ANNUAL **REPORT** 2020



"ADAPTABILITY is the simple secret of survival."

- Jessica Hagedorn -

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UFS

Natural and Agricultural Sciences ANNUAL **REPORT** 2020

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FOREWORD

MESSAGE FROM THE DEAN

In 2018 university life slowly returned to normality after the turbulent previous two years, and this continued through 2019, which created an environment conducive to excellent teaching, as well as the opportunity for research. And then came 2020!! Who would have believed that the world would turn upside down due to the influence of such a small virus which caused so much tragedy and misery to so many people around the world?

What started as a very promising year for us at the UFS, 2020 changed to one where we had to become increasingly innovative to ensure that the year ended as an academic success. In a year characterised by an array of unfamiliar and unsettling events, COVID-19 forced universities worldwide to embrace different ways of teaching. And this was no different for the UFS. We were challenged to rapidly transition to digital teaching, and for staff and students alike, it was a difficult year as we adapted to different methods amid the stress and alienation of the lockdowns.

2020 taught us many new innovative things about tertiary education. Teaching moved online, on an untested and unprecedented scale. Student assessments also partly moved online, with much trial and error and uncertainty for everyone. Importantly, these interruptions will not just be a short-term issue, but could also have long-term consequences for the affected cohorts and are likely to increase inequality in society if we are not innovative enough in our approach to teaching.

The Faculty embarked on projects to convert all the teaching material into electronic format to ensure successful teaching during the extended periods of lockdown. New innovative measures were developed for assessments, and we also succeeded in completing all the practical work and fieldwork for all our academic modules. . The Faculty was at the forefront of assisting students and staff to work on-line. One hundred and fifty (150) computers were made available to vulnerable students in Computer Science, and computers was also made available at a very reduced price to all staff without laptops, to function effectively from home.

The success of all the personnel's dedication and commitment is demonstrated by the good pass rates and above-average percentages of the students in 2020. What is encouraging, is that the average marks of the Faculty deviated with only 3% from other years. This is a measure of the brilliant measures put in place to keep our standard the same as in the past. Our academic integrity was ensured by different quality assurance measures, such as face-to-face classes (assessment was done in controlled environments) and face-to-face exams on campus. All our personnel must be commended for their sacrifice and their commitment, as well as their loyalty, which ensured the successful completion of the 2020 academic year. If it was not for the dedication of the teaching staff, and especially the Faculty Teaching and Learning Manager, Elzmarie Oosthuizen and her staff, as well as the programme directors, we would not have managed to come through the year so successfully.

Another thing that 2020 taught us is that we should take ownership of our own destination as a Faculty and not rely on the ways that other institutions have functioned. The careers of 2020 university graduates may be severely affected by the COVID-19 pandemic. Evidence suggests that poor market conditions at labour market entry, cause workers to accept lower paid jobs, and that this has permanent effects for the careers of some. Graduates from programmes with high predicted earnings can compensate for their poor starting point through both within- and across-firm earnings gains, but graduates from other programmes have been found to experience permanent earnings losses from graduating during the pandemic. The world again has been made aware of the importance of science. We can proudly say that we are part of this and that several of our staff were involved in studies to understand this pandemic. We can also contribute by encouraging our students to be part of the solution, to understand the pandemic and to do research that will ensure that we will never get into such a position again. This will make them very sought after in the labour market.

Despite all the additional effort that staff had to put in to making the year successful from a teaching point of view, we had the most successful year ever with regard to research outputs. The Faculty produced nearly 470 research units, which is 60 more that our previous best. This is an indication of the dedication of the staff. The NRF-rating system is a valuable tool for benchmarking the quality of our researchers against the best in the world and most of the rated researchers from the Faculty who submitted for re-rating moved from a lower to a higher rating category. The programme for identifying new potential applicants and helping researchers to obtain rating or improve the category in which they are rated, yielded good results. Nine newly rated researchers (six emerging researchers in the Y-category and three established researchers in the C-category), were added to our list of rated researchers. The ultimate rating for established researchers is an A-rating and Prof Max Finkelstein improved his rating from an A2-rating to an A1-rating – this confirms him as a leading international scholar in his field for the high quality and impact of his research outputs.



2020 also saw several new interventions and initiatives:

1. The Faculty held its first on-line prize-giving to reward our deserving students.
2. New industry advisory boards were established to assist the departments in planning the way forward.
3. At the end of 2020, all approval processes were completed to sanction the reorganisation of the Faculty, that resulted in the closure of the Division of Food Science. As from 2021 the Department of Microbial, Biochemical and Food Biotechnology will change its name to the Department of Microbiology and Biochemistry. Also, as part of this restructuring, the former Department of Animal, Wildlife and Grassland Sciences has become the Department of Animal Science. In addition, Department of Consumer Science and the Centre for Sustainable Agriculture, Rural Development and Extension combined to become the Department of Sustainable Food Systems and Development. The Department will focus on the development of sustainable food systems, and creating partnerships to benefit the local, national and international agribusiness sector, thus positioning the Faculty and the UFS as a fundamental role-player in sustainable food development in Africa.
4. The strategy of the Faculty to modernise the large research equipment is proving to be very successful and a great deal has been invested in much-needed equipment over the past few years – much of it culminating during the year under review. 2020 was an exciting year for the Unit for Microscopy as it acquired four new items of research equipment. The large equipment drive in the Faculty culminated in the purchase of a new Jeol Transmission Electron Microscope (TEM), a Biological Scanning Electron Microscope and a Zeiss Confocal Microscope. In order to accommodate the new equipment, which arrives in 2021, the Centre was renovated in November 2020. The glass houses at the Qwaqwa Campus were also upgraded in 2020. The Biology Undergraduate Laboratory on the Bloemfontein Campus, the largest and most advanced digital microscopy laboratory in Africa and the third largest in the world, was officially launched in 2020. This is a shared facility between the Department of Plant Sciences and the Department of Zoology and Entomology.
5. Much-needed investments were also made on the experimental farm to ensure quality training to agricultural students. A flock of 100 pregnant Dohne Merino ewes were purchased and small wool farmers in the region received training in wool classing, sheep handling and management. The Innovation Hub is also nearing completion with a brewery, cheese factory, and container park for offices and laboratories. Two new vegetable tunnels will be erected in 2021 as part of the development.
6. With the phasing out of the SAENSE platform the Centre for Mineral Biogeochemistry (CMBG), under the leadership of Dr Robert Hansen, was established and will serve as a research platform for industry. The Centre forms part of the recently-formed Biogeochemical Research Infrastructure Platform (BIOGRIP) and will operate across departments as expertise is needed for particular industry projects.

Despite international travel restrictions, international collaboration continued. Several departments had very active collaboration with international universities and in this regard the departments of Microbial, Biochemical and Food Biotechnology, Animal Science, Plant Sciences, Chemistry and Physics led the way. On the local front the Department of Plant Sciences on the Qwaqwa Campus started the year off on a high note by hosting the 46th Annual Conference of the South African Association of Botanists (SAAB 2020). The annual Combined Congress of the South African Society of Crop Production (SASCP), the Soil Science Society of South Africa (SSSSA), the Southern African Weed Science Society (SAWSS), and the Southern African Society for Horticultural Sciences (SASHS) was hosted by the Department of Soil, Crop and Climate Sciences in January on the Bloemfontein Campus.

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

- Dr WA Lombard from the Department of Agricultural Economics received the Joseph F Donnermeyer New Scholar Award from the International Society for the Study of Rural Crime (ISSRC). The award is bestowed on an early-career researcher.
- A group of students from the Department of Agricultural Economics and the Centre for Sustainable Agriculture, Rural Development and Extension won the International Case Study Competition presented by IFAMA.
- Prof Hennie Snyman and Prof Mike MacNeil of Animal Science, Prof Hendrik Swart of Physics, Prof Abdon Atangana of the Institute for Groundwater Studies, Prof Louis Scott and Prof Johan Grobbelaar of Plant Science, Prof Robert Schall of Mathematical Statistics and Prof Jeanet Conradie from Chemistry were included on the list of top 2% scientists worldwide, published by Stanford University in PLOS Biology. Prof Atangana was also voted in the top 1% of scientists on the prestigious Clarivate Web of Science list and is the youngest mathematician to be honoured in such a way.
- Dr Foch-Henri de Witt was elected as a member of the South African Society for Animal Science (SASAS) Council.
- Prof Jonathan Noble's new book, a peer-reviewed monograph titled *The Architecture of Peter Rich: conversations with Africa*, was published by Lund Humphries.
- Mr Pierre Oosthuizen reviewed the *SA Akademie se Bouwoordeboek* and completed the updating of this bilingual building dictionary. This 2020 publication edition contains more than 1 480 additional Afrikaans and English building terms.
- The South African Academy for Science and Arts awarded the 2020 Stals Prize for Town and Regional Planning to Prof JJ (Das) Steÿn, Research Fellow of the Department of Urban Regional Planning. This award is based on, among other things, his numerous publications in Afrikaans and the important role he has played in the Town and Regional Planning profession in South Africa.
- Dr Eduan Kotzé was elected to the South African Institute of Computer Scientists and Information Technologists (SAICSIT) Council as a Council Member.
- Dr Karen Ehlers was appointed for another term on the National Forensic Oversight and Ethics Board (NFOEB).
- Prof Samuel Adelabu and Dr Adriaan Van der Walt were elected as board members of the Society of South African Geographers (SSAG).
- Prof Johan Meyer of the Department of Mathematics and Applied Mathematics was inaugurated as a member of the Academy of Science of South Africa (ASSAf).
- Prof Zakkie Pretorius, Research Fellow in the Department of Plant Science, and Prof Paul Oberholzer from the Centre for Environmental Management, were nominated for the 2019/2020 National Science and Technology Forum (NSTF)-South32 Awards.
- Prof Zakkie Pretorius received an Honorary Membership and Prof Liezel Herselman a Fellow Award in recognition of their services to and promotion of the objectives of the Southern African Plant Breeders' Association (SAPBA) and exceptional achievements / contributions to Plant Breeding.
- Dr Angeline van Biljon was elected to serve on the SAPBA executive committee.
- Prof Linda Basson and Gerhard de Jager (PhD student) were part of the South African National Antarctic Programme (SANAP) on board the SA Agulhas II Research Vessel of South Africa, on the SANAE 2019/2020 Antarctic Annual Relief Voyage.

I also want to thank all my staff in the Dean's Office (photo below) for the continued support and assistance they provide in the running of the office and the overall functioning of the Faculty. Their work behind the scenes is often hidden and goes unnoticed by most, but is invaluable in ensuring that the inner workings of the Faculty run according to plan and at a high standard – particularly in the challenging year that was 2020.

It is my pleasure to present to you our 2020 Annual Report and extend my sincere gratitude to the staff and students for their selfless commitment to make this faculty and university great. 2020 was a very testing year for the Faculty of Natural and Agricultural Sciences and the challenge is to improve and implement in 2021 the lessons learnt in 2020. Willie Nelson said that once you replace negative thoughts with positive ones, you'll start having positive results – that is the recipe to success in our faculty.

I want to conclude with the wise words of Martin Luther King, Jr "The ultimate measure of a man is not where he stands in moments of comfort and convenience, but where he stands at times of challenge and controversy." Let's all take on the challenge in 2021!



Prof Danie Vermeulen during the 2020 Virtual Academic Awards ceremony

Prof Danie Vermeulen
Dean of the Faculty of Natural and Agricultural Sciences



Members of the Deans's Office. 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

AGRICULTURAL
SCIENCES

DEPARTMENT OF AGRICULTURAL ECONOMICS

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OVERVIEW OF 2020

The Department of Agricultural Economics performed well during 2020, despite the challenges brought by the COVID-19 pandemic. One new staff member was appointed, and some members of staff were promoted. As a result of the lockdown restrictions in various countries due to COVID-19, the Department's involvement in conferences was low; however, we are confident that the situation will improve in the near future. We are also proud that a student from the Department was part of the winning team of the International Case Study Competition presented by the International Food and Agribusiness Management Association (IFAMA). The Department is involved in a range of research activities and projects, some of which were concluded during 2020. Twenty-seven (27) journal articles were published during the year, and a pleasing number of postgraduate students were enrolled.

ACHIEVEMENTS

Staff Achievements

Dr WA Lombard, a researcher and lecturer in the Department, received the Joseph F Donnermeyer New Scholar Award from the International Society for the Study of Rural Crime (ISSRC), in December 2020. The award is bestowed on an early-career researcher for a publication pertaining to rural criminology during the 12 months of the award year. An early researcher is considered to be someone who has received a PhD within the past seven years and is showing stable research development. Dr Lombard received the award for his research on the economic impact of livestock theft in South Africa. His article, co-authored with Dr YT Bahta, titled 'Economic impact and factors affecting sheep and goat theft in South Africa', was published in *Acta Criminologica: African Journal of Criminology & Victimology*.



Dr WA Lombard

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

- **Chairperson Trophy for Service to Department**
  Dr Yonas Bahta
- **HA Kotze Trophy for Outreach**
  Mr Johann Strauss and Mr Markus Monteiro
- **Theo Potgieter Trophy for Farmer Outreach**
  Dr Janus Henning
- **MF Viljoen Trophy for Research**
  Dr Yonas Bahta
- **CS Blignaut Trophy for Teaching and Learning**
  Dr Frikkie Maré
- **LK Oosthuizen Trophy for Community Service**
  Dr Frikkie Maré

Student Achievements

A group of students from the Department of Agricultural Economics and the former Centre for Sustainable Agriculture, Rural Development and Extension (CENSARDE) won the International Case Study Competition presented by IFAMA. The convener of the team was Dr Jan Swanepoel, from CENSARDE, who said "It is an amazing accomplishment to be world champions. The competition was a wonderful opportunity to showcase the talent of the UFS on the international stage. It has also been a platform for some insightful and educational conversations with students and specialists from around the world. Winning has been an affirmation of the high standard that the UFS holds and has shown that the department is excelling on a global scale". The group participated against teams from 17 other countries, and faced the Philippines in the final round, during which the finalists presented their essay online to a panel of judges, made up of an international team of researchers, entrepreneurs, and policy makers. The UFS team members that emerged as winners in the category for Graduates / Early Career Professionals were Carien Denner, Alina Ntsiapane, and Andries Strauss (all from CENSARDE), and Michelle Marais from the Department of Agricultural Economics.



From the left, Jaco van Loggerenberg (from Rooi Stoel Media), JW Swanepoel, Alina Ntsiapane, Andries Strauss, Carien Denner, Evert Kleynhans (from Rooi Stoel Media), and Michelle Marais

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

- **Student ambassador trophy**
  Mr Mario van den Heever
- **Student assistant trophy**
  Ms Sanezwa Songca

TEACHING AND LEARNING

The Department offers three undergraduate programmes – BSc Agricultural Economics, BAgric Agricultural Economics and BAgric Agricultural Management.

RESEARCH AND INNOVATION

Our research endeavours during 2020 centred around three broad themes, viz., (i) water-related research funded by the Water Research Commission (WRC), (ii) research on livestock economics, mainly funded by Red Meat Research and Development South Africa (RMRD SA) and industry partners, and (iii) projects concerning drought.

The WRC project, led by Dr Nicolette Matthews and Prof Bennie Grové, which is aimed at developing a bio-economic model to develop water and salt stress management guidelines within a precision agriculture framework, was in its final year in 2020.

Prof Yonas Bahta's research in 2020 was aimed at identifying factors affecting smallholder livestock farmers' agricultural drought resilience to food insecurity in the Northern Cape. To achieve this objective, the Agricultural Drought Resilience Index (ADRI) was constructed using a structural equation model as an outcome variable against explanatory variables – such as assets, adaptive capacity, source of income, migration, social safety nets, access to credit, and rainfall – with other economic, social, institutional and economic variables. This project has been funded by the National Research Foundation (NRF) Thuthuka Programme since 2018.

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

In another collaborative research project, Prof Jordaan and Dr Janus Henning worked with scientists from the University of KwaZulu-Natal (UKZN) on a project for the WRC, exploring entrepreneurial development paths to facilitate the participation of rural youth in formal agricultural activities.

Ms Pascalina Pilane was 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.

The Livestock Economics unit was involved in a variety of research projects related to the economics of livestock production in South Africa. Their research endeavours were mainly funded by RMRD SA, the Red Meat Producers Organisation (RPO), and private agribusinesses. Mr Walter van Niekerk was part of the research team studying predation in South Africa, funded by RMRD SA, while Dr Lombard led two other projects funded by RMRD SA – one on the economic impact of stock theft and the factors affecting stock theft in South Africa, and the other on eye-tracking technology for red meat marketing in the Mangaung Metropolitan Municipality.

Prof Abiodun Ogundeji worked on an NRF-Thuthuka project titled 'Farmers' coping and adaptation strategies to drought and other water-related risks in a changing climate', and a WRC-funded project titled 'Development of scenarios for future agricultural water use in South Africa'.

Dr Frikkie Maré continued his research on the economics and environmental impacts of beef production. Cheri-Lynn Steyn's master's project focuses on the backgrounding (i.e. the period between weaning and feedlot placement) of beef cattle, to determine for how long weaners of various weaning weights should be backgrounded. Factors such as animal production, market prices, and the feedlot facilities need to be taken into consideration when establishing the optimal backgrounding period for different weight classes of weaners. The research was conducted at Sernick's Liebenbergstroom feedlot, during which 405 Bonsmara weaners were assigned to different treatments, backgrounded and then placed on the feedlot. Starch digestibility analyses were conducted through Central Analytical Laboratories (CAL) and rumen scoring was completed by Sernick's research unit manager, Dawid Smit, in collaboration with Dr Schabort Froneman from Zoetis Animal Health. Various research assistants from the Department of Agricultural Economics assisted with the monthly weighing of all of the animals.

The master's project of Grace Smythe investigates health preconditioning of weaners as a management practice that is aimed at enhancing their immunity to ensure that they are better equipped to handle the stress and increased exposure to diseases that they face in the feedlot environment. Health preconditioning has been proven to have many advantages, and, as a result, health preconditioning is internationally considered to be a value-added management practice. However, in South Africa it is currently unclear if feedlots and cow-calf producers consider preconditioning to be an economic value-added management practice. The study therefore aims to determine, through telephonic surveys, whether feedlot operators and cow-calf producers perceive it to be a value-added management practice, and, if they do, what the monetary value is. The study will address the rumours surrounding the topic and contribute to the debate regarding potential price premiums for health preconditioned weaners.

ENGAGED SCHOLARSHIP

The Department is dedicated to giving back to the farming community at large by providing the agricultural sector with relevant information. During 2020 this was done in various ways, including farmers' days, farmer-arranged conferences, and the 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.

The South African Futures Exchange (SAFEX) Johannesburg Stock Exchange (JSE) Agricultural Derivative Market course was presented in English and Afrikaans by Johann Strauss and Markus Monteiro. 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 usually presented, two in Afrikaans and two in English.

NATIONAL AND INTERNATIONAL COLLABORATION

Prof Yonas Bahta attended the 22nd Senior Policy Seminar (SPS XXII) of the African Economic Research Consortium (AERC), from 9 to 10 March in Abuja, Nigeria. The policy seminar is unique, bringing together senior policymakers from African countries as well as economic researchers, to share knowledge and debate on urgent policy issues relating to the sustainable development of African economies. It is anticipated that collaboration opportunities will arise from these interactions.



Prof Yonas Bahta

OTHER ACTIVITIES

Ms Zimbini Coka is working on a book with Prof Michael Aliber, from the University of Fort Hare, about Mr Arthur Matakane, an ordinary rural man with a long, fascinating life. Mr Matakane was born in 1930 in Lower Gqumashe, outside Alice in the Eastern Cape, where he still farms and maintains a home. The book is based on an extensive ongoing series of interviews that have been conducted with Mr Matakane.

POSTGRADUATE STUDENTS

In 2020, a total of 32 students was registered for the three honours programmes offered by the Department. Fifteen master's and eight doctoral students were also registered.

In terms of graduations, 44 students graduated with honours degrees, and four with master's degrees – OJ Pêrel and BD Jammer with the MAgric (Agricultural Management), K Netshifhefhe with the MSc (Agricultural Economics), with distinction, and MM August with the MAgric (Agricultural Economics).

STAFF MATTERS

Two of our staff members were promoted to Associate Professor level in 2020 – Henry Jordaan (1 January), and Abiodun Ogundeji (from 1 August).

Prof Edilegnaw Wale Zegeye joined the Department of Agricultural Economics in October 2020, as Professor of Agricultural Development Economics and Policy. Before joining the UFS, he was at UKZN Agricultural Economics (Senior Lecturer [2009–2013], Associate Professor [2014–2019], and Professor [2020]). Prior to that he worked as an economist at the Genetic Resources Policy Initiative (GRPI) project of Bioversity International in Kenya (2007–2009), and a postdoctoral fellow at the University of Bonn (2006–2007). He has also been a consultant to the International Food Policy Research Institute (IFPRI) and the International Livestock Research Institute (ILRI), among others. He received his doctoral degree (2004) in Agricultural and Natural Resources Economics from the University of Bonn. His PhD thesis won the 'Prize of Friends of ZEF', selected as the best doctoral thesis of the years 2003 and 2004 at the Center for Development Research (ZEF), University of Bonn.

RESEARCH OUTPUTS

Research Articles

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Ridoutt, B. & Garcia, J.N. 2020. Cropland footprints from the perspective of productive land scarcity, malnutrition-related health impacts and biodiversity loss. *Journal of Cleaner Production* 260: 121150.

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Thutwa, K., Chabo, R., Nsoso, S.J., Mareko, M., Kgwatalala, P.M. & Owusu-Sekyere, E. 2020. Indigenous Tswana pig production characteristics and management practices in southern districts in Botswana. *Tropical Animal Health and Production* 52: 517-524.

Vanham, D., Mekonnen, M.M. & Chapagain, A.K. 2020. Arjen Y. Hoekstra 1967–2019. *Nature Sustainability* 3:80.

STAFF (2020)

Head of Department: Dr F Maré

Professor: Dr W Zegeye
Associate Professors: Prof B Grové, Prof H Jordaan and Prof A Ogundeji
Senior Lecturers: Dr J Henning, Dr WA Lombard, Dr F Maré and Dr N Matthews
Lecturers: Ms P Mohlotsane, Mr P Mokhatla, Mr J Strauss and Mr W van Nierkerk
Junior Lecturers: Ms Z Coka and Mr M Monteiro

Senior Researcher: Dr Y Bahta
Researcher: Ms P Madende
Research Assistants: Mr T Adetoro, Mr D de Kock, Ms A Erasmus, Ms R Hadebe, Mr B Jammer, Mr C Kotzé, Ms P Languza, Ms M Marais, Mr A Moatlhodi, Mr C Richards, Mr M Roodman, Ms G Smythe, Ms S Songca, Ms C-L Steyn, Mr M van den Heever, and Ms H Viljoen
Research Fellows: Dr E Owusu-Sekyere, Dr B Ridout and Dr D Strydom
Affiliated Researcher: Mr P Oosthuizen
Programme Director: Dr F Maré
Officers: Ms I Combrinck and Ms C van der Merwe



DEPARTMENT OF ANIMAL SCIENCE

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OVERVIEW OF 2020

The year started out on a positive note with excellent rains in some areas of the country and optimistic prospects for the agricultural sector in South Africa. However, 2020 soon became the most extraordinary year in recent memory. The whole country was forced into the hardest lockdown possible due to the COVID-19 pandemic. Fortunately, the agricultural sector was one of the few industries that was allowed to continue to operate, saving the country from an even worse economic slump. This again confirmed the important role of this sector for both economic stability and food supply in South Africa.

Unfortunately, the devastating drought is still being felt in parts of the Karoo, as well as the Eastern and Northern Cape. Although the Department of Animal Science and other role players actively work towards alleviating the effects of the drought, very little can be achieved if the rain stays away. Predictions of future extremes in climate necessitate the proper management of natural resources and the use of adapted genotypes for future farming success.

The restructuring of the Faculty of Natural and Agricultural Sciences nears completion. As part of this restructuring, the former Department of Animal, Wildlife and Grassland Sciences has become the Department of Animal Science, and gained two new academics – Prof Arno Hugo (Meat Scientist) and Dr Koos Myburgh (Dairy Scientist), with operational laboratories. This opens new and exciting possibilities where both these disciplines, together with wool science, can be accommodated within a new curriculum to address the full value chain of livestock species. This alignment of the academic curriculum will not only help to produce a better student who is more sought after in the industry, but will also increase the interdisciplinary research potential of the Department and broaden our footprint into Africa.

ACHIEVEMENTS

Staff Achievements

Prof Hennie Snyman and Prof Mike MacNeil were both included on the list of top scientists worldwide, recently published by Stanford University in *PLOS Biology*.

Prof Japie van Wyk and Prof Frikkie Neser both achieved a C2-rating from the National Research Foundation (NRF) in 2020.

Dr Foch-Henri de Witt was elected as a member of the South African Society for Animal Science (SASAS) Council.

Dr Errol Cason won first prize in a countrywide beer brewery competition.

Student Achievements

Sune Hayward (Bachelor of Science in Agriculture majoring in Animal Sciences) was awarded the Faculty prize for the student who achieved the best results in respect of a four-year Bachelor's degree.

Carina le Roux, a master's student of Dr Ockert Einkamerer, won first prize for the best literature review in the Animal Feed Manufacturers Association (AFMA) Intervarsity Writer's Cup. The title of her article was 'Lucerne hay quality grade and its effect on lam feed intake ad nutrient digestibility'.

TEACHING AND LEARNING

The Department consists of five sub-disciplines (Animal Breeding, Animal Nutrition, Animal Physiology, Rangeland Science, and Wildlife Science) which are integrated in a multi-disciplinary manner into Animal Production Systems. BSc (Agriculture) degrees are offered in three disciplines – Animal Science, Wildlife Science or Rangeland Science, while two BAgric degrees in Animal Production Management and Wildlife Management are presented by the Department. Students who obtained a BSc (Agriculture) degree and qualify for postgraduate studies, can continue to an MSc (Agriculture) degree in Animal Breeding, Animal Nutrition, Animal Physiology, Animal Production, Rangeland Science or Wildlife Science. Graduates with a BAgric degree can continue with a BAgric (Honours) and later an MAgric in Animal Production Management and Wildlife Management. All MSc (Agriculture) and MAgric candidates who qualify can continue to a PhD or NQF level 10 equivalent.



Ockert Einkamerer (left) and Courtney Erasmus (right) during feed identification student training

RESEARCH AND INNOVATION

The Department of Animal Science is actively involved in both research and technology transfer in the various primary and secondary animal industries it serves. The Department focuses on several broad topics, namely animal breeding, monogastric nutrition (pigs, poultry, hindgut fermenting herbivores, and wild carnivores) and ruminant nutrition (cattle, sheep, goats, and wild antelopes), animal physiology, rangeland science, and wildlife science.

Research topics are quite diverse and applicable to the current problems farmers, producers, and wildlife ranchers face. A general holistic trend is adopted in the research conducted by the Department to ensure that relevant issues are addressed in a multidisciplinary approach by considering the environment, the consumer, and the producer.



Mkonzo cattle practical

ENGAGED SCHOLARSHIP

The experimental farms received excellent rains in 2020 and managed to harvest a substantial amount of fodder, more than that needed on the farms. The Department was therefore in the privileged position to be able come to the aid of farmers in the western parts of the Free State with feed after they suffered from a devastating fire.



Courtney Erasmus and Bianca Valentin with the bales ready to be sent to farmers in the western Free State

Prof Frikkie Neser was a judge at the Breedplan Pick n Pay National Stud Farmer of the Year and the Pick n Pay award for the farmer who made the most progress in the last decade.

Lectures were presented at farmers' days and symposia, while research trials sponsored by companies such as Voermol, Molatek, Nutri Feeds, Supreme Chicken, Arbor Acres, Sernick and the Agricultural Research Council (ARC) were completed.

Several community projects are still ongoing. Two Nguni cattle projects in the Northern Cape and Free State have been effective in training black farmers for the past ten years, in collaboration with the Industrial Development Corporation (IDC) and the respective provincial departments of agriculture and rural development. This project involves more than 90 farmers and more than 1 000 head of registered Nguni cattle. The recognition received has been very positive.



Animal identification practical

The use of spineless cactus pear (*Opuntia ficus-indica*) as an important source of animal feed is also being investigated. More than 52 hectares of spineless cactus pear orchards have been established on 26 farms, to use as an alternative feed source and also help to provide additional income and/or fodder for resource-poor farmers.

The predator management information centre (PMC) conducts research into the impact of predators (black-backed jackal and caracal) on the livestock industry in South Africa. This problem is estimated to cost the livestock industry in South Africa more than R2 000 million annually.

NATIONAL AND INTERNATIONAL COLLABORATION

Both national and international collaboration are important for any academic institution. Collaboration with the ARC is of special importance for the University, and the two institutions share several students, while the ARC has also funded some of the research done within the Department.

Local collaboration was also extended to other organisations, such as the Universities of Pretoria, Fort Hare and Stellenbosch, the Department of Agriculture (Glen, Elsenburg, and Grootfontein), the majority of breeding societies, Artificial Insemination (AI) stations, Breedplan SA, South African Studbook, and various poultry and feed companies.

Internationally, there are ongoing projects in collaboration with the Institut National de la Recherche Agronomique (INRA) in France, and several international researchers, such Dr Michael MacNeil and Dr Vincent Ducrocq, are actively involved in both teaching and research in this Department.

ZZ2 (Natuur Boerdery) has requested the UFS to develop and register a new and/or improved Effective Microbe (EM) product with similar characteristics and uses as EM·1®. Currently this project is spearheaded by Dr Mariana Erasmus and Dr Robert Hansen from the Centre for Mineral Biogeochemistry (CMBG) and Dr Errol Cason from the Department of Animal Science.

POSTGRADUATE STUDENTS

Twenty-one (21) students were enrolled at honours level in 2020, with 42 at master's level and 14 at doctoral level.

Five students graduated with BAgric Hons majoring in Animal Production Management – one of whom passed with distinction (Luke David Barnard). A further five students graduated with the BAgric Hons majoring in Wildlife Management. Kyle James Hartley passed with distinction.

In terms of BScAgric Hons, two students graduated with Animal Science as major, and one with Wildlife Science as major.

Christopher Reusch graduated with the MSc (Agriculture) in Wildlife, and Benita Elago and Thandululo Mudzungwane with the MSc (Agriculture) in Animal Science.

One student graduated with PhD, with specialisation in Wildlife:

Kruger, Quinette

Thesis: Developing a management information system for coordinated predation management in South Africa

Promoter: Prof HO de Waal

STAFF MATTERS

The Department welcomed two new academics in 2020 – Prof Arno Hugo and Dr Koos Myburgh, as well as Eileen Roodt (Laboratory Technician), Ilze Auld (Secretary), John Lamle and Ntabiseng de Bruin (Cleaners).

Dr Ockert Einkamerer was promoted to Senior Lecturer.

RESEARCH OUTPUTS

Research Articles

Abo-Ismail, M.K., Akanno, E.C., Crowley, J.J., Hays, D.P., Khorshidi, R., Macneil, M., Plastow, G. & Wang, Z. 2020. Estimation of genetic parameters and trends for growth traits in Hays Converter cattle using multiple -trait and random regression models. *Livestock Science* 103(5): 1-10.

Bercovitch, F.B. 2020. A comparative perspective on the evolution of mammalian reactions to dead Conspecifics. *Primates*. DOI: 10.1007/s10329-019-00722-3.

Bercovitch, F.B. 2020. Giraffe taxonomy, geographic distribution and conservation. *African Journal of Ecology* 58: 150-158. DOI: 10.1111/aje.12741.

Boligon, A.A., Cardoso, F.F., De Costa, R.F., Gomes Cláudia, C., Junqueira, V.S., Leal Joal, J.B., Macneil, M., Minho, A., Schmidt, P.I., Simoes, M.R.S. & Yokoo, M.J. 2020. Breeding objectives of Brangus cattle in Brazil. *Journal of Animal Breeding and Genetics* 137: 177-188). DOI: 10.1111/jbg.12415.

Bolton, J.G. & Janecke, B. 2020. Variation in mammal diversity and habitat affect heterogeneity and processes of a granite catena. *Koedoe : African Protected Area Conservation and Science* 62: 1-12. DOI: 10.4102/koedoe.v62i2.1592.

Carter K.D., Deacon, F., Fienieg, E., Lee D.E., Muller, Z., Scheijen, C.P.J., Strauss, M. & Van Oosterhout, C. 2020. Giraffe translocation population viability analysis. *Endangered Species Research 41:* 245-252. DOI: 10.1101/619114.

Carter, K.D., Deacon, F., Lee, D.E., Muller, Z., Scheijen, C.P.J. & Strauss, M. 2020. Giraffe translocations: A review and discussion of considerations. *African Journal of Ecology* 00*:* 1-13). DOI: 10.1111/aje.12727.

Cardoso, F.F., Cardoso, L.L., Dambros, M.C., De Freitas, A.K., Devincenzi, T., Feijó, F.D., Lobato, F.D.P., Macneil, M.M. & Tarouco, J.U. 2020. Sample size and prediction of weight and yield of individual cuts from Braford steers pistol hindquarters. *Scientia Agricola*. Vol. 77: 1-8. DOI: 10.1590/1678-992X-2018-0224.

Cardosom, F.F., Cardoso, L.L., Giongo, C., Macneil, M., Mendonca, F.S. & Nalerio, E. 2020. Breed direct, maternal and heteros is effects due to Angus, Caracu, Hereford and Nelore on carcass and meat quality traits of cull cows. *Livestock Science* 243*:* 1-7. DOI: 10.1016/j.livsci.2020.104374.

Cason, E.D., Mahlomaholo, B.J., Taole, M.M., Abong, G.O., Vermeulen, J-G., DeSmidt, O., Vermeulen, M., Steyn, L., Valverde, A. & Viljoen, B. 2020. Bacterial and fungal dynamics during the fermentation process of Sesotho, a traditional beer of Southern Africa. *Frontiers in Microbiology* 11: art 1451. DOI: 10.3389/fmicb.2020.01451.

Coetzer, W.G., Coetzee, L.M., Cason, E.D., Grobler, J.P., Schneider, S.R. & Boucher, C.E. 2020. A Preliminary Assessment of Skin Microbiome Diversity of Zebrafish (Danio rerio): South African Pet Shop Fish. *Indian Journal of Microbiology* 61. DOI: 10.1007/s12088-020-00900-8.

Daffue, W., Deacon, F., Luther-Binoir, I., Meuffels, J. & Mitchell, E.P. 2020. Testicular disorder of sexual development with cryptorchidism, penile hypoplasia and hypospadias in a giraffe (Giraffa Camelopardalis giraffa). *Journal of the South African Veterinary Association* 91*:* 1-6. DOI: 10.4102/jsava.v91i0.1971.

Dzama, K.K., Kgari, R.D., Makgahlela, M.L. & Muller, C.J.C. 2020. Evaluation of female fertility in dairy cattle enterprises – A review. *South African Journal of Animal Science* 50. DOI: 10.4314/sajas.v50i6.8.

Einkamerer, O.B., Elago, B.T., Ganswindt, A. & O'Neill, H.A. 2020. Concentrations of faecal glucocorticoid metabolites in South African Mutton Merino sheep fed various sources of roughage. *South African Journal of Animal Science* 50: 21-28. DOI: 10.4314/sajas.v50i4.2.

Foster, L.A., Fourie, P.J. & Neser, F.W.C. 2020. Effect of different levels of supplementation after weaning on beef heifer development. *South African Journal of Animal Science* 50. DOI: 10.4314/sajas.v50i1.14.

Grobler, R., De Witt, F., Cason, E.D., Einkamerer, O.B., Josling, G.C., O'Neill, H.A., Fair, M.D., Baloyi, J.J., MacNeil, M.D. & Neser, F.W.C. 2020. Training the next generation of animal scientists for South Africa. *Animal Frontiers* 10:10-17. DOI: 10.1093/af/vfaa017**.**

Gryzenhout, M., Cason, E.D., Vermeulen, M., Kloppers, G.A.E., Bailey, B. & Ghosh, S. 2020. Fungal community structure variability between the root rhizosphere and endosphere in a granite catena system in Kruger National Park, South Africa. *Koedoe 62*: a1597. DOI: 10.4102/koedoe.v62i2.1597.

