health Sciences	209	3.25%
Protection Services	180	2.80%
Eco Car Project	157	2.44%
External Work	145	2.25%
Technical	142	2.21%
Medical Virology	103	1.60%
Zoology and Entomology	103	1.60%
Institute for Groundwater Studies (IGS)	101	1.39%
South African Doping Control Laboratory (SADoCoL)	86	1.34%
Geography	72	1.12%
Qwaqwa Campus	63	0.98%
Brewery	60	0.93%
Agricultural Economics	54	0.84%
Instrumentation Division	54	0.84%
University Estates	52	0.81%
Engineering Sciences	32	0.50%
Computer Science and Informatics	27	0.42%
Geology	20	0.31%
Zoology and Entomology Qwaqwa	19	0.30%
South Campus	17	0.26%
Criminal Sciences	11	0.24%
Genetics	11	0.24%
Facilities	9	0.14%
Human Molecular Biology	9	0.14%
Industrial Psychology	8	0.12%
Plant Breeding	7	0.11%
Urban and Regional Planning	6	0.09%
Bio Security Lab	5	0.08%
Postal & Documentation	5	0.08%
Pharmacology	5	0.08%

Client	Total Time Spent (Hours)	% Time Spent
Architecture	4	0.06%
Clinical Research	4	0.06%
ICT Services	4	0.06%
National Control Laboratories	4	0.06%
Visual Arts	4	0.06%
Drama & Theatre	2	0.03%
Centre of Mineral Biochemistry	2	0.03%
Centre for Environmental Management (CEM)	2	0.03%
Kovsie Gear	2	0.03%
Haematology	1	0.02%
Simulation Unit	1	0.02%
Total	**6 435**	**100.00%**

A total of 1 097 hours were spent on development (17.04%), 4 703 hours on maintenance (73.09%), and 635 hours on administration (9.87%).

Work for the Faculty of Natural and Agricultural Sciences amounted to 3 961 hours (61.56%), while 2 474 (38.44%) hours were spent on work for departments/divisions outside the Faculty.

The table below provides information on the projects completed in 2021 per department/division.

Mark Jackson, Control Technician in the Division

Table 2: Completed projects (2021)

Department/Division	Apparatus
Centre for Microscopy	1 x 16 Zone Alarm system 1 x Access control system 1 x TEM Chiller temperature indicator
Physics	1 x Polari meter 1 x Photo gate Experiment upgrade 1 x Germanium Crystal mounting and heater
Soil, Crop and Climate Sciences	2 x Closed environment gas circulator 1 x Practical timer 1 x Programmable cold room controller
Plant Sciences	1 x Time control and grow lights in glasshouses 1 x Extension of access control
Animal Science	5 x Communication system and controller for borehole pumps
Biotechnology	8 x GSM monitoring system on fridges
SCI South Campus	1 x Upgrade to CCTV System
Food Science	2 x GSM fridge and freezer monitoring system
Health Sciences	1 x Freezer alarm system
Kovsie Act	10 x Eco car
University Estates	1 x Remote water level monitor 1 x Remote battery monitor

By the end of 2021, there were nine unfinished projects.

Table 3: Unfinished projects (2021)

Department/Division	Apparatus
Animal Science	1 x Upgrade pasteuriser
Brewery	1 x Commission brewery plant
Chemistry	2 x Airflow sensors
Physics	1 x Upgrade to Millikan experiment 1 x Upgrade to Elektronik experiment
Plant Science	1 x Upgrade Lyssimeter
Soil, Crop and Climate Sciences	1 x Upgrade growth cabinet
Solar Car Project	1 x Design control systems on solar car

Adriaan Hugo, Head of the Electronics and Instrumentation Divisions

STAFF (2021)

Head of Division:

Mr AB Hugo

Assistant Head:

Mr I Basson

Control Technicians:

Mr MH Jackson and Mr HJ Roodt

Technical Assistant:

Mr D de Koker

Secretary:

Ms A Kasper (shared with the Instrumentation Division)

INSTRUMENTATION DIVISION

CONTACT DETAILS

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OVERVIEW OF 2021

2021 presented many challenges for the Division of Instrumentation. The challenges ranged from COVID-19 related absenteeism to having new personnel who needed to be mentored. Despite these challenges we still managed to have a successful year.

Two personnel members left the Division at the beginning of the year and the posts were soon filled. We were granted an additional post, which was filled later in the year. The new members, Pieter Lotz, Sandile Luthuli and Petrus Matlwane, helped to establish new skills in the Division.

The highlights of 2021 included the design and building of the ECO car that formed part of KOVSIE ACT's green energy initiative, and the building of a custom Hammer mill for Agriculture, as well as a Hot Stage Slide mechanism for Chemistry.

The Division worked tirelessly to repair and maintain equipment for all the departments, as well as external clients. We thank the University for being our primary client and all the departments for their continued support.