Janecke, B. 2020. Vegetation structure and spatial heterogeneity in the Granite Supersite, Kruger National Park. *Koedoe: African Protected Area Conservation and Science* 62: 1-10. DOI: 10.4102/koedoe.v62i2.1591.

Janecke, B. & Van Tol, J.J. 2020**.** Connections between abiotic and biotic components of a granite catena ecosystem in Kruger National Park. *Koedoe: African Protected Area Conservation and Science* 62*:* 1-2. DOI: 10.4102/koedoe.v62i2.1638.

Kuloyo, O., Fourie, R., Cason, E., Albertyn, J & Pohl, C.H. 2020. Transcriptome analyses of Candida albicans biofilms, exposed to arachidonic acid and fluconazole, indicates potential drug targets. *G3: Genes, Genomes, Genetics* 10: 309-3108. DOI: 10.1534/g3.120.401340.

MacNeil, M.M., Mahlako, M.L., Neser, F.W.C., Van Der Westhuizen, L. & Van Wyk, J.B. 2020. Genetic variability and relationships in nine South African cattle breeds using microsatellite markers. *Tropical Animal Health and Production* 52*:* 177-184). DOI: 10.1007/s11250-019-02003-z.

MacNeil, M., Neser, F.W.C., Pyoos-Daniels, G.M., Scholtz, M.M. & Theunissen, A.A. 2020. Genetic effects from an Afrikaner, Bonsmara, and Nguni three-breed diallel and topcrosses of Angus and Simmental sires. *South African Journal of Animal Science* 50*:* 819-829. DOI: 10.4314/sajas.v50i3.3.

Makgahlela, M.L., Neser, F.W.C. & Scholtz, M.M. 2020. A balanced perspective on the importance of extensive ruminant production for human nutrition and livelihoods and its contribution to greenhouse gas emissions. *South African Journal of Science* 116: 1-3. DOI: 10.17159/sajs.2020/8192.

Naidoo, Y., Valverde, A., Cason, E.D., Pierneef, R.E. & Cowan, D. 2020. A clinically important, plasmid-borne antibiotic resistance gene (β-lactamase TEM-116) present in desert soils. *Science of the Total Environment* 719: 137497. DOI: 10.1016/j.scitotenv.2020.137497.

Purtschert, R., Yokochi, R., Jiang, W., Lu, Z-T., Mueller, P., Zappala, J., Van Heerden, E., Cason, E., Lau, M., Kieft, T.L., Gerber, C., Brennwald, M.S. & Onstott, T.C. 2020.

Underground production of 81Kr detected in subsurface fluids. *Geochimica et Cosmochimica Acta* 295: 64-79. DOI: 10.1016/j.gca.2020.11.024.

Ramukhithi, F., Mapholi, N.O., Maqhashu, A., Nedambale, T.L., Nephawe, K.A., Nxumalo, K.S., O'Neill, H.A. & Sebei, P.J. 2020. Assessment of genetic variation in Bapedi sheep using microsatellite markers. *South African Journal of Animal* Science 50: 318-324. DOI: 10.4314/sajas.v50i2.15.

Valverde, A., Cason, E.D., Gómez-Arias, A., Bozkale, D., Govender, D., Riddell, E. & Cowan, D. 2020. Pollution shapes the microbial communities in river water and sediments from the Olifants River catchment, South Africa. *Archives in Microbiology* 203: 295-303. DOI:10.1007/s00203-020-02035-2.

Vermeulen, M., Cason, E.D. & Swart, W.J. 2020. The rhizobiome of herbaceous plants in Clovelly and Sterkspruit soils of the Stevenson–Hamilton supersite. *Koedoe 62*: a1596. DOI: 10.4102/koedoe.v62i2.1596.

Conference Contributions

Conference Papers/Posters

Bopape, M.E., Pyoos-Daniels, G.M. & Scholtz, M.M. 2020. *Feed intake and water behaviour of different beef cattle genotypes.* Poster presented at the North West Department of Agriculture and Rural Development Animal Husbandry Symposium (Virtual Symposium). 18-19 November 2020.

Cason, E.D., Van Wyk, J.B., Vermeulen, P.D. & Neser, F.W.C. 2020. *Estimation of genetic parameters for reproduction traits in South African Brahman cattle*. Poster presented at the European Federation of Animal Science (EAAP) 2020 Virtual Meeting. 1-4 December 2020.

Chabalala, N.T., Scholtz, M.M., Pyoos-Daniels, G.M. & Chadyiwa, M.C. 2020. *Perspective on the methane production of primary beef production systems in South Africa.* Poster presented at the North West Department of Agriculture and Rural Development Animal Husbandry Symposium (Virtual Symposium). 18-19 November 2020.

Chadyiwa, M.C., Scholtz, M.M. & Neser, F.W.C. 2020. *Improved cow efficiency can reduce the carbon footprint of beef production.* Paper delivered at the North West Department of Agriculture and Rural Development Animal Husbandry Symposium (Virtual Symposium). 18-19 November 2020.

Einkamerer, O.B. 2020. *Sheep nutrition: new trends in intensive sheep operations.* Invited paper delivered at the Ruminant Formulation Workshop, AFMA Forum, Sun City, South Africa. 3-5 March 2020.

Erasmus. S. & Scholtz, M. 2020. *Die gebruik van groeistimulante in beesvleis produksie / The role of growth promotors in beef production.* Paper delivered at the Afrikanerbees Opleidingsdag, Thabazimbi, South Africa. 29 August 2020.

Jordaan, F.J, Neser, F.W.C, Maiwashe, A., King, Z. & Scholtz, M.M. 2020. *Changes in cow productivity and its environmental impact in the landrace beef breeds of South Africa.* Paper delivered at the North West Department of Agriculture and Rural Development Animal Husbandry Symposium (Virtual Symposium). 18-19 November 2020.

Jordaan, F.J. & Scholtz, M.M. 2020. *Voerperiode om inkomste te optimaliseer / Feeding period for optimized income*. Paper delivered at the Afrikanerbees Opleidingsdag, Thabazimbi, South Africa. 29 August 2020.

Pyoos, G.M., Scholtz, M.M., MacNeil, M.D., Theunissen, A. & Neser, F.W.C. 2020. *Alternative measures of cow efficiency for Afrikaner, Bonsmara, Nguni, Angus and Simmental sired calves*. Poster presented at the North West Department of Agriculture and Rural Development Animal Husbandry Symposium (Virtual Symposium). 18-19 November 2020.

Schmidt, B., MacNeil, M.D. & Gonda, M.G. 2020. *Partitioning Variation in Measurements of Beef Carcass Traits Collected Using Ultrasound.* Paper delivered at the 52nd Annual Beef Improvement Federation Research Symposium and Convention (BIF), Kissimmee, Florida, USA. 9-12 June 2020.

Scholtz, M.M., Chadyiwa, M.C., Jordaan, F.J., Pyoos-Daniels, G.M. & Chabalala, N.T. 2020. *Going green with livestock production.* Paper delivered at the National Dialogue on Climate Smart Agriculture, Kempton Park, South Africa. 6-7 February 2020.

Scholtz, M.M., Jordaan, F.J., Chadyiwa, M.C., Pyoos-Daniels, G.M., Theunissen, A. & Chabalala, N.T. 2020. *Die rol van die Afrikaner in vleisbees-produksie na 2020 / The role of the Afrikaner in beef production beyond 2020*. Paper delivered at the Afrikanerbees Opleidingsdag, Thabazimbi, South Africa. 29 August 2020.

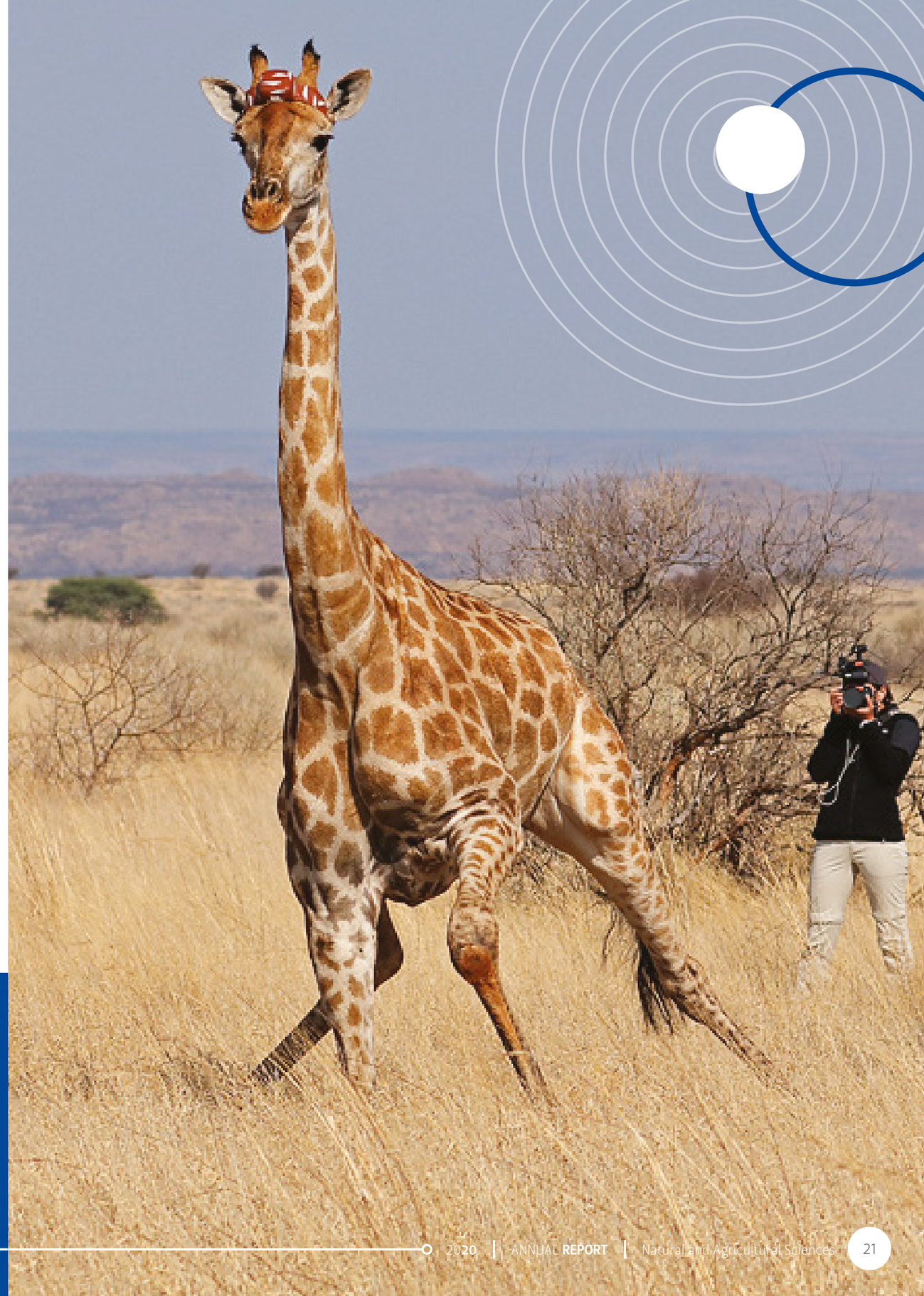
Scholtz, M.M., Neser, F.W.C., Makgahlela, M.L. & Pyoos-Daniels, G.M. 2020. *A balanced perspective on the importance of livestock foods and its environmental impact.* Paper delivered at the North West Department of Agriculture and Rural Development Animal Husbandry Symposium (Virtual Symposium). 18-19 November 2020.

Seshoka, M.M., Theunissen, A., Pyoos, G.M., Peterson, W., Neser, F.W.C. & Scholtz, M.M. 2020. *The effect of climate on the pre-weaning performance of diverse beef cattle genotypes at Vaalharts.* Poster presented at the North West Department of Agriculture and Rural Development Animal Husbandry Symposium (Virtual Symposium). 18-19 November 2020.

STAFF (2020)

Head of Department: Prof FWC Neser

Professors: Prof A Hugo, Prof FWC Neser and Prof GN Smit
Senior Lecturers: Dr ED Cason, Dr F Deacon, Dr FH de Witt, Dr OB Einkamerer, Dr MD Fair, Dr K Myburgh and Dr HA O'Neill
Lecturers: Ms R Grobler, Dr BB Janecke, Ms GC Josling, Mr L Kruger and Dr PJ Malan
Junior Lecturers: Mr J Barnard, Mr G Janse van Rensburg and Ms JW Paulse
Affiliated Professors: Prof FB Bercovitch, Prof HO de Waal, Prof V Ducrocq, Prof JPC Greyling, Prof M MacNeil, Prof M Makgahlela, Prof A Maiwashe, Prof TL Nedambale, Prof MM Scholtz, Prof H Snyman and Prof JB van Wyk
Programme Director: Dr M Fair
Veterinarian: Dr L Meiring
Technicians: Ms E Roodt and Ms JAM van der Merwe
Officer: Mr KR Moopelwa
Senior Assistant Officers: Mrs I Auld and Ms NAK Green
Assistant Officer: Ms CJ Williams
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 2020

After an active start in 2020 with the Combined Congress held on the UFS Bloemfontein Campus and several national and international visits by staff members, most of the experimental research activities and planned travels came to a halt as the country went into a lockdown due to the COVID-19 pandemic. Major efforts were implemented by staff members to move teaching modules to an online mode. Only in the second semester, some face-to-face teaching activities could be re-initiated and fieldwork became feasible again. The national lockdown thus caused some major disruptions in the teaching and research activities and dominated most of 2020. However, it did provide the opportunity for staff members to renew curricula and teaching modes, and to develop new articles and research skills.

ACHIEVEMENTS

Staff Achievements

The annual Combined Congress of the South African Society of Crop Production (SASCP), the Soil Science Society of South Africa (SSSSA), the Southern African Weed Science Society (SAWSS), and the Southern African Society for Horticultural Sciences (SASHS) was hosted by the Department of Soil, Crop and Climate Sciences from 21 to 23 January on the Bloemfontein Campus. Dr Gesine Coetzer, Dr Elmarie van der Watt and Dr Gert Ceronio formed part of the local organising committee. Our staff and students made four presentations at the congress, and Prof Johan van Tol received the prize for the best presentation in Soil Science. A workshop, with the theme 'Soil fertility and crop nutrition symposium: principles and practices', was also presented at the workshop.

Dr Van der Watt was elected as secretary of the SASCP and Dr Nester Mashingaidze was co-opted as a member of the Society. Dr Ceronio received a Fellowship award from the SASCP.



Dr Gert Ceronio (left) receiving the Fellowship award from the SASCP

Student Achievements

Master's student Mischke Bouwer completed her MSc degree at the UFS and obtained a Fulbright Scholarship to study towards her PhD at the Southern Illinois University in Carbondale, Illinois.

Grain SA awarded bursaries for academically deserving postgraduate students from previously disadvantaged groups. One honours and two master's candidates were awarded bursaries.

Ms Zuné du Plessis was the first recipient of the Agrometeorology Prize for the best final year student at the autumn graduation ceremony.

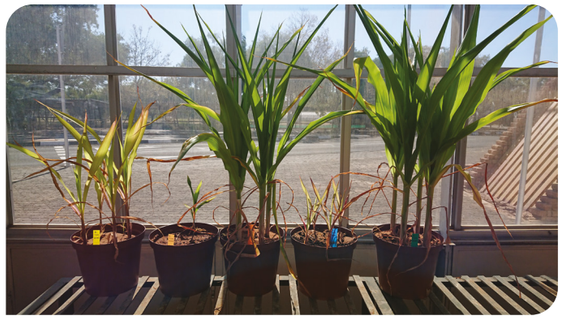
TEACHING AND LEARNING

When the national lockdown came into effect in March 2020, all classes had to move online. Students and lecturers alike had to adapt quickly to a new teaching environment. Lecturers quickly learned how to set up online assessments, but struggled to keep students in rural areas with poor internet connection engaged. During the second semester, teaching moved to a blended approach (face-to-face and online).

The research project requirement for fourth-year BSc and BSc Hons students in Soil Science, Crop Science or Agrometeorology was revised in 2020. All students undertook a research project selected from a range of possible topics, either on campus or on the experimental farm of the Department. The images below reflect some of the projects undertaken by the students.



Macadamia germination and seedling growth as influenced by different temperature and growth medium



Maize plant growth as influenced by different organic soil amendment



Green pepper plant growth as influenced by different temperatures and water applications



Cabbage growth as influenced by different organic soil amendments



RESEARCH AND INNOVATION

Dr Johan Barnard was involved in the finalisation of a five-year project funded by the Water Research Commission (WRC), titled 'Management guidelines for technology transfer to reduce salinisation of irrigated land with precision agriculture', led by Prof Leon van Rensburg. Three final reports were submitted at the conclusion of the project.



Trial done for ABInBev at the lysimeter facility located at Kenilworth Experimental Farm

Dr Johan Barnard commenced a one-year project funded by Anheuser-Busch InBev (ABInBev) titled 'Sorghum above-ground biomass and grain yield response to water management practices" came to an end with the submission of the final report. In December ABInBev indicated that they will fund the project for an additional year in order to obtain measurements from a second growing season.

Dr Barnard was also instrumental in the successful application for a three-year WRC-funded interdisciplinary project titled 'Economic management of conjunctive use of irrigation water and shallow groundwater'. The project leader is Prof Bennie Grové, and the project will be undertaken together with researchers from the the Department of Agricultural Economics. In addition, Dr Barnard developed management guidelines for technology transfer to decrease salinisation of irrigated land with precision agriculture continues as well as various factors affecting sunflowers emergence such as herbicides, temperatures and fertilisation practices.

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 an NRF-funded project on improving regional soil information for hydrological modelling. Prof Van Tol is also leading a Department of Environmental Affairs – Natural Resource Management (DEA-NRM) funded project on developing soil rehabilitation norms for selected catchments. Dr Elmarie Kotze and Dr Makhosazana Aghoghovwia are part of this project team. Funding was also obtained from the South African National Biodiversity Institute (SANBI) to improve the understanding of hydropedological processes in the Mngeni, Goukou and Breede River catchments.

Prof Cornie van Huyssteen is leading projects to characterise the soil and geomorphology of selected ephemeral pans in the Northern Cape, in order to determine the effect of soil taxonomy on the prediction of maize yield potential, and to evaluate the yield response of maize to soil type and slope.

Dr Elmarie van der Watt continued natural product screening to identify plants producing potential fungicides, pharmaceuticals, insecticides and herbicides during the year, and produced some encouraging results. New projects also commenced on testing the repellent activity of plant extracts against red spider mites (*Tetranychus urticae*) and other insects on several crops. 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.) was also investigated.

Dr Ceronio has expanded his field trial research with the main aim of training postgraduate agronomists. The first year of a three-year research project to evaluate the effects of a changing environment and late planting dates on maize plant development, yield and quality, was completed successfully at the Departments' research farm, Kenilworth. This project forms part of the larger project, 'Climate Resilience Consortium', involving the Agricultural Research Council (ARC) Grain Crops Institute, the UFS and the University of Pretoria.

The Department has been awarded funding for five years by Grain SA for a long-term experiment that includes crop rotation and tillage practices. The implementation of this trial is led by Dr Ceronio, while a multidisciplinary team of scientists from this Department and the Department of Plant Sciences is involved in taking measurements. Crop establishment commenced successfully in November, and the first cycle of the project will be completed in four years.

The cactus pear project that was established in November 2015 on the West Campus in collaboration with the ARC (involving Dr Coetzer and Dr Fouche), is still an important source of research outputs for the Department. Currently, two master's students and one doctoral student are working on research projects in the cactus pear orchard. A new organic fertiliser trial was also established in August. Even though the 2019/20 season was very dry, in February 2020 more than 20 tons of fruit were harvested on 0.75 ha. On the same area, during the lockdown period in July, 30 tons of plant material (cladodes) were removed during pruning, and more than 20 000 cladodes were supplied to the industry as plant material.



Cactus pear fruit load and fruit thinning in fertilisation trial



Cactus pear high density planting after pruning

The genotype bank on the West Campus is the only well-maintained planting in South Africa and an important source of plant material for the industry. Tissue cultured plants of two cactus pear cultivars known for their resistance to cochineal and Cactoblastis (cactus moth) were imported from Italy in November. These two cultivars have great potential as fodder cultivars in South Africa.

Dr Coetzer established a research project in collaboration with the South African Pecan Nut Producers Association (SAPPA) and Kynoch, which is being conducted as part of the MSc Agric study by Mr Wian Visser on the West Campus and in a commercial orchard in the Jan Kempdorp district. The aim of this project is to evaluate the influence of different foliar applied zinc carriers



Cactus pear tissue cultures plants imported from Italy and transplanted in air pots

on the growth, physiology, quality and yield of pecan nuts. Zinc deficiencies are considered to be a chronic feature in the production of pecan nuts. Zinc is used in various physiological and biochemical processes which ensures successful growth, yield and quality of the nuts produced.



Two-year-old pecan nut trees on West Campus



Foliar application of Zn in a commercial orchard at Jan Kempdorp

Staff members of the Department also worked hard during lockdown in July, harvesting carrots from a foliar applied fertiliser trial conducted by Dr Coetzer and Dr Ceronio. The aim of this project is to determine whether fertiliser applied as a foliar application can be beneficial for the yield and quality of carrots, which are important factors affecting marketing of this important vegetable. Carrots must comply with very strict quality standards for both the fresh produce and the processing markets.



Staff members washing and grading carrots from the fertilisation trial on the West Campus during lock down

Charles Tharaga has been researching the water use of sweet cherries under rain-fed conditions in the eastern Free State, for a number of years. However, due to COVID-19, no research activities could be undertaken in 2020. He was nominated for a scholarship to attend training on remote sensing for agricultural water management at IHE Delft in the Netherlands, but the training was postponed to 2022.

Dr Weldemichael Tesfuhuney, as principal investigator, completed a project funded by WRC with the aim to increase agricultural productivity through the knowledge uptake of smallholder farmers by practicing integrated techniques to promote food security and improve natural resource management in Thaba Nchu rural communities. Dr Tesfuhuney also made a contribution to a WRC-funded project completed in 2020, aimed at assessing the basis of water allocation on selected water-stressed irrigation schemes in South Africa through the application of the SAPWAT4 model. Two field trials for PhD research projects supervised by Dr Tesfuhuney also continued – for a summer crop (maize) to investigate the effect of cover crop (sunn hemp) on resources use, and for a winter crop (wheat) to study the effect of temperature on growth and development of various wheat cultivars in the eastern Free State.

Prof Linus Franke successfully applied for funding from the Regional University Forum for Capacity Building in Agriculture (RUFORUM) to conduct research and train three MSc students on assessing the carbon dynamics in grasslands under different management strategies. This work is conducted in collaboration with the UFS Department of Animal Science. He also completed a project on resource-use efficiencies of potato farmers in North West Province, funded by Potatoes SA.

Prof Franke, together with Dr Sean van der Merwe from the UFS Statistical Consultation Unit, organised a course on the use of R for statistical analyses, for academics in this Department and the Department of Plant Sciences.

ENGAGED SCHOLARSHIP

Prof Linus Franke continued as editor-in-chief of the *South African Journal of Plant and Soil*. He also served as editor for *Land* (an MDPI open access journal), and was the convener of the specialist committee assigning NRF-ratings in the field of Earth Sciences.

Dr Ceronio presented talks at farmers' days presented by South African Breweries (SAB) at Vaalharts and Caledon, as well as Griekwaland Wes Kooperatief (GWK) at Douglas, on chilling and frost damage in barley and wheat, respectively.

Dr Van der Watt and Dr Coetzer served as panel members who evaluate applications for NRF bursaries for MSc and PhD students in 2020.

NATIONAL AND INTERNATIONAL COLLABORATION

As reported above, research projects were undertaken in collaboration with Agraforum, the WRC, SAB, AB-InBev, SAPPA, Kynoch, Grain SA, Potatoes SA and RUFORUM.

Dr Coetzer and Dr Van der Watt started collaboration with the *Natuurboerdery* section of ZZ2, which will involve screening plant extracts for their potential use on tomatoes. Screening of different plant extracts will be done to determine if they can be used as natural products to improve tomato growth.

As part of a cotutelle agreement with the University of Bourgogne, Dr Kotzé and Prof Van Tol are supervising two PhD students, working on soil- and water related-research in the montane fire climax grasslands of Cathedral Peak in the Drakensberg.

Ms Neo Mathinya was visited by the rest of her PhD supervisory team from Wageningen University and Research (WUR) in the Netherlands. Together, the team visited her study sites in Thaba Nchu (the Free State) and Emmaus (KwaZulu-Natal) in February.



Ms Neo Mathinya together with her supervisory team, from the left, Prof Linus Franke (UFS), Dr Gerrie van de Ven (Plant Production Systems, WUR), Neo Mathinya (UFS) and Prof Ken Giller (Plant Production Systems, WUR)

Prof Johan van Tol continued collaborating with researchers at TU Dresden (Germany). Two journal articles were published on the impact of soil information on hydrological modelling.

Dr Stephan Steyn visited the University of Pretoria in December where he acted as external evaluator for their honours programme in Meteorology.

Prof Franke visited Wageningen University in February 2020 to attend the PhD graduation ceremony of Mr Michael Kermah whom he supervised. He also jointly supervises two PhD students with The International Maize and Wheat Improvement Center (CIMMYT), in Zimbabwe, and one PhD student with the International Institute of Tropical Agriculture (IITA), in Zambia.

POSTGRADUATE STUDENTS

In 2020, a total of 25 students were enrolled for the BSc Hons degree, 39 for MSc studies, and 15 for PhD studies.

In terms of graduations, Margaret Mota, Lutendo Muelelwa, Itumeleng Sekoboane, Daniël Jordaan, Khumo Jaola, Natasja Combrink, Mischke Bouwer, Zikhona Gqalaqha and Sindy Tlomatsana, graduated with the MSc degree.

Two PhDs were conferred in 2020:

Steyn, Abraham Stephanus

Thesis: Assessing climate-related fire danger across the central grassland biome of South Africa.

Promoter: Prof AC Franke

Chichongue, Oscar Joao

Thesis: Comparison of Crop Management systems for smallholder farmers in Mozambique.

Promoters: Prof JJ van Tol and Dr GM Ceronio

POSTDOCTORAL RESEARCH FELLOWS

The Department hosted four postdoctoral research fellows during 2020:

- Dr Palo Francis Loke, from Lesotho
- Dr Sabelo Mvimbela, from Eswatini
- Dr Cinisani Tfwala, from Eswatini
- Dr Achamyeleh G Mengistu, from Ethiopia

STAFF MATTERS

Ms T Mboleli was appointed as a cleaner in the Department in September 2020, and Mr B Tshabang started as an Officer in the soil laboratory early in 2020.

Dr Stephan Steyn obtained his PhD in Agrometeorology from the UFS.

RESEARCH OUTPUTS

Research Articles

Aghoghovwia, M.P., Hardie, A.G. & Rozanov, A.B. 2020. Characterisation, adsorption and desorption of ammonium and nitrate of biochar derived from different feedstocks. *Environmental Technology*. DOI: 10.1080/09593330.2020.1804466.

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Chibarabada, T.P., Modi, A.T. & Mabhaudhi, T. 2020. Options for improving water productivity: A case study of bambara groundnut and groundnut. *Physics and Chemistry of the Earth, Parts A/B/C* 115. DOI: 10.1016/j.pce.2019.10.003.

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Dlamini, J.C., Chadwick, D., Hawkins, J.M.B., JMartinez, J. Scholefield, D., Ma, Y. & Cárdenas, L.M. 2020. Evaluating the potential of different carbon sources to promote denitrification. *The Journal of Agricultural Science* 158(3): 194-205. DOI: 10.1017/ S0021859620000520.

Du Plessis, C., Van Zijl, G.M., Van Tol, J.J. & Manyevere, A. 2020. Machine learning digital soil mapping to inform gully erosion mitigation measures in the Eastern Cape, South Africa. *Geoderma* 368. DOI: 10.1016/j.geoderma.2020.114287.

Du Preez, C.C. & Van Huyssteen, C.W. 2020. Threats to soil and water resources in South Africa. *Environmental Research* 183: 109015.

Franke, A.C., Muelelwa, L.N. & Steyn, J.M. 2020. Impact of climate change on yield and water use efficiencies of potato in different production regions of South Africa. *South African Journal of Plant and Soil* 37(3): 244-253. DOI: 10.1080/02571862.2020.1736345.

Franke, A.C. & Sekoboane, I.E. 2020. Exploring Variability in Resource Use Efficiencies Among Smallholder Potato Growers in South Africa. *Potato Research.* **DOI:** 10.1007/s11540-020-09473-x.

Janecke, B.B., Van Tol, J.J., Smit, I.P.J., Van Aardt, A.C., Riddell, E.S., Seaman, M.T. et al. 2020. Biotic and abiotic connections on a granitic catena: Framework for multidisciplinary research. *Koedoe* 62(2): a1600. DOI: 10.4102/ koedoe. v62i2.1600.

Mabuza, B.B. & Van Huyssteen, C.W. 2020. Effect of added organic substrates on reduction in a soil from the Maputaland Coastal Plain. *South African Journal of Plant Soil* 37(2): 108-115.

Mamera, M., Van Tol, J.J., Aghoghovwia, M.P. & Kotzé, E. 2020. Sensitivity and Calibration of the FT-IR Spectroscopy on Concentration of Heavy Metal Ions in River and Borehole Water Sources. *Applied Sciences* 10(21): 1-16. DOI: 10.3390/ app10217785.

Mamera, M., Van Tol, J.J., Aghoghovwia, M.P. & Mapetere, G. 2020. Community Faecal Management Strategies and Perceptions on Sludge Use in Agriculture. *International Journal of Environmental Research and Public Health*: 17. 1-21. DOI:10.3390/ijerph17114128.

Marais, A., Kotzé, E., Labuschagne, J., Visser, L. & Morris, C.D. 2020. Proposed adaptation of the KMnO4 oxidation method for determining active carbon for South African soils. *South African Journal of Science* 116(1/2):15-16.

Mararakanye, N., Le Roux, J.J. & Franke, A.C. 2020. Using satellite-based weather data as input to SWAT in a data poor catchment. *Physics and Chemistry of the Earth, Parts A/B/C* 117. DOI: 10.1016/j.pce.2020.102871.

Mashingaidze, N., Ekesa, B., Ndayisaba, C.P., Njukwe, E., Groot, J.C.J., Gwazane, M. & Vanlauwe, B. 2020. Participatory exploration of the heterogeneity in household socioeconomic, food and nutrition security status for the identification of nutrition-sensitive interventions in the Rwandan Highlands. *Frontiers in Sustainable Food Systems* 4: 47. DOI: 10.3389/ fsufs.2020.00047.

Mavunganidze, Z., Madakadze, I.C., Nyamangara, J., Mafongoya, P. & Mashingaidze, N. 2020. Weed community responses to soil type during transition to no-till practice on smallholder farms in Zimbabwe. *Weed Research* 60: 334-342. DOI: 10.1111/wre.12437.

Mengistu, A.G., Tesfuhuney, W.A., Woyessa, Y.E. & Van Rensburg, L.D. 2020. Analysis of the Spatio-Temporal Variability of Precipitation and Drought Intensity in an Arid Catchment in South Africa. *Climate* 8(6): 70. DOI: 10.3390/cli8060070.

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Ncoyi, K., Du Preez, C.C. & Kotzé, E. 2020. Comparison of soil phosphorus fractions after 37 years of wheat production under different management practices in a semi-arid climate. *South African Journal of Plant and Soil* 37(3):184-193.

Nebo, G.I., Manyevere, A., Araya, T. & Van Tol, J.J. 2020. Short-term impact of conservation agriculture on soil strength and saturated hydraulic conductivity in the South African semiarid areas. *Agriculture* 10(414). DOI: 10.3390/agriculture10090414.

Ngobeni, B., Masele, S., Mabelo, N.J., Van der Watt, E. & Manduna, I.T. 2020. Disruption of microbial cell morphology by *Buxus macowanii*. *BMC Complementary Medicine and Therapies* 20: 266. DOI: 10.1186/s12906-020-03049-5.

Parwarda, C., Magomani, M.I. & Van Tol, J.J, 2020. Impacts of different prescribed fire frequencies on selected soil chemical properties in a semi-arid savannah thornveld. *Cogent Environmental Science* 6(1):1868171. DOI:10.1080/23311843.2020.1868171.

Parwarda, C., Van Tol, J.J., Tibugari, H. & Mandumbu, R. 2020. Characterisation of soil physical properties and resistance to erosion in different areas of soil associations. *African Crop Science Journal* 28: 93-109. DOI: 10.4314/acsj.v28i1.8 .

Pretorius, M.L., Van Huyssteen, C.W., Brown, L.R., Grundling, A.T. & Downs C.T. 2020. A characterisation of wetland soil types on the Maputaland Coastal Plain. *South African Journal for Plant and Soil*. 37: 389-403.

Riddell, E., Nel, J., Van Tol, J., Fundisi, D., Jumbi, F., Van Niekerk, A. et al. 2020. Groundwater–surface water interactions in an ephemeral savanna catchment, Kruger National Park, *Koedoe* 62(2): a1583. DOI: 10.4102/koedoe. v62i2.1583.

Sandhage-Hofmann, A., Löffler, J., Kotzé, E., Weijers, S., Wingate, V., Wundram, D., Weihermüller, L., Pape, R., Du Preez, C.C. & Amelung, W. 2020. Woody encroachment and related soil properties in different tenure-based management systems of semiarid rangelands. *Geoderma* 372: 114399.

Seepamore, M.K., Du Preez, C.C. & Ceronio, G.M. 2020. Impact of long-term production management practices on wheat grain yield and quality components under a semi-arid climate. *South African Journal of Plant and Soil* 37: 194-201.

Tesfuhuney, W.A. & Mbeletshie. E.H. 2020. Place-based perceptions, resilience and adaptation to climate change by smallholder farmers in rural South Africa. *International Journal of Agricultural Research Innovation and Technology* 10(2): 116-127. DOI: 10.3329/ijarit.v10i2.51585.

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Van Tol, J.J., Van Zijl, G.M. & Julich, S. 2020. Importance of detail soil information for hydrological modelling in an urbanised environment. *Hydrology* 7: 34. DOI:10.3390/hydrology7020034.

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Verster, A.M., Liang, J.E., Rostal, M.K., Kemp, A., Brand, R.F., Anyamba, A., Cordel, C., Schall, R., Zwiegers, H., Paweska, J.T. & Karesh, W.B. 2020. Selected wetland soil properties correlate to Rift Valley fever livestock mortalities reported in 2009-10 in central South Africa. *PloS One*. 15(5): e0232481.

Books/Chapters in Books

Books

Van Huyssteen, C.W. 2020. *Relating the South African soil taxonomy to the World Reference Base for soil resources.* Bloemfontein, SunMedia.

Chapters in Books

Dos Anjos, L.H.C., Schad, P. & Van Huyssteen, C.A. 2020. Comparação da classificação de solos da XIII RCC no SiBCS e nos Sistemas Internacionais WRB e Soil Taxonomy. [Comparison of the XIII RCC soils classification in SiBCS and in the International Systems WRB and Soil Taxonomy.] In: *Guia de Campo da XIII Reunião Brasileira de Classificação e Correlação de Solos: RCC do Maranhão*. M.B. Silva, J.F. Lumbreras, V.Á. De Oliveira, M.R. Coelho (Eds). Embrapa Solos, Brazilia. Chapter 20.

Du Preez, C.C., Van Huyssteen, C.W., Kotze, E. & Van Tol, J.J., 2020. Ecosystem services in sustainable food systems: operational definitions, concepts and applications, definitions. In: *The Role of Ecosystem Services in Sustainable Food Systems.* Rusinamhodzi, L (Ed). Elsevier, United Kingdom. Chapter 2, 00. 17-42.

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Conference Contributions

Conference Papers/Posters

Du Plessis, C., Van Zijl, G.M., Van Tol, J.J. & Manyevere, A. 2020**.** *Mapping soil factors influencing erosion using machine learning algorithms in the T35D-E catchment in the Eastern Cape province*. Paper delivered at the Combined Congress of the Soil Science Society of South Africa, South African Society of Crop Production, South African Society of Horticultural Sciences and Southern African Weed Science Society, Bloemfontein, South Africa. 20-23 January 2020.

Esterhuizen, M. & Ceronio, G.M. 2020. *Influence of cold stress on the yield and quality of malting barley (Hordeum vulgare L.)*. Poster presented at the Combined Congress of the Soil Science Society of South Africa, South African Society of Crop Production, South African Society of Horticultural Sciences and Southern African Weed Science Society, Bloemfontein, South Africa. 20-23 January 2020.

Khetsha, Z.P., Sedibe, M.M., Pretorius, R.J. & Van der Watt, E. 2020. *Effects of synthetic amalgamated agricultural phytohormones on the changes in leaf trichome morphology and density, selected essential oil yield and quality parameters of simulated hail-damaged rose geranium (Pelargonium graveolens)*. Paper delivered at the Combined Congress of the Soil Science Society of South Africa, South African Society of Crop Production, South African Society of Horticultural Sciences and Southern African Weed Science Society, Bloemfontein, South Africa. 20-23 January 2020.

Kotzé, E. 2020. *Carbon and the farmer*. Paper delivered at the Conservation Agriculture Western Cape - Jack Human Conservation Agriculture Week, Stellenbosch, South Africa. 4 August 2020.

Mamera, M., Van Tol, J.J., Aghogovwia, M.P. & Kotze, E. 2020. *Sensitivity and calibration of the FT-IR spectroscopy on the concentration of heavy metal elements in solution*. Poster presented at the Combined Congress of the Soil Science Society of South Africa, South African Society of Crop Production, South African Society of Horticultural Sciences and Southern African Weed Science Society, Bloemfontein, South Africa. 20-23 January 2020.

Mashingaidze, N., Twomlow, S. & Madakadze, M. 2020. *Weed growth and crop yield responses to tillage and mulching under different crop rotation sequences in semi-arid conditions, Eastern Free State*. Paper delivered at the Combined Congress of the Soil Science Society of South Africa, South African Society of Crop Production, South African Society of Horticultural Sciences and Southern African Weed Science Society, Bloemfontein, South Africa. 20-23 January 2020.

Steyn, A.S. & Franke, A.C. 2020. *Decrease in total burned area despite an increase in climatological fire danger over the Central Grassland Biome of South Africa*. Paper delivered at the 55th Annual Congress of the Grassland Society of Southern Africa (GSSA-2020) (virtual). 30 June-3 July 2020.

Van der Watt, E., Allemann, J. & Mota, M.M., 2020. *Alleviation of residual herbicide phytotoxicity on dry beans using Brassinosteroids.* Paper delivered at the Combined Congress of the Soil Science Society of South Africa, South African Society of Crop Production, South African Society of Horticultural Sciences and Southern African Weed Science Society, Bloemfontein, South Africa. 20-23 January 2020.

Van Tol, J.J., Julich, S., Bouwer, D. & Riddell, E.S. 2020. *Hydropedological response in a Savannah hillslope under different precipitation regimes.* Paper delivered at the Combined Congress of the Soil Science Society of South Africa, South African Society of Crop Production, South African Society of Horticultural Sciences and Southern African Weed Science Society, Bloemfontein, South Africa. 20-23 January 2020.

Van Zijl, G.M., Bouwer, D., Van Tol, J.J., Le Roux, P.A.L. & Lorentz, S.A. *Saving urban infrastructure from water damage: Digital soil mapping combines with hydrological modelling to determine remedial actions*. Paper delivered at the Combined Congress of the Soil Science Society of South Africa, South African Society of Crop Production, South African Society of Horticultural Sciences and Southern African Weed Science Society, Bloemfontein, South Africa. 20-23 January 2020.

Van Zyl, G. & Ceronio, **G.M.** 2020. *Influence of planting techniques and maturity group on soya bean (Glycine max) yield in different agro-ecologies in the North Eastern Free State*. Paper delivered or Poster presented at the Combined Congress of the Soil Science Society of South Africa, South African Society of Crop Production, South African Society of Horticultural Sciences and Southern African Weed Science Society, Bloemfontein, South Africa. 20-23 January 2020.

Technical Reports

Keestra, S.D., Franke, A.C., Wosten, H. & Mashingaidze, N. 2020. *Potential role of Conservation Agriculture in South Africa for carbon sequestration for climate mitigation: a provisional research agenda*. Report to Wageningen Environmental Research - Report 3024. 52 pp.

STAFF (2020)

Head of Department: Prof AC Franke

Professor: Prof CW van Huyssteen
Associate Professors: Prof AC Franke and Prof JJ van Tol
Senior Lecturers: Dr J Barnard, Dr G Ceronio, Dr G Coetzer, Dr E Kotze, Dr N Mashingaidze and Dr E van der Watt
Lecturers: Dr AP Aghoghovwia, Mrs VN Mathinya, Dr S Steyn, Dr W Tesfuhuney, Mr PC Tharaga and Mrs L de Wet
Associate Researcher: Prof CC du Preez
Programme Director: Dr E van der Watt
Senior Assistant Officers: Ms R Etzebeth, Ms A Moffat and Ms D Terblanche,
Senior Officer: Ms L Henning
Officer: Ms N Radebe and Mr B Tshabang
Messenger: Mr E Moeti
Cleaner: Ms T Mboleli



DEPARTMENT OF

SUSTAINABLE FOOD SYSTEMS AND DEVELOPMENT

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OVERVIEW OF 2020

The year 2020 marked an unprecedented one on a global level, highlighting various important factors. Faced with the challenges of the COVID-19 pandemic, food security has once again been prominent and provided a challenge for human societies. Nations increasingly face and experience the consequences of this relentless global issue. Sustainable food production depends on a complex food system composed of a range of stakeholders and activities involved in the production, processing, distribution, consumption, and disposal of food products that originate from agriculture. The production of food, preparation of food, 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.

The UFS Faculty of Natural and Agricultural Sciences has been home to two separate academic entities that could potentially be major contributors to studies on food systems – the Department of Consumer Studies (with expertise related to food processing, marketing and consumption) and the Centre for Sustainable Agriculture, Rural Development and Extension (CENSARDE), which studies sustainable farming practices to establish sustainable animal and crop production. These two academic entities create a natural link that provides the potential for training, development and research from a food systems perspective.

Against this background the Department of Sustainable Food Systems and Development was formed, combining these two former entities. The Department will focus on the development of sustainable food systems, developing leading research and capacity, promoting leadership, and creating partnerships to benefit the local and national agribusiness sector, thus positioning the Faculty and the UFS as a fundamental role-player to research challenges that impact on sustainable food development in Africa.

The successful implementation in 2019 of the postgraduate qualifications in the former CENSARDE – the Postgraduate Diploma in Sustainable Agriculture (PGDipSA) and the Master of Sustainable Agriculture (MSA) – contributed to the pleasing number of enrolments and successful graduates in 2020. With the continuous dedication of our academic and support service staff, we were able switch to online learning platforms with ease and were still able to deliver 54 PGDip and 79 master's graduates in the 2020 academic year.

ACHIEVEMENTS

Staff Achievements

Ms Anathi Makamane was appointed to the International Food and Agribusiness Management Association's (IFAMA) Young Board of Directors.

Dr Hlamalani Ngwenya acted as process facilitator for the Food and Agriculture Organization (FAO) and International Food Policy Research Institute (IFPRI) global study on Agriculture Human Capital Investment Study (AHCI) conducted in nine countries.

Student Achievements

Ms Esmaré Olivier won the Free State Woman's Agricultural Union Prize for the final-year student in Consumer Science with the best performance through all the years of study.

Ms Calista von Wielligh won the Beth Erlank Prize for the final-year student in Consumer Science with the best performance in Clothing.

A team of students from the UFS won the IFAMA International Case Study Competition, competing with students from 17 other countries, including India, Australia, and Canada. The UFS team members in the category for Graduates/Early Career Professionals were Carien Denner, Alina Ntsiapane and Andries Strauss (from the former CENSARDE), and Michelle Marais from the Department of Agricultural Economics. They submitted an essay and video addressing the challenge 'How can the sustainability, productivity, and market access of smallholder sugar cane farmers be improved?'. Dr Jan Swanepoel, Senior Lecturer in the Department, was of the opinion that the personal approach to the problem taken by the students, and their focus on people, contributed to their success.



The UFS team that won the IFAMA International Case Study Competition, from the left, Carien Denner, Alina Ntsiapane, Andries Strauss and Michelle Marais

TEACHING AND LEARNING

Despite the COVID-19 pandemic and lockdown restrictions, staff successfully adapted to virtual learning in a manner that allowed continuation without disruption. We managed to increase the number of enrolled and graduating students during the 2020 academic year, with a pass rate above 85% in all undergraduate modules.

RESEARCH AND INNOVATION

In 2020, research in the Department focused on the following key areas.

Ensuring sustainable food security through the reduction of food waste

This area of research is closely aligned with Sustainable Development Goal (SDG) 12.3. In South Africa, 26% of the population regularly experience starvation, whilst another 28.3% are at risk of experiencing starvation. In a world that faces both scarcities of natural resources and extreme poverty, research on food waste prevention is essential. Food waste is a challenge that not only relates to food security but also to environmental issues, such as greenhouse gas emissions along the food supply chain, and waste disposal. There has also been expanding interest in establishing food waste interception and recovery programmes throughout the world. South Africa needs location and culture-specific solutions and interventions, based on our diversity. Limited research exists on the drivers of household food waste in relation to consumers' perceptions, attitudes and behaviour in South Africa.

Evaluating coping strategies, and government support to developing intervention programmes to improve food insecurity and vulnerability

Research was focused on assisting to identify intervention solutions which can support local governments in future policy drafting and training of extension officers, as well as developing platforms for consumer information dissemination, thereby impacting food security positively on household and regional level. This research is in line with SDG 2.3 and 12.3. The neighbouring countries of Lesotho and Eswatini were also part of the initiatives.

In Lesotho we were involved with the oyster mushroom cultivation initiative, funded by an external donor in cooperation with the Lesotho Government. The researchers determined the influence of the initiative on access and availability of the involved households. The information obtained will be used for consumer acceptability profiles, followed by product development to create markets for the cultivators, consequently increasing incomes.

In Eswatini, research focused on intervention solutions to increase food security among rural households in the Lubombo region. This brought new insights to coping strategies of households, as well as inputs and assistance needed from government. It further elucidated the situation of relief food aid and the role it plays in the livelihoods of the households.

Determining the link between food insecurity and malnutrition and identifying possible areas of concern to policy makers

Malnourishment (i.e. stunting, wasting, underweight) is prominent in children. Moreover, nutrient inadequacy may compromise the structural development of the brain and the child's ability to succeed at school. Although studies have been conducted on food (in)security in rural areas, few studies have investigated the relationship between food (in)security and malnutrition of children, especially in urban informal settlements. Urbanisation is occurring at a rapid pace, with the increase in people living in the cities occurring mainly in developing countries. Although migration to urban areas happens in anticipation of access to better employment opportunities and healthcare, the result is often high levels of food insecurity and poor nutrition, especially among children. Therefore, this 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.

Textile sustainability and product development

The textile industry is one of the most polluting industries. Much of this pollution is not only caused by the manufacture of textile fibres, but also the processing and consumer care of the articles.

Research was focused on sustainable processing, which includes scouring and dyeing of locally (Free State) produced wool. In the course of the research, electrochemically activated water, catholyte, will be used as an environmentally friendly alternative to detergents, to scour the wool. In addition, lower temperatures will be used to save energy, and the use of natural dye, in the form of brown onion peels, will be examined.

Another project will investigate how wool from Dorper sheep, which is unsuitable for the wool market, can be used to create window covers to provide insulation from extreme winter weather conditions. If successful, the project could be used to empower communities.

Within certain sectors of the textile industry, a social and moral conundrum exists related to animal cruelty; this is particularly true in the leather sector. For centuries, animal skins have been used to produce products ranging from upholstery and furniture to high-end clothing, jackets, shoes, handbags and accessories. This research will explore the possibility of bacterial cellulose as a potential textile. It is grown by fermenting tea leaves and sugar, together with a starter culture, known as a symbiotic colony of bacteria and yeast (SCOBY). Performance properties will be evaluated, as well as consumer acceptance of an item of apparel.

Recent trends in textile engineering have emphasised the development of functional textiles, which are user-requirement specific and engineered to meet the performance requirements of the user under extreme conditions. The complexity and interrelationship of the mechanisms that play a role in thermal and moisture management should not be underestimated when considering the evaluation or design of textile fabrics. For centuries, mohair has been regarded as one of the most luxurious and superior fibres known to man, and mohair products are used in a range of household and apparel applications. In many of these applications, although the thermal conductivity and moisture management properties of the fabrics play an important role in ensuring their functionality, there is little to no literature or evidence to support this. This research will focus on determining the thermo-physiological comfort properties of fabrics containing mohair.

Product development

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.

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.

There is a rising rate of undernourishment in developing and underdeveloped countries, and South Africa is no exception. 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. 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. The plants, including *Carpobrutus edulis* and *Portulacaria Afra,* have been known to be edible plants, yet no research is available on the best varieties for optimal quality, preferred cooking methods, their acceptability to consumers and the nutrient content.

Effect of COVID-19 on consumer behaviour

Dr Jana Vermaas, Dr Natasha Cronjé, Dr Albie du Toit, Ms Petro Swart and Ms Kirsty Green formed a research action team to determine the effect of the Level 5-lockdown on purchase behaviour and food preparation.

ENGAGED SCHOLARSHIP

COVID-19 and the lockdown forced all our staff and students to become more creative in the way we approach and attempt to reach our outcomes. With this in mind, the final-year Consumer Science students planned and developed a video related to food security. The videos were aimed at the student community and were made available on the Blackboard success portal 'Eat & Succeed'. The videos focused specifically on preservation and fresh ideas on how to buy in bulk and preserve. As food security is a major concern among students, any information assisting students in remaining food secure is welcomed.

The UFS Food Environment Project continued to implement the 'UFS Community Garden Project' – a vegetable production and training programme. Due to the stakeholder's dedication, planning and fundraising efforts, two 300m² tunnels were erected on the Bloemfontein Campus, next to 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), while seeds and seedlings were sponsored by Mr Herman du Plessis from Sakata Seeds, and Mr Deon Coetzee from Kwaggafontein Nursery. UFS Facilities management, 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.



Food tunnels

Together, the two tunnels provide shelter for 40 vegetable boxes. Each residence on the Bloemfontein Campus was allocated one vegetable box, and 80 students from each participating residence received training and were assisted with planting one type of vegetable crop (beetroot, broccoli, carrots, cabbage, cauliflower, kale, or Swiss chard). The Department for Sustainable Food Systems and Development embarked on planning to expand the vegetable production system by establishing an additional two tunnels on the UFS experimental farm, Paradys, in 2021.



With produce from the food tunnels, from the left, JW Swanepoel, Gilbert Makanda, Paballo Mphahlele, Alina Ntsiapane and Teddy Sibiya (February 2020)

Members of the Department were also involved in providing service to the academic community by reviewing articles – Dr Jana Vermaas for the *Journal of Consumer Science*, Dr Natasha Cronjé the *Journal of Cleaner Production* and *Journal of Consumer Sciences* and Dr Alba du Toit for *PLoS ONE*, the *Journal of Culinary Science and Technology* and *CyTA – Journal of Food*.

NATIONAL AND INTERNATIONAL COLLABORATION

Although most of the planned training could not be undertaken due to COVID-19 related restrictions, the stakeholders in the Regional Universities Forum for Capacity Building in Agriculture (RUFORUM) project managed to keep many aspects of the project on track in 2020.

A flock of 100 pregnant Dohne Merino ewes were purchased from a commercial farmer. Master's student, Bonga Madyibi, used these sheep as subjects in his clinical trials on the prevalence of wire worm. Further research on the lambing-cycle was concluded during October and November 2020. In November, small wool farmers in the region received training in wool classing, and sheep handling and management.



RUFORUM Community project

The wool was utilised for research purposes, as well as training of members of the community in wool processing, entrepreneurship and value adding. Community members were eager to show us their completed products, and this has motivated other community members to also learn to knit to produce different types of wool products to create an income for themselves. We look forward to selling products and generating a profit in the coming year.



Products from the RUFORUM Community project



Products from the RUFORUM Community project

The Agribusiness Transformation Programme, supported by the partnership between the UFS and Standard Bank, focused on assisting, training and mentoring 25 farmers to become productive and well-functioning agribusiness contributors that provide solutions for the much-needed challenges in food security, job creation, and the development of agricultural products. The programme is an initiative of UFS, Standard Bank and the Free State Department of Agriculture and Rural Development (FSDARD). The impact of the programme is substantial, with the possibility of developing a model that will be replicated in the rest of South Africa and Africa.

POSTGRADUATE STUDENTS

Seventy-nine (79) students graduated in 2020 with the structured Master of Sustainable Agriculture (MSA), while a further 54 students graduated with the Postgraduate Diploma in Sustainable Agriculture (PGDipSA).

Seven students graduated with the BSc Hons (Consumer Science) and six students obtained MSc Consumer Science degrees – O Mpemba, V Sigwela, L Mathee, M Chenene, N Nkoko, N Jooste.

PhD degrees were conferred on the following four candidates in 2020:

Manenzhe, Teboho Derick
Thesis: Developing a Sustainable Farm Management model for Land Reform in Mpumulanga, South Africa
Promoter: Prof E Zwane and Prof J van Niekerk (co-promoter)

Bese, David Fundisile
Thesis: Sustainable Farmer livelihoods and enhancement of Food Security in Mbashe Municipality, Eastern Province, South Africa
Promoter: Prof E Zwane

Kuipa, Prince Jonathan Tutsirai
Thesis: The Agricultural Financing Gap in Zimbabwe: Rationing, sustainable credit access and participation in Rural Financial markets
Promoter: Dr D Ncube and Prof J van Niekerk (co-promoter)

Pheto-Moeti, Mabokang Baatshwana
Thesis: The meaning and symbolism of cultural dress practices in Lesotho
Promoter: Dr J Vermaas and Prof A Pelser (co-promoter)

STAFF MATTERS

Dr Alba du Toit was appointed as a permanent Senior Lecturer for Food and Product Development in November 2020.

Mr Martin Rost was awarded his master's degree in Dairy Technology, a highly specialised qualification in dairy management; in the process he gained years of focused and intensive experience in dairy production, management and distribution. Mr Rost is Master Cheese maker, producing specialised, artisanal made, upmarket German soft and semi-soft cheeses, both natural and infused with organic herbs, as well as natural yoghurts. His cheese business is fully operational and located on the Bloemfontein Campus.

Ms Petro Swart retired at the end of 2020 after many years of teaching and mentoring. She will continue on a contract appointment to assist with this transition period.

RESEARCH OUTPUTS

Research Articles

Adelabu, D.B., Clark, V.R. & Bredenhand, E. 2020. Potential for Sustainable Mountain Farming: Challenges and Prospects for Sustainable Smallholder Farming in the Maloti-Drakensberg Mountains. *Journal of Mountain Research and Development* 40(1): A1-A11. DOI: 10.1659. MRD-JOURNAL-D-19-00058.1.

Bothma, C., Cronjé, N., Koen, M. & Hugo, A. 2020. Product development and consumer acceptability of soup made from *Clarias gariepinus*. *CYTA Journal of Food* 18(1): 572-579.

De Wit, M., Du Toit, A., Osthoff, G. & Hugo, A. 2020. Antioxidant content, capacity and retention in fresh and processed cactus pear (*Opuntia ficus-indica* and *O. robusta*) fruit peels from different fruit-coloured cultivars. *Frontiers in Sustainable Food Systems* **4: 133.**

Du Toit, A., De Wit, M., Fouché, H., Venter, S. & Hugo, A. 2020. Relationship between weather conditions and the physiochemical characteristics of cladodes and mucilage from two cactus pear species *PLoS ONE* **15(8):** e0237517. DOI: 10.1371/journal.pone.0237517**.**

Kau, J.S., Mmbengwa, V.M. & Swanepoel, J.W. 2020. Small-scale Citrus Farming among Selected Countries: Determinants for Exports and Production. *Journal of Human Ecology* 72(1-3): 199-210.

Maziya, M., Tirivanhu, P., Kajombo, R.J. & Gumede, N.A. 2020. Gender disparities in poverty among smallholder livestock farmers in South Africa. *South African Journal of Agricultural Extension* 48(2). DOI: 10.17159/2413-3221/2020/v48n2a535.

Ndleleni, N.W., Malebana, I.M.M., Du Toit, C.J.L., Nephawe, K.A., Meeske, R. & Nkosi, B.D. 2020. Effects of silage sealing films on fermentation dynamics of ensiled maize and nutrient utilization by Damara rams. *South African Journal of Animal Science* 50(1): 17-25.

Ndwambi, K., Nesamvuni, A.E., Mpandeli, N.S., Tshikolomo, K.A. & Van Niekerk, J.A. 2020. GIS based Land Suitability Modelling for the Selected Subtropical Fruit-Case of Limpopo Province, South Africa. *South African Journal of Human Ecology* 71(1-3): 49-61.

Nkosi, B.D., Meeske, R., Muya, M.C., Langa, T.T., Thomas, R.S., Malebana, I.M., Motiang, M.D. & Van Niekerk, J.A. 2020. Microbial additives affect silage quality and ruminal dry matter degradability of avocado (*Persia Americana*) pulp silage. *South African Journal of Animal Science* 49(6).

Nkosi, B.D., Seshoka, M.L., Fourie, P.J., Kanengoni, A.T., Malebana, I.M.M. & Thomas, R.S. 2020. Dietary enzyme addition on the growth performance and carcass characteristics of pigs fed diets containing avocado oil cake silage. *Journal of Tropical Animal Health and Production* 52: 2945-2953.

Senda, T.S., Kiker, G.A., Masikati, P.S.T, Chirima, A. & Van Niekerk J.A. 2020. Modelling Climate Change Impacts on Rangeland Productivity and Livestock Population Dynamics in Nkayi District, Zimbabwe. *Applied Science* 10(7): 2330.

Thomas, R.S., Malebana, I.M., Mpanza, T.D.E., Langa, T.T. & Nkosi, B.D. 2020. Availability of agro-industrial by-product in the Cape provinces of South Africa and a review on their potential uses in animal feed. *Journal of Food Measurement and Characterization* 13: 2347-2356.

Tinta, N., Steyn, H. & Vermaas, J. 2020. Barriers experienced by people with disabilities participating in income-generating activities. A case of a sheltered workshop in Bloemfontein, South Africa. *African Journal of Disability* 9: a662. DOI: 10.4102/ajod.v9i0.662.

Van Koppen, B., Hofstetter, M., Nesamvuni, A.E. & Chiluwe, Q. 2020. Integrated management of multiple water sources for multiple uses: rural communities in Limpopo Province, South Africa. Global Climate Change and Environmental Policy. Agricultural Perspectives. *Water SA* 46(1): 1-11.

Van Niekerk, J.A., Manenzhe, T.D. & Zwane, E.M. 2020. Performance and sustainability of commercial cooperatives and sole proprietorships citrus farms in Mpumalanga Province, South Africa. *South African Journal of Agricultural Extension* 48(1): 70-83.

Chapters in Books

Ngwenya, H. & Khunou, J. 2020. Agriculture and Food Security. In: *COVID -19 Rapid Emergency Needs Assessment for the most vulnerable groups report***.** UNDP South Africa. pp 90-102.

STAFF (2020)

Head of Department: Prof JA van Niekerk

Associate Professor: Prof JA van Niekerk
Senior Lecturers: Dr A du Toit and Dr JW Swanepoel
Lecturers/Researchers (Permanent): Dr N Cronjé, Dr HJ Ngwenya, Ms N Tinta, Dr JF Vermaas and Dr I van der Merwe
Lecturers/Researchers (Part-time/Affiliated): Dr JH Barnard, Ms K Green, Dr E Kotze, Mr L Kruger, Ms A Makamane, Dr P Malan, Prof E Nesamvuni, Prof F Neser, Dr D Nkosi, Ms K Thobejane Mr J van den Berg, Prof J van Rooyen, Mrs L von Maltitz and Dr E Zwane
Junior Lecturers: Ms A Makamane and Ms PZ Swart
Lecturer (Contract/Part-time): Ms F van Tonder
Programme Director: Dr I van der Merwe
Senior Officers: Ms A Calitz, Ms G Green and Ms D Jacobs
Officers: Ms R Coetzee and Ms C Denner
Senior Assistant Officer: Mrs W van der Walt
NRF Intern: Ms K Matlhoko

BUILDING
SCIENCES

DEPARTMENT OF ARCHITECTURE

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OVERVIEW OF 2020

The 2020 academic year presented many unique challenges due to the COVID-19 pandemic. However, through challenges such as hard lockdown, reduced contact lectures, meetings via Zoom, cancelled events, and limited international travel, we nevertheless come out of 2020 with significant achievements.

ACHIEVEMENTS

Staff Achievements

Martie Bitzer was granted study leave from January to the end of July for her PhD with Design titled 'Ecdysis: Shedding Skin as Performative Agent in the Negotiation of New Transitions for Architecture and Art'. She worked specifically on the development of architecture and art in the form of five pavilion structures designed on the above topic. Her thesis deals with the emancipation of the enclosure in architecture, which follow performative acts detected in early definitions and re-definitions of enclosed spaces or 'walls' viewed as the skin of buildings. Martie made good progress and hopes to submit her thesis at the end of 2021.

Mpendulo Quinton Myeni, was granted special leave in February 2020 to attend the International Film Festival, 'Pan African Film Festival', in Los Angeles. There he won the prestigious IamAfrican Jury award for his film *Eyelash*.



Mpendulo Myeni

In March 2020, Dr Hendrik Auret and David van der Merwe's intended paper 'Architecture as an art of care in historically marginalised communities: the case of Heidedal, South Africa', was accepted for presentation at the 27th World Congress of the International Union of Architects (UIA) 2020 in Rio de Janeiro, Brazil. Unfortunately, due to the COVID-19 pandemic the conference was postponed to July 2021.

Prof Noble's new book, a peer-reviewed monograph titled *The Architecture of Peter Rich: conversations with Africa*, was published by Lund Humphries, in October. The book, which has 184 pages, 20 high quality colour plates, some 100 black and white illustrations, with commendation by Juhani Pallasmaa (Professor Emeritus, Helsinki) and a forward by BV Doshi (former Pritzker Prize winner), is the culmination of five years of writing and research.

Prof Noble was invited to write a foreword for Pieter Mathews' new book, *Musings: architecture, photography, essays, and art on the works of Mathews and Associates Architects*.

Student Achievements

Architecture student, Nicola Smuts, received two awards for her academic achievements in 2019 at the Faculty of Natural Agricultural Sciences, Virtual Academic Awards Ceremony held in November 2020. She won the South African Institute of Architects (SAIA) best third-year student, and the Ora Joubert Theory Book prize.

Architecture students, Nicki Vollmer, Suzani van der Merwe and Dehan Kassimatis were placed winner, 1st runner-up and 2nd runner-up respectively for the Free State Corobrik Student of the Year Regional Awards.



Suzani van der Merwe



Nicki Vollmer



Dehan Kassimatis

Jaco van der Watt, received the Best Use of Clay Masonry award at the Free State Corobrik Student of the Year Regional Awards.



Jaco van der Watt

TEACHING AND LEARNING

Digital Teaching

2020 was a challenging year for all, due to the need for a rapid transition to digital teaching. However, by year-end our external examiners and staff were delighted with the outcome, with pass rates and quality of work that appear to be on par with previous years.

We are especially proud of our March (professional) students who excelled, in what can only be described as a highly successful year, without any trace of a drop in standards.

In total, 25 March (professional) students started the year and only one discontinued his studies due to personal reasons. One Recognition of Prior Learning (RPL) student would like to extend his studies into 2021, but the rest submitted their master's work, and only one failed.

We held face-to-face examinations in December 2020 with an esteemed panel of external examiners. Five students obtained distinctions in all three of their main subjects. All in all, seven students managed to receive design distinctions, seven with distinctions in construction, and eight in theory.

Curriculum Development

Prof Noble led a series of curriculum development workshops with academic staff in the Department, in support of the new undergraduate modules in the history and theory of architecture. These new modules have been introduced with the intention of integrating history and theory (formerly taught separately) and to address issues of decolonisation.

Further curriculum development workshops were held in support of the studio-based majors, in architectural design and construction (undergraduate and postgraduate), in support of our South African Council for the Architectural Profession (SACAP) assessment year of 2022, which is evaluated on the basis of the work of 2021.

RESEARCH AND INNOVATION

The new PhD with Design programme was supported by two research symposia, the first from 25 to 28 February, and an all-digital symposium from 11 to 13 August. We were pleased to welcome Dr Urs Bette from the University of Adelaide, who joined us for the first symposium, giving the keynote address and who was a guest critic to some 17 PhD presentations. The visit by Dr Bette, who attended both symposia, has helped cement collaborative ties between our respective design-based PhD programmes, at the University of Adelaide and the UFS.

Also attending both symposia were guest critics Dr Magda Minguzzi and from Gqeberha (formerly Port Elizabeth).

Associate Prof Gerhard Bosman was awarded funds from the Central Research Fund (CRF) for his new research project 'Community care and engagement for culturally significant architecture in the Free State Province', which will be run in collaboration with Dr Anita Venter (Centre for Development Support) and David van der Merwe (Architecture).

The 2020 Creative Research submissions to the Department of Higher Education and Training (DHET), were open for the working period 2017 to 2019. No less than 11 creative research submissions from candidates in the PhD with Design programme were submitted for peer review. Prof Noble and Hendrik Auret facilitated these submissions, coaching the respective PhD candidates and helping to write the crucial 'author's statement' about the work. Ten of the submissions have been supported by positive peer reviews (details listed under Creative Output section of Research Outputs of this report) and will now be forwarded to a national committee for the decisions regarding the award of subsidy.

NATIONAL AND INTERNATIONAL COLLABORATION

COVID-19 forced universities worldwide to embrace online symposia, and our PhD programme benefited from this. On 16 May, and again on 17 October, Prof Noble was invited as a guest critic at the Design-based PhD Symposium at University of Adelaide, to which all our PhD candidates were invited. We reciprocated by inviting guest critics Dr Jo Russell-Clarke, Dr Tanya Court and Dr Urs Bette from the University of Adelaide, to contribute to our second PhD symposium, held from 11 to 13 August.

Our PhD cohort was also invited to attend the Practise-based Research Symposium at RMIT, Melbourne, from 3 to 5 June. We hope to maintain these significant collaborations in the future, helping to internationalise our new design-based PhD programme.

In September, Prof Noble was invited to deliver two guest lectures to the honours year architectural theory students at the Nelson Mandela University (NMU) on his earlier book *African Identity in Post-Apartheid public architecture: white skin, black mask*s.

In October, Prof Noble was invited to deliver a lecture about his new book – *The Architecture of Peter Rich: conversations with Africa* – at the University of the Witwatersrand, to the honours year architectural theory students.

POSTGRADUATE STUDENTS

Henry Pretorius completed his design-based research master's degree, supervised by Prof Noble, titled 'Extrapolating the Unseen – above, below and beyond the surface of my sketchbooks pages'. The oral examination is scheduled for January 2021.

STAFF MATTERS

Mr Phadi Mabe joined the academic staff, as a full-time lecturer, from mid-2020. Phadi intends to enrol for a PhD, with specialisation in Design, in 2021.

RESEARCH OUTPUTS

Research Articles

Auret, H.A. 2020. Care, Place and the Sophia Gray Laureates: pursuing architecture as a focal practice. *Architecture SA* 98: 28-33.

Auret, H.A. 2020. Drawing on "interfinities": a reflection on Jonathan Jacobson's book and Sophia Gray Exhibition. *Architecture SA* 98: 8-11.

Auret, H.A. 2020. The responsibility of architecture: beauty, justice and the call of care. *Acta Theologica* 40(29): 152-175.

Noble, J.A. 2020. Mediation and materiality at the South African embassy in Ethiopia. *South African Journal of Art History* 35(2): 1-18.

Books

Noble, J.A. 2020. *The Architecture of Peter Rich: conversations with Africa*. London: Lund Humphries.

Chapters in Books

Peters, W. 2020. Hans Hallen's 1960s medium-rise apartment buildings on Durban's Berea. In: *Hans Hallen. Selected 1960s projects in Durban*. S. Bodei (Ed). Melfi (Italy), Casa editione Libria. pp 67-108.

Conference Contributions

Conference Paper/Posters

Bosman, G. 2020. *Change for contemporary earth construction: a second paradigm shift*. Paper delivered at the Archtheo '20 XIV International Theory and History of Architecture Conference, Istanbul, Turkey (Online). 6 November 2020.

Creative Output

Dodd, H. & Noble, J.A. 2018 (reporting year 2020). Building C002: Moroka Hall of Residence, Dining Hall, Lecture Rooms and Offices. Sol Plaatje University.

Dodd, H. & Noble, J.A. 2019 (reporting year 2020). Tower intercity Johannesburg, Re-imagining Tower on Main to include EQUITY, DIVERSITY and DENSITY in the inner city of Johannesburg.

Dodd, H. & Noble, J.A. 2019 (reporting year 2020). Motif Exhibit, Newtown Johannesburg.

Jacobson, J. & Noble, J.A. 2019 (reporting year 2020). Sophia Gray Memorial Lecture and Exhibition, Architecture and Landscape, Oliewenhuis Bloemfontein.

Jacobson, J. & Noble, J.A. 2019 (reporting year 2020). Sophia Gray Memorial Lecture and Exhibition, Archicomix. Oliewenhuis Bloemfontein.

Mathews, P. & Auret, H.A. 2017 (reporting year 2020). Architectural Adhocism in South Africa: Oaktree Studio, Pretoria.

Mathews, P. & Auret, H.A. 2017 (reporting year 2020). Guerrilla re-scripting of everyday places: Saadjies Art Collection and Nomadic Exhibition.

Mathews, P. & Auret, H.A. 2017 (reporting year 2020). Poetry and pragmatism in architecture: Afrikaans Hoer Seunskool Art Campus, Pretoria.

Mathews, P. & Auret, H.A. 2018 (reporting year 2020). Interdisciplinary poetic densification: Stand van Poësie/Poetic Stand Bike Stand, Pniel, Western Cape.

STAFF (2020)

Head of Department: Prof JA Noble

Professor: Prof JA Noble
Associate Professor: Prof G Bosman
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, Mr H Raubenheimer and Mr ZG Wessels
Junior Lecturers: Mr JI Olivier and Mr DPG van der Merwe
Contract Lecturers: Mr J Mitchell, Mr V Moutzouris, Mrs H Nel, Mrs K Salzmann-McDonald, Prof JD Smit and Mrs P Smit
Research Associate: Ms MY Le Roux
Research Fellow: Prof WH Peters
Secretary: Mrs Y Pretorius
Assistant Officer - Professional Services: Mr MQ Myeni
Assistant Officers: Mrs Z Bronkhorst and Mr LT Keswa
Messenger: Ms TJ Mohatlane

DEPARTMENT OF

QUANTITY SURVEYING AND CONSTRUCTION MANAGEMENT

CONTACT DETAILS

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OVERVIEW OF 2020

The year 2020 started off well for the Department with its student registrations. However, as was experienced by the entire institution, nationally and globally, the COVID-19 pandemic and subsequent lockdowns brought about many challenges for students and staff alike. The situation called for flexibility and resilience. The willingness and commitment of staff and students to adapt and carry on in the midst of unprecedented challenges, was commendable. The teaching and learning modes had to be adapted, including the assessment plans and strategies. Staff provided continued support and learning opportunities beyond their call of duty. It was not easy to manage remotely, but a strong team spirit prevailed and the academic project was completed successfully overall.

The Department also attended to the finalisation of its new undergraduate programme application, and subsequently a BSc Construction Economics and Management degree programme was approved for implementation. The new programme opens it doors to its first cohort of students in 2021.

Despite the disruptions as a result of the pandemic, the research outputs showed a steady improvement and efforts were made to maintain an upward trend.

The Department is grateful to its team of dedicated staff and students for their collaborative efforts in making 2020 a productive year.



Quantity Surveying and Construction Management staff members



ACHIEVEMENTS

Staff Achievements

Mr Pierre Oosthuizen reviewed the 'SA Akademie se Bouwoordeboek' and completed the updating of this bilingual building dictionary. The year 2020 marked 60 years after the first publication and 30 years since the previous print of this work. This 2020 publication edition contains more than 1 480 additional Afrikaans and English building terms. The Dictionary will be extremely valuable to professionals, practitioners, academics and students in the built environment. A must-have resource on their bookshelves!