Pieter Lotz with the ECO car

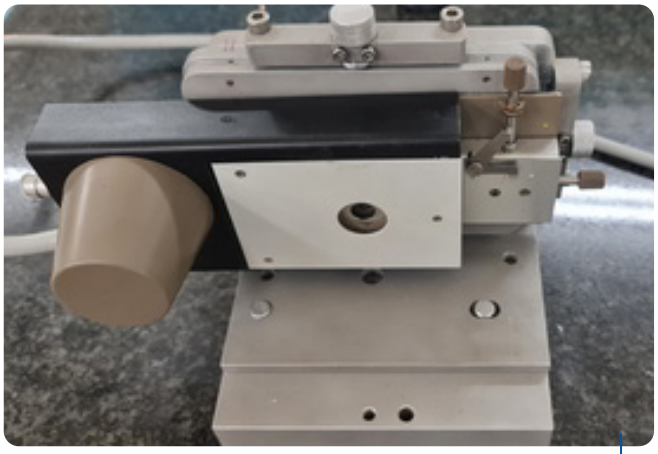
WORK ACTIVITIES

In total, 274 work requisitions were received in 2021, 12 of which were for development projects. Some were new and others were extensions of existing instruments, as well as the upgrading of older instruments.

Table 1 illustrates the time spent on work for the 44 departments which made use of the services of the Instrumentation Division in 2021.

Table 1: Use made of the Instrumentation Division by departments and divisions (2021)

Department/Division	Total Time Spent (Hours)	% Time Spent
Physics	1 260	17.70%
Animal Sciences	813	11.42%
Kovsie Act	811	11.39%
Chemistry	516	7.24%
Internal Administration	491	6.89%
University Estates	491	6.89%
Soil, Crop and Climate studies	401	5.63%
Instrumentation Division	375	5.27%
Biotechnology	296	4.16%
Brewery	231	3.24%
External Work	196	2.75%
Plant Sciences	177	2.49%
Institute for Groundwater Studies (IGS)	159	2.23%
Chemistry South Campus	159	2.23%
National Control Laboratory (NCL)	156	2.19%
Zoology and Entomology	76	1.07%
Genetics	72	1.01%
Facilities	68	0.96%
Electronic Division	56	0.79%
South African Doping Control Laboratory (SADoCoL)	56	0.79%
Technical	45	0.63%
Eco Car Project	36	0.51%
Centre for Environmental Management (CEM)	24	0.34%
Sustainable Feeding	22	0.31%
Health Sciences	20	0.28%
Office of the Dean	15	0.21%
Engineering Sciences	14	0.20%
Provisioning	13	0.18%
Sport Sciences	13	0.18%
Kovsie Sport	10	0.15%
Kovsie Hockey Club	7	0.12%
Pharmacology	7	0.12%
Bidvest	6	0.08%
Geology	6	0.08%
Animal Research Centre	5	0.07%
Drama and Theatre	3	0.04%
Computer Science and Informatics	3	0.04%
Medical Virology	3	0.04%
Centre of Mineral Biochemistry	2	0.03%
Art Gallery	1	0.01%
Architecture	1	0.01%
Centre for Microscopy	1	0.01%
FlippieGroenwoud Building	1	0.01%
Fine Arts	1	0.01%
Total	**7119**	**100.00%**



The Hot Stage Slide mechanism for the Department of Chemistry

Lucas Odendaal with the newly built Hammer mill

Work for the Faculty of Natural and Agricultural Sciences amounted to 4 839 hours (68%), while 2 280 (32%) hours were spent on work for departments/divisions outside the Faculty.

The table below provides a list of the completed projects in 2021 per department/division.

Table 2: Completed projects (2021)

Department/Division	Apparatus
Centre for microscopy	2 x UPS stands 2 x Battery Boxes
Chemistry	1 x Horizontal and vertical adjustable heating stage 1 x Cell changer carriage
Genetics	1 x Pig cage 9 x Grids
Physics	3 x Chiller Structures and changes to roofs 1 x Reactor vessel
Plant Breeding	1 x Mist spraying system 2 x Grow lamp trolleys
Soil, Crop and Climate Sciences	1 x Electric hammer mill 1 x Plant cutter
Animal Science	1 x Bakkie Rails
IGS	1 x Load deck for bakkie

STAFF (2021)

Head of Division:

Mr AB Hugo

Assistant Head:

Mr BJ Crouse

Control Technicians:

Mr S Luthuli, Mr NJ Kruger and Mr L Odendaal

Technical Assistant:

Mr P Matlwane and Mr WJR Storm

Technical Aide:

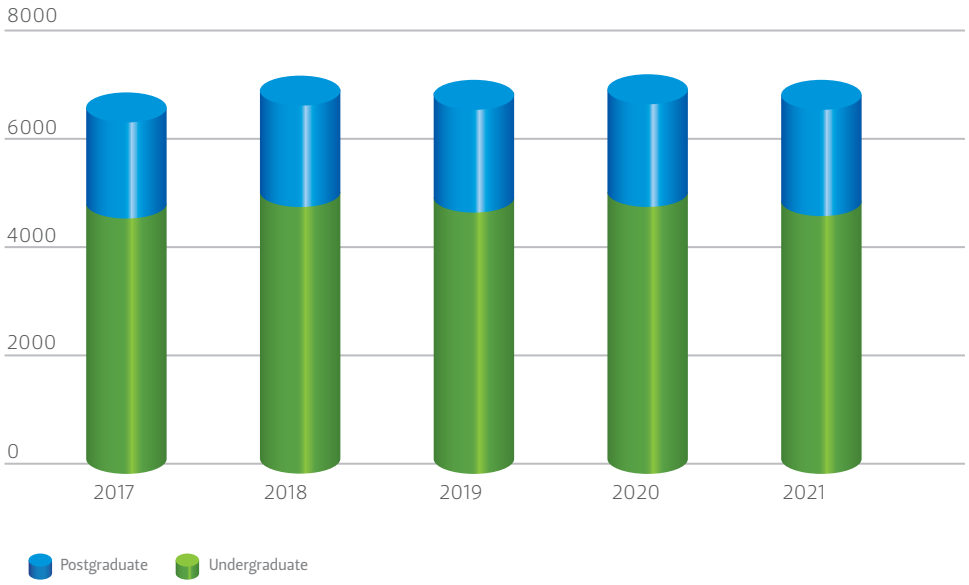
Mr L Mokoena

Secretary:

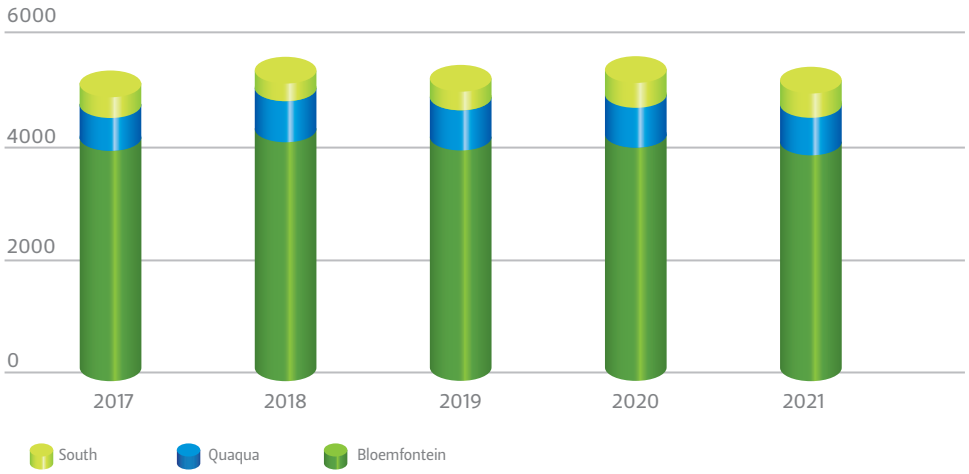
Ms A Kasper (shared with the Electronics Division)

FACULTY STATISTICAL DATA

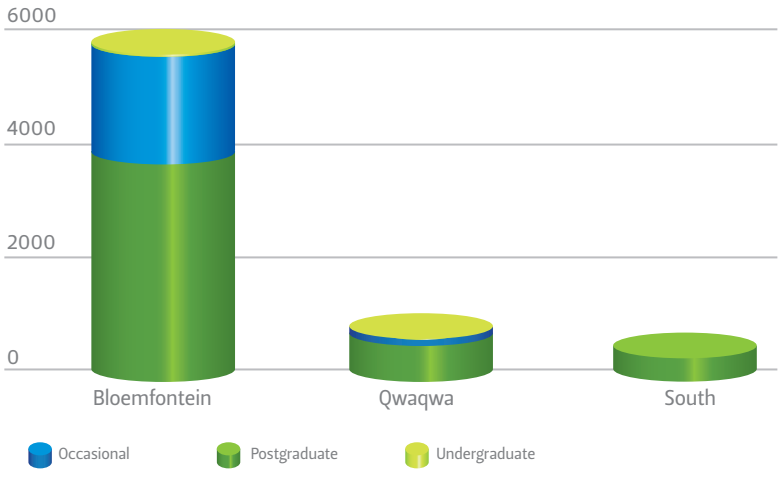
REGISTRATIONS BY STUDY LEVEL (2017 – 2021)