Pierre Oosthuizen

Student Achievements

The Department is proud of the following students who received recognition at the annual Faculty prize-giving:

- Miss Y de Beer: Best first-year student in the BSc (Quantity Surveying) programme
- Mr M Engelbrecht: Best second-year student in the BSc (Quantity Surveying) programme
- Mr C Grivas: Best third-year student in the BSc (Quantity Surveying) programme
- Mr A Stoman: Best fourth-year student in the BSc Honours (Quantity Surveying) programme
- Miss Y de Beer: Best all-round student in any year of study (Quantity Surveying)
- Ms Z Stapelberg: Best second-year student in the BSc (Construction Management) programme
- Ms M Karsten: Best student in Quantity Surveying Research Report

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 which can be followed in both the public and private sectors, and not limited to the construction sector.

The Department offers the BSc Construction Management and BSc Quantity Surveying undergraduate degrees for both residential (full-time) and compact learning (part-time).

The number of students enrolled in these undergraduate programmes programmes was:

- BSc Construction Management and BSc Quantity Surveying residential (full-time): 100
- BSc Construction Management and BSc Quantity Surveying compact learning (part-time): 31

RESEARCH AND INNOVATION

Three research groups funded by the Faculty Central Research Fund grants continued their work throughout year. The research focused on three main areas – Innovation (4IR) in the Construction Industry, Public Sector Construction Project Delivery and Sustainable Human Settlement. The empirical studies were hampered by the national lockdown, but the respective project plans have been revised and the various research groups are progressing with their research. Some of the findings of the studies, particularly the research work on sustainable human settlements, were disseminated through two journal publications in 2020.

ENGAGED SCHOLARSHIP

The Department of Quantity Surveying and Construction Management was approached to provide project management advice to the Free State Department of Health's (FSDoH) COVID-19 project team. Due to their project management expertise, Mr Henry Deacon and Mr Hendri du Plessis were identified by the Department to facilitate the process of identifying the most realistic and strategic ways to assist the FSDoH, which already had multiple teams of specialists assisting in planning and preparing for the yet unknown challenges ahead. Through this process, the most efficient way to assist the FSDoH was identified as being providing support to the Office Director, who served as project coordinator, with overall project coordination advice. Communication and risk identification were highlighted as the most important facets to focus on. Subsequently, a coordination plan (as a working document) was developed to assist with the communication workflow and coordination within the FSDoH. Through this coordination plan, certain gaps could be identified and the contribution of work streams and their respective champions within the COVID-19 project team could be enhanced. The purpose of the plan was to assist the project coordinator in making sense of the various stakeholders' interactions, as well as to assist with risk management and scenario planning.

Prof Kahilu Kajimo-Shakantu was appointed as one of the two external reviewers to assess the development, performance, future perspectives and sustainability of the Urban Real Estate Research Unit (URERU) at the University of Cape Town (UCT), for re-accreditation purposes. URERU is housed in the Department of Construction Economics and Management in the Faculty of Engineering and the Built Environment. Its main focus areas include urban development and management, property market dynamics and trends, African real estate markets, and real estate investment and finance. Prof Kajimo-Shakantu, served as the national reviewer while Prof Carsten Lausberg from Nürtingen-Geislingen University, Germany, was the international reviewer. The appointment reflected external institutional confidence and recognition of the knowledge, competence and experience of the reviewers in such processes by the UCT Review Committee.

Staff members of the Department also continued to engage with various other institutions in the country which offer built environment programmes, serving as external examiners and external moderators for dissertations and theses as well as modules and programmes related to Property, Construction Management and Quantity Surveying disciplines.

POSTGRADUATE STUDENTS

The Department offers postgraduate degrees at honours, master's and doctoral levels, majoring in Quantity Surveying and Construction Management. It also offers masters by research and PhD in Property Science. Included in our postgraduate programmes is a master's by course work degree in Land and Property Development Management (MLPM), specialising in Project Management or Property Valuation respectively.

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

- BSc Honours: 98
- MLPM: 49 (for both specialisations)
- MSc: 16
- PhD: 7

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

- BSc Hons (Construction Management): 7
- BSc Hons (Quantity Surveying): 69
- MLPM (Project Management): 3
- MLPM (Property Valuation): 7

POSTDOCTORAL RESEARCH FELLOWS

The Department was pleased to extend the contracts for postdoctoral fellowships to Dr T Ayodele and Dr P Tunji-Olayeni, both from Nigeria.

STAFF MATTERS

The Department welcomed the appointment of Dr Fredrick Simpeh as a Senior Lecturer in the Department from 1 May 2020. It also sadly bid farewell to Mrs Sandra Olivier, Assistant Officer, who retired at the end of December 2020.

RESEARCH OUTPUTS

Research Articles

Adaralegbe, O.A., Opawole, A. & **Kajimo-Shakantu. K.** 2020. A simplified approach to on-site related risk factors assessment in educational institutional projects. *International Journal of Civil Engineering and Technology* 11(6): 44-52.

Amoah, C., Kajimo-Shakantu, K. & Van Schalkwyk, T. 2020. The empirical reality of project management failures in the construction of social housing projects in South Africa. *Journal of Facilities Management* 18(4):417-435.

Amoah, C., **Kajimo-Shakantu, K. & Van Schalkwyk, T.** 2020. Satisfaction level of the RDP housing beneficiaries in Bloemfontein, South Africa. *Journal of Construction* 13(2):17-35.

Amoah, C. **& Simpeh, F.** 2020. Implementation challenges of COVID-19 safety measures at construction sites in South Africa. *Journal of Facilities Management* 19(1):111-128.

Ayodele, T.O, Ekemode, S.O. & Kajimo-Shakantu, K. 2020. The Nexus between Demographic Correlates, Career and Organisational Commitment: The Case of Real Estate Employees in Nigeria. *Journal of Facilities Management* 18(5): 521-545.

Ayodele, Y. O., Oladokun, T. T. & Kajimo-Shakantu, K. 2020. Employability skills of real estate graduates in Nigeria: a skill gap analysis. *Journal of Facilities Management* 18(3): 297-323.

Kok, B. & Amoah, C. 2020. An evaluation of the application of the green building principles in student accommodation in Bloemfontein. *Journal of Construction* 13(1):32-50.

Masia, T., Kajimo-Shakantu, K. & Opawole, A. 2020. A case study on the implementation of green building construction in Gauteng province, South Africa. *Management of environmental Quality: An International Journal* 31(3): 602-623.

Nemec, J., Xhala, C.N. & Kajimo-Shakantu, K. 2020. Public Private Partnership projects as a source for financing of public infrastructure investment, Public Private Partnership. Memlekett-jeke menshik Apriptestick. (2): 47-52.**Simpeh, F. & Adisa, S.** 2020. On-campus student accommodation safety measures: provision versus risk analysis. *International Journal of Building Pathology and Adaptation*. DOI: 10.1108/IJBPA-06-2020-0047.

Simpeh, F. & Shakantu, W. 2020. On-campus university student accommodation model. *Journal of Facilities Management* 18(3): 213-229.

Tunji-Olayeni, P., Kajimo-Shakantu, K. & Osunrayi , E. 2020. Practitioners' experiences with the drivers and practices for implementing sustainable construction in Nigeria: a qualitative assessment *Smart and Sustainable Built Environment* 9(4): 443-465. DOI 10.1108/SASBE-11-2019-0146.

Conferences Contributions

Conference Papers/Posters

Adaralegbe, O. A., Opawole, A. & Kajimo-Shakantu, K. 2020. *Assessment of management strategies for residual on-site related risk factors in educational institutional building projects*. Paper delivered at 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.



Adisa, S. & Simpeh, F. 2020. *Assessment of security measures: a compared analysis of two universities student housing*. Paper delivered at 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.

Agenbag, H. & Amoah C. 2020. *The impact of modern construction technology on the workforce in the construction industry*. Paper delivered at 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.

Ayodele, T. O. & **Kajimo-Shakantu, K.** 2020. *The fourth industrial revolution (4IR) and the construction industry - the role of data sharing and assemblage*. Paper delivered at 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.

Morena, M. & Amoah C., 2020; *Assessment of the mitigating measures for cost overruns in the South African construction industry*. Paper delivered at 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.

Opawole, A. & **Kajimo-Shakantu, K.** 2020. *Analysis of risk occurrence in projects executed by small and medium sized contracting firms.* Paper delivered at 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.

Simpeh, F. & Akinlolu, M. 2020. *A Scientometric Review of Student Housing Facilities Research Trends*. Paper delivered at 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.

Tunji-Olayeni, P., **Kajimo–Shakantu, K**., **Ayodele, T. O**. & **Emmanuela, K**. *Factors Affecting Students' Learning in Civil Engineering Measurement*. Paper delivered at 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.

Tunji-Olayeni, P.F, **Kajimo-Shakantu, K. & Oni, A. A.** 2020. *Work-Life Experiences of Women in the Construction Industry: A Case of Women in Lagos Mainland, Nigeria*. Paper delivered at 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.

Conference Proceedings

Opawole, A. & Kajimo-Shakantu, K. 2020. Assessment of political risk factors associated with public-private partnership projects delivery in developing countries: a case of Lagos State Nigeria. In: *Proceedings of the 11th Construction Industry Development Board; the Construction Industry in the Fourth Industrial Revolution (CIDB)*, Johannesburg, South Africa. C. Aigbavboa and W. Thwala (Ed). Springer. 29-30 July 2019. pp 364–372.

Bremer, T., Deacon, H., Els, M.M. & Mare, I. 2020. The Implications of not utilizing a Quantity Surveyor as Principal Agent for Residential Construction Projects. In: *Proceedings of the 11th Construction Industry Development Board: the Construction Industry in the Fourth Industrial Revolution (CIDB)*, Johannesburg, South Africa. C. Aigbavboa and W. Thwala (Ed). Springer 29-30 July 2019. pp 512- 520.

Els, M.M. & Mangese, X. 2020. Supplementing Quantity Surveying Traditional Services with Arbitration as one of the Alternative Dispute Resolution (ADR) Methods. In: *Proceedings of the 11th Construction Industry Development Board; the Construction Industry in the Fourth Industrial Revolution (CIDB)*, Johannesburg, South Africa. C. Aigbavboa and W. Thwala (Ed). Springer. 29-30 July 2019. pp 428- 439.

STAFF (2020)

Head of Department: Prof K Kajimo-Shakantu

Associate Professor: Prof K Kajimo-Shakantu
Senior Lecturer: Dr F Simpeh
Lecturers: Dr C Amoah, Mrs T Bremer, Mr AH Deacon, Mr H du Plessis, Mrs M-M Els, Mr PM Oosthuizen, Mrs C Ferreira and Ms TL van Schalkwyk
Contract Lecturers: Mr D Hugget, Mr R Schaaf, Mrs M Serfontein, Mr C Skibbe, Dr L Spencer, Mr W Strydom and Mrs E van der Walt
Affiliated Research Fellows: Prof T Haupt, Dr K Ibrahim, Prof F Muleya and Dr A Opawole
Programme Directors: Mrs T Bremer and Mr H du Plessis
Officers - Professional Services: Mrs A Beukes, Mr TH Mogorosi and Ms M Roux
Senior Assistant Officers: Ms R Runkel and Ms M Sepheka
Assistant Officer: Mrs S Olivier
Secretary: Mrs E van der Walt
Messenger/Service Worker: Ms M Mohapi

DEPARTMENT OF
URBAN AND REGIONAL PLANNING

CONTACT DETAILS

Prof Maléne Campbell
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OVERVIEW OF 2020

While 2020 started like any normal year, the impact of COVID-19 was soon felt in the Department, with cancellations of block weeks, conferences and planned fieldwork. However, the Department soon adjusted to online teaching and video-conferencing. Nonetheless, it has been a difficult year for staff and students alike, adapting to new ways amid the stress and alienation of the lockdowns. Furthermore, sadly three students withdraw from studies due to increased financial pressures.

The Dean has indicated that the Department is meeting and exceeding expectations in service learning and research output. The goals set for research outputs have been achieved in the last five years, with over 1.5 research output units produced per C1 academic staff member annually.

Increased research grants allowed the Department to appoint additional support/administrative staff to assist in alleviating staff members' workload. Mr Stuart Denoon-Stevens received a multi-million rand grant from the National Research Foundation (NRF) related to the South African Planning Education Research (SAPER) project. This grant allows for international partnerships, PhD bursaries, and administrative assistance.



Mr Stuart Denoon-Stevens

Prof Verna Nel has a grant from the NRF that includes one honours and one master's bursary. The grant allows students to be paid for fieldwork and other assistance. Dr Thulisile Mphambukeli also has grants for R600 000, which allows research assistants to be appointed.



Prof Verna Nel



Dr Thulisile Mphambukeli

Prof Ivan Turok was appointed as the South African Research Chairs Initiative (SARChI) Chair for Strengthening Urban Economies: People, Pace, Production and Policy. The Chair works in close partnership with the UFS and the Human Sciences Research Council (HSRC), and brings together networks from both institutions to create a virtual team to refine and operationalise the research programme. Three UFS departments are directly involved – the Centre for Development Support (CDS), the Department of Economics and Finance, and the Department of Urban and Regional Planning. The associated funding is substantial and this funding provided also some bursaries for students.

In addition, this Department generates an additional Senior Lecturer Equivalent (SLE) beyond what is required. Staff members allocate their time across teaching, supervision, research, and generating third-stream income. Three short learning programmes with associated Continuous Professional Development (CPD) points were approved. These are on Land Use Management, which Prof Verna Nel presents, Socio-Cultural Aspects, which Dr Thulisile Mphambukeli and Dr Kgosi Mocwagae present, and Human Settlements, which Thomas Stewart presents.

The Department successfully secured a New Generation of Academics Programme (nGAP) position, which increased the teaching and research staff capacity, as well as the equity of the Department. Miss Abongile Mgwele was appointed in this position.



Miss Abongile Mgwele

ACHIEVEMENTS

Staff Achievements

Prof Nel and Dr Mphambukeli achieved NRF-ratings, which brings the percentage of rated teaching staff in the Department to 50%.

The Managing Director of the Russian National Committee on BRICS (Brazil, Russia, India, China and South Africa) Research expressed his gratitude to Dr Mphambukeli on behalf of the Academic Forum Organizing Committee for her immense contribution to the Forum that was held from 22 to 24 October in Moscow, Russia.

The Doctor of Philosophy in Urban and Regional Planning was conferred upon Dr KS Mocwagae, lecturer and Programme Director for the Department.



Dr Kgosi Mocwagae

The South African Academy for Science and Arts awarded the 2020 Stals Prize for Town and Regional Planning to Prof JJ (Das) Steÿn, Research Fellow of this Department. This award is based on, among other things, his numerous publications in Afrikaans and the important role he has played in the Town and Regional Planning profession in South Africa. Over the past 73 years, about 150 Stals Prizes have been awarded and only 15 UFS academics have been recipients of this prestigious prize. Prof Steÿn is the only recipient who is an Urban and Regional Planner or Building Scientist (which includes Architecture, Quantity Surveying and Construction Management). As editor of the journal *Town and Regional Planning* for the past 21 years, Prof Steÿn has focused on planning issues through well-founded headlines. This in-house Kovsie journal has grown to such an extent that it is listed on the Norwegian Scientific Electronic Library Online (SciELO) and is read in over 60 countries.



Prof Das Steÿn

TEACHING AND LEARNING

The Department of Urban and Regional Planning focuses on postgraduate qualifications for Urban and Regional Planning professionals, as well as Human Settlements professionals.

RESEARCH AND INNOVATION

Due to our efforts and as part of our commitment to help our students pass their mini-dissertations successfully, which in turn enhances the innovative teaching and learning practice in our Department, Dr Mphambukeli, in collaboration with Dr Mocwagea and Dr Matamanda, successfully ran two Writing Workshops. These efforts contributed to ensuring that 22 out of 33 Master of Urban and Regional Planning (MURP) students passed in 2020, despite of the lockdown that was in place for most of the year.

Furthermore, for some time, Dr Mphambukeli has been mentoring and supervising Dr Mocwagae and Dr Matamanda, both whom have graduated with their doctoral degrees.

Dr Mphambukeli and her team secured a R500 000 grant for a Joint National Institute for the Humanities and Social Sciences (NIHSS) and Chinese Academy of Social Sciences (CASS) research project. Her team focuses on exploring the land policies in Brazil, Russia, India, China and South Africa (the BRICS countries), which inform agricultural practices in South Africa and China. Within the parameters of the theme on social justice, sustainable development, and quality of life, they focus on documenting the land policies approached and strategies adopted. The aim of the project is to support the agriculture-land-water-labour nexus. Additionally, they will propose a common agricultural land policy for China and South Africa. The title of the research project is 'Exploring the Situated Political Ecology and Economy of Agricultural Land Policies in BRICS: A Case Study of China and South Africa'.

In China and South Africa, agricultural land policies are intrinsically connected to water, food production and employment. They therefore propose to explore the situated political ecology and economy of agricultural land policies in these two countries. To this end, the project addresses the following research questions: What policies inform and guide agricultural land in China and South Africa? What agricultural land policies, approaches and practices inform the implementation of these policies with respect to water, food production and employment in China and South Africa? And what common agricultural land policy can promote agricultural cooperation between China and South Africa?

ENGAGED SCHOLARSHIP

Prof Nel continued to serve on the South African Council for Planners (SACPLAN) and was chairperson of its Education and Training Committee, constituted in terms of the Planning Profession Act, 2002. She also represented the Committee of the Heads of Planning Schools on the Department of Agriculture, Land Reform and Rural Development's Steering Committee for a Capacity Building project. As part of the Karoo Regional Spatial Development Framework, Prof Nel participated in the Young Professional Planners training programme in a colloquium on implementing spatial planning and a workshop on the institutional aspects of implementation.

Prof Maléne Campbell was appointed as the new Editor of *Town and Regional Planning,* listed on SciELO.

Dr Mphambukeli was appointed as a Guest Associate Editor by *Frontiers in Sustainable Cities* from the United Kingdom. She also serves on the Editorial Board of *Africanus: Journal of Development Studies*, Unisa Press (E-ISSN 2663-6522, Online). In addition, she was appointed as a reviewer and evaluator of the 2020 flagship Individual Research Fellowship (IRF) competition offered by the African Peacebuilding Network (APN) programme of the Social Science Research Council (SSRC) based in New York, USA.

NATIONAL AND INTERNATIONAL COLLABORATION

Prof Nel, Prof Campbell and Mr Stewart participated in a South African Swedish Universities Forum Project. During 2020, Prof Nel contributed to an application for the extension of the project on peri-urban areas, and showcasing her work in the three-day digital workshop.



Mr Thomas Stewart

POSTGRADUATE STUDENTS

In 2020, the following postgraduate students were enrolled in the Department of Urban and Regional Planning:

- 25 for Honours in Spatial Planning, and 9 for Honours in Spatial Planning (specialising in Human Settlements)
- 33 for the Master in Urban and Regional Planning (Professional)
- 1 for the Master in Urban and Regional Planning
- 16 for the PhD in Urban and Regional Planning

In 2020 a total of 26 students graduated with the honours degree in Spatial Planning – Nonhlankla Maphoso and Maseline Tiani (with distinction). Four students graduated with the specialisation in Human Settlements.

At master's level, 22 students graduated with the Professional Master of Urban and Regional Planning – Carolyn Reynolds (with distinction) – and one student, Andile Mshumpela, with the Research Master of Human Settlements.

In 2020, degrees were conferred upon the following three students who graduated with the Doctor of Philosophy in Urban and Regional Planning:

Burger, Everardt
Thesis: An exploration of the sustainability of a public transportation system for a smaller metropolitan area in South Africa: A case study of Mangaung Metropolitan Municipality
Promoter: Prof VJ Nel

Mocwagae Kgosi
Thesis: A Tale of Three Dams: Exploring the Qwaqwa Water Crisis for Effective Planning in Post-Apartheid South Africa
Promoters: Dr TN Mhambukeli and Prof V Okorie

Sinxadi, Lindelwa
Thesis: Reconceptualising urban public open spaces: A case of Freedom Square in Mangaung, South Africa.
Promoters: Prof MM Campbell and Prof G Bosman

POSTDOCTORAL RESEARCH FELLOWS

The Department of Urban and Regional Planning hosted Dr AR Matamanda, from Zimbabwe, as a postdoctoral fellow. He was supervised by Prof Campbell, and was part of the team led by Dr Mphambukeli which was awarded the one-year grant by NIHSS and CASS.

During 2020, Dr Matamanda successfully supervised three master's mini-dissertations and co-authored seven research articles and two book chapters.

STAFF MATTERS

During the lockdown in May 2020, the Departmental secretary, Mrs Riana Hugo, sent laptops and tablets on loan by courier to postgraduate students in remote and rural areas. She also sent study material on memory sticks to students who struggled with internet access in remote and rural areas. In addition, on a daily basis Mrs Hugo followed up telephonically with the students diagnosed with COVID-19, students whose family members were diagnosed with COVID-19, and students who struggled with the pressures of working and studying from home while taking care of their families, as well as informed them which professional services the UFS could provide to them



Mrs Riana Hugo

RESEARCH OUTPUTS

Research Articles

Chigudu, A. & Chirisa, I. 2020. The Quest for a Sustainable Spatial Planning Framework in Zimbabwe and Zambia. *Land Use Policy* 92: 104442.

Chirisa, I., Chivenge, M., Mutambisi, T., Matamanda, A.R. & Ncube, R. 2020. Disaster Mitigation and Response in Cities: Drawing Lessons from the COVID-19 Pandemic. *Journal of Social Sciences* 63(1-3): 21-31.

Chirisa, I., Matamanda, A.R. & Mazanhi, P. 2020. Resisting, frustrating or embracing the urban agenda: Chieftaincies in Southern Africa examined constitutionally and statutorily. *Land Use Policy* 95(2020). DOI: 10.1016/j.landusepol.2020.104618.

Chirisa, I., Mutambisi, T., Chivenge, M., Mabaso, E., Matamanda, A.R. & Ncube, R. 2020. The urban penalty of COVID-19 lockdowns across the globe: manifestations and lessons for Anglophone sub-Saharan Africa. *GeoJournal*. DOI: 10.1007/s10708-020-10281-6.

Chirisa, I., Mutambisi, T., Chivenge, I., Mbasera, M., Sidambe, M., Muchenje, B., Mukwashi, T., Mabaso, I. & Zengeni, D. 2020. Scope for Virtual Tourism for African Destinations under the Impact of COVID-19. *Journal of Social Sciences* 64(1-3): 1-13.

Chirisa, I. & Ncube, R. 2020. Decentralised Energy Systems for Zimbabwean Cities: Dilemmas in Going Back to Where We Came From. *Journal of Urban Systems and Innovations for Resilience in Zimbabwe* 2(1): 160-180.

Denoon-Stevens, S.P., Andres, L., Jones, P., Melgaço, L., Massey, R. & Nel, V. 2020. Theory versus Practice in Planning Education: The View from South Africa. *Planning Practice & Research* (Online). DOI: 10.1080/02697459.2020.1735158.

Denoon-Stevens, S.P. & Nel, V. 2020. Towards an understanding of proactive upzoning globally and in South Africa. *Land Use Policy* 97: 104708.

Lekgori, D.N., Paradza, P. & Chirisa, I. 2020. Nuances of Compulsory Land Acquisition and Compensation in Botswana: The Case of the Pitsane-Tlhareseleele Road Project. *Journal of African Real Estate Research* 5(1): 1-15. DOI: 10.15641/jarer.v5i1.811.

Matamanda, A.R. 2020. Battling the Informal Settlement Challenge through Sustainable City Framework: Experiences and Lessons from Harare, Zimbabwe. *Development Southern Africa* 37(2): 217-231.

Matamanda, A.R. 2020. Living in an Emerging Settlement: The Story of Hopley Farm Settlement, Harare Zimbabwe. *Urban Forum* 31: 473–487 DOI: 10.1007/S12132-020-09394-5.

Matamanda, A.R. 2020. Mugabe's urban legacy: a postcolonial perspective on urban development in Harare, Zimbabwe. *Journal of Asian and African Studies*. DOI: 10.1177/0021909620943620.

Matamanda, A.R., Chirisa, I., Dzvimbo, M.A. & Chinozvina, Q. 2020. The political economy of Zimbabwean Urban informality since 2000 – A contemporary governance dilemma. *Development Southern Africa* 37(4): 694-707. DOI: 10.1080/0376835X.2019.1698410.

Matamanda, A.R., Mphambukeli, T.N. & Chirisa, I. 2020. Applied Systems Analysis in Water Access for Emerging Human Settlements: A Case Study of Hopley Farm, Harare, Zimbabwe. *Urban Water Journal* 17(9): 763-773. DOI: 10.1080/1573062X.2020.1811882.

Melore, T.W. & Nel, V. 2020. Resilience of informal settlements to climate change in the mountainous areas of Konso, Ethiopia and QwaQwa, South Africa. *Jàmbá: Journal of Disaster Risk Studies* 12(1): a778. DOI: 10.4102/jamba.v12i1.778.

Muleya, N. & Campbell, M. 2020. A multisensory approach to measure public space quality in the city of Bulawayo, Zimbabwe. *Town and Regional Planning* 76: 56-71.

Ncube, R., Mhlanga, G., Matamanda, A.R., Ndaayashata, P. & Chirisa, I. 2020. The Political Economy of Education and Knowledge under Economic Stress: Reflections on Colonial and Post-colonial Zimbabwe. *Journal of Social Sciences* 65(1-3): 7-16.

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Prof Innocent Chirisa

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Professor: Prof VJ Nel
Associate Professor: Prof MM Campbell
Senior Lecturers: Dr TN Mphambukeli and Mr T Stewart

Lecturers: Mr SP Denoon-Stevens, Ms A Mgwele and Dr KS Mocwagae
NRF Intern: Mr M Chauque
Research Associates: Prof I Chirisa and Prof JJ Steÿn
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NATURAL
SCIENCES

DEPARTMENT OF CHEMISTRY

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OVERVIEW OF 2020

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 and the University Access Programme (UAP) – with 230 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. The postgraduate students on the Bloemfontein Campus in 2020, included 17 honours, 30 MSc, and 28 PhD students, as well as 8 postdoctoral associates from India, Nigeria, Sudan, Ethiopia and Cameroon.

The 2020 academic year was very challenging with all the restrictive measures due to the COVID-19 pandemic. Early in the lockdown period, the Department embarked on a project to convert all the teaching material into electronic format to ensure successful teaching during the extended periods of lockdown. New innovative measures were developed for assessments, and we also succeeded in completing all the practical work for all our academic modules, covering at least 80% of the original material. The success of all the personnel's endeavours, dedication and commitment is demonstrated by the good pass rates and above-average percentages of the students in 2020. All our personnel must be commended for their sacrifice and their commitment, as well as their loyalty, which ensured the successful completion of the 2020 academic year. During this period, we also succeeded in producing 89 accepted publications in international accredited journals, while four PhD and seven 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

Prof Vladimir Azov commenced working on a joint NRF/FWO (Research Foundation - Flanders) grant with a Belgian collaborator, Prof Ulrich Hennecke, from the Vrije Universiteit Brussel, and was also invited to serve on the editorial board of the journal *Mendeleev Communications* (Elsevier).

Both Dr Anke Wilhelm and Dr Charlene Marais received Thuthuka funding from the National Research Foundation (NRF). Dr Wilhelm's project, titled 'Investigation into South African Botanicals as Potential Anti-Psychotic Agents Utilizing a Zebrafish Larval Locomotive Bioassay', received funding for a second year. Dr Marais' project is titled 'Metathesis and hydroformylation as new catalytic methodology for the synthesis of phenolic compounds with potential anticarcinogenic activity'.

Prof André Roodt was invited to serve on a special Panel of the Council for Higher Education (CHE) to evaluate the PhD/Doctorate programmes offered at South African universities. Prof Roodt is a Fellow of the Royal Society of Chemistry and a member of the American Chemical Society and was formally admitted as an honorary member of the Croatian Crystallographic Society.

Dr Alice Brink was selected to participate in the Department of Higher Education and Training (DHET): Future Professors Programme (FPP). She was invited to serve on the editorial board of Taylor & Francis Group for the journal *Crystallography Reviews,* and she also became a Member of the South African National Committee for International Union of Crystallography.

Student Achievements

Ms ZG Morerwa, Mr FJF Jacobs, Ms L Kapp, Mr S Redgard and Mr C van Staden successfully passed the international virtual 'Rigaku School for Practical Crystallography', hosted by Rigaku Corporation.

At the annual Faculty prize-giving ceremony (held as a virtual event in 2020), the following students received prizes as best students during 2019 in the different categories: Siyanda Khoza (Best Second-year student in Chemistry for 2019), Hannah van Dyk was awarded PPS Best BSc Student Prize (average of 91%) and the Best Third-year student in Chemistry for 2019, Glendin Swart (Best Honours student in Chemistry for 2019), Tankiso Ngake (Louis Leipoldt Prize for Best MSc thesis) and A Ramadan (Bruker Prize for Best PhD thesis).

Ms R Mogale received first-place for her oral presentation at the international PhyChem 2020 Symposium, hosted by the UFS in September 2020.



Awardees at the FreeStatePhyChem-2020 Symposium, from the left, Khanyisile Dhlamini, Refilwe Mogale, Emmie Chiyindiko, Nandisiwe Mateyise, and Kovo Akpomie (Absent: Chih-Wei Tsai)

Several postgraduate students successfully participated in the virtual South African Chemical Institute (SACI) Young Chemist Symposium, hosted by the University of Johannesburg on 17 and 18 November, namely Ms Khanyisile Dhlamini (1st place for Best Oral Presentation [MSc]), Ms Refilwe Mogale and Ms Melanie Visser (Best Poster Presentation [PhD]) and Mr Christo van Staden (2nd place for Best Oral Presentation [PhD]).



Participants at the SACI Young Chemist Symposium, from the left, Ms Khanyisile Dhlamini (Best MSc Oral Presentation), Ms Refilwe Mogale (PhD), Ms Melanie Visser (Best PhD Poster Presentation)) and Mr Christo van Staden (2nd place PhD Oral Presentation)

TEACHING AND LEARNING

The lecturers in the Department of Chemistry successfully completed all 43 modules presented on the three campuses in 2020. The average and pass rates for all the modules were very similar or even slightly higher than previous academic years, in spite of all the challenges of the COVID-19 pandemic. Early in the lockdown period the Department decided upon a strategy to convert all the teaching material to electronic format to enable online teaching. This included power-point voice-overs, videos and Question Mark assignments. During this period, all lecturing staff and postgraduate students were instructed to work from home. The honours students returned in July and all their practical work was completed in block sessions while their formal theoretical assessments were completed in December.

The teaching of Chemistry modules on the South Campus is managed by Ms Rina Meintjes, assisted by four full-time facilitators. They also manage the Chemistry first-year Extended Programme teaching activities on the Qwaqwa Campus (140 students), as well as the Chemistry enrolment and courses at some Further Education and Training (FET) colleges, such as the Goldfields FET College in Welkom. However, in 2020 no students were enrolled at these colleges. In total 201 students were enrolled at the beginning of 2020 in the first-year Chemistry modules for the BSc Extended Programme on the South Campus, while 36 were enrolled in the UAP , which is designed to prepare students with low Admission Point (AP) scores for acceptance/enrolment for mainstream courses on the Bloemfontein Campus. As from 2021 the UAP will be phased out. Dr Uwe Siegert is the laboratory manager of the multidisciplinary laboratory on the South Campus and trained the South Campus students in the practical aspects of Chemistry during 2020.

Teaching on the Qwaqwa Campus also involves the theory and practical aspects of all four classic Chemistry disciples from the first to the third year, for approximately 72 first-year students, 70 second-year students, and 60 third-year students. The honours course had an enrolment of six students, and involved the teaching of subjects applicable to Polymer Science, aligned with the research focus of the Campus.



RESEARCH AND INNOVATION

In the **Analytical Chemistry** division, Prof Karel von Eschwege (NRF C3-rated) 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, among 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 investigating various aspects of pollution and greenhouse gases. In order to seek more affordable pharmaceuticals for both animal and human applications, his group started with extensive syntheses of various anaesthetics and new related and more potent derivatives. Six articles were published in international peer-reviewed journals.

Dr Rebotsamang Shago's research involved the synthesis of porphyrin-silicon conjugates for the removal of heavy metals in contaminated water.

The other part of the Analytical Chemistry group is managed by Prof Walter Purcell (C3-rated). The group focuses on a number of 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 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 lately recovery of Co and Li from spent batteries.

Different advanced analytical techniques are employed, such as microwave and acid dissolution procedures, while Inductively Coupled Plasma (both Optical Emission [ICP-OES] and mass spectroscopy [ICP-MS]), Graphite Furnace Atomic Absorption Spectroscopy (GFAAS), and Infrared and UV/visible (UV/vis) spectroscopy were used for the identification and quantification of the different elements, with ISO 17025 criteria as benchmark. Elements that are currently being investigated are niobium, tantalum, zirconium, hafnium, all the platinum-group elements (PGE), rare earth elements, as well as lithium beneficiation. The group includes two MSc students, one PhD student and a postdoctoral associate.

The **Organic Chemistry** division consists of three distinct research directions, i.e. the Phytochemistry group (Dr Susanna Bonnet and Dr Anke Wilhelm), Process Chemistry group (Dr Charlene Marais and Prof Ben Bezuidenhoudt) and Prof Vladimir Azov's group which specialises in Supramolecular Chemistry.

Dr Susanna Bonnet is investigating the development of commercial drugs and phytomedicines from indigenous knowledge to treat and sedate patients suffering from psychotic diseases. Our access to bioassays (through ChanPharm, an Austrian pharmaceutical company) to identify GABA(A) modulators, offers 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. Dr Bonnet is also running projects on the investigation of black wattle bark extract in collaboration with the wattle industry (sulfomethylation, aminometylation, sulfitation, carboxylation, etc.).

Dr Anke 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. An established collaboration with ChanPharm investigates the GABAergic activity of South African botanicals in the search of novel anti-epileptic drugs.

The Process Chemistry group investigates new methodologies for the synthesis of organic compounds with the emphasis on catalytic processes. One of the students in the Suprachem group continued to work on the synthesis tetrathiafulvalene/azobenzene molecular switches, whereas the second one started the project aimed at the synthesis of unnatural amino acids with redox active donor/acceptor substituents.

Dr Linette Twigge, who is also part of the Organic division as manager of the Nuclear Magnetic Resonance (NMR) facility, contributes to the research done within all the groups in the Department of Chemistry by implementing new NMR techniques to advance their research.

The third group, led by Prof Vladimir Azov, concentrated on Supramolecular Chemistry and deals with the investigation of self-assembly, molecular recognition and switching properties of molecular systems containing tetrathiafulvalene (TTF) building blocks.

The **Inorganic Chemistry** division consists of two separate research groups, which are independently led by Prof André Roodt (B2-rated) and Prof Deon Visser (C2-rated).

The research of the Roodt 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. The group was financially supported by grants from the prestigious Swiss-South Africa Joint Research Programme (SSAJRP: 2017-2020), the NRF Competitive Programme for Rated Researchers (CPRR) and Unrated Researcher Programmes, and by SASOL. Members of the group include Dr Johan Venter (NRF grantholder), Dr Alice Brink (SASOL grantholder, DHET FPP Fellow, and Y1-rated), Dr Marietjie Schutte-Smith (NRF grantholder and Y2-rated) and Dr Dumisani Kama. The research was also supported by Dr Pennie Mokolokolo as Chief Officer - Professional Services. In addition, the group included two postdoctoral fellows, three MSc and seven PhD students. The Roodt Group members were involved in 15 publications and group members attended several virtual conferences and presented six oral and poster contributions during the year. An update of the PCT Patent granted in 2019 was also published in the USA, late in 2020.

The Visser Group focuses on the application of organometallic complexes in photoluminescence studies, particularly in the fight against cancer and in the development of organic light emission devices (OLED's). Techniques used include X-ray crystallography, NMR, chemical kinetics and photoluminescence, and cell fluorescence spectroscopy, cytotoxicity and phototoxicity. In 2020, eight articles were published, one MSc student graduated (virtual) while another two MSc students finished their studies within one year – both will graduate in April 2021. Currently the group consists of four MSc and four PhD students. Two conference contributions (both virtual) were made by the research group at national conferences.