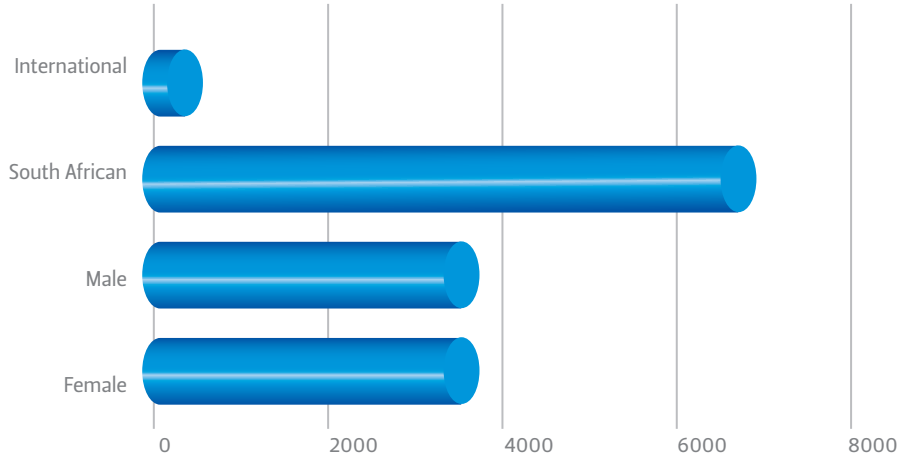
UNDERGRADUATE REGISTRATIONS BY CAMPUS (2017 – 2021)



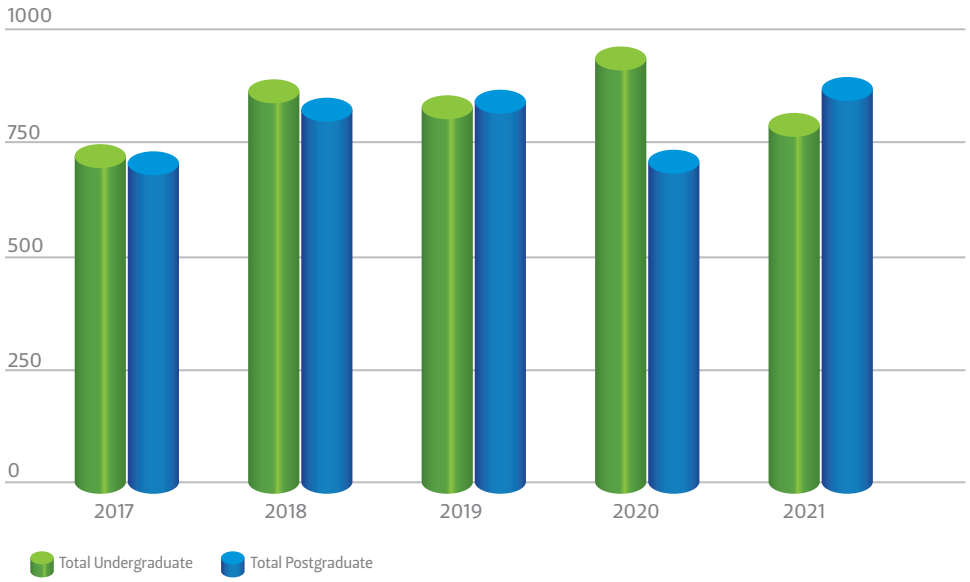
TOTAL REGISTRATIONS PER CAMPUS BY LEVEL OF STUDY (2021)



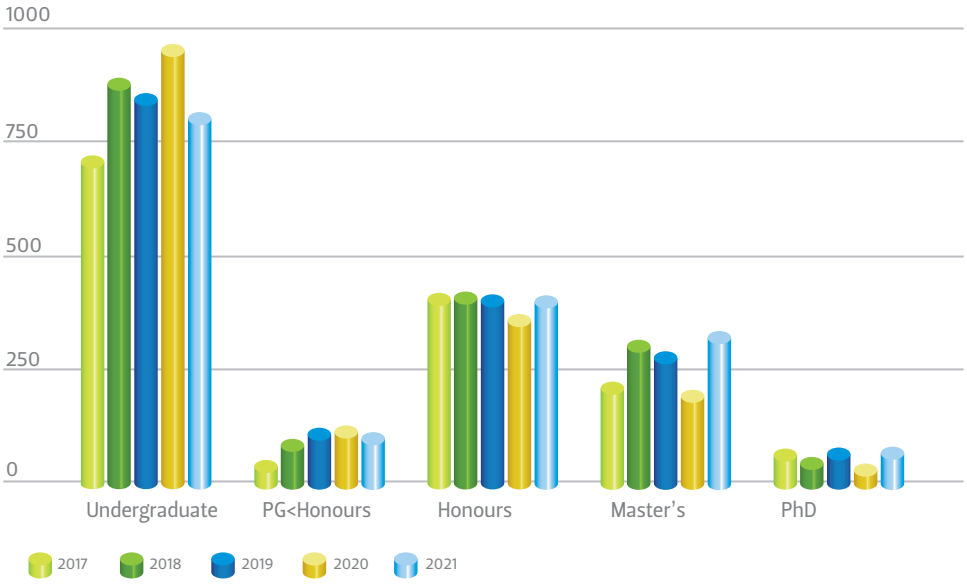
STUDENTS NUMBERS BY NATIONALITY AND GENDER (2021)



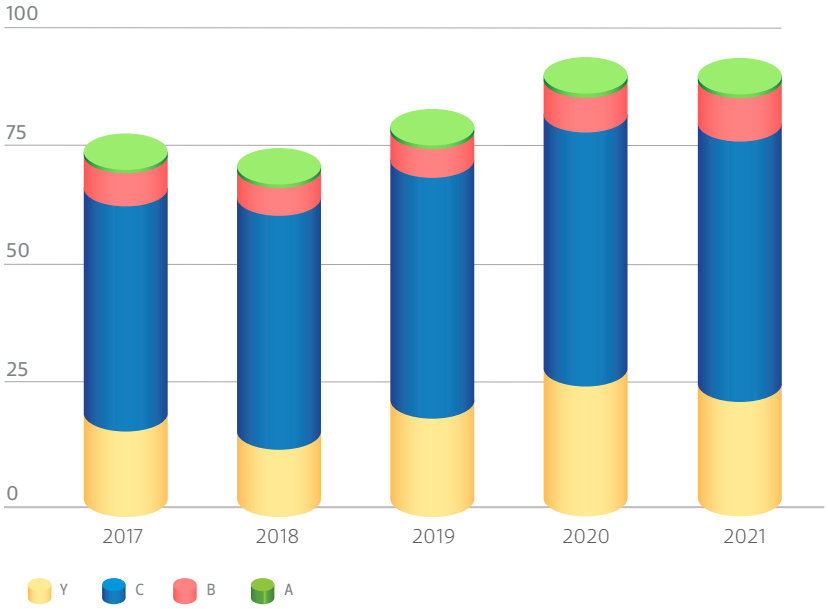
GRADUATIONS BY QUALIFICATION LEVEL (2017 – 2021)



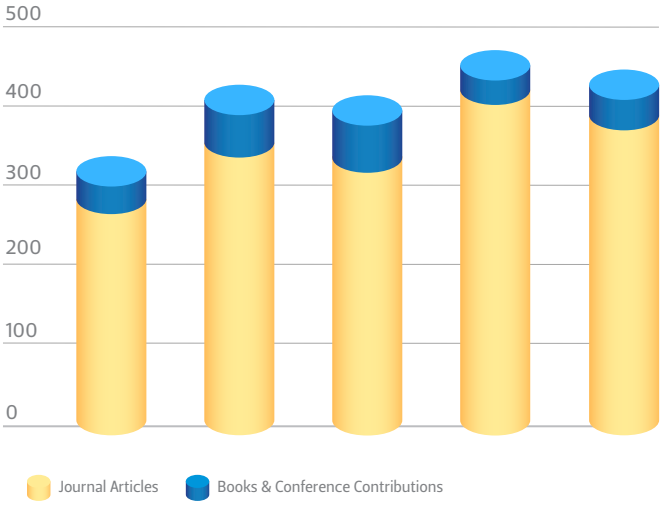
GRADUATIONS BY QUALIFICATION TYPE (2017 – 2021)



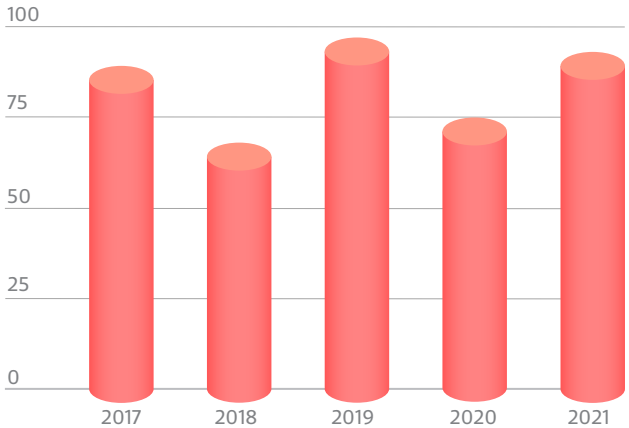
NRF RATED RESEARCHERS (2017 – 2021)



RESEARCH OUTPUTS (2017 – 2021)



POSTDOCTORAL RESEARCH FELLOWS



ACRONYMS

LIST OF ACRONYMS

Principal acronyms and abbreviations used in this Report

0 – 9

4IR	Fourth Industrial Revolution

A

A4U	Alliance 4 Universities
AB InBev	Anheuser-Busch InBev
ACCESS	Alliance for Collaboration on Climate and Earth Science Systems
ACE South Africa	Association/Society of Spanish Scientists in South Africa
ACM	Association for Computing Machinery
ACTC	African Climate Technology Centre
ADM	Agricultural derivatives market
AEE	Association of Energy Engineers
AEMG	Applied and Environmental Microbiology Group
AEASA	Agricultural Economics Association of South Africa
AFMA	Animal Feed Manufacturers Association
AfRota	Antigens and reassortant strains for rotaviruses circulating in Africa
AgriFoSe	Agriculture for Food Security
AJFAND	African Journal of Food, Agriculture, Nutrition and Development
AMD	Acid mine drainage
ANSTO	Australian Nuclear Science and Technology
AP	Air permeability
APD	African Pollen Database
ARC	Agricultural Research Council
ARC–GC	Agricultural Research Council-Grain Crops
ARC–ITSC	Agricultural Research Council-Institute for Tropical and Sub-Tropical Crops
ARC–SG	Agricultural Research Council-Small Grain
ARS	Agricultural Research Services
ARU	Afromontane Research Unit
ASAQS	Association of South African Quantity Surveyors
ASSAf	Academy of Science of South Africa
AU	African Union