Dr Alice Brink and Dr Dumisani Kama manage the X-ray Crystallographic facility for the Department and the international databases – the Cambridge Crystallographic Data Centre (CCDC) and the Inorganic Crystal Structure Database (ICSD). The SA Precious Metal Permit is also managed according to Government Regulations by the Inorganic Division on behalf of the University.

The **Physical Chemistry** division is divided into six distinct and separate research groups which are independently supervised by Prof Jannie Swarts (C1-rated), Prof Jeanet Conradie (C1-rated), Prof Lizette Erasmus (C3-rated), Prof Lyudmila Moskaleva, Dr Ernie Langner and Dr Eleanor Müller (Y2-rated). The division's Professional Officer is Ms Ina du Plessis.

The Swarts group researched gold-metallocene complexes intended for heterogeneous catalysis, the kinetic studies involving the reduction of nickel and copper tripeptides with complex cyanides of iron, tungsten and molybdenum, as well as ferrocene-containing phthalocyanines with liquid crystalline properties and polymers with biomedical applications. The group collaborate closely with Syngaschem BV at the Dutch Institute for Fundamental Energy Research (DIFFER), Technical University Eindhoven, the Netherlands. Prof Swart is also a recipient of an NRF Rated Research grant.

Prof Jeanet Conradie's group focuses 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 Conradie is a member of SACI, Academy of Science of South Africa (ASSAf), International Society of Electrochemistry (ISE) and Society of Porphyrins and Phthalocyanines (SPP) and currently holds NRF CPRR and Knowledge Interchange and Collaboration (KIC) grants.



Prof Jeanet Conradie (invited speaker) and Dr Clive Oliver (organiser) at the 1000 IµS Symposium at UCT, standing in front of a painting of Prof PD Hahn, the first professor in Chemistry at UCT (January 2020)

Prof Lyudmila Moskaleva's group focuses on computational studies which are directed to chemo catalysis with two groups of heterogeneous catalysts (gold-based alloys and rare-earth oxides), and to electrocatalysis (oxygen reduction reaction and CO_2 reduction). In addition, they work on hybrid 2D materials with targeted properties composed of graphene and boron nitride structural motives. Their research also focuses on surface reactivity of solids at the atomic level using first-principles quantum-chemical methods, molecular dynamics, statistical theory, microkinetic modelling and thermodynamics. The group consisted of one postdoctoral fellow, four PhD students, and one MSc student. The group published articles in journals with high impact factors, such as *ACS Catalysis*, *ACS Energy Letters*, and *Energy & Environmental Science*.

Prof Lizette Erasmus and her group focus on research in materials science and heterogeneous catalysis. In 2020 the projects were on Frustrated Lewis Pairs for CO_2 capture and conversion, Morphology controlled Nanocrystals as model heterogeneous catalysts, and Cisplatin anchored on nanodiamonds for potential anticancer drugs.

Dr Ernie Langner's research focuses on the synthesis, characterisation, physical properties and application of selected Metal Organic Frameworks (MOFs). Some of these MOFs are nanosized and are being investigated for biomedical applications and CO_2 capture. Other MOFs are tested for photocatalysis, CO_2 conversion and as precursors for Fischer-Tropsch catalysts and received a SASOL Grant for 2020 for this research. The

grant money was allocated towards student bursaries, running expenses and general lab consumables. Dr Langner also received funding from Syngaschem BV in the Netherlands. The Langner group consists of four PhD students and one MSc student.

Dr Eleanor Müller's research concentrates on anti-cancer research and the synthesis of possible chemotherapeutic drugs. Newly synthesised potential anti-cancer drugs in the form of polymers, nanoparticles and organometallic compounds have been 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 wider campus. Dr Müller received funding from Syngaschem BV in the Netherlands, and the Central Research Fund.

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 a number of universities at undergraduate and postgraduate levels and represented the UFS on international research councils.

In the Inorganic Chemistry division, Dr Alice Brink acted as a reviewer for *Acta Crystallographic C* and the *Journal of Coordination Chemistry*. She serves on the Editorial Board for *Crystallographic Reviews*. She also acted as reviewer for NRF-rating and -funding applications.

Prof Roodt acted as reviewer for the NRF and as member of the Editorial Board of the *Journal of Coordination Chemistry*, and also acted as a reviewer for that journal and *Inorganic Chemistry*, *Crystal Growth and Design, Crystal Engineering Communications, Dalton Transactions, Organometallics, Inorganica Chimica Acta, New Journal of Chemistry* and *Acta Crystallographica B*.

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

Professor Conradie acted as the Physical Chemistry Editor for the *South African Journal of Chemistry*. She also acted as a reviewer for the NRF in evaluating the quality of the research funding and rating applications, and reviewed for publications in *ACS Omega* (ACS), *ChemPhysChem* (Wiley), *Data in Brief* (Elsevier), *European Journal of Inorganic Chemistry* (Wiley), *Inorganic Chimica Acta* (Elsevier), *Journal of Electroanalytical Chemistry* (Elsevier), *Journal of Molecular Modelling* (Springer), *Polyhedron* (Elsevier), *Electroanalysis* (Wiley) and *Computational and Theoretical Chemistry* (Elsevier). She also acted as external moderator for an MSc thesis from North-West University.



Prof Susan A Bourne, the first woman professor in Chemistry at UCT, and Prof Jeanet Conradie, the first woman professor in Chemistry at UFS (January 2020)

Prof Moskaleva acted as a reviewer for *Chemistry – A European Journal, ACS Applied Materials & Interfaces, The Journal of Physical Chemistry C, Journal of Catalysis, Chemical Engineering Science, ACS Nano, Computational and Theoretical Chemistry*, and *Molecules*. She also acted as external examiner for an MSc thesis from Rhodes University and for a PhD thesis from the University of Bremen, Germany.

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 a number of Chemistry modules from the University of Fort Hare and Nelson Mandela University.

Dr Shago also served on the NRF panel of reviewers for Chemistry and Material Sciences, and Dr Langner was reviewer for NRF-rating applications and also acted as examiner for an MSc thesis.

Dr Müller acted as a reviewer for publications in *Inorganica Chimica Acta, Inorganic Chemistry and Transition Metal Chemistry* and *Journal of Electroanalytical Chemistry*.

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

Prof Azov submitted manuscript reviews for the following internationally acclaimed journals: *Chemistry - A European Journal, The Journal of Organic Chemistry, Chemical Communications, Chemical Physics Letters, Molecules, Chemical Engineering Journal, Russian Chemical Reviews, Doklady Chemistry and Journal of Natural Products*. He was also involved in several NRF-rating and SARChI research chair applications, and served as a member of NRF National Equipment Programme (NEP) and SARChI panel.

Other Organic Chemistry staff members acted as reviewers for the following internationally respected journals: *Journal of Natural Products* (Bezuidenhoudt, Bonnet, Wilhelm and Marais), *The Journal of Organic Chemistry* (Bezuidenhoudt), *Phytochemistry* (Bonnet), *Phytochemistry Letters* (Bonnet and Wilhelm) and *Natural Product Communications* (Wilhelm).

The Department of Chemistry held the International FreeStatePhyChem Symposium Online on 30 October 2020, organised by Prof Jeanet Conradie and Prof Lyudmila Moskaleva. The symposium aimed to foster interest and engagement of students in physical chemistry research. It took place online via Blackboard Collaborate platform. The physical chemistry students and postdocs delivered 11 oral presentations followed by lively discussions. The best presentations were honoured by award certificates. (Symposium web page at fb.me/FreeStatePhyChem).

NATIONAL AND INTERNATIONAL COLLABORATION

Prof Von Eschwege has active collaborations with Laser Research Institute at the Physics Department at Stellenbosch University (femtosecond laser spectroscopy), the Chemistry Department 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.

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, SA) continued during 2020. Similarly, the group's collaboration on model homogeneous catalysts continued with Prof Vadim Boyarskiy from the State University of Saint Petersburg and Dr Fanie Otto (SASOL). In addition, the research on environmental chemistry, i.e. hydrogen generation and carbon dioxide utilisation in collaboration also with Prof Roger Alberto (University of Zürich, Switzerland), proceeded very well. Prof Roodt started collaboration with Prof Houcine Naili from the University of Sfax in Tunisia, and was invited to start new research collaboration with Prof Felix Zelder at the University of Zürich on reaction mechanisms on chemosensing, co-supervising a Swiss PhD student.

Dr Brink continued her 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 (USA) is ongoing. An interdisciplinary collaboration with Dr Tshepiso Makhafola (Central University of Technology) was established during 2020.

Prof Visser and Dr Schutte-Smith initiated collaboration with Prof Justin Wilson and colleagues at Cornell University and published a joint paper in *Inorganic Chemistry*. They also have an ongoing collaboration with Prof Gilles Gasser at Chimie ParisTech in France, and a paper was published in Dalton Transactions during 2020. Prof Visser and Dr Schutte-Smith continued their research collaboration with Dr Fabio Zobi from the University of Fribourg, Switzerland, Prof Demetrius Papadopoulos, from Athens, Greece, Dr Gregory Smith from the University of Cape Town (UCT), Dr Gilles Gasser from ParisTech, France, and with Prof Ted Kroon from the UFS Department of Physics.

Dr Wilhelm and Dr Schutte-Smith initiated collaboration with Dr Lucie Rarova at Palacky University, Czech Republic. The manuscript(s) from this collaboration will be published in 2021 and 2022. They also collaborated with Prof Steffen Hering from ChanPharm, an Austrian pharmaceutical company, and with Dr



Leon van Kralingen from the Wattle Industry, Pietermaritzburg, on projects which involve the derivatisation of wattle tannin extracts for industrial applications, as well as with Dr Richard Burghoff from the Institute for Commercial Forestry Research, University of KwaZulu-Natal (UKZN) – supported with a grant received from Forestry Sector Innovation Fund.

The oral presentation by Dr Wilhelm at the virtual 11th European Zebrafish Conference, raised much interests, and a number of delegates have subsequently contacted regarding possible future collaborations.

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

Prof Azov has started a new collaboration with Vrije Universiteit Brussel, funded by the joint NRF/FWO 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 participates 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. He also collaborates with Dr M Zeller (Purdue University) and Prof Vande Velde (University of Antwerp) on crystallography of organic molecules.

Prof Swarts collaborates nationally with Prof M Landman (University of Pretoria) and internationally with Prof Mike Cook (University of East Anglia, Norwich, England), Prof Henry Lang (Chemnitz Technical University, Chemnitz, Germany) and Prof Hans Niemantsverdriet of Syngaschem BV at DIFFER, Eindhoven University of Technology, the Netherlands.

Prof Conradie also collaborated with Prof M Landman from the University of Pretoria, and with Dr F Malan from the same university. Other national collaborators included Dr Gurthwin

Bosman and Dr Christine Steenkamp of the Laser Research Institute, Physics Department, Stellenbosch University, and Dr CGCE van Sittert of North-West University. Internationally she collaborates with Prof Abhik Ghosh (Department of Chemistry and Centre for Theoretical and Computational Chemistry, University of Tromsø, Tromsø, Norway), Prof Irena Hoskovcová (University of Chemistry and Technology Prague, Czech Republic), Prof Penny Brothers (University of Auckland, New Zealand), Prof JH Potgieter (Wits and Manchester Metropolitan University, Manchester, UK), Claude P Gros (Université de Bourgogne, Dijon France), Karl M Kadish (University of Houston, Houston, Texas, USA), S Samar Hasnain (University of Liverpool, Liverpool, UK), Prof Elisa Tomat (The University of Arizona, Tucson, USA), 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 Germany within the research unit Nanoporous Gold Catalysts (NAGOCAT) of the German Research Foundation (DFG). Joint workshops of PhD students, postdocs, and primary investigators (PIs) were held in February 2020 (in Paderborn), October 2020 (online) and December 2020 (online). She also collaborated on current topics in electrocatalysis and jointly published with the groups of Prof Zhi-Jian Zhao (Tianjin University, Tianjin, China), Prof Liqiang Mai (Wuhan University of Technology, Wuhan, China), and Prof Dingsheng Wang (Tsinghua University, China).

Prof Erasmus has an international collaboration with Prof Hans Niemantsverdriet from SynCat@DIFFER in the Netherlands, working on Frustrated Lewis Pairs.

Dr Langner has a national collaboration with Dr Kobus van der Walt (Central University of Technology) on the development of polypropylene powders for laser sintering. He also collaborated with Prof Niemantsverdriet of Syngaschem BV at DIFFER, on CO_2 adsorption. Dr Müller also collaborates internationally with Prof Niemantsverdriet.

Prof Purcell collaborates with Prof Herman Potgieter from the School of Chemical and Metallurgical Engineering at the University of the Witwatersrand (where Prof Purcell also a Visiting Professor), Prof Hendrik Swart from the Physics Department, Ms Justine Magson from the Geology Department, Kumba Iron Ore and various industrial partners.

OTHER ACTIVITIES

Prof Swarts managed the large equipment drive at the UFS that culminated in the purchase of a new Jeol Transmission Electron Microscope, a Biological Scanning Electron Microscope and a Zeiss Confocal Microscope. The value of these equipment items was over R47,000,000.

Prof Von Eschwege serves in a constant advisory capacity to companies in the renewable energy sector.

Dr Langner is a member of the Ethics Committee, Natural and Agricultural Sciences.

POSTGRADUATE STUDENTS

In 2020 there were 20 BSc Hons, 31 MSc, and 30 PhD students enrolled in the Department of Chemistry on the Bloemfontein Campus.

The following MSc students graduated in 2020: J Faber (with distinction), FJF Jacobs (with distinction), L Jansen van Vuuren (with distinction), K Mentoor, D van der Westhuizen (with distinction), JC Truscott (with distinction), and FMA Muller (with distinction).

Four PhD students graduated in 2020:

Govender, Maheshini
Thesis: Synthesis and characterization of ferrocenylalkoxy-functionalised polyphosphzenes for biomedical applications
Promoter: Dr E Müller

Mabaleha, Mohale Benedict
Thesis: Search for psychoactive compounds: Survey and bioassay-guided isolation of phytochemicals from the Lesotho medicinal plant *Cussionia paniculata* (Arraliaceae)
Promoter: Dr S Bonnet

Ngarivhume, Talkmore
Thesis: A survey of plants used by traditional healers for the treatment of malaria in Zimbabwe, and activity-guided isolation of anti-malarial compounds from *Tithonia diversifolia* leaves
Promoter: Dr S Bonnet



Prof Lyudmila Moskaleva and Prof Vladimir Azov at the Chemistry Department 'Drive By / Walk Through' Year-End Function

Swart, Petrus Johannes
Thesis: Synthetic, electrochemical, spectroscopic and computational aspects of ferrocene derivatives coordinated to subphthalocyanines
Promoter: Prof J Conradie

The Department is also involved in the structured/taught master's qualification – Master in Nanoscience (Chemistry). Three students graduated in 2020, namely YW Abraha (*cum laude*), MP Masiu, and LK Parrott.

POSTDOCTORAL RESEARCH FELLOWS

The Department of Chemistry hosted seven postdoctoral fellows in 2020:

- Dr Alexander Orbett (South Africa)
- Dr Mohammed Abdelaziz Elkhidir Elmakki (Sudan)
- Dr Blener Buitendach (South Africa)
- Dr Okikiola Olaniyan (Nigeria)
- Dr Alhadji Malloum (Nigeria)
- Dr Kovo Akpomie (Nigeria)
- Dr Manish Sinha (India)

STAFF MATTERS

Dr Dumisani Kama was appointed as Senior Lecturer in Inorganic Chemistry and Dr Pennie Mokolokolo was appointed as Chief Officer – Professional Services for Inorganic Chemistry.
Paulus Maxhaka and Emmanuel Tau were also newly appointed to the Department in 2020.

Mrs Ina du Plessis's application for retirement was approved. She worked at the Department of Chemistry from January 1990, a total of 30 years. She fulfilled her job with absolute devotion and high work ethic.

RESEARCH OUTPUTS

Research Articles

Adeniyi, A.A., Akintayo, C.O., Akintayo, E.T. & Conradie, J. 2020. The conformational change of Plukenetia conophora oil derivatives and their acidic resistance, intra-fragment interactions, stability in different solvent media. *Journal of Molecular Modeling* 26(11): 312.

Adeniyi, A.A., Akintayo, C.O., Akintayo, E.T. & Conradie, J. 2020. The conformational search, the stability, fragment interaction and resistance to acidic attack of epoxyl-polyurethanes in different solvent media. *Structural Chemistry* 31: 861-875.

Adeniyi, A.A. & Conradie, J. 2020. A Theoretical investigation of the fragment's interaction, non-linear optical and electronic properties of tris(β-diketonato)iron(III) complexes. *Structural Chemistry* 2020(31): 215-232.

Adeniyi, A.A. & Conradie. J. 2020. Cyclic Voltammetric and DFT analysis of the reduction of Manganese(III) Complexes with 2-Hydroxybenzophenones. *Electroanalysis* 32(12): 2913-2925.

Adeniyi, A.A., Tankiso, L., Ngake, T.L. & Conradie, J. 2020 Cyclic Voltammetric Study of 2-hydroxybenzophenone (HBP) derivatives and the correspondent change in the orbital energy levels in different solvents. *Electroanalysis* 32(11): 2659-2668.

Adeniyi, A.A., Von Stein, P-F.X, Bosman, G.W., Steenkamp, C.M, Chiweshe, T., Von Eschwege, K.G. & Conradie, J. 2020. Probing ultrafast reaction mechanisms of photo-excited dithizone through transient absorption spectroscopy and computational CASSCF studies. *Journal of the Optical Society of America B: Optical Physics* 37(11): A356-A366.

Akpomie, K. & Conradie. J. 2020. Advances in application of cotton based adsorbents for heavy metals trapping, surface modifications and future perspectives: A review. *Ecotoxicology and Environmental Safety* 201:110825.

Akpomie, K. & Conradie. J. 2020. Banana peel as a biosorbent for the decontamination of water pollutants. A review. *Environmental Chemistry Letters* 18: 1085-1112.



Chemistry Department 'Drive By / Walk Through' Year-End Function, from the left Magda Meyburgh, Prof Walter Purcell, Ina du Plessis and Dr Ernie Langner

Akpomie, K. & Conradie. J. 2020. Biogenic and chemically synthesized *Solanum tuberosum* peel–silver nanoparticle hybrid for the ultrasonic aided adsorption of bromophenol blue dye. *Scientific Reports* 10: Art. 17094.

Akpomie, K. & Conradie. J. 2020. Efficient synthesis of magnetic nanoparticle-*Musa acuminata* peel composite for the adsorption of anionic dye. *Arabian Journal of Chemistry* 13: 7115-7131.

Akpomie, K. & Conradie. J. 2020. Synthesis, characterization, and regeneration of an inorganic–organic nanocomposite (ZnO@biomass) and its application in the capture of cationic dye. *Scientific Reports* 10: 14441.

Alexander, O., Brink, A. & Visser, H.G. 2020. The crystal structure of bis(μ2-5,7-dichloroquinolin-8-olato-κ3N,O:O)-tetrakis(5,7-dichloroquinolin-8-olato-κ2N,O)bis(methanol-κ1O) dieuropium(III) — toluene (1/1). *Zeitschfrift für Kristallographie NCS* 235(1): 247-249.

Alexander, O.T. & Roodt, A. 2020. The crystal structure of (E)-1-(quinolin-2-ylmethyl)-2-((1-(quinolin-2-ylmethyl)pyridin-2(1H)-ylidene)amino)pyridin-1-ium, C30H25BrN5. *Zeitschfrift für Kristallographie NCS* 235(6): 1381-1383.

Azov, V.A., Mueller, L. & Makarov, A.A. 2020 Laser ionization mass spectrometry at 55: Quo Vadis? *Mass Spectrometry Reviews* 1-52. DOI: 10:1002/mas.21669.

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Research Reports

Brink, A. 2020. *Molecular Catalyst Materials for Critical Evaluation of Fundamental Fischer Tropsch Reactions*. Report delivered to Sasol.

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Von Eschwege, K.G. 2020. *Cenercor technical model for hydrogen production – an independent assessment.* Report delivered to Central Energy Corporation (CENEC).

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Conference Contributions

Conference Papers/Posters

Abraha, Y.W., Tsai, C-W., Niemantsverdriet, J.W. & Langner, E.H.G. 2020. *Ligand Exchanged ZIF-8 Derivatives with Greatly Improved CO_2 Adsorption Capacity*. Poster presented at the International FreeStatePhyChem-2020 Symposium (Virtual Meeting), University of the Free State, Bloemfontein, South Africa. 30 October 2020.

Akpomie, K.G. & Conradie J. 2020. *Ultrasonic assisted sorption of oil from oil-in-water emulsion onto Ananas comosus peel-silver nanocomposite*. Poster presented at the International FreeStatePhyChem-2020 Symposium (Virtual Meeting), University of the Free State, Bloemfontein, South Africa. 30 October 2020. (2^{nd} prize in Postdoctoral category).

Akpomie, K.G., Odewole, O.A. & Conradie, J. 2020. *One-Pot Synthesis and Characterization of an Inorganic-Organic Composite 27 (Zno@BM) For Oil Water Separation*. Paper delivered at the International Conference of Organic Synthesis/ Medicinal Chemistry Research Group (Virtual Conference), University of Nigeria, Nsukka, Nigeria. 10-12 August 2020.

Akpomie, K.G., Odewole, O.A, Conradie, J. 2020. *Synthesis and Characterization of a Magnetic-Organic Composite for Dye Adsorption 28*. Paper delivered at the International Conference of Organic Synthesis/Medicinal Chemistry Research Group (Virtual Conference), University of Nigeria, Nsukka, Nigeria. 10-12 August 2020.

Belay, A.N., Venter, J.A. & Alexander, O.T. 2020. *Crystal structure of 4-(dimethylamino)pyridin-1-ium-2,5-dichloro-3,6-dioxocyclohexa-1,4-diene-1,4-bis(olate) 4-dimethylaminopyridine(2:1) water undeca-solvate*. Poster presented at the 4^{th} International Symposium on Halogen Bonding (ISXB4), (Virtual Event), Stellenbosch University, South Africa. 2-5 November 2020.

Brink, A. 2020. *Inorganic Chemistry to Protein - The advantages of tuneable radiation.* Paper delivered at the BrightnESS2: Mini Symposium for Neutron Techniques (Virtual Meeting), Stellenbosch University, South Africa. 25 August 2020.

Brink, A. 2020. *The nuclearity manipulation of radiopharmaceuticals - how to bridge the CSD & PDB.* Paper delivered at the Cambridge Crystallographic Data Centre (CCDC) Global User Group Meeting (Virtual Meeting), Cambridge University, UK. 14 October 2020.

Chiyindiko, E. & Conradie, J. 2020. *Electrochemical study of benzophenones: effect of substituents and solvent.* Poster presented at the International FreeStatePhyChem-2020 Symposium (Virtual Meeting), University of the Free State, Bloemfontein, South Africa. 30 October 2020. (2^{nd} prize in PhD category).

Chiyindiko, E. & Conradie, J. 2020. *Exploring the reduction of benzophenones and electron distribution with High Performance Computing.* Microtalk delivered at the 14^{th} CHPC National Conference, Birchwood, South Africa. 30 November-2 December 2020.

Conradie, J. & Swarts, P. 2020. *Influence of the Axial, Peripheral and Non-peripheral Substituents on the Redox Properties of Subphthalocyanines: an Electrochemical and DFT Study.* Poster presented at the 71^{st} Annual Meeting of the International Society of Electrochemistry (Online), Belgrade, Serbia. 31 August-4 September 2020.

Dhlamini, K.S. & Moskaleva, L. 2020. *Computational study of carbon monoxide reactivity when adsorbed on as stepped Au(221) surface and interacting with water and oxygen species*. Paper delivered at the International FreeStatePhyChem-2020 Symposium (Virtual Meeting), University of the Free State, Bloemfontein, South Africa. 30 October 2020.

Dhlamini, K.S. & Moskaleva, L. 2020. *Computational study of carbon monoxide reactivity when adsorbed on a stepped Au(221) surface and interacting with water and oxygen species*. Paper delivered at the South African Chemical Institute Young Chemists Symposium 2020 (Virtual Meeting), University of Johannesburg, South Africa. 18 November 2020. (1^{st} place for MSc student talks).

Dhlamini, K.S. & Moskaleva, L. 2020. *Computational study of carbon monoxide reactivity when adsorbed on a stepped Au(221) surface and interacting with water and oxygen species.* Paper delivered at the 2020 CHPC National Conference (Virtual Conference), Birchwood, South Africa. 1-3 December 2020.

Jacobs, F.J.F. & Brink, A. 2020. *From Radiopharmaceuticals to Potential H_2 /CO_2 Catalysts.* Paper delivered at Virtual Seminar between University of the Free State and University of Zurich, South Africa and Switzerland. 19 August 2020.

Jacobs, F.J.F., Venter, G.J.S., Roodt, A. & Brink, A. 2020. *Understanding weak interactions of radiopharmaceuticals for use in macromolecular structures*. Paper delivered and poster presented at ISXB-4 Virtual 2020: 4^{th} International Symposium on Halogen Bonding (Virtual Meeting), Stellenbosch University, South Africa. 2-5 November 2020.

Malloum, A. & Conradie, J. 2020. *Solvation Free Energy of the Proton in Acetonitrile.* Microtalk delivered at the 14^{th} CHPC National Conference, Birchwood, South Africa. 30 November-2 December 2020.

Malloum, A. & Conradie, J. 2020. *Water-Ammonia Proton Transfer Free Energy and Enthalpy.* Poster presented at the International FreeStatePhyChem-2020 Symposium (Virtual Meeting), University of the Free State, Bloemfontein, South Africa. 30 October 2020. (2^{nd} prize in MSc category).

Malloum, A. & Conradie, J. 2020. *Water-Ammonia Proton Transfer Free Energy and Enthalpy*. Poster presented at the African Physical Society (AfPS) International Conference, Trieste, Italy. 18-20 November 2020.

Masiu, M.P. & Langner, E.H.G. 2020. *Cytotoxicity studies of Ferrocenecarboxylic acid and cisplatin prodrug anchored on the surface of ZIF-8 nanoparticles*. Poster presented at the International FreeStatePhyChem-2020 Symposium (Virtual Meeting), University of the Free State, Bloemfontein, South Africa. 30 October 2020.

Mogale, R. & Langner, E.H.G. 2020. *The synthesis and characterisation of azobenzene dicarboxylate MOFs with different metal centers (M = Al^{3+}, Fe^{3+}, Zr^{4+}, Ti^{4+}) and their Application in Catalytic CO_2 Conversion*. Poster presented at the International FreeStatePhyChem-2020 Symposium (Virtual Meeting), University of the Free State, Bloemfontein, South Africa. 30 October 2020.

Mogale, R. & Langner, E.H.G. 2020. *The synthesis and characterisation of azobenzene dicarboxylate MOFs with different metal centers (M = Al^{3+}, Fe^{3+}, Zr^{4+}, Ti^{4+}) and their Application in Catalytic CO_2 Conversion.* Paper delivered at the 14^{th} CHPC National Conference (Virtual Conference), Birchwood, South Africa. 30 November-2 December 2020.

Mtshali, Z., Von Eschwege, K.G. & Conradie, J. 2020. *Density Functional Theory Calculations of Manganese-polypyridine Complexes.* Microtalk delivered at the 14^{th} CHPC National Conference., Birchwood, South Africa. 30 November-2 December 2020.

Mtshali, Z., Von Eschwege, K.G. & Conradie, J. 2020. *Electrochemical study of Tris(1,10-phenanthroline) manganese(II): effect of concentration and scan rate*. Poster presented at the International FreeStatePhyChem-2020 Symposium (Virtual Meeting), University of the Free State, Bloemfontein, South Africa. 30 October 2020.

Olaniyan, O. & Moskaleva, L. 2020. *Characterization of thermal properties of graphene and hexagonal boron nitride composite with alternating boron nitride and carbon chains: a first principles study.* Paper delivered at the International FreeStatePhyChem-2020 Symposium (Virtual Meeting),

University of the Free State, Bloemfontein, South Africa. 30 October 2020.

Olaniyan, O. & Moskaleva, L. 2020. *Thermal properties of an intermediate two-dimensional material between graphene and hexagonal boron nitride: a first-principles study*. Paper delivered at the 14th CHPC National Conference (Virtual Conference), Birchwood, South Africa. 30 November-2 December 2020.

Redgard, S. & Roodt, A. 2020. *CO2 fixation using 5-coordinate Pt & Pd complexes and its anomalies*. Paper delivered at the Seminar between University of the Free State. and University of Zurich (Virtual Seminar), South Africa & Switzerland. 19 August 2020.

Mateyise, N.G.S., Conradie, M.M. & Conradie, J. 2020. *HPC calculations to identify the correct DFT approach of the iodomethane oxidative addition to rhodium reaction.* Microtalk delivered at the 14th CHPC National Conference (Virtual Conference), Birchwood, South Africa. 30 November-2 December 2020.

Mateyise, N.G.S, Conradie, M.M. & Conradie, J. 2020. *Kinetic study of a model catalyst: [Rh((C$_4$H$_3$S-C$_4$H$_2$S)COCHCOCF$_3$)(CO)(PPh$_3$)] + CH$_3$I*. Poster presented at the International FreeStatePhyChem-2020 Symposium (Virtual Meeting), University of the Free State, Bloemfontein, South Africa. 30 October 2020. (2nd prize in MSc category).

Van der Merwe, J., Smith, C., Vlok, M., Powrie, Y., Reuter, H., Wilhelm, A. & Swart, K. 2020. *Use of a larval zebrafish locomotor assay to identify and isolate GABA$_A$ receptor modulators in Ammocharis coranica*. Poster presented at the Annual Academic Day (Virtual Meeting), Faculty of Medicine and Health Sciences, Stellenbosch University, South Africa. 26-27 August 2020.

Van Staden, C., Kama, D.V., Moskaleva, L., Kroon, R.E., Schutte-Smith, M. & Visser, H.G. 2020. The Manipulation of Aurophilic Interactions by Altering Phosphorous Based Ligand Systems. Paper delivered and Poster presented at Poster at ISXB-4 2020: 4th International Symposium on Halogen Bonding (Virtual Meeting), Stellenbosch University, South Africa. 2-5 November.

Van Staden, C., Moskaleva, L., Kroon, R.E., Kama, D.V., Schutte-Smith, M. & Visser, H.G. 2020. *Luminescent Au(I) Complexes with potential application for chemosensing and pollution treatment.* Paper delivered at the South African Chemical Institute Young Chemists Symposium 2020 (Virtual Meeting), University of Johannesburg, South Africa. 18 November 2020. (2nd place for PhD student talks).

Wilhelm, A., Bonnet, S.L. & Hering, S. 2020. *Establishing a locomotive zebrafish larvae bioassay using GABAA receptor modulators*. Paper delivered at the 11th European Zebrafish Meeting 2020 (Virtual Meeting), Prague, Czech Republic. 26-27 October 2020.

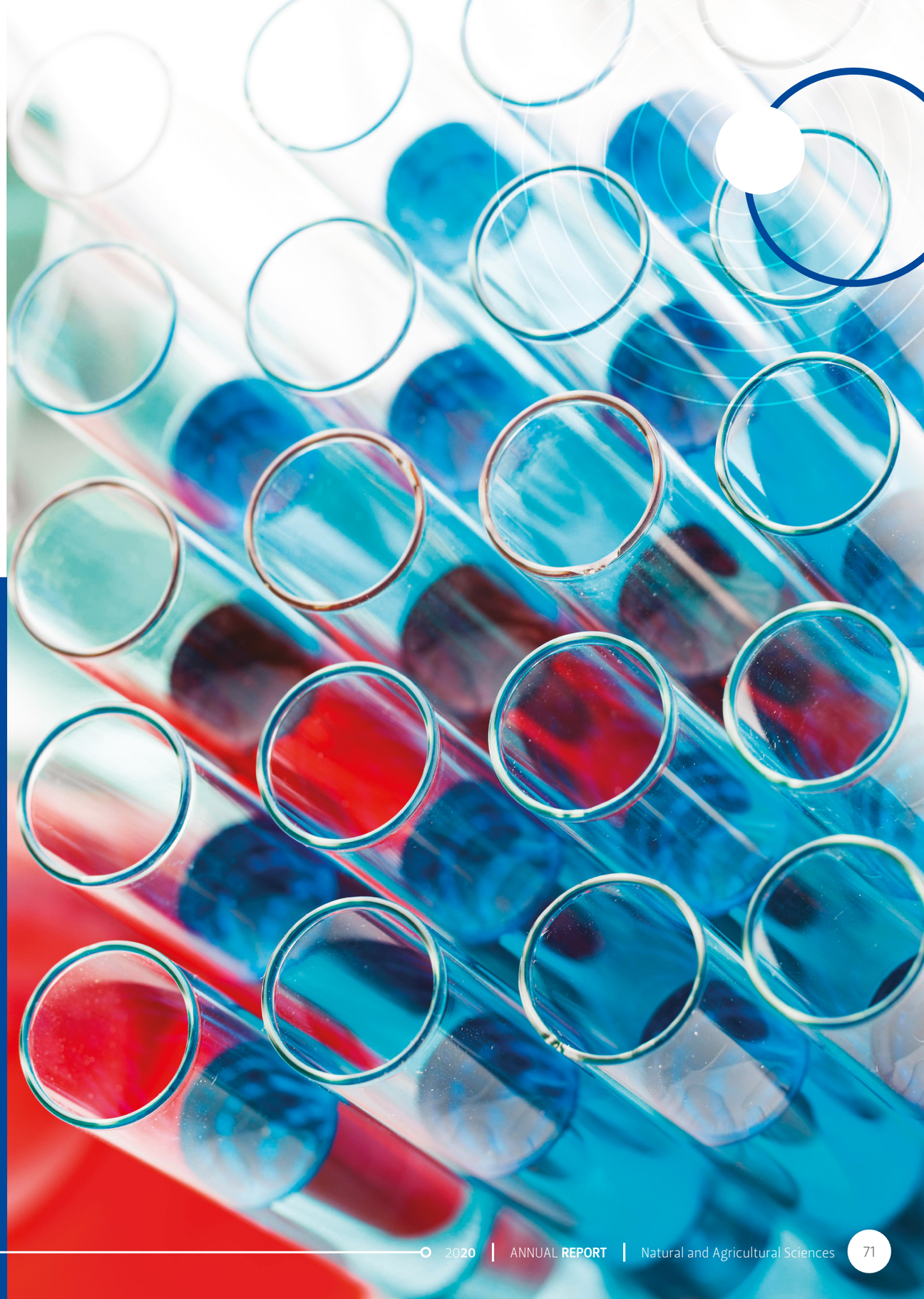
STAFF (2020)

Head of Department: Prof W Purcell

Bloemfontein Campus:
Distinguished Professor: Prof A Roodt
Professors: Prof VA Azov, Prof J Conradie, Prof E Erasmus, Prof L Moskaleva, Prof W Purcell, Prof JC Swarts, Prof HG Visser and Prof KG von Eschwege
Senior Lecturers: Dr S Bonnet, Dr A Brink, Dr DV Kama, Dr EHG Langner, Dr C Marais, Dr E Müller, Dr M Schutte-Smith, Dr JA Venter and Dr A Wilhelm
Lecturers: Dr RF Shago and Dr L Twigge (NMR Manager)
Junior Lecturer: Mr L Nkabiti
Researcher/Research Assistant: Mr FMA Muller
Research Associates: Prof BCB Bezuidenhoudt and Prof KJ Swart
Programme Director (Physical Sciences): Dr JA Venter
Secretary: Ms E Andrews
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 M Meyburgh, Dr PP Mokolokolo and Mr R Swart
Technical Aid Assistants: Mr ID Fish, Mr J Mafahle, Mr LP Maxhaka, Mr GI Nkotshana and Mr E Tau

Qwaqwa Campus:
Subject Head (Acting): Dr M Mngomezulu
Senior Lecturer: Dr JP Mofokeng
Lecturers: Dr MA Malimabe, Dr M Mngomezulu, Dr NF Molefe, Mr K Mpitso and Mr TA Tsotetsi
Junior Lecturers: Mr R Moji, Mrs M Mbongo
Officers - Professional Services: Ms CE Clarke-König, Ms P Leche and Mr MFT Mosoabisane
Senior Assistant Officer: Mr MA Motsoeneng

South Campus:
Lecturer: Mrs R Meintjes
Facilitators: Ms C de Klerk, Dr M du Plessis, Ms L Siegert, Dr R Siegert and Ms B van Tonder
Technical Aid Assistant: Mr T Shago



DEPARTMENT OF
COMPUTER SCIENCE AND INFORMATICS

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OVERVIEW OF 2020

The Department of Computer Science and Informatics (CSI) faced unique challenges due to the COVID-19 pandemic and lockdown, as students cannot complete programming modules without proper devices. Many students do not own laptops and many could not access a laptop. To help students to complete the academic year, the Department acquired 150 i5 laptops to loan to vulnerable students.

The second advisory board meeting was held on 2 October 2020. Industry members were asked to prepare presentations on two questions, namely what the post-COVID-19 curriculum should look like, and the digital skills that they think students need to take them into the Fourth Industrial Revolution (4IR) paradigm. The presentations were excellent and the Department will package the presentations and suggestions into a single model. The model will be presented at the next advisory board meeting (May 2021) in order to prioritise the suggestions. After this meeting, a departmental colloquium will be held to take an in-depth look at our curriculum to determine what we can implement and change for 2022.

ACHIEVEMENTS

Staff Achievements

Prof Liezel Nel was the winner of the 2020 UFS Excellence in Learning and Teaching Award in the category Research in Teaching and Learning.



Prof Liezel Nel

Dr Eduan Kotzé was elected to the South African Institute of Computer Scientists and Information Technologists (SAICSIT) Council as an Ordinary Council Member from 2020 to 2022 (https://www.saicsit.org/).

Student Achievements

Two of Dr Lizette de Wet's master's students, Mrs Marie Lonergan and Mr Bennie Botha (the latter a staff member at the UFS Department of Nursing), completed their degrees *cum laude*.

Mr Botha received the IEEE Virtual Reality (IEEEVR) Diversity Scholarship Award in 2020 after virtually presenting a paper based on his master's studies, titled 'Usability of a Foreign Body Object Scenario in Virtual Reality for Nursing Education' at the IEEE Conference on Virtual Reality and 3D User Interfaces Abstracts and Workshops.

Mr Riaan Bezuidenhout, a master's student of Dr Wynand Nel, also completed his master's degree *cum laude*.



Mr Bennie Botha

TEACHING AND LEARNING

In response to the COVID-19 pandemic, all undergraduate and postgraduate module offerings were revised for emergency remote teaching during the first semester of 2020. In the second semester, we followed a blended learning approach, using a mix of face-to-face and online delivery modes.

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 forced 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 planned for 2021 include online assessments, submissions and automations.

RESEARCH AND INNOVATION

Blockchain Technology

The Blockchain Technology research area, which falls in the 4IR domain, was expanded in 2020. Mr Riaan Bezuidenhout, a master's student of Dr Wynand Nel, researched Bitcoin's Proof-of-work (PoW) consensus algorithm. Four different PoW algorithms were developed, each contributing to reduce the number of hash calculations needed to solve a block of transactions, which ultimately translates to a reduction in the amount of energy required to keep the network running. An article from this work was published in the *Journal of Construction Project Management and Innovation*. The research was funded by the Manufacturing, Engineering and Related Services Skills Education Training Authority (merSETA) and is part of the Smart Resource Trading (SRT) for the Future project.

Computer Science Education

The Computer Science Education (CSE) research group, under the guidance of Prof Liezel Nel, continued its work on the 'decoding' of Computer Science education and the unique challenges experienced by students in mastering discipline-specific concepts. This long-term project thus 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.

An international expert in the field of 'Decoding the Disciplines', Prof David Pace (Emeritus Professor at the Indiana University Bloomington), recognised recent publications by this group for their unique contributions made towards a new version of the paradigm, Decoding 2.0. One student from this research group, Pakiso Khomokhoana, completed his PhD in 2020, and three other doctoral students are currently working on decoding-related projects.

Data Science / Natural Language Processing

The Data Science / Natural Language Processing (NLP) research group, led by Dr Eduan Kotzé, continued work on the linguistic aspects of online hate speech, general text classification and stylometry (authorship). Mr Ian van der Linde, working in this research group, completed his MSc in 2020, and Dr Oluwafemi Oriola (a postdoctoral fellow), four doctoral and three master's students continued their work on NLP-related projects.

Dr Eduan Kotzé was co-author of the book *Reinventing the Social Scientist and Humanist in the Era of Big Data: A perspective from South African Scholars* with Dr Burgert Senekal and Dr Susan Brokensha. This book explored the big data evolution by interrogating the notion that big data is a disruptive innovation that appears to be challenging existing epistemologies in the humanities and the social sciences. Exploring various (controversial) facets of big data, such as ethics, data power, and data justice, the book attempts to clarify the trajectory of the epistemology of (big) data-driven science in the humanities and the social sciences.

An interdisciplinary research grant of R50 000, jointly awarded to the Department of English and the Department of Computer Science and Informatics in 2020, will be used to fund a project to investigate machine learning and deep learning models for document classification in an archival context.

Eye-Tracking

Prof Tanya Stott continued the collaborative eye-tracking research aimed at identifying and categorising the eye movements of school learners who find it difficult to read and understand a science text. Data was collected from a sample of top learners in socio-economically disadvantaged schools to analyse the behaviour of 'barkers' – readers who encode at the word level. The aim is to find a suitable intervention technique to assist these learners in becoming better comprehenders.

There are currently several papers published on the subject and more papers are under development. Prof Scott published in the *Journal of Eye Movement Research* (JEMR) on eye movements while looking at art works, as well as a paper, with Dr Eduan Kotzé, on the potential use of eye-tracking in the business intelligence development, in the *Electronic Journal of Information Systems Evaluation* (EJISE), an ISI journal.

Human-Computer Interaction

The research interest of Dr Lizette de Wet falls within the discipline of Human-Computer Interaction (HCI). She specifically works on the evaluation of usability and user experience (UX) in a variety of application areas. Although she has worked on the use of Brain-Computer Interfaces (BCIs) as an evaluation tool over the past few years, she added the evaluation of virtual reality (VR) applications in Nursing education to the focus.

In 2020, research projects that were concluded involved the evaluation of a game-based assessment in comparison to traditional paper-based assessments in students' understanding of assessment questions, as well as the evaluation of a Virtual Hospital Ward Environment where Nursing students were expected to handle a foreign body object in a patient's lung as part of their training.

Research projects to be continued in 2021 include the evaluation of the influence of technostress trifecta aspects on student academic performance, and a study in which the usability and user experience of an online portal and a mobile application will be compared.

An interdisciplinary research grant of R150 000, jointly awarded to the Department of Nursing and the Department of Computer Science and Informatics, will be used to fund a project using an omnidirectional treadmill (KatWalk™ Mini) in an effort to reduce cyber sickness for Nursing students while navigating immersive VR.

In order to facilitate the research in this group, the Department has acquired a variety of tools and technologies on BCIs over the past few years, such as the Emotiv EPOC, SmartBCI, and Emotiv Insight, as well as the Oculus Rift for use in VR research.

Research papers on the research described above were accepted in journals and conferences in 2020. The presentations at conferences in 2020 were all virtual due to COVID-19 restrictions.

Internet of Things

Prof Paul Kogeda is working 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.

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.

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

Mr Fani Radebe's research area is 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 Human-Computer Interaction (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, namely 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.

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

At the request of the UFS Centre for Teaching and Learning (CTL), Prof Liezel Nel prepared a three-minute video explaining how she utilised the 'electronic progress report' as an assessment strategy during the COVID-19 pandemic. This video was used during online training sessions provided to UFS academic staff members in October 2020, as part of the #UFSTeachOn campaign.

UFS CTL and the office of the Deputy Vice-Chancellor: Academic recognised Prof Liezel Nel as a #UFSTeachOn Champion for her hard work and commitment to teaching and learning during 2020.

Information Technology Service Learning (ITSL) Project

In the CSIS2642 (Information Technology Service-Learning) module, the Department of Computer Science and Informatics second-year students present computer literacy training to Mangaung and Botshabelo community members. This computer literacy training includes Microsoft Word and Microsoft Excel training in the form of accredited structured short learning programmes. The ITSL project is organised and presented annually by Mr Rouxan Fouché, assisted by three community partners, namely the Mangaung Concerned Residents (MCR) organisation, the South African Red Cross Society, and the Love Life Youth Development organisation.

In 2020, the ITSL project could not be presented in its usual format due to COVID-19 lockdown restrictions. After discussions with community partners, the ITSL project was undertaken with the assistance of the Love Life Youth Development centre, who provided the venue and facilitator in Botshabelo. Students who were enrolled for the service-learning module at the UFS produced computer literacy training videos and assignments that were shared with the Botshabelo Love Life Youth centre facilitator on a weekly basis.

The contact sessions were spread out from Monday to Friday to allow for social distancing in the venue. The facilitator from the Love Life Youth Development centre provided onsite support in the participants' mother tongue and gave feedback for improvement of the training on a weekly basis. The project was undertaken over 11 weeks during the second semester of 2020. At the end of the the ITSL project, 100 members of the Botshabelo community completed both the short learning programmes and will receive accredited certificates from the Department of Computer Science and Informatics during the graduation ceremony in February 2021.

Participants of the courses presented over the past few years range from individuals who have just left school to those who are well on their way to retirement. The importance of computer literacy and its impact on the successful application for employment is often overlooked. Reporting on the previous courses presented in 2018 and 2019 to 350 individuals from the Mangaung community, the MCR indicated that numerous attendees had been able to acquire employment as administration personnel with their newly acquired computer literacy skills and qualifications. The skills they acquired have also enabled community members to start their own businesses where they can now electronically keep track of all their information and use of electronic marketing.

This service-learning module currently has a very positive impact on the community and the students involved, and will be extended to further increase the impact we have on the computer literacy level of our surrounding community.

NATIONAL AND INTERNATIONAL COLLABORATION

Dr 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 and violent events in South Africa, as well as conversational agents (CAs).

Dr Burgert Senekal continued his fellowship with Dr Eduan Kotzé's research group. Dr Oluwafemi Oriola, from Nigeria, was appointed as a research fellow from November 2020 and is also involved with Dr Kotzé's research group.

Prof Paul Kogeda collaborated with Dr Vitalis Ozianyi from Strathmore University, Kenya, on water resource management – in terms of the detection and prediction of water leakage. They engaged in a South Africa-Kenya joint science and technology research collaboration.

Dr Christa van Staden, currently living in Kazakhstan, was appointed as a research fellow from January 2020 and works closely with Prof Liezel Nel's research group.

Prof Kenneth Holmqvist, from Sweden, continued his fellowship with Prof Pieter Blignaut's eye-tracking research group.

OTHER ACTIVITIES

The UFS LEGO Robotics and Python Project, under the guidance of Mr Daniël Wium, started strongly in 2020, with interest vastly exceeding the number of available positions. Unfortunately, COVID-19 restrictions halted the classes prematurely. Nevertheless, a number of learners participated in the national Talent Search and performed very well. Of the ten participants from our project, two received bronze certificates (top 50%), one

a silver certificate (top 21%) and five received gold certificates (top 7%). One learner, Nabeel Seedat, achieved a full score – one of only three learners who managed to do so out of 1 793 in the Grade 8 and 9 section,.

POSTGRADUATE STUDENTS

Seventeen students enrolled as honours students in 2020, with 10 master's and 15 doctoral students making up the postgraduate student cohort.

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 Oluwafemi Oriola completed his postdoctoral fellowship during 2020, and was thereafter appointed as a research fellow, continuing the collaboration with Dr Kotze.

STAFF MATTERS

Two staff members obtained their PhD degrees, namely Pakiso Khomokhoana and Fani Radebe.

Dr Ruth Wario (C3) and Prof Paul Kogeda (C2) achieved NRF-ratings in 2020.



Dr Ruth Wario



Prof Paul Kogeda

RESEARCH OUTPUTS

Research Articles

Akinyelu, A. & Blignaut, P. 2020. Convolutional neural network-based methods for eye gaze estimation: A survey. *IEEE Access* 8: 142581-142605. DOI:10.1109/ACCESS.2020.3013540.

Akinyelu, A.A., Ezugwu, A.E. & Adewumi, A.O. 2020. Ant colony optimization edge selection for support vector machine speed optimization. *Neural Computing & Applications* 32: 11385-11417. DOI: 10.1007/s00521-019-04633-8.

Atsa'am, D.D., Wario, R. & Okpo, F.E. 2020. A new terrorism categorization based on casualties and consequences using hierarchical clustering. *Journal of Applied Security Research* 15(3): 369-384. DOI: 10.1080/19361610.2020.1769461.

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Beelders, T. & Bergh, L. 2020. The role that composition plays in determining how a viewer looks at landscape art. *Journal of Eye Movement Research* 13(2): 13. DOI: 10.16910/jemr.13.2.13.

Beelders, T. & Kotzé, E. 2020. Augmenting the business intelligence lifestyle model with usability: using eye-tracking to discover the *why* of usability problems. *The Electronic Journal of Information Systems Evaluation* 23(1): 96-111. DOI: 10.34190/EJISE.20.23.1.007.

Bezuidenhout, R., Nel, W. & Burger, A. 2020. Nonlinear proof-of-work: Improving the energy efficiency of Bitcoin mining. *Journal of Construction Project Management and Innovation (JCPMI)* 10(1): 20-32. DOI: 10.36615/jcpmi.v0i1.351.

Botha, B., De Wet, L. & Botma, Y. 2020. Experts' review of a virtual environment for virtual clinical simulation in South Africa. *Computer Animation and Virtual Worlds* 2020: e1983. DOI: 10.1002/cav.1983.

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Gadebe, M.L. & Kogeda, O.P. 2020. Top-K human activity recognition dataset. *International Journal of Interactive Mobile Technologies* 14(18): 69-85. DOI: 10.3991/ijim.v14i8.16965.

Holmqvist, K. & Blignaut, P. 2020. Small eye movements cannot be reliably measured by video-based P-CR eye-trackers. *Behaviour Research Methods* 52: 2098-2121. DOI: 10.3758/s13428-020-01363-x.

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STAFF (2020)

Head of Department: Dr E Kotzé

Bloemfontein Campus:
Associate Professors: Prof P Kogeda and Prof T Stott
Adjunct Professor: Prof L Nel
Senior Lecturer: Dr L de Wet
Lecturers: Mr R Fouché, Dr P Khomokhoana, Mr J Marais, Dr W Nel, Mrs TS Nkalai and Mr D Wium
Junior Lecturer: Mr C Cilliers
Research Fellows: Prof K Holmqvist, Dr O Oriola, Dr BA Senekal and Dr C van Staden
Programme Director: Mr J Marais
Officer: Mrs S Opperman
Senior Assistant Officers: Mr S Radebe and Mr V van der Bank
Assistant Officers: Mrs S Mocwana and Mrs R Smith
Messenger: Mr W Baranya

Qwaqwa Campus:
Subject Head: Dr F Radebe
Senior Lecturer: Dr Ruth 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: Mrs M Mahakoe and Mr M Makhanya
Secretary: Ms P van der Merwe

South Campus:
Junior Lecturer: Mrs M Thakaso
Senior Assistant Officer: Mr A Thompson
Assistant Officer: Mrs S de Klerk

DEPARTMENT OF
ENGINEERING SCIENCES

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OVERVIEW OF 2020

The research on Energy Analytics, the main Engineering Sciences (EnSci) focus area of the Green Building Index (GBI) project, was completed with the presentation of courses to industry. The development of a Green Manufacturing Index (GMI) has progressed well, and the research on Energy Efficient Building Materials has entered the practical experimentation phase.

One new initiative commenced in 2020 – the Centre for Digital and Data Engineering (CDDE) – which is in the start-up phase.

The existing research focus area of smart grids, micro grids and grid protection, culminated in the establishment of EnSci's Grid Related Research group.

A new research area in geopolymer cement and -concrete is under development.

ACHIEVEMENTS

Staff Achievements

Mr Louis Lagrange was elected to serve on the Association of Energy Engineers (AEE) Certified Lighting Efficiency Professional (CLEP) Body of Knowledge Team to upgrade the international training course for 2021.

Dr Jacques Maritz was selected for the UFS Emerging Scholar Accelerator Programme for the period 2021 to 2023.

TEACHING AND LEARNING

The Department of Engineering Sciences equips students with a fundamental three-year BSc degree majoring in Physics and Engineering subjects. Graduates can then articulate into the third year of engineering at other participating universities. The articulation allows for the disciplines of civil, electrical, electronic, mechanical, aeronautical, industrial, and mechatronic engineering.

From the total of 46 different modules for the degree, various departments in the Faculty present the fundamental modules on physics, chemistry, computer science, mathematics and applied mathematics. Engineering Sciences presents the 22 engineering-related modules that cover the areas of structural design and geo-techniques for civil engineering, signal and power systems, computer logic and microprocessors for electronic/electrical engineering, and machine design, fluid mechanics and thermodynamics for mechanical engineering.

In 2020, there were 92 registered students in Engineering Sciences – 39 in their first year, 37 in their second year, and 16 in their third year. EnSci followed a distance learning approach in the first half of 2020, and thereafter a blended learning approach.

RESEARCH AND INNOVATION

Engineering Sciences conducts its research activities under the broad theme 'energy'. The following specific focus areas are currently being pursued:

Green Building Index (GBI)

The use of resources in existing buildings is currently either not measured at all, or measured inappropriately – mainly due to the complexities and cost of accurate measurement; this results in the inefficient use of resources. This project involves conducting research on the current status of measuring the use of resources in existing buildings, and the subsequent development of an appropriate simple measuring system (metric) for building managers, architects, engineers, and technicians to identify and quantify opportunities for 'green' resource engineering.

Green Manufacturing Index (GMI)

This research is an expansion of the current UFS-merSETA Green Building Index and aims to optimise the use of resources and energy in manufacturing processes. Specifically aimed at manufacturing and related processes, we research the construction of a dynamic measuring system to rate the specific manufacturing process according to a standard that will typically be a weighted combination of safeguarding energy, carbon footprint minimisation, and resource optimisation.

The proposed system will be based on the design of an index that will involve both modelling and measurement of several manufacturing processes. This will ultimately culminate into a Decision Support System (DSS) and will be made available to operational managers and process engineers to benchmark, and thus manage, the manufacturing processes from the perspective of 'green sustainability'.

Energy Efficient Building Materials

The results from the GBI project are yielding information that will allow us to apply a range of new materials to minimise energy consumption in existing buildings. This research will result in better understanding of the specific application(s) for new generation energy-efficient materials. The project investigates the need for high performance materials as part of the particular building sector GBI case studies.

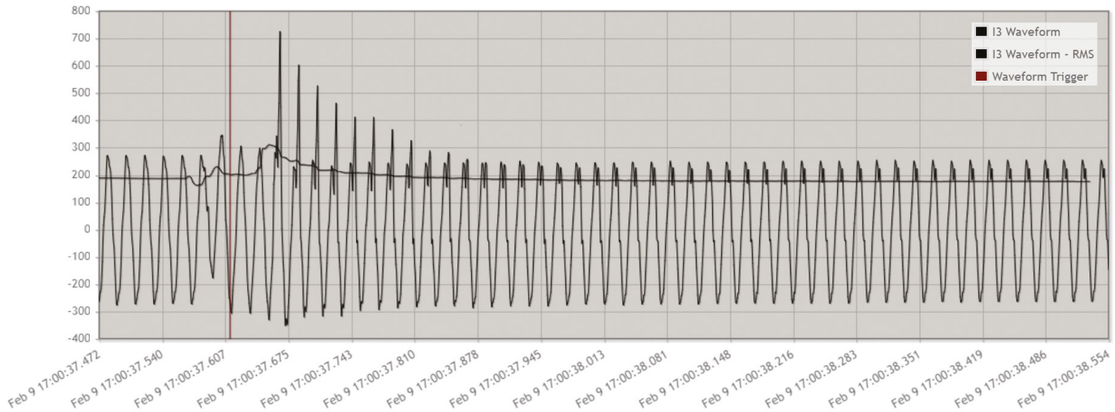
Centre for Data and Digital Engineering (CDDE)

The CDDE is exploring smart grid technology as a priority project, with the aim to create a blue-print for a smart grid to assist industry. There will be spin-offs for optimising the use of energy. The CDDE has facilitated numerous UFS collaborations across several departments and there is already robust participation from industry.

Grid-related research

At the core of the UFS grid-related research is a smart grid that can be considered to be the natural evolution of power grids within the era of Big Data, Internet of Things (IoT) and Machine Learning. Smart grids offer efficient monitoring and control of resources (including e.g. electricity, water, steam, etc.) to promote savings and the protection of valuable infrastructure.

Most of the research in resource prediction undertaken in 2019 and 2020 was aimed at the utilisation of Gaussian Process Regression (GPR) in different energy fields. GPR is currently considered as a golden thread that serves several energy fields with stochastic processes. Several applications were found in the forecasting of solar power, wind power and consumer load prediction. The acquisition of the advanced ION9000 meter in 2020, enabled the project to capture power quality transients that incorporate a range of physics and grid protection problem sets.

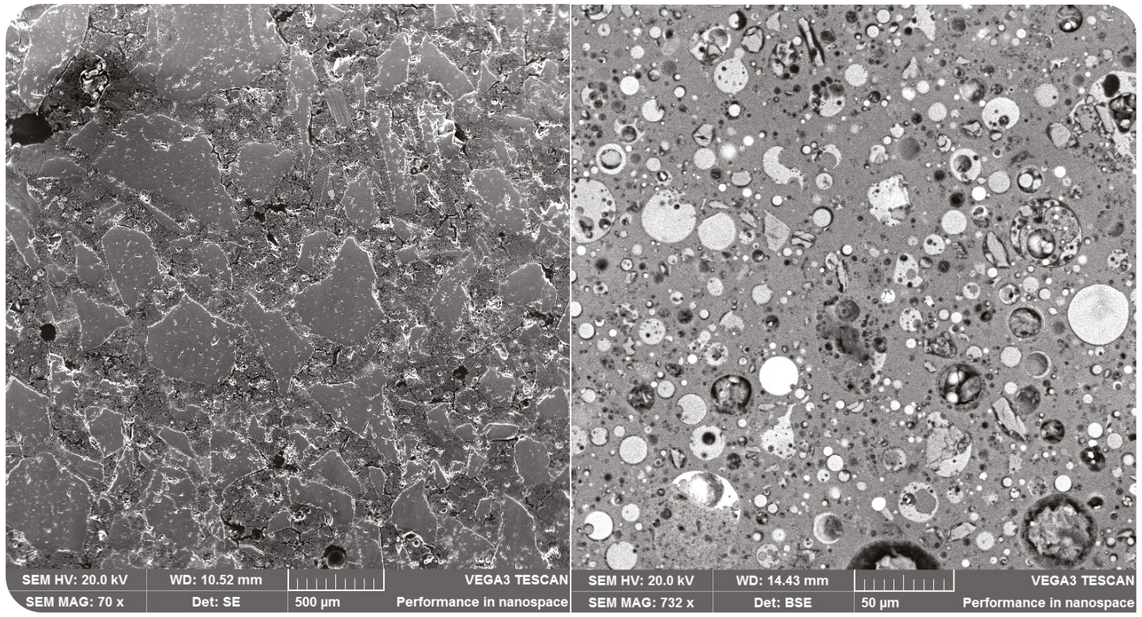


The power quality transients captured by the new ION9000

Aimed at smart grid status, the UFS will improve resource service delivery to its staff and students, while sculpting a digital twin of the campus's power grid, consumer network and resource generators. Linked to this core is further research in grid protection, as well as energy IoT, data methodologies, meter infrastructure, communication infrastructure, best practices, policies, cyber security cases, PV Hydrogen technology, energy devices based on magnetic/electric field interactions, energy modelling, grid topology/grid protection and IoT driven optimised maintenance.

One-part geopolymer cement

The cement industry is responsible for approximately 6% of the overall carbon emissions worldwide; as a result, the construction industry is facing criticism regarding environmental impacts caused by the production of conventional cement. The main objective of this project is to formulate a user-friendly geopolymer binder that can be activated by adding water and cured at normal ambient temperatures. Dr Abdolhossein Naghizadeh conducts research on green concretes based on industrial waste materials. In 2020 he published the findings of a study on the effect of different ingredients on the properties of geopolymer concrete produced using coal ash.



Microscopic feature of fly ash-based green concrete, captured by the Scanning Electron Microscope (SEM) at the Department of Geology



Dr Abdolhossein Naghizadeh with the SEM equipped with Energy Dispersive Spectroscopy (EDS)

Characterisation of alternative cements (Inter-university collaboration)

This project consists of several research programmes on different aspects of alternative cements based on South African industrial by-products. The scope of the project includes mix design of fly ash geopolymer concrete, ambient-cured geopolymer cement, 3D printing of concrete, etc.

NATIONAL AND INTERNATIONAL COLLABORATION

Engineering Sciences has maintained its international collaboration on Renewable Hydrogen integration studies with the University of KU Leuven in Belgium.

Collaboration with the University of Johannesburg and the University of KwaZulu-Natal was started on the cement-related research projects.

STAFF MATTERS

During 2020, Dr JM Maritz and Dr A Naghizadeh joined the staff as Lecturers, and Mr SJ Erasmus as Research and Development Engineer, while Mr TG Gropp and Mr F Blignaut joined the staff as temporary research assistants. Prof HJ Marx retired and Mr NB Bernstein resigned.

Mr JF Lubbe obtained his MSc (Mechanical Engineering) degree from the University of Stellenbosch. The title of his dissertation was ‘Evaluating the Potential of Gaussian Process Regression for Data-driven Renewable Energy Management’.

RESEARCH OUTPUTS

Research Articles

Lubbe, F., Maritz, J. & Harms, T. 2020. Evaluating the Potential of Gaussian Process Regression for Solar Radiation Forecasting: A Case Study. *Energies* 2020(13): 5509.

Naghizadeh, A. & Ekolu, S.O. 2020. Effects of compositional and physico-chemical mix design parameters on properties of fly ash geopolymer mortars. *Silicon.* DOI: 10.1007/s12633-020-00799-2.

STAFF (2020)

Head of Department: Mr LF Lagrange

Associate Professor: Prof HJ Marx
Lecturers: Mr NB Bernstein (permanent), Dr JM Maritz (permanent), Dr A Naghizadeh (permanent), Mr CJB Bezuidenhout, Ms EP Boje, Mr JA Deacon, Mr JJ Haefele and Mr C Potgieter
Junior Lecturers: Ms HC Oosthuizen and Mr IP Scott
Researchers: Mr SJ Erasmus, Mr F Blignaut and Mr TG Gropp
Programme Director: Prof Johan Venter
Senior Assistant Officer: Ms C du Toit
Assistant Officer: Ms ZV Mngomezulu
Senior Technician: Mr HJdW Lubbe



Mr Louis Lagrange



Ms Zanele Mngomezulu



Ms Christine du Toit



Mr Nathan Bernstein



Dr Jacques Maritz



Dr Hossein Naghizadeh



Mr Stefaans Erasmus



Mr DeWet Lubbe



Mr Zirke le Roux



Prof Hendrik Marx

DEPARTMENT OF GENETICS

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OVERVIEW OF 2020

The Department of Genetics presents undergraduate and postgraduate programmes in the broad fields of Genetics and Forensic Genetics / Forensic Science. The Department has 18 permanent members of staff. In addition, a number of affiliated staff contribute significantly to research and postgraduate training. Research and specialised training is carried out under the themes of Behavioural Genetics, Conservation- and Population Genetics, Human Genetics, Molecular Systematics and Plant Molecular Genetics and Genomics, Forensic Genetics, and Forensic Science. Developments and achievements in these fields are reported in the sections that follow.

During 2020, several staff members served on national councils or boards of professional societies. One member of staff (Dr Riël Coetzer) obtained his NRF-rating – increasing the number of rated scientists in the Department to three – and one staff member (Frank Maleka) completed his PhD, with seven out of 12 permanents academic members of staff now PhD-qualified. An MSc student in the Department (Kyla Dooley) was runner-up in the UFS institutional Three-Minute Thesis Competition.

The COVID-19 pandemic, and the need for remote teaching that resulted, had a significant effect on undergraduate and postgraduate activities. Nevertheless, staff and students managed to adapt to new modes of delivery and we are satisfied that the 2020 programme was completed without sacrificing quality. For the postgraduate programme, a lab-booking system was introduced to ensure social distancing in laboratories while research and training continued, and student seminars were delivered online.

In terms of research outputs, the Department of Genetics produced 26 journal papers and two book chapters. Included in the journal papers is one on susceptibility of vervet monkeys to COVID-19, one of the first papers produced on a COVID-19 related topic by the University.

Travel restrictions resulted in the cancellation of most research-related field trips, and the annual conferences of many societies were cancelled, leading to only three conference outputs for 2020.

ACHIEVEMENTS

Staff Achievements

Dr Karen Ehlers was appointed for another term on the National Forensic Oversight and Ethics Board (NFOEB). She was also appointed as a chairperson of an *ad hoc* subcommittee to review the turnaround strategy of the Forensic Science Laboratory (FSL) of the South African Police Services (SAPS).



Dr Karen Ehlers



Kyla Dooley

Prof Paul Grobler continued to serve on the council of the Southern African Wildlife Management Association (SAWMA).

Dr Riël Coetzer, Senior Professional Officer, received his NRF Y2-rating, bringing the number of NRF-rated staff members in the Department to three.

The programme to fast-track the PhD studies of six members of staff continued under the mentorship of Prof Renate Rebello. As a first output from this initiative, Dr Frank Maleka was awarded his PhD in 2020. His thesis made a significant contribution to the Clivia breeding industry by presenting the first *Clivia miniata* tepal transcriptome.

Student Achievements

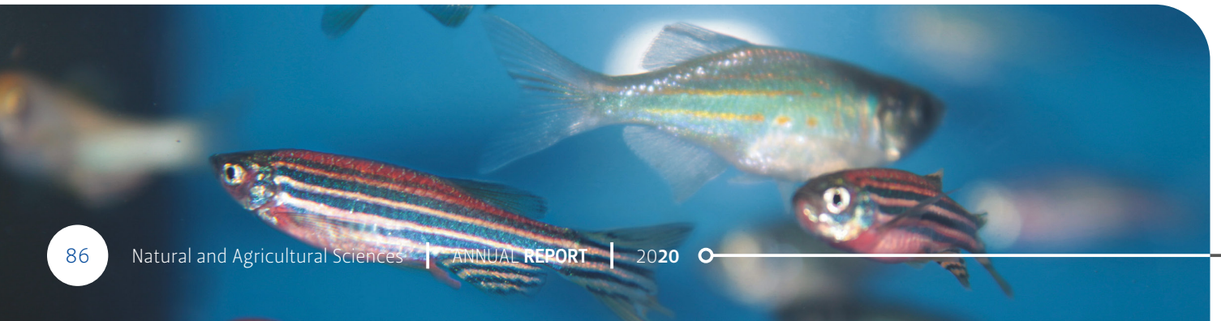
Ms Kyla Dooley was the runner-up in the Three-Minute Thesis Competition hosted by the UFS. She presented her research on the use of male-specific DNA in the analysis of DNA evidence collected after crimes of a sexual nature have been committed.

TEACHING AND LEARNING

During the reporting period, 14 modules were presented at undergraduate level and 18 modules at honours level. The large growth in second-year numbers in 2019 continued to third-year modules (GENE3714, GENE3734, GENE3744) in 2020, with numbers in the third-year increasing from around 160 per module to ~240. While good for sustainability, these numbers present significant challenges in terms of assessment and practicals. However, in 2020, the numbers of first-year students dropped from 599 to 517, and for second-year students from 388 to 240.

Any report on Teaching and Learning in 2020 is unavoidably dominated by the effects of the COVID-19 pandemic, and the need for remote teaching that resulted. In many ways, staff and students managed to adapt to new modes of delivery, either online or through much reduced contact time. It was necessary to reinvent modules to provide additional learning opportunities, and thus was both challenging and exciting. Many meaningful discussions and potentially permanent changes originated from these changes. The effect of remote teaching on student performance varied. For example, the pass rate increased from 86.6% to 98.1% for GENE2616 and 75% to 100% in HMBG2614. On the other hand, pass rates under lockdown conditions dropped compared to previous years in several modules (in BLG1623 from 93.0% to 73.5%; in GENE3714 from 88.2% to 83.7%, and in GENE3734 from 96.6% to 90.0%).

Prof Renate Rebello successfully completed two independent Sector Education Training Authority (SETA) courses – on Assessing (Conducting Outcome-based Assessment) and



Moderating (Outcome-based Assessments). These courses were undertaken through the UFS Division for Staff Training and Development and the course was facilitated by The Peritum Institute.

RESEARCH AND INNOVATION

In terms of research outputs, the Department of Genetics produced 26 journal papers, two book chapters, and three conference presentations in 2020. The Department produced one of the first papers on Campus related to COVID-19. The paper, published in *PlosONE*, dealt with the susceptibility of vervet monkeys to COVID-19, and resulted from a collaboration between Prof Grobler and Dr Coetzer, Prof Felicity Burt (UFS Department of Medical Virology) and several other collaborators from the USA. Prof Christopher Schmitt from Boston University was the lead author.

Travel restrictions due to COVID-19 resulted in the cancellation of a number of research-related field trips. Notwithstanding these limitations, several student and staff projects made good progress. The Departmental Research Committee, originally formed some time ago, was re-established in 2020 and some of our methods and modes of linkage with institutional Ethics Committees now serve as a model for other similar committees in the Faculty.

A significant development relating to research in 2020 was the requirement by the Department of Agriculture, Forestry and Fisheries (DAFF) that all laboratories handling animal samples should be BSL2 (Biosafety Level 2) compliant before Section 20 veterinary approvals can be granted. Since this impacted on several sections within the Department of Genetics, and several other departments in the Faculty, Prof Grobler arranged a webinar with DAFF, UFS researchers and the Vice-Rector Research, Innovation and Internationalisation, during which fruitful discussions were held.

Research in the Department is conducted under seven broad themes, namely Behavioural Genetics, Conservation- and Population Genetics, Human Genetics, Molecular Systematics and Plant Molecular Genetics and Genomics, Forensic Genetics and Forensic Science.

Behavioural Genetics

This research group focuses on the influence of neurotransmitter systems and their underlying genes on behaviour in humans and animals. Progress has been made in the study on juvenile delinquency, with an invitation to an international conference during 2020 (postponed to 2021). Collaboration with an equine behaviour specialist was also established.

Conservation- and Population Genetics

Conservation Genetics aims to study and conserve natural patterns of genetic diversity and differentiation within and between animal populations, and the processes that sustain these patterns. A number of focus areas in conservation genetics are in the spotlight during training and research in the Department of Genetics, including the study of genetic diversity, the preservation of natural patterns of geographic genetic structure, hybridisation between closely related species, and the adaptive significance of variation.

Highlights from this group included significant progress in the use of our zebrafish system and associated experimental work, the start of a large insect barcoding project, focusing on the Eastern Cape; and significant growth in projects relating to mussels, covering the Free State and Northern Cape, the Okavango Delta in Botswana, and the Northern Cape coast.



Mart-Mari Myburgh and Dr Riël Coetzer conducting fieldwork on invertebrate biodiversity in the central Winterberg mountains of the Eastern Cape

Human Genetics

The human genetics team members focus on genetic aspects of HIV, diabetes, psychiatric disorders, pharmacogenetic and pharmacokinetic animal studies, and pre-eclampsia. The Highly Active Antiretroviral Therapy (HAART) to HEART research study, carried out at the Pelonomi Hospital on HIV and diabetes co-morbidities, reached a participant level of 500 community members having being assessed and referred for treatment.

Plant Molecular Genetics and Genomics

The research group is mainly focussed on elucidating the genetics of flower pigmentation in ornamental *Clivia miniata* – using a variety of approaches to identify genes in the *C. miniata* genome, profile the expression of specific transcripts of interest during flowering and also screen pigmentation genes for genetic variants that associate with variation in flower colour. The genetic basis of clonal variation in cultivars of prickly pear is also studied.