B

BCI	Brain-Computer Interface
BGR	Bundesanstalt für Geowissenschaftrn unf Rohstoffe / Federal Institute for Geosciences and Natural Resources
BIOGRIP	Biogeochemistry Research Infrastructure Platform
BNG	Breaking New Ground
BRICS	Brazil, Russia, India, China and South Africa
BSL2	Biosafety Level 2
BTG	Bridge the Gap Geosciences Guidance Program

C

CanaDAM	Canadian Discrete and Algorithmic Mathematics
CASS	Chinese Academy of Social Sciences
CAZymes	Carbohydrate-Active Enzymes
CBC	Centre for Biological Control
CBHE	Capacity Building in Higher Education

CCDB	Canadian Centre for DNA Barcoding
CDDE	Centre for Digital and Data Engineering
CDF	Centre for Digital Futures
CDS	Centre for Development Support
CEA	Alternative Energies and Atomic Energy Commission
CEM	Centre for Environmental Management
CEM	Construction Economics and Management
CER	Chartered Enterprise Risk Actuary
CIMERA	Centre of Excellence for Integrated Mineral and Energy Resource Analysis
CIMMYT	International Maize and Wheat Improvement Centre
CLEP	Certified Lighting Efficiency Professional
CLiPS	Computational Linguistics and Psycholinguistics Research Center
CLSM	Con-focal laser scanning microscope
CMBG	Centre for Mineral Biogeochemistry
COIL	Collaborative Online International Learning
CONICET	Consejo Nacionel de Investigaciones Cientificas y Técnicas / National Scientific and Technical Research Council (Argentina)
COVID	Coronavirus disease
CPRR	Competitive Programme for Rated Researchers
CPUT	Cape Peninsula University of Technology
CREST	Centre for Research Evaluation, Science and Technology
CSE	Computer Science Education
CSIR	Council for Scientific and Industrial Research
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CSL	Community Service Learning
CTA	Cherenkov Telescope Array
CTL	Centre for Teaching and Learning
CUT	Central University of Technology
CYP	Cytochrome P450

D

DAAD	Deutscher Akademischer Austausschdienst / German Academic Exchange Service
DAFF	Department of Agriculture, Forestry and Fisheries
DESTEA	Department of Economic, Small Business Development, Tourism and Environmental Affairs
DFG	Deutsche Forschungsgemeinschaft / German Research Foundation
DHET	Department of Higher Education and Training
DIFFER	Dutch Institute for Fundamental Energy Research
DiMTEC	Disaster Management Training and Education Centre for Africa
DNA	Deoxyribonucleic Acid
DOAJ	Directory of Open Access Journals
DON	Deoxynivalenol
DRD	Directorate Research Development
DSSC	Dye-sensitized solar cells
DSI	Department of Science and Innovation
DWS	Department of Water and Sanitation

E

EAT	Energy Audit Rechnician
ECLA	Electronic Computer Literacy Assessment
EDP	Edamame Development Program

EGU	European Geosciences Union
EMPA	Electron microprobe analyser
EnSci	Engineering Sciences
EPA	European Pollen Database
ESP	Enzyme Science Programme
ESSRP	Earth Systems Science Research Programme
EU	European Union
EWSETA	Energy & Water Sector Education Training Authority

F

F2F	Face-to-face
FABI	Forestry and Agricultural Biotechnology Institute
FE	Filtration efficiency
FEMIA	Fundamentals of Energy Management in Africa
FHB	Fusarium head-blight
FIB	Focused ion beam
FOSC	Food Systems and Climate
FPP	Future Professors Programme
FRAME	Fostering Research and Intra-African knowledge transfer through Mobility and Education
FSDARD	Free State Department of Agriculture and Rural Development
FSDESTEA	Free State Department of Economic, Small Business Development, Tourism and Environmental Affairs
FWO	Fonds Wetenschappelijk Onderzoek – Vlaanderen (Research Foundation – Flanders)