Molecular Systematics

The focus in this research group is on mycology, biosystematics, biodiversity, fungal conservation, nanoparticles as antimicrobials, and enzymatic activities. Dr Gryzenhout, who leads this group, is actively involved with citizen scientists in South Africa, resulting in members of the public sending samples to the group for identification.

Other focus areas in 2020 were the macrofungi of South Africa, invasion biology of ectomycorrhizal fungi in South Africa, psychedelic mushrooms, fungal ecology, industry applications from fungi, and pecan health.

Forensic Genetics and Forensic Sciences

The research focus is on improving post-mortem interval estimation using gene expression studies of insects, cuticular hydrocarbon dating and soil microbes; investigating Y-STR loci in different population groups in South Africa, Zimbabwe and Botswana; and the statistical analysis and interpretation of genomic DNA Short tandem repeat (STR) databases in South Africa. In 2020, over 300 males were successfully DNA-typed with Y-STR markers. Section 20 approval was obtained for research into the improvement of the estimation of the post-mortem interval.

In terms of Forensic Chemistry, the focus was on the various types of drug evidence recovered from crime scenes.

ENGAGED SCHOLARSHIP

Prof Grobler served a subject editor for two accredited journals – *Mammalian Biology* (Springer) and *African Journal of Aquatic Sciences* (Francis & Taylor).

A number of staff members acted as external examiners for students at other South African tertiary institutions.

NATIONAL AND INTERNATIONAL COLLABORATION

Several staff members were engaged in collaborative projects. Stakeholders include national and provincial conservation departments, the National Zoological Gardens-South African Biodiversity Institute (NZG-SANBI), and SAPS, as well as various hospitals, schools, equestrian centres, farmers and plant breeders.

POSTGRADUATE STUDENTS

The total number of postgraduate students registered in the Department of Genetics in 2020 was 40 honours, 45 MSc and 21 PhD students.

As with undergraduate modules, most of the modules in the honours programme were heavily impacted by the lockdown. All honours modules were modified to be year-long modules, which assisted greatly. Lecturers continued with online teaching and assessment; however, when students returned for part of the second half of the year, there was some opportunity for face-to-face interaction and laboratory work, and most lecturers were relieved to be able to go back to this mode of teaching.

The biggest impact of COVID-19 was on the year-long, laboratory-based honours research projects. An online scheduling system was implemented for the laboratories, but laboratory-time per student could not match the levels of previous years due to the need for social distancing. Research projects were modified to some extent to reduce sample sizes in projects, and good results were obtained. We are satisfied that high quality training in laboratory techniques was maintained, but at the expense of volume in projects.

The COVID-19 restrictions also impeded training on the use of the ABI3500 genetic analyser. Training on this instrument is mandatory for the Forensic Genetics students as they are trained with a view to employment in laboratories that use such instruments.

Our MSc and PhD students were also impacted by the reduced laboratory-time and the aforementioned introduction of a booking and scheduling system. While many projects made good progress, some delays were inevitable. The Department normally holds postgraduate student and staff research presentations every Wednesday; however, when this was not possible due to the lockdown, we implemented online presentations.

Just before lockdown started in March 2020, a number of staff and postgraduate students from the Evolutionary Genetics group visited Doornkloof Nature Reserve and Hunters Moon Game Farm, in the Northern Cape. This proved an extremely productive exercise as students gained exposure to practical conservation management. Students also had the opportunity to present their research. This will become an annual event and will be resumed as soon as COVID-19 allows.



Postgraduate students and staff at the Doornkloof Nature Reserve, from the left Mr Antonie Kloppers (MSc), Ms Motlalepule Mosala (Hons), Ms Bongi Mbongo (Hons), Ms Hannah Janse van Vuuren (MSc), Ms Mart-Mari Myburgh (MSc), Ms Kathryn Step (Hons), Mr Thabang Madisha, Dr Riël Coetzer, Prof Paul Grobler, Mr Heath Cronje (Manager: Doornkloof and PhD student) and Mr Victor Kroon (Hunters Moon Game Farm)

Ms Kerissa Chetty and Ms Lulama Nkonka obtained their MSc degrees in 2020.

PhD degrees were awarded to the following candidates:

Allen, Anri
Thesis: Genetic variation in selected South African pecan nut (*Carya illinoinensis*)
Promoters: Prof JJ Spies and Dr GM Coetzer

Maleka, Frank
Thesis: Sequencing and characterization of the *Clivia miniata* flower transcriptome
Promoters: Prof JJ Spies and Prof J Albertyn

Mthembi, Meshack
Thesis: Chemical profiling of the street cocktail drug 'Nyaope' in South Africa using gas chromatography-mass spectrometry (GC-MS)
Promoters: Dr EM Mwenesongole, Prof M Cole and Prof JP Grobler

POSTDOCTORAL RESEARCH FELLOWS

The Department hosted one postdoctoral fellow in 2020 – Dr Soumya Gosh (from India), working in the Biosystematics research group of Dr Gryzenhout.

STAFF MATTERS

Prof Antoinette Kotze, who has a long association with the Department as collaborator and Affiliated Associate Professor; was appointed as Affiliated Full Professor.

Congratulations to Dr Gerda Marx, Mrs Zurika Murray and Mrs Sue-Rica Schneider and their partners who all became parents of new babies during a very difficult year.

Ms Elmarie Blom and Ms San-Marie Burger were appointed on a part-time basis to stand in for staff members on maternity leave.

RESEARCH OUTPUTS

Research Articles

Alhouri, A., Salloum, A., Harfouch, R.M. & Soumya, G. 2020. Possible Side Effects of using Detergents during the Covid19 Pandemic in Syria. *Annals of Clinical Cases*. 1(4):1023.

Bairu, M.W., Coetzer, W.G. & Amelework, A.B. 2020. Development of an SSR-based DNA fingerprinting method for black wattle (*Acacia mearnsii* De Wild). *New Zealand Journal of Forestry Science* 50:6. DOI:m10.33494/nzjfs502020x56x.

Botham, J.L., Haddad, C.R., Gryzenhout, M., Swart, V.R. & Bredenhand, E. 2020. High genetic diversity of spider species in a mosaic montane grassland landscape. *PLoS ONE* 15(6): e0234437. DOI: 10.1371/journal.pone.0234437.

Boyer, D., Jahnke, L.M., Mulligan, C.A. & Turner, T.R. 2020. Members of the 2019 workshop on Data Sharing in Biological Anthropology. Response to the Letters to the Editor concerning AJPA Commentary on Data Sharing in Biological Anthropology: Guiding principles and best practices. *American Journal of Physical Anthropology*. 172: 333-336. DOI: 10.1002/qjpa.24065.

Breytenbach, N., Grobler, J.P. & Bindeman, H. 2020. Performance trait analysis and genetic diversity of the SA Boerperd. *South African Journal of Animal Science* 50(1): 99-108. DOI: 10.4314/sajas.v50i1.11.

Chebii, V.J., Oyola, S.O., Kotze, A., Entfellner, J.B.D., Mutuku, J.M. & Agaba, M. 2020. Genome-Wide Analysis of Nubian Ibex reveals Candidate Positively Selected Genes that contribute to Its adaptation to the desert Environment. *Animals* 10(11): 2181. DOI:10.3390/ani10112181.

Czenze, Z.J., Naidoo, S., Kotze, A. & McKechnie, A.E. 2020. Bat thermoregulation in the heat: Limits to evaporative cooling capacity in three southern African bats. *Journal of Thermal Biology* 89: 102542.

Dalton, D.L., De Bruyn, M., Thompson, T. & Kotzé, A. 2020. Assessing the utility of DNA barcoding in wildlife forensic cases involving South African antelope. *Forensic Science International Reports* 2: 1-8.

Du Toit, Z., Dalton, D.L., Du Plessis, M., Jansen, R., Grobler, J.P. & Kotze, A. 2020. Isolation and characterization of 30 Short Tandem Repeats (STRs) for Temminck's ground pangolin (*Smutsia temminckii*) and potential for cross amplification in other African species. *Journal of Genetics* 99: 20.

Edelhoff, H., Zachos, F.E., Fickel, J., Epps, C.W. & Balkenhol, N. 2020. Genetic analysis of red deer (*Cervus elaphus*) administrative management units in a human-dominated landscape. *Conservation Genetics* 21: 261-276. DOI: 10.1007/s10592-020-01248-8.

Ghosh, S., Kam, G., Nijjer, M., Stenner, C. & Cheeptham, N. 2020. Culture dependent analysis of bacterial diversity in Canada's Raspberry Rising Cave revealed antimicrobial properties. *International Journal of Speleology* 49(1): 43-53. DOI: 10.5038/1827-806X.49.1.2291.

Gryzenhout, M., Cason, E.D., Vermeulen, M., Kloppers, G.A.E., Bailey, B. & Ghosh, S. 2020. Fungal community structure variability between the root rhizosphere and endosphere in a granite catena system in Kruger National Park, South Africa. *Koedoe* 62(2): a1597. DOI: 10.4102/koedoe. v62i2.1597.

Gryzenhout, M., Vermeulen, M., Pambuka, G. & Jacobs, R. 2020. First report of various Fusarium species from the Stevenson-Hamilton Supersite granite catena system in the Kruger National Park, South Africa. *Koedoe* 62 (2): a1599. DOI: 10.4102/koedoe.v62i2.1599.

Jasinska, A.J., Dong, T.S., Lagishetty, V., Karke, W., Jacobs, J., Schmitt, C.A., Cramer, J. D., Coetzer, W. G., Grobler, J. P., Turner, T.R., Freimer, N., Pandrea, I. & Apetrei, C. 2020. Shifts in microbial diversity, composition, and functionality in the gut and genital microbiome during a natural SIV infection in vervet monkeys. *Microbiome* 8: Article 154. DOI: 10.1186/240168-020-00928-4

Kemp, L.V., Kotze, A., Jansen, R., Dalton, D.L., Grobler, J.P. & Little, R.M. 2020. Review of trial reintroductions of the long-lived, cooperative breeding Southern Ground-Hornbill *Bucorvus leadbeateri*. *Bird Conservation International* 30(4): 1-26.

Kumar, P., Mathpal, M.C., Inwati, G.K., Ghosh, S., Kumar, V., Roos, W.D. & Swart, H.C. 2020. Optical and surface properties of Zn doped CdO nanorods and antimicrobial applications. *Colloids and Surfaces A: Physicochemical and Engineering Aspects* 605: 125369. DOI: 10.1016/j.colsurfa.2020.125369.

Linden, B., Dalton, D.L., Ralph, T.M.C., Silva, I., Kotze, A. & Taylor, P.J. 2020. Adding another piece to the southern African Cercopithecus monkey phylogeography puzzle. *African Zoology* 55(4): 351-362. DOI: 10.1080/15627020.2020.1835534.

Luther, I., Maree, L., Kotze, A., Hildebrandt, T., Göritz, F., Hermes, R. & Van der Horst, G. 2020. Sperm motility, kinematics, morphometry and morphology over two seasons in free-ranging African elephants (*Loxodonta africana*). *Reproduction, Fertility and Development* 32(4): 425-438. DOI: 10.1071/RD19182.

Magliolo, M., Prost, S., Orozco-terWengel, P., Burger, P., Kropff, A.S., Kotze, A., Grobler, J.P. & Dalton, D.L. 2020. Unlocking the potential of a validated single nucleotide polymorphism array for genomic monitoring of trade in cheetahs *(Acinonyx jubatus). Molecular Biology Reports.* 48(1): 171-181 (Online). DOI: 10.1007/s11033-020-06030-0.

Ngcauzele, A., Van der Horst, G., Kotze, A., Jonker, T. & Maree, L. 2020. Quantitative sperm characteristics of Tankwa goats with special reference to hyperactivated motility. *South African Journal of Animal Science* 50(5): 687-699. DOI: 10.4314/sajas.v50i5.6

Schmitt, C. A., Bergey, C. M., Jasinska, A. J., Ramensky, V., Burt, F., Svardal, H., Jorgensen, M. J., Freimer, N. B., Grobler, J. P. & Turner, T. R. 2020. ACE2 and TMPRSS2 variation in savannah monkeys (Chlorocebus spp.): Potential risk for zoonotic/anthroponotic transmission of SARS-CoV-2 and a potential model for functional studies. *PLOS ONE* 15(6), e0235106. DOI: 10.1371/journal.pone.0235106

Smith, R.M., Kotzé, A., Grobler, J.P. & Dalton, D.L. 2020. Genetic diversity and molecular characterization in the Toll-like receptor 9 of Cape Mountain Zebra *(Equus zebra zebra)* sub-populations. *Infection, Genetics and Evolution* 78: 10448. DOI: 10.1016/j.meegid.2019.104118.

Smith, R.M., Kotze, A., Grobler, J.P. & Dalton, D.L. 2020. Identifying sequence variation in cation channel sperm associated genes in Cape mountain zebra *(Equus zebra zebra)*. *South African Journal of Animal Science* 50(6): 807-813. DOI: 10.4314/sajas.v50i6.6.

Udensi, U.O., Emeagi, I.L., Thomas, T.L., Ghosh, S. & Achilonu, C.C. 2020. Genetic Polymorphism and Lineage of Pigeon Pea [Cajanus cajan (L.) Millsp.] inferred from Chloroplast and Nuclear DNA gene regions. *Arabian Journal for Science and Engineering* 4(11). DOI: 10.1007/s13369-020-05036-x.

Zhao, Z., Heideman, N., Grobler, J.P., Jordaan, A., Bester, P. & Hofmeyr, M.D. 2020. Unraveling the diversification and systematic puzzle of the highly polymorphic Psammobates tentorius (Bell, 1828) complex (Reptilia: Testudinidae) through phylogenetic analyses and species delimitation approaches. *Journal of Zoological Systematics and Evolutionary Research* 58(1): 308-326. DOI: 10.1111/jzs.12338.

Books/Chapters in Books

Kotze, A., Ogden, R., Gaubert, P., Ahlers, N., Ades, G., Nash, H. & Dalton, D.L. 2020. Understanding illegal trade in pangolin through forensics: application in law enforcement. In: *Pangolins: Science, Society and Conservation*. D.W.S. Challender, H.C. Nash & C. Waterman (Eds). Academic Press (ISBN: 978-0-12-815507-3). pp. 322-332.



Pietersen, D.W., Jansen, R., Swart, J., Panaino, W., Kotze, A., Rankin, P. & Nebe, B. 2020. Temminck's pangolin *Smutsia temminckii* (Smuts, 1832) In: *Pangolins: Science, Society and Conservation*. D.W.S. Challender, H.C. Nash & C. Waterman (Eds). Academic Press (ISBN: 978-0-12-815507-3). pp. 176 -193.

Conference Contributions

Conference Papers/Posters

Kotze, A. 2020. *Collaborative goat research: unique Egypt/ South Africa opportunities*. Paper delivered at the Symposium: The Use of Genomics in Conservation Of Genetics Resources and Bioinformatics Analysis, Cairo, Egypt. 8 January.

Magliolo, M., Dalton, D. Burger, P., Prost, S., Orozco-terWengel, P., Kropff, S., Kotze, A. & Grobler, JP. 2020. *Validation of a Single Nucleotide Polymorphism marker set for forensic parentage verification in cheetah*. Paper delivered at the 4th Annual Meeting in Conservation Genetics, Frankfurt, Germany. 26-28 February.

Gagnon, C.M., Svardahl, H., Jasinska, A.J., Freimer, N.B., Grobler, J.P., Turner, T.R. & Schmitt, C.A. 2020. *Evidence of Selection in the UCP1 Gene Region Suggests Local Adaptation to Irradiance Rather than Cold Temperatures in Savanna Monkeys (Chlorocebus spp.)*. Paper delivered at the 89th Annual Meeting of the American Association of Physical Anthropologists, Los Angeles, USA. 15-18 April.

STAFF (2020)

Head of Department: Prof JP Grobler

Professor: Prof JP Grobler
Associate Professor: Prof R Rebello
Senior Lecturers: Dr K Ehlers, Dr M Gryzenhout and Dr G Marx
Lecturers: Mrs H Bindeman, Dr S Brink, Dr F Maleka, Mrs Z Murray, Mrs S Schneider, Mr T Viljoen and Mrs L Wessels
Junior Lecturer: Miss Z Raffie

Affiliated Professors: Prof A Kotze and Prof F Zachos
Affiliated Associate Professor: Prof B Reilly
Affiliated Senior Lecturer: Dr E Mwenesongole
Affiliated Lecturer: Lt-Col A Lucassen
Research Fellow: Prof JJ Spies
Programme Directors: Dr K Ehlers and Mrs Z Murray
Officers - Professional Services: Dr WG Coetzer and Mr T Madisha
Senior Assistant Officer: Ms B Henn
Assistant Officer: Ms B Segoje
Technician: Ms B Radise

DEPARTMENT OF GEOGRAPHY

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OVERVIEW OF 2020

The Department of Geography is situated on two of the three campuses of the University of the Free State (UFS). Of the total number of 19 staff members, 11 are on the Bloemfontein Campus and 8 on the Qwaqwa Campus.

The 2020 academic year presented many challenges due to the COVID-19 pandemic; however, the staff managed to fulfil their duties through the blended learning approach adopted by 26 public universities across the country. Several successes were celebrated in the Department – with two new doctoral holders, and an associate professorship and full professorship being awarded.

ACHIEVEMENTS

Staff Achievements

Prof Samuel Adelabu was appointed as the Chair of the Investigating Committee of the South African Council for Natural Scientific Professions (SACNASP).



Prof Samuel Adelabu

Adriaan van der Walt obtained his PhD from the University of Witwatersrand in December 2020; his thesis was titled 'An analysis of extreme temperature events in South Africa: 1950-2015'. Dr Van der Walt presented at the Alliance for Collaboration on Climate and Earth System Science (ACCESS) Habitable Planet Workshop (HPW) Research Conference (8 to 10 December 2020) at which he was one of three winners for the best PhD research paper presentations, for his paper 'Statistical classification of South African seasonal divisions on the basis of daily temperature data'.

Elizabeth Rudolph also obtained her PhD in 17 December 2020, from the University of Fort Hare, for her thesis titled 'Towards a reconstruction of Marion Island's glacial history'.



Dr Liezel Rudolph on Marion island

Prof Adelabu and Dr Van der Walt were elected as board members of the Society of South African Geographers (SSAG), and Dr Van der Walt was also elected as treasurer of the SSAG Student and Young Professionals Group. Dr Sifiso Xulu and Dr Van der Walt received the SSAG Centenary Award.

Prof Geofrey Mukwada received a C2-rating from the National Research Foundation (NRF) and has been promoted to the level of full professor. He was also admitted into the Responsible Research and Innovation Networking Globally (RRING) Project, which is coordinated by the United Nations Scientific and Cultural Organization (UNESCO). The main aim of this project is to bring Responsible Research and Innovation (RRI) into the linked up global world to promote mutual learning and collaboration.

TEACHING AND LEARNING

The second-year Urban Geography students (GEOH2614) collaborated with the library staff who facilitated sessions on searching and citing references; this initiative was spearheaded by Mrs Tobeka Mehlomakhulu.

The development of qualitative research practicals was included in the second-year curriculum.

The third-year students attended an excursion to rural areas around Thaba Nchu to enrich their knowledge about the lack of development, lived-challenges, and constraints in rural areas.

RESEARCH AND INNOVATION

Prof Adelabu continued his research on fire risk analysis in mountainous protected areas which started in 2016 as part of the Afromontane Research Unit (ARU) on the Qwaqwa Campus. Part of the project was funded by NRF-Thuthuka from 2017 to 2019.

Dr Jay le Roux is establishing a national input database to run the Soil and Water Assessment Tool (SWAT) model in a GIS, that will be made available as an 'open-source' baseline, in order to standardise SWAT modelling efforts in South Africa. This study, funded by the Water Research Commission (WRC), will provide well-structured and geo-spatial input datasets in 'cloud storage', including digital elevation data, drainage networks, land cover codes, soil map and attribute tables, and weather statistics required as input by SWAT.

During November 2020, Dr Le Roux and two masters' students, Lefa Morake and Nardus Bosman, collaborated with Prof David Hedding from Unisa, to study gully erosion in the Tsitsa River

Catchment, in the Eastern Cape. In order to meet basic societal needs, the Department of Water and Sanitation (DWS) is planning water resource developments on the Tsitsa River, nested within the Mzimvubu River Catchment – the only large river network in South Africa without a dam. Unfortunately, large parts of the catchment are severely eroded due to the presence of highly erodible soils. One of the research aims is to use unmanned aerial vehicles (UAVs) to map gullies in detail, including the extent of source areas where sediment is generated, as well as the spatial extent of sediment storages.



At Tsitsa Falls, from the left, Jay le Roux, David Hedding, Nardus Bosman and Lefa Moraka

Not only are these gully erosion features spectacular (being several kilometres long and over 100 metres wide), but gully erosion feeds massive amounts of sediment into the river network. A YouTube video illustrates the magnitude of a large gully network near Tsolo (Tsolo gully exploration: https://www.youtube.com/watch?v=nF9izujoGG0).

Restoration resources are usually limited and strategic information on sensitive and erosion-susceptible areas are required to avoid future degradation. In order to implement resources and investments optimally, it is important to prevent further erosion by protecting areas that are not eroded. Therefore, supported by the Department of Environmental Affairs, Forestry and Fisheries – National Resource Management, Dr Le Roux is also mapping vegetated and/or gully-free areas that are susceptible to gully development in South Africa, as well as the estimated sediment yield potential from the susceptible areas if gully development occurs. An article (Le Roux and Van der Waal, 2020) was published in the *South African Geographical Journal* and results were also presented online at the European Geosciences Union (EGU) General Assembly in May 2020.

Mrs Tobeka Methomakhulu has established a research niche on land issues in rural areas, on which a paper has been submitted.

Prof Mukwada founded the Mountain Climate Research Group, comprising staff, postdoctoral research fellows, and postgraduate students who are doing research on climate change. Membership



Gully erosion near Tsolo in the Eastern Cape
Photo credit: Prof David Hedding, Unisa

is open to everyone at the UFS, irrespective of faculty. He also started the University Partnership Initiative (UPI), which, with funding from the United States (US) Embassy, supports partnerships between South African and US universities. The current partnership is between the UFS and the Appalachian State University. Additionally, Prof Mukwada is managing an NRF-funded project to set up automated weather stations in the Drakensberg Mountains.

In collaboration with other academics at the UFS and the Appalachian State University, Prof Mukwada received a US Embassy-funded UPI Grant for the Mountain-to-Mountain Research Project, which will expand research, leadership and academic curricular horizons at the Qwaqwa Campus and the UFS as a whole. He also successfully coordinated the University Staff Doctoral Programme through the unprecedented challenges presented by the COVID-19 pandemic.

ENGAGED SCHOLARSHIP

Dr Van der Walt presented his PhD findings and implications thereof in several news reports and radio interviews. These included *Rapport* ('Somer bult sy spiere al meer', 29 November 2020), *Cape Argus* ('South Africa is now having longer summers', 23 November 2020), *The Citizen* ('South African summers are getting longer - study', 19 November 2020), *Business Insider* ('South Africa's summer lasts for six months, say researchers – and starts earlier in Johannesburg than in Cape Town', 30 September 2020), Radio Sonder Grense (RSG) Monitor Potgooi (2 December 2020), SAfm The Jet Set Breakfast (21 November 2020) and SAfm Sunrise (23 November 2020).

Findings from Dr Rudolph's PhD were published in *The Conversation*, an online science communication publication, and in an online edition of an Afrikaans newspaper, *Die Vryeweekblad*. She also spoke about the significance of these findings during a morning interview with SAfm.

As Chair of the Association of Polar Early Career Scientists of South Africa (APECSSA), Dr Rudolph coordinated an Early Career Researcher webinar on 15 September 2020, with over 11 speakers from South Africa's national polar science community. Among others, Prof Steven Chown, the President of the Scientific Committee on Antarctic Research (SCAR), joined the webinar from Melbourne, Australia, to give the keynote speech and opening session. This one-day webinar was attended by an average of 110 participants throughout the day. These included both young and established researchers from across the globe, in various disciplines within the sciences and humanities.

Dr Rudolph was also involved in compiling an expedition and travel guide aimed at young and early career researchers who embark on polar research expeditions. It also included extensive advice on conference preparation, international travel and making the most of international research and collaboration visits.

Prof Mukwada served as a member of the Thabo Mofutsanyana Disaster Advisory Forum.

NATIONAL AND INTERNATIONAL COLLABORATION

Prof Adelabu has active and continuing research and teaching collaborations with colleagues at the University of KwaZulu-Natal (UKZN), South African National Space Agency (SANSA), University of Limpopo, University of the Witwatersrand, Agricultural Research Council (ARC), University of Johannesburg, Walter Sisulu University, North-West University, University of Cape Town, University of Ibadan, University of Tokyo, among others.

Dr Le Roux was involved in the South African Land Degradation Monitor (SALDi) project, in collaboration with Friedrich-Schiller-University Jena, Germany, to explore a wide range of methodological approaches to assess land degradation and its dynamics over various spatial and temporal scales.

Overlapping with the SALDi project, he and Ms Marike Stander collaborated with the Northwest Agricultural and Forestry University in China, focusing on fingerprinting techniques (identify tracer[s] for erodible soils) and modelling of soil erosion processes in a research catchment in Ladybrand, within the Welbedacht Dam Catchment. 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.

Dr Le Roux also collaborated with Dr Althea Grundling from the ARC in a WRC-funded project titled 'Ecosystem resilience of headwater wetlands in two catchments, Eswatini and South Africa'. The project mapped different hydrogeomorphic wetland types, as well as determining the relationships between the distribution of wetlands types, underlying geology and related processes, including hydrology and geomorphology, illustrated with conceptual hydrological/geomorphology response diagrams.

Prof Mukwada continued an affiliate membership with the Department of Geography and WA Franke College of Forestry and Conservation at the University of Montana.

Dr Melissa Hansen continued her collaboration with the University of Tokyo and Akita International University in Japan, on the project investigating migration and sustainable development in Qwaqwa and Akita.

POSTGRADUATE STUDENTS

In 2020, 21 honours, 23 master's and 24 doctoral students were enrolled in the Department of Geography.

Nineteen (19) students graduated with their honours degrees, and three students with their MSc – M Semela and P Nxumalo in Environmental Geography (Qwaqwa), and K Setshedi in Plant Sciences (University of Witwatersrand – co-supervised by Prof Adelabu).

Three candidates completed and graduated with the PhD:

Adagbasa, Efosa
Thesis: Modelling Ecological Vulnerability to Fore in A Mountainous and Protected Area: A Remote Sensing and GIS Approach
Promoter: Prof S Adelabu

Onaolapo, Titilope
Thesis: Spatial Analysis of Housing Patterns in a Mountainous Area
Promoters: Dr T Okello and Prof S Adelabu

Pretorius, Anneri
Thesis: A Sustainable Rural Transport Framework: The Case of Maluti-A-Phofung Local Municipality
Promoter: Prof G Mukwada

POSTDOCTORAL RESEARCH FELLOWS

During 2020, the Department of Geography hosted one postdoctoral fellow – Dr Dapo Olusola, from Nigeria. Dr Olusola published four peer-reviewed journal articles and two peer-reviewed conference proceedings during the year, under the supervision of Prof Samuel Adelabu. He has one book chapter and five manuscripts under review.

Prof Mukwada has recruited two postdoctoral fellows and is in the process of hiring the third under an NRF grant. All three will commence their tenure in 2021.

STAFF MATTERS

Prof Samuel Adelabu was promoted to Associate Professor in July 2020, and was appointed as Head of Department (effective from January 2021), and will be based at the Bloemfontein Campus.

Prof Mukwada was awarded his full professorship in 2020.

Dr Abraham Matamanda was appointed as Lecturer in Human Geography on the Bloemfontein Campus.

On the Qwaqwa Campus, Dr Sifiso Xulu was appointed as Lecturer in Remote Sensing and GIS on the Qwaqwa Campus, and Dr Mbali Pewa was appointed as Lecturer in Human Geography.

RESEARCH OUTPUTS

Research Articles

Adagbasa, E.G., Adelabu, S.A. & Okello, T.W. 2020. Development of post-fire vegetation response-ability model in grassland mountainous ecosystem using GIS and remote sensing. *ISPRS Journal of Photogrammetry and Remote Sensing* 164: 173-183.

Adedeji, O., Olusola, A., James, G., Shaba, H.A., Orimoloye, I.R., Singh, S.K. & Adelabu, S. 2020. Early warning systems development for agricultural drought assessment in Nigeria. *Environmental Monitoring and Assessment* 192(12): 1-21.

Adelabu, S.A., Adepoju, K.A. & Mofokeng, O.D. 2020. Estimation of fire potential index in mountainous protected region using remote sensing. *Geocarto International* 35(1): 29-46.

Adepoju, K.A. & Adelabu, S.A. 2020. Improving accuracy of Landsat-8 OLI classification using image composite and multisource data with Google Earth Engine. *Remote Sensing Letters* 11(2): 107-116.

Adepoju, K., Adelabu, S. & Mokubung, C. 2020. Mapping Seriphium plumosum encroachment and interaction with wildfire and environmental factors in a protected mountainous grassland. *Environmental monitoring and assessment* 192(6): 1-15.

Kudo, S., Allasiw, D.I., Omi, K. & Hansen, M. 2020. Translocal learning approach: A new form of collective learning for sustainability. *Resources, Environment and Sustainability* 2: 100009.

Le Roux, J.J. & Van der Waal, B. 2020. Gully erosion susceptibility modelling to support avoided degradation planning. *South African Geographical Journal* 102(3): 406-420.

Mararakanye, N., Le Roux, J.J. & Franke, A.C. 2020. Using satellite-based weather data as input to SWAT in a data poor catchment. *Physics and Chemistry of the Earth, Parts A/B/C* 117: 102871.

Mofutsanyana, S.S., Collins, N.B., Adelabu, S.A., Chatanga, P. & Sieben, E.J. 2020. Changes in plant functional composition of wetland vegetation along an aridity gradient on the Highveld plateau of South Africa. *Applied Vegetation Science* 23(4): 622-634.

Mohamed, A.A. & Mukwada, G. 2020. Temperature changes in the Maloti-Drakensberg region: an analysis of trends for the 1960–2016 Period. *Atmosphere* 10(8): 471.

Mukwada, G., Taylor, S.J., Manatsa, D., Mahasa, P. & Robinson, G. 2020. Combating food insecurity in a rapidly changing mountain climate environment: insights from Lesotho. *Climatic Change* 163(2): 989-1006.

Mutana, S. & Mukwada, G. 2020. Can mountain route tourism work for the poor? Exploring worldviews from Maluti Route in the Drakensberg Region of South Africa. *Tourism and Hospitality Research* 20(1): 18-30.

Nel, W., Boelhouwers, J.C., Borg, C.J., Cotrina, J.H., Hansen, C.D., Haussmann, N.S., Hedding, D.W., Meiklejohn, K.I., Nguna, A.A., Rudolph, E.M. & Sinuka, S.S. 2020. Earth science research on Marion Island (1996–2020): a synthesis and new findings. *South African Geographical Journal* 103(1): 1-21.

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Conference Contributions

Conference Papers/Posters

Adagbasa, E.G., Adelabu, S.A. & Okello, T.W. 2020. *Small Scale Soil Erosion Susceptibility Modelling in a Protected Mountainous Grassland using Sentinel-2, Field, and Climate data.* Paper delivered at IEEE International Geoscience and Remote Sensing Symposium (Online). 26 September-2 October 2020.

Gaspar, L., Le Roux, J.J., Mabit, L., Gómez, J.A. & Lizaga, I. 2020. *Soil erosion and driving factors of soil carbon distribution: a worldwide threat*. Paper delivered at the European Geosciences Union (EGU) General Assembly (Online). 4-8 May 2020.

Le Roux, J.J. & Van der Waal, B. 2020. *Gully erosion susceptibility modelling for avoided degradation planning*. Paper delivered at the European Geosciences Union (EGU) General Assembly (Online). 4-8 May 2020.

Nyama, V. & Mukwada, G. 2020. *Perspectives on citizen participation in development planning in rural Zimbabwe*. Paper delivered at the Southern Africa City Studies Conference, University of the Witwatersrand,, Johannesburg, South Africa. 31 August-4 September 2020.

Olusola, A. & Adelabu, S.A. 2020. *Estimation of soil moisture and evapotranspiration products from Land Data Assimilation Systems for Nigeria.* Paper delivered at the Conference of the Arabian Journal of Geosciences (Online). 2-5 November 2020.

Olusola, A. & Adelabu, S.A. 2020. *Implications of rainfall variabilities in the light of climate change on crop production in the Sudano-Sahelian belt of 2 Nigeria.* Paper delivered at the Water Energy Nexus Conference 2020 (Online). 2-4 December 2020.

Omobepade, B.P., Adelabu, S.A., Okello, T.W. & Adagbasa, E.G. 2020. *Assessing Transportation Logistics for White Shrimp (Nematopalaemon hastatus) Marketing using ArcGIS Network Analysis.* Paper delivered at the 4th International Conference on Science and Sustainable Development, Ota, Nigeria. 11-15 May 2020.

Rudolph, E. M., Hedding, D. W. & Nel, W. 2020. *An early deglaciation at sub-Antarctic Marion Island from cosmogenic 36Cl exposure dating: implications for landscape development*. Paper delivered at the Scientific Committee on Antarctic Research 2020 (Online). 3-5 August 2020.

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Van der Walt, A.J. & Fitchett, J.M. 2020. *Statistical classification of South African seasonal divisions on the basis of daily temperature data*. Paper delivered at the Alliance for Collaboration on Climate and Earth System Science (ACCESS), Habitable Planet Workshop (HPW) Research Conference, South Africa (Online). 8-10 December 2020.



STAFF (2020)

Head of Department: Prof SA Adelabu

Bloemfontein Campus:
Associate Professor: Prof SA Adelabu
Senior Lecturer: Dr J le Roux
Lecturers: Mrs M Dunn, Ms E Kruger, Mrs T Mehlomakhulu, Dr EM Rudolph, Mrs M Stander and Dr AJ van der Walt
Programme Director: Ms E Kruger

Senior Officer – Professional Services: Mrs S Brits
Senior Assistant Officer: Ms N van Dyk

Qwaqwa Campus:
Subject Head: Dr TW Okello
Professor: Prof G Mukwada
Senior Lecturer: Dr TW Okello
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 GEOLOGY

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OVERVIEW OF 2020

The Department of Geology is responsible for teaching and research in the geological sciences in 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 the PhD by research.

In 2020 the Department awarded a total of 77 degrees – 37 BSc, 25 BSc Hons and 15 MSc. The Department enrolled 131 undergraduate, 25 honours and 52 master's students (34 in MRM, and 18 in Geology, Geochemistry and Environmental Geology), and 7 PhD candidates.

Ms Rinae Makhadi's promotion to lecturer and the successful completion and submission of the doctoral thesis by Adriaan Odendaal are highlights in the Department's staff development drive.

The Department published 16 journal articles, a chapter in a book, three articles in conference proceedings and delivered one conference paper.

A panel of three external academics conducted the departmental five-year audit review from 4 to 7 August 2020. Due of the prevailing COVID-19 situation, it was not possible for the panel to visit UFS and all the interviews and discussions took place using Microsoft Teams. The Directorate for Institutional Research and Academic Planning (DIRAP) set up the terms of reference and arranged all interviews and engagements of the review panel with the staff and Head of Department, and the Dean. The Department submitted its self-evaluation report to the panel for the review. The emphasis of the academic review process was on continuous improvement and development of the Department, with the view to enrich further the quality of the work that it does. The review provided an opportunity for the Department, together with the panel, to reflect critically on the work it has done over the last few years, its current state and future direction. In its feedback, the review panel provided a list of commendations and recommendations to assist in the improvement plan of the Department.

ACHIEVEMENTS

Staff Achievements

Dr Martin Clark and Dr Mathew Huber won the Excellence in Learning and Teaching Award, in the category 'Technology Enhanced Learning', from the Faculty of Natural and Agricultural Sciences. The award was for their presentation titled 'Bringing together the old and the new: Combining traditional field exercises, gamification, and 4IR components for efficient and effective holistic learning of Geology students' presented at the 2020 Excellence in UFS Learning and Teaching conference, held in September 2020.