G

GBI	Green Building Index
GCERN	Global Climate Emerging Research Network
GCRF–START	Global Challenges Research Fund – Synchrotron Techniques for African Science and Technology
GEF	Global Environment Facility
GEUS	Geological Survey of Denmark and Greenland
GFZ	GeoForschungsZentrum / German Research Centre for Geosciences
GGHNP	Golden Gate Highlands National Park
GIS	Geographic information systems
GLYAT	Glycine-N-acyltransferase
GMI	Green Manufacturing Index
GNDR	Global Network of Covil Society Organisations
GOSG	Giraffe and Okapi Specialist Group
GP	Global Platform
GPI	Global Peatlands Initiative
GRRG	Grid Related Research Group
GSSA	Geological Society of South Africa

H

HCI	Human-Computer Interaction
H.E.S.S.	High Energy Stereoscopic System
HMF	Hans Merensky Foundation
HPEM	High-Performance Engineering Materials
HRTEM	High-resolution transmission electron microscope
HSRC	Human Sciences Research Council

I

IAPS	Invasive alien plant species
ICCB	International Congress on Conservation Biology
ICDF	Interdisciplinary Centre for Digital Futures
ICDP	International Continental Scientific Drilling Programme
ICT	Information and Communications Technology
IEPA	Institute of Energy Professionals Africa
IFMA	International Farm Management Association
IGD	Institute of Global Dialogue
IGS	Institute for Groundwater Studies
IHSP–SA	Institute of Human Settlements Practitioners of Southern Africa
IMEC	Impact Mitigation and Ecological Compensation
IMA	International Mineralogical Association
INRAE	International Research Institute for Agriculture, Food and Environment (France)
INTI	National Institute of Industrial Technology (Argentina)
IoT	Internet of Things
IPTA	International Pulsar Timing Array
ISDS	International Society for Development and Sustainability
ISE	International Society of Electrochemistry
ISO	International Organization for Standardization
IT	Information Technology
ITSL	Information Technology Service Learning
IUCN	International Union for Conservation of Nature
IUCr	International Union of Crystallography

J

JAR	Just-about-right
JSE	Johannesburg Stock Exchange

K

KPA	Kovsie Phahamisa Academy
KTH	KTH Royal Institute of Technology (Sweden)
KZN	KwaZulu-Natal

L

LCA	Leadership for Conservation in Africa
LED	Light-emitting diode
LIS	Library and Information Services
LRF	Livestock Registering Federation
LTE	Long-term experiment

M

M–2–M	Mountain-to-Mountain
MAGIC	Merensky Group for Airborne Geological Image Classification
MAR	Management aquifer recharge
MARSA	Management of aquifer recharge in South Africa
MCR	Mangaung Concerned Residents
mDIS	ICDP drilling information management system
MDM	Master of Disaster Management
MDPI	Multi-disciplinary Digital Publishing Institute
merSETA	Manufacturing, Engineering and Related Services Skills Education Training Authority

METF	Minerals Education Trust Fund
MINSA	Mineralogical Association of South Africa
MLA	Mineral Liberation Analyser
MLPM	Master of Land and Property Development Management
MoU	Memorandum of Understanding
MRM	Mineral Resource Management
MS	Multiple sclerosis
MSA	Master of Sustainable Agriculture
MURP	Master of Urban and Regional Planning

N

NAGOCAT	Nanoporous Gold Catalysts
Nano SIMS	Nanoscale secondary ion mass spectroscopy
NAS	Natural and Agricultural Sciences
NbS	Nature-based Solutions
NDMA	National Disaster Management Agency
NEP	National Equipment Programme
nGAP	New Generation of Academics Programme
NGS	Next Generation Sequencing
NGTax	Next Generation Taxonomy
NIHSS	National Institute for the Humanities and Social Sciences
NIV	Nivalenol
NLP	Natural Language Processing
NMO	Neuromyelitis optica
NMR	Nuclear Magnetic Resonance
NMU	Nelson Mandela University
NOAA	National Oceanic and Atmospheric Administration
NORCE	Norwegian Research Centre
NRF	National Research Foundation
NSFAS	National Student Financial Aid Scheme
NSH	No Student Hungry
NSTF	National Science and Technology Forum
NUL	National University of Lesotho
NUST	Namibia University of Science and Technology
NWU	North-West University
NZG	National Zoological Garden

O

OCBIL	Old, climatically buffered infertile landscape
OIA	Office of International Affairs
OPDT	Oil and Protein Seeds Development Trust
ORI	Okavango Research Institute

P / Q

PASA	Petroleum Agency SA
PASAE	Pan-African Society of Agricultural Engineers
PDMC	Provincial Disaster Management Centre
PGE	Platinum-group element
PI	Primary / Principal investigator
PICO	Presenting Interactive Content

PMI	Post-mortem interval
PNNL	Pacific Northwest National Laboratory
PROBUS	Professional Retired Organization of Business Executives
QPM	Quality protein maize

R

RDP	Reconstruction and Development Plan
REI	Research, Education and Investment
RFID	Radio frequency identification
RISE	Research and Innovation Staff Exchange
RISE	Research Internships in Science and Technology
RMRD SA	Red Meat Research and Development South Africa
RUFORUM	Regional Universities Forum for Capacity Building in Agriculture
RWA	Russian wheat aphid

S

SAAB	South African Association of Botanists
SAAG	Southern African Association of Geomorphologists
SAAO	South African Astronomical Observatory
SACAIR	Southern African Conference for Artificial Intelligence Research
SACAP	South African Council for the Architectural Profession
SACI	South African Chemical Institute
SACLA	Southern African Computer Lecturers' Association
SACNASP	South African Council for Natural Scientific Professions
SACPLAN	South African Council for Planners
SACS	South African Committee for Stratigraphy
SADC	Southern African Development Community
SADoCoL	South African Doping Control Laboratory
SAENSE	Screening Applications and Exploring Novelty in Specialised Environments
SAEON	South African Environmental Observation Network
SAFEX	South African Futures Exchange
SAGE	Scientific Advisory Group on Emergencies
SAIA	South African Institute of Architects
SAIAB	South African Institute of Aquatic Biodiversity
SAIP	South African Institute of Physics
SALDi	South African Land Degradation Monitor
SALGA	South African Local Government Association
SAMAC	South African Macadamia Growers Association
SAMC2022	Southern African Mountain Conference 2022
SAMO	South African Mathematics Olympiad
SAMRC	South African Medical Research Council
SAMS	South African Mathematical Society
SANAS	South African National Accreditation System
SANBI	South African National Biodiversity Institute
SANEDI	South African National Energy Development Initiative
SANParks	South African National Parks
SANSA	South African National Space Agency
SAPBA	South African Plant Breeders' Association
SAPER	South African Planning Education Research
SAPPA	South African Pecan Nut Producers Association

SAPS	South African Police Services
SARChI	South African Research Chairs Initiative
SARS	Severe Acute Respiratory Syndrome
SARUA	Southern African Regional Universities Association
SASAS	South African Society for Animal Science
SASC	South African Shark Commission
SASCP	South African Society of Crop Production
SASRI	South African Sugarcane Research Institute
SASRN	South African Sclerotinia Research Network
SASUF	South Africa – Sweden University Forum
SAVC	South African Veterinary Council
SciELO	Scientific Electronic Library Online
SCOBY	Symbiotic culture of bacteria and yeast
SDG	Sustainable Development Goal
SDS	Sudden death syndrome
SEL	Schweitzer Engineering Labs
SEM	Scanning electron microscope
SEMDSA	Society for Endocrinology Metabolism and Diabetes in South Africa
SERIAL	Socio-ecological resilience in agricultural landscapes
SET	Science, engineering and technology
SIGCHI	Special Interest Group for Computer-Human Interaction
SLP	Short Learning Programme
SPIZA	Spiders of South Africa
SPLUMA	Spatial Planning and Land Use Management Act
SPP	Society of Porphorins and Phthalocyanines
SSA	Share Screen Africa
SSAG	Society of South African Geographers
SSAJRP	Swiss-South Africa Joint Research Programme
SSC	Species Survival Commission
SSL	Solid-state lighting
SSRC	Social Science Research Council
STEM	Science, technology, engineering and mathematics
STR	Short tandem repeat
SUPE	Situated Urban Political Ecology
SWAT	Soil and Water Assessment Tool

T

TAAG–A	Topology, Algebra, Analysis, Geometry and Application
TCHAO	Transport and Change of Aerosol and Ozone
TEM	Transmission electron microscope
TEPI	Tiny Earth Partner Instructor
TIA	Technology Innovation Agency
TUT	Tshwane University of Technology
TVU	Technical and Vocational University

U

U3A	University of the Third Age
UAP	University Access Programme
UAV	Unmanned aerial vehicle
UCT	University of Cape Town

UFS	University of the Free State
UHT	Ultra-high-temperature processing
UIA	International Union of Architects
UJ	University of Johannesburg
UK	United Kingdom
UKZN	University of KwaZulu-Natal
UN	United Nations
UNEP	United Nations Environment Programme
UniZulu	University of Zululand
UP	University of Pretoria
US	United States
USA	United States of America
USDA	United States Department of Agriculture
USDP	University Staff Development Programme
UT–LS	Upper troposphere-lower stratosphere
UV	Ultraviolet
UWC	University of the Western Cape

V

VR	Virtual reality
VUB	Vrije Universiteit Brussel

W

wbm	Wheat breadmaking
WCT	Winter Cereal Trust
WIL	Work-integrated-learning
Wits	University of the Witwatersrand
WLED	White light-emitting diode
WLS	Water-limited-stress
WP	Work Package
WRC	Water Research Commission
WSN	Wireless Sensor Network
WWTW	Waste Water Treatment Works

X / Y / Z

ZIF	Zeolite imidazolate framework
ZSSA	Zoological Society of Southern Africa
ZWT	Zebrafish water tank

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“EVEN THE DARKEST
NIGHT WILL END AND
THE SUN WILL **RISE.**”
- Victor Hugo -