Dr Martin Clark and Dr Matthew Huber utilising aerial photography and 3D models in field studies

Student Achievements

The Department of Geology annually recognises the best-performing students by awarding various prizes and financial incentives. Mr Madaka was the best first-year Geology student and the winner of the Impala Platinum prize and the Wiley book prize. Marizanne van Ede was the winner of the financial prize supported by the Professional Provident Society (PPS) for the best second-year Geology student, and Thapelo Lepolesa received the Exxaro Resources Ltd book prize and financial prize from the Department as the best third-year Geology student.

The Bridge the Gap (BTG) programme was launched by the students of the UFS Geology Department in collaboration with the students from the University of the Witwatersrand (Wits) and the University of Johannesburg (UJ). The initiative was featured in the Geological Society of South Africa (GSSA) *Geobulletin* in September 2020.

TEACHING AND LEARNING

The Department offered six undergraduate programmes for the BSc, majoring in Geology, Environmental Geology, Geochemistry, Geology and Geography, Geology and Chemistry, and Geology and Physics. Seventeen (17) undergraduate and 13 honours modules were offered, including a new module introduced in 2019, on 'Skills development and ethics for geoscience professionals' to equip graduates with an industry-relevant practical edge.

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 respective modules.

COVID-19 made 2020 a very difficult year for teaching and learning, providing many challenges. This was particularly true for Geology because geological teaching and learning is heavily dependent on field excursions, and visits to mineral exploration sites, geoscience laboratories, national geoscientific institutions and mines. As soon as the lockdown started, the Department introduced a number of innovative techniques, such as videos and online lectures, to cover the theoretical components of the teaching and learning project. However, the Department realised early in the first semester that the teaching and learning of geological sciences would be incomplete without the practical and laboratory components of the geological modules, which require instruction and close supervision by the academic staff. It was necessary to intervene with some form of face-to-face engagements, such as boot camps and limited outcrop investigations.

The designing of boot camps aimed at including face-to-face, intense and continuous practical sessions for the students over short periods, to replace the normal semester-long practical and laboratory sessions. Students were prepared for the boot camp sessions through online videos and lectures to ease the workload for each module. The boot camps were held from 7 September to 7 October, and involved three practical modules (GLGY 2652, 2632, and GLGY 2662) and laboratory-based modules such as GLGY 2612 (Mineralogy) and GLGY1614 (Introduction to Geology and Planet Earth). A week was assigned to each module and students handed in assignments during the week and wrote a semester test at the end of each module session.

There was strict control and observance of COVID-19 guidelines such as social distancing, use of masks and gloves, and application of sanitiser during the boot camps. No infections or other COVID-related issues were reported.



Second-year students in practical classes on geological structures and map preparation skills in a boot camp under strict COVID-19 guidelines

The boot camp was very successful, and enabled the Department to complete the teaching and learning project successfully with minimal negative impact. The success can be attributed to the collective effort of all staff, particularly the support and teaching staff as well as the programme director, who were directly involved in the logistics and implementation of the boot camp and in the limited outcrop visits. Although both students and lecturers were under tremendous pressure, the boot camp sessions covered the practical aspects of all the first- and second-year modules with significant practical and laboratory components.



Students sketching and mapping out a rock face on top of Musgrave Koppies



Students observing a road-cutting close to Thaba Nchu Mountain

RESEARCH AND INNOVATION

The Bushveld Complex research project, funded by the International Continental Scientific Drilling Program (ICDP) since 2019, made slow progress in 2020 due to the restrictions resulting from the COVID-19 pandemic. In December, Prof Frederick Roelofse and Ms Justine Magson participated in a virtual training session, organised by the Operational Support Group (OSG) of the ICDP, on ICDP's drilling information management system (mDIS) that will be used to store the data generated over the course of the project.

A very significant funding agreement has concluded in 2020 between the UFS and the Hans Merensky Foundation (HMF) to launch a five-year project titled 'Merensky Group for Airborne Geological Image Classification (MAGIC)', under the leadership of Dr Martin Clark, the principal investigator. The overarching aim of the MAGIC project is to perform focused research on the development of remote sensing technologies using unmanned aerial vehicles (UAV) and satellites for application in the mining and groundwater exploration industries in South Africa and beyond. Specific focus areas include mineral exploration, extraction and remediation, as well as regional groundwater exploration and management. The proposed research targets two areas – the Barberton Greenstone Belt (Mpumalanga) and the Karoo. Remote sensing technologies will aim to better characterise the structural architecture and history of the rocks in Mpumalanga and the Karoo in order to manage better near-surface groundwater resources.

Significant progress on water treatment technologies has been made over a number of years on a collaborative project with the former SAENSE (a biochemistry platform funded by the Technology Innovation Agency [TIA] and located at UFS). With the phasing out of the SAENSE platform, the Centre for Mineral Biogeochemistry (CMBG) in the Department of Geology, which forms part of the recently-formed Biogeochemical Research Infrastructure Platform (BIOGRIP – operated from the University of Cape Town), absorbed the staff and projects that were ongoing as part of the afore-mentioned collaboration. Dr Robert Hansen leads the CMBG.

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 in Mpumalanga. Engineers from Zutari have been appointed to conduct the feasibility study, with technical input from the CMBG team and DRDGOLD Limited.

Dr Hansen and his team also commenced with a Welkom wetlands impact study in 2020. The project has a broad scope and the long-term aim is to understand the biogeochemistry of the Welkom wetlands and determine the processes controlling the fate of pollutants in this wetland system. A reconnaissance study has been conducted and two honours students and one master's student are 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 in the Mooketsi area of the Limpopo Province. The project is focused on addressing how much of the compost material is immediately available for plant uptake, the chemical composition of these nutrients, and the rate at which the nutrients are released.

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 UJ and the School of Earth Sciences at Wits. In 2020, Prof Bisrat Yibas secured additional research funding from the DSI-NRF CIMERA, increasing to three the number of MSc projects in the Department funded by the Centre of Excellence.

Dr Hendrik Minnaar continued his research on the crust formation processes in the Paleoproterozoic Richterveld Magmatic Arc. He also secured funding from the Research, Education and Investment (REI) Fund of the GSSA in support of his research in the Northern Cape to determine the age of the Vuurdood Subsuite in the Vioolsdrif Suite.

Justine Magson received research funding from the Central Research Fund (CRF) for Sr isotopic variations in bifurcating chromitite layers of the UG1 at the Impala Platinum Mine, Rustenburg. The study aims to contribute to the understanding of chromitite bifurcations and their formation. Isotopic signatures analysis and mineral chemistry, as well as detailed petrographic studies of the bifurcating chromitites of the UG1 at No 11 Shaft of Impala Platinum, will be used to achieve the objective of the research.

Ms Magson continued her PhD research on a project titled 'Probing magma dynamics and mineralization in the Bushveld Complex using high-resolution, multi-isotope (Fe-Cu-Zn and Sr-Nd-Hf-Pb) analysis across major compositional and mineralogical discontinuities'. In October 2020, she visited Rhodes University to collect mineral chemistry data from her samples using the Electron Probe Micro Analyzer (EMPA - Jeol JXA 8230 Superprobe).



The Jeol JXA 8230 Superprobe at Rhodes University used by Justine Magson

Adriaan Odendaal completed his PhD research on the fluvial-lacustrinal Beaufort Group of the Karoo Supergroup, and investigated the Ecca-Beaufort contact, west of Bloemfontein, and the occurrence of large-scale mass movements in the Thaba Nchu area.

Ms Jarlen Keet continued with her research for her PhD on deciphering the lateral and vertical variation of strontium, neodymium and sulphur isotopes of the Flatreef, to understand the implications for the formation of the reef and its comparison to the Merensky Reef in the western and eastern Busveld Complex. Her research aims at understanding the implications of the isotope variations in the Flatreef and its comparison with the Merensky Reef in the western and Eastern Bushveld Complex.

As part of his PhD studies, 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, in the Bushveld Complex in the North West Province. The study includes an evaluation of different ore mineralogy and texture types to flotation response, the identification of critical characteristics that have an influence on flotation performances and platinum-group elements (PGE) recovery. This will enable Mr Moitsi to gain the insight into factors that influence 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 her PhD study, Ms Megan Welman-Purchase continued researching 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.

Ms Thendo Mapholi and Mr Justin Nel worked on the final versions of their MSc dissertations on Nkombwa Phosphate Mineralogy and on the structural geology of the Namaqualand Mobile Belt, respectively, and are set to graduate in 2021.

As part of the continuous drive to develop the research and its teaching infrastructure of the Department, Justine Magson secured several core stands as a donation from Kumba Iron Ore Ltd to alleviate the shortage of core stands in the Department's core shed. Dr Hendrik Minnaar and Justine Magson transported the core stands to UFS and set them up in the Core Shed, and are ready for use.



The core stands donated by Kumba Iron ore being transported to the Geology Department Core shed



The acquired core stands in the core shed ready for use

ENGAGED SCHOLARSHIP

Prof Frederick Roelofse continued to serve as chair of the Palaeoproterozoic Task Group of the South African Committee for Stratigraphy (SACS) and was involved in the review of four lithostratigraphic descriptions for publication in the *South African Journal of Geology*. Lithostratigraphic descriptions for the Verena Granite (Lebowa Granite Suite, Bushveld Complex) and the Hekpoort Formation (Pretoria Group, Transvaal Supergroup) were finalised and published under his leadership.

Mr Ernest Moitsi continued to serve as the co-opted Committee Member of Mineralogical Association of South Africa (MINSA).

NATIONAL AND INTERNATIONAL COLLABORATION

The Department has excellent collaborative relationships with the industry, as illustrated by the Minerals Education Trust Fund (METF) subventions to all our full-time academic staff members to date, and increasing levels of collaboration. The feedback the Department received from mining companies on the quality of our graduates has been very encouraging. As a result, student bursaries, research support in the form of access to mine facilities and research materials such as drill cores and samples, are improving. The mining industry supports by way of providing access to their facilities and materials such as samples for a number of honours, master's and doctoral research projects. Staff research and interaction with the industry have also improved significantly.

The collaboration agreement with De Beers, which commenced in 2018, continued into 2020, resulting in three additional projects for honours students. The research collaboration expands 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.

As reported above, the collaboration with the GeoForschungsZentrum (GFZ) German Research Centre for Geosciences, the University of the Witwatersrand and the Friedrich-Alexander University, led to the grant from the ICDP, continued into 2020, as did the collaboration with DSI-NRF CIMERA.

The staff of the Geology Department maintained active collaboration with researchers from the following institutions:

- University of Cape Town
- University of Johannesburg
- University of Pretoria
- Rhodes University
- University of the Witwatersrand
- Central University of Technology
- Council for Geoscience
- Sibanye-Stillwater Company
- McGregor Museum
- Louisiana State University, USA
- Université De Lille, France
- University of Exeter, UK
- University of Leoben, Austria
- Natural History Museum, London, UK
- Universität Hamburg, Germany
- University of Vienna, Austria
- Natural History Museum Vienna, Austria
- University of Gothenburg, Sweden
- University of Oslo, Norway
- Friedrich-Alexander University, Germany
- German Research Centre for Geosciences – GFZ Potsdam, Germany
- Museum of Natural History, Sweden
- Polish Academy of Sciences, Poland
- Zavaritsky Institute of Geology and Geochemistry, Russia

Ms Jarlen Keet participated in the University of Western Australia's Centre for Exploration Targeting (CET) online short course series, titled the 'Magmatic Mineral Systems', from 7 to 20 November. These courses provide the opportunity for geoscientists from both industry and academia to gain better insights on the latest advances in Ni-Cu-PGE sulfide targeting, from terrain to deposit scale. It is anticipated that collaborative projects could emanate from these interactions.

POSTGRADUATE STUDENTS

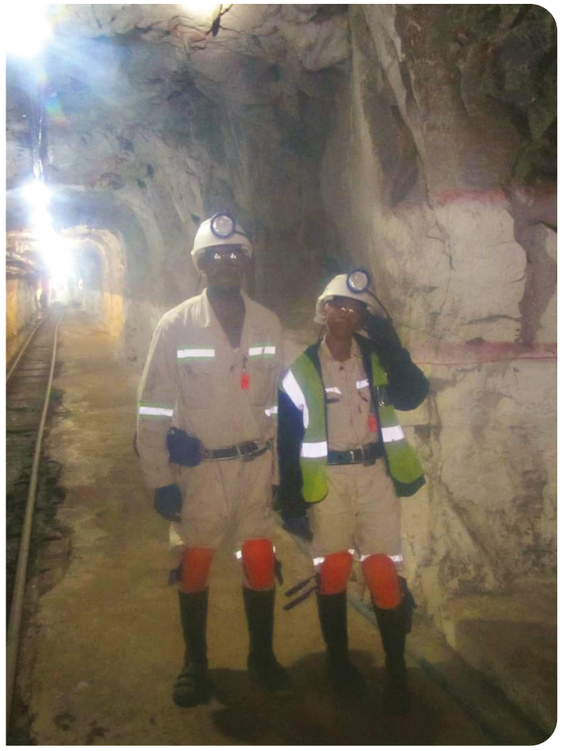
The Department of Geology offers a variety of postgraduate programmes, including honours (with specialisation in Geology, Geochemistry and Mineralogy, and Environmental Geology), four different MSc programmes (Geology, Geochemistry, Environmental Geology, and Mineral Resource Management), and the PhD degree by research. In 2020, the Department enrolled 84 postgraduate students – 25 BSc Hons, 52 MSc and 7 PhD candidates.

Forty postgraduate students (25 BSc Hons and 15 MSc) obtained their degrees in 2020. Seven of the MSc awardees who have completed their MSc research successfully in 2020 are:

- Danita Hohne (Geochemistry)
- Marcelle Ferreira (Geology)
- Francois Byleveld (Geology)
- Dakalo Nempfumbada (Geochemistry)
- Mariska Nicholson (Geology)
- Ryan Nel (Geology)
- Monique Maree (Geology)

The other eight MSc awardees have successfully completed the two-year intensive modules and mini-dissertations required for the fulfillment of MRM qualification and obtained their degrees in 2020. These graduates are Pieter van der Merwe, Cindi Henderson, Marelize du Toit, Zandile Mjoli, Franco Burger, Gilbert Malose Thobejane, Tlou Piet Sebola, and Lawrence Ngalela.

The normally intensive field schedule, which forms part of the extensive honours programme, could not be implemented due to COVID-19 travel restrictions. However, under strict adherence to COVID-19 guidelines, Ernest Moitsi and honours student, Tshepang Moseki, conducted sampling at underground workings of Khuseleka Shaft of the Sibanye-Stillwater Rustenburg Platinum Operations in North West Province.



Ernest Moitsi and Tshepang Moseki conducting sampling at Khuseleka Shaft, Sibanye-Stillwater Rustenburg Platinum Operations

POSTDOCTORAL RESEARCH FELLOWS

Dr Emmylou Kotzé, from South Africa, was appointed as a postdoctoral fellow at the end of 2020. She is working in the Bushveld Research Group under the guidance of Prof Roelofse.

Our other postdoctoral research fellow, Dr Martin Clark (from Canada), will be principal investigator of the MAGIC project.

STAFF MATTERS

Mrs Petro Swart retired at the end of 2020 after serving the Department for nearly three decades.

In October 2020, the Department welcomed Ms Ruvey Zaal as senior administrative and financial officer. Ms Zaal had previously worked in the UFS Department of History.

The Department congratulated Ms Rinae Makhadi on her promotion to Lecturer. Adriaan Odendaal completed and submitted his doctoral thesis in 2020. The accomplishments of Rinae and Adriaan are important highlights in the career development strategy of the Department.

Dr Elizaveta Kovaleva resigned in December 2020 after just over a year of tenure in the Department.

RESEARCH OUTPUTS

Research Articles

Darrocha, A.F.S., Cribba, A.T., Buatois, L.A., Germs, G.J.B., Kenchington, C.G., Smith, E.F., Mocke, H., Gretchen, R.O'.N, Schiffbauer, J.D., Maloney, K.M., Racicota, R.A., Katherine A.T., Gibson, B.M., Almond, J., Koestera, B., Boag, T.H., Tweedt, S.M. & Laflamme, M. 2020. The trace fossil record of the Nama Group, Namibia: Exploring the terminal Ediacaran roots of the Cambrian explosion. *Earth-Sciences Reviews* 212: 103435. DOI: 10.1016/j.earscirev.2020.103435.

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Knoll, A. H., Germs, G.J.B., Tankard, A. & Welsink, H. 2020. Tonian microfossils from subsurface shales in Botswana. *Precambrian Research* 345:105779. DOI: 10.1016/j.precamres.2020.105779.

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Kovaleva, E. 2020. Textural identification of polycrystalline Magmatic, tectonically - deformed, and shock- related zircon aggregates. *Minerals* 10(5): 469.

Kovaleva, E. & Dixon, R. 2020. Properties of Impact-Related Pseudotachylite and Associated Shocked Zircon and Monazite in the Upper Levels of a Large Impact Basin: A Case Study from the Vredefort Impact Structure. *Minerals* 10(12): 1053. DOI: 10.3390/min10121053.

Kovaleva, E., Huber, M.S. & Dixon, R. 2020. Material mixing in shock-induced pseudotachylites, Vredefort impact structure, South Africa. *Lithos* 370–371: 105621. DOI: 10.1016.j.lithos.105621.

Makhadi, R., Oke, S.A. & Ololade, O.O. 2020. The Influence of Non-Engineered Municipal Landfills on Groundwater Chemistry and Quality in Bloemfontein, South Africa. *Molecules* 25(23): 1-16. DOI: 10.3390/molecules25235599.

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Stephens, J., Killick, D., Wilmsen, E., Denbow, J. & Miller, D. 2020. Lead isotopes link copper artefacts from northwestern Botswana to the Copperbelt of Katanga Province, Congo. *Journal of Archaeological Science* 117: 105124. DOI: 10.1016/j.jas.2020.105124.

Walter, B.F, Steele-MacInnis, M., Giebel, R.J., Marks, M.A.W. & Markl, G. 2020. Complex carbonate-sulfate brines in fluid inclusions from carbonatites: Estimating compositions in the system H20-Na-K-C03-S04-Cl. *Geochim Cosmochim Acta* 277: 224-242. DOI: 10.1016/j.gca.2020.03.30.

Chapters in Books

Yibas, B. 2020. Oxidation Processes and Formation of Acid Mine Drainage from Gold Mine Tailings, a South African Perspective. In: *Recovery of Byproducts from Acid Mine Drainage Treatment.* E. Fosso-Kankeu, C. Wolkersdorfer & J.vBurgess, J. (Eds). Wiley: Scrivener Publishing LLC. Chapter 4: pp 73–96. DOI10.1002/9781119620204.ch4.

Conference Contributions

Conference Papers/Posters

Clark, M.D. & Huber, M.S. 2020. *Bringing together the old and the new: Combining traditional field exercises, gamification, and 4IR components for efficient and effective holistic learning of Geology students*. Paper presented at the 2020 Excellence in UFS Learning and Teaching Conference, Bloemfontein, South Africa. 22 September 2020.

Huber, M.S., Kovaleva, E., Clark, M.D. & Fourie, F. 2020. *Evaluating the Emplacement Mechanisms of Vredefort Impact Melt Dikes*. Paper delivered at the 11th Planetary Crater Consortium (Virtual meeting). 5-7 August 2020.

Webb, S.J., Trumbull, R.B., Ashwal, L.D., Roelofse, F., Khoza, D. & Hayes, B. 2020. *The Bushveld Complex Drilling Project: an ICDP project on the origins, emplacement and consequences of the world's largest known igneous intrusion.* Paper delivered at the American Geophysical Union (AGU) Fall Meeting (Global virtual meeting 1-17 December 2020.

Conference Proceedings

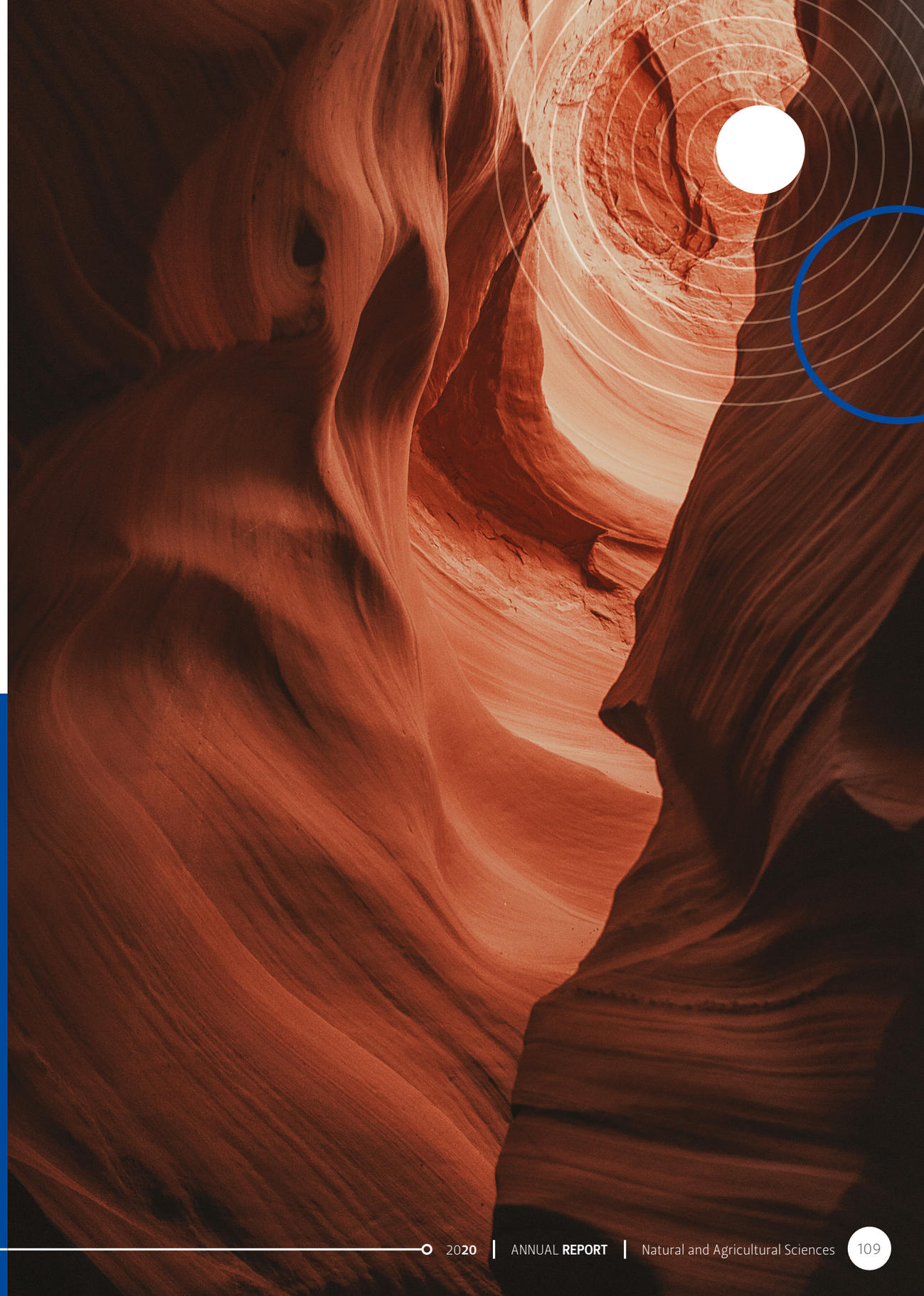
Lourens, P., Erasmus, M., Hansen, R.N. & Allwright, A. 2020. Groundwater Nitrate Bioremediation of a Fractured Rock Aquifer System in South Africa. In: *Proceedings of IMWA 2020 'Mine Water Solutions'.* Christchurch, New Zealand, 9-13 November 2020. J. Pope, Ch. Wolkersdorfer, A. Weber, L. Sartz & K. Wolkersdorfer, K. (Eds). pp. 140-145.

Welman-Purchase, M. 2020. A Model of the Behaviour of Cyanide in Witwatersrand Sulfidic Au-tailings Environment. In: *Proceedings of IMWA 2020 'Mine Water Solutions'.* Christchurch, New Zealand, 9-13 November 2020. J. Pope, Ch. Wolkersdorfer, A. Weber, L. Sartz & K. Wolkersdorfer (Eds). pp. 100-105.

STAFF (2020)

Head of Department: Prof B Yibas

Professor: Prof B Yibas
Associate Professor: Prof F Roelofse
Senior Lecturers: Dr R Hansen, Dr M Huber, Dr E Kovaleva and Dr H Minnaar
Lecturers: Ms JJ Keet, Ms J Magson, Ms R Makhadi, Mr ME Moitsi and Mr A Odendaal, Ms Michelle Dimmick-Touw (contract)
Junior Lecturers: Ms T Mapholi and Mr J Nel
Research Fellows: Prof WP Colliston, Dr PG Meintjes, Dr L Nel, Dr HE Praekelt and Prof WA van der Westhuizen
Affiliated Professors: Prof DE Miller, Prof R Schemers and Prof A Scooch
Affiliated Associate Professors: Prof CD Geert, Prof GJB Germs, Prof L Jacobson and Prof RP Schouwstra
Affiliated Lecturers: Mr E Bergh, Prof C Dohm, Mr A van Niekerk, Dr H Prinsloo, Mr T Diale, Mr P Viljoen, Prof K Visser and Mr A Venter
Affiliated Researchers: Dr RJ Giebel, Ms HCF Pretorius and Dr MJ van der Merwe
Research Associate: Dr Johan Loock
Programme Director: Ms J Magson
Programme Director (Mineral Resources Management [MSc]: Ms M Dimmick-Touw
Senior Assistant Officers: Mr A Felix, Ms P Swart, 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 2020

The year of 2020 kicked off very well for our Department, but came to an abrupt halt on 26 March when the President declared national lockdown. At this point we had to convert to an online mode of teaching, which proved very difficult for our mathematical and very computer-based modules, where face-to-face tuition is in reality essential for proper education and assessment. It also proved difficult for the professional exemption modules for the actuarial students, which requires face-to-face tuition according to the accreditation agreement between the Department of Mathematical Statistics and Actuarial Science and the Actuarial Society of South Africa (ASSA). However, we managed to comply with all requirements as set out by ASSA and completed the year with success.

The COVID-19 pandemic saw our lecturers being seriously affected. The additional work related to lecturing online and the possibility of lecturers being affected by COVID, placed a great deal of pressure on all staff, who were already operating under unprecedented demands.

Unfortunately, the appointment we made at the start of the year of 2020 did not come to fruition, as the appointee was based in Hong Kong and, due to COVID-19, the necessary work permits could not be issued. He finally managed to get all paperwork completed and will commence duties in February 2021.

Despite the demands of 2020, our Department managed to complete the academic project, delivered practical and block sessions of computer courses and face-to-face exams where necessary, with minimal issues. We will take what we can from 2020 and be ready for 2021.

ACHIEVEMENTS

Staff Achievements

Dr Michael von Maltitz was awarded the second prize in the category Innovation in Technology Enhanced Learning in the UFS 2020 Excellence in Learning and Teaching Awards.

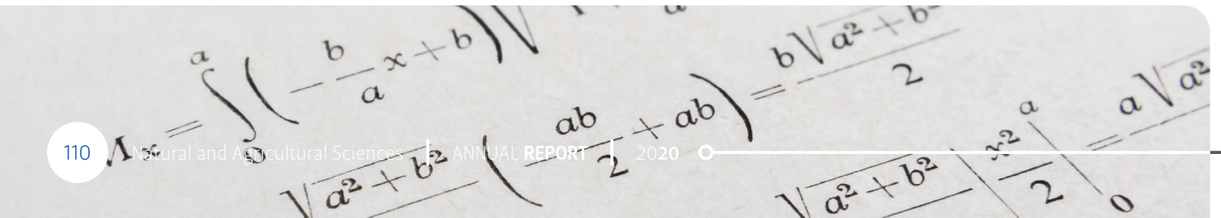
Student Achievements

The following students were won awards in their year of study:

- Nadine Mottian: Best first-year student in Statistics
- Bianca Steyn: Best second-year student in Statistics
- Khanyisile Kumbi: Best third-year student in Statistics
- Jessica Bakken: Best first-year student in Business Calculations
- Anne-Mien Schoombie: Best first-year student in Mathematical Statistics
- Franco Marais: Best second-year student in Mathematical Statistics
- Laenita Laubscher: Best third-year student in Mathematical Statistics

TEACHING AND LEARNING

The Department of Mathematical Statistics and Actuarial Science presents degrees in Actuarial Science, Mathematical Statistics, Applied Statistics and Econometrics. As indicated above, 2020 presented new challenges for all undergraduate teaching due to the COVID-19 pandemic, but the Department faced the challenges and emerged with success.



RESEARCH AND INNOVATION

Our Department specialises in Extreme Value Theory (Prof Andrehette Verster and Dr Delson Chikobvu), Bayesian Statistics (Dr Sean van der Merwe and Prof Abrie van der Merwe), Multiple Imputation (Dr Michael von Maltitz), statistics in education (Dr Linda van der Merwe and Mrs Liza da Silva), paired comparisons (Dr Sjòlander) and various financial types of research within Actuarial Science (Mr Frans Koning, Mr Louwtjie Voges, Mr Jan Blomerus, Ms Zani Ludick), including mortality analysis and improvements.

The Statistical Consultation Unit is growing and performing extremely well, providing a professional statistical service to the UFS research community.

ENGAGED SCHOLARSHIP

Members of our Department continue to demonstrate a high level of activity as co-editors and reviewers of journals and books. Our interactions with relevant professional sectors, in particular with the actuarial industry, are good. There is good participation in several ASSA committees, such as the Microinsurance Committee, the Damages Committee and other academic committees.

Some staff members are involved in the professional actuarial examinations, as well in the marking thereof.

NATIONAL AND INTERNATIONAL COLLABORATION

Prof Jan Beirlant from KU Leuven visits the Department on an annual basis and lectures the Extreme Value Theory (EVT) course. He also actively engages in research with our Department on the topic of EVT.

POSTGRADUATE STUDENTS

In October 2020, a total of 13 Honours students graduated from the Department – five students graduated with the BSc Hons majoring in Actuarial Science, two with the BSc Hons majoring in Applied Statistics, five with the BSc Hons majoring in Mathematical Statistics, and Elize Ferreira graduated with the BSc Hons majoring in Mathematics and Applied Mathematics, with distinction.

The following students completed the Master of Science degree in 2020: Esta Bekker, Johannes Frederik Besselaar, Sonelca Zoetjé Southey, Stanley Mohlakola Lekata, Tsepang Yvonne Seotla, and Nthabiseng Gladys Thateng.

POSTDOCTORAL RESEARCH FELLOWS

The postdoctoral fellow who had been hosted by Prof Max Finkelstein in 2019, Dr Nilen Hazra, did not continue into 2020. However, the Department plans to recruit more postdoctoral fellows in 2021.

STAFF MATTERS

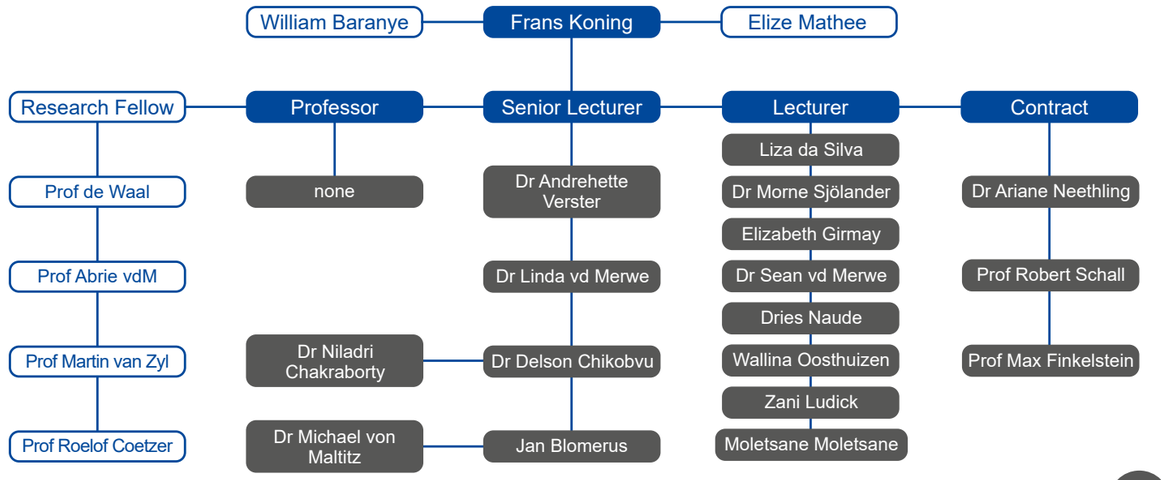
Many of the staff struggled to cope with the changes in 2020 due to the unprecedented challenges resulting from the COVID-19 pandemic and the need to convert to a predominantly online platform for delivering the academic project. This saw one staff member resigning at the end of October, to be replaced early in 2021.

Dr Mandla Diko, who started working in the Statistical Consultation Unit, also carried some teaching duties.

The appointment of Dr Niladri Chakraborty did not realise due to the various hurdles created by COVID-19 and its effect on international movement. He will start work with the UFS in February 2021.

In 2020 Dr Sean van der Merwe was promoted to Senior Lecturer, and Dr Andrehette Verster was promoted to Associate Professor.

2020 Staff Diagram



RESEARCH OUTPUTS

Research Articles

Albrecher, H., Araujo-Acuna, J.C. & Beirlant, J. 2020. Fitting nonstationary cox processes: an application to fire insurance data. *North American Actuarial Journal* 1-29. DOI: 10.1080/10920277.2019.1703752.

Bladt, M., Albrecher, H. & Beirlant, J. 2020. Combined tail estimating using censored data and expert information. *Scandinavian Actuarial Journal* 1-24. DOI: 10.1080/03461238.2019.1694974.

Burger, D.A., Schall, R., Ferreira, J.T. & Chen, D-G. 2020. A robust Bayesian mixed effects approach for zero inflated and highly skewed longitudinal count data emanating from the zero inflated discrete Weibull distribution. *Statistics in Medicine* 39(9): 1275-1291. DOI: 10.1002/sim.8475.

Grill, S., Ring, A., Brannath, W. & Scharpenberg, M. 2020. Assessing consistency in clinical trials with two subgroups and binary endpoints: A new test within the logistic regression model. *Statistics in Medicine* 39(30): 4551-45733. DOI: 10.1002/sim.8719.

Cha, J.H. & Finkelstein, M.S. 2020. Is perfect repair always perfect? *Springer* 29: 90-104. DOI: 10.1007/s11749-019-00645-7.

Cha, J.H. & Finkelstein, M.S. 2020. On optimal life extension for degrading systems. *Journal of Risk and Reliability* 234(3): 487-495. DOI: 10.1177/1748006X19897468.

Cha, J.J. & Finkelstein, M. 2020. Stochastic modelling of operational quality of *k*-out-of-*n* systems. *Springer:* 28: 424-441. DOI: org/10.1007/s11750-019-00536-y.

Chikobvu, D. & Jakata, O. 2020. Analysing Extreme Risk in the South African Financial Index (J580) using the Generalised Extreme Value Distribution. *Statistics, optimization and information computing* 8: 915-933. DOI: 10.19139/soic-2310-5070-866.

Finkelstein, M.S., Cha, J.H. & Levitin, G. 2020. A hybrid preventive maintenance model for systems with partially observable degradation. *IMA Journal of Management Mathematics* 31(3): 345-365. DOI: 10.1093/imaman/dpz018.

Finkelstein, M.S., Cha, J.H. & Levitin, G. 2020. On a new age-replacement policy for items with observed stochastic degradation. *Quality Reliability Engineering Institution* 36(3): 1132-1143. DOI: 10.1002/qre.2619.

Finkelstein, M.S. & Levitin, G. 2020. On missions' quality of performance for systems with partially or completely observable degradation. *Journal of Risk and Reliability* 234(5): 676-685. DOI: 10.1177/1748006X20924885

Finkelstein, M.S. & Vaupel, J. 2020. On some stochastic properties of lives lived and left in non-stationary populations. *Journal of Mathematical Biology* 80:1845-1856. DOI: 10.1007/s00285-020-01481-2.

Kajambeu, R., Sigauke,C., Bere, A., Chikobvu, D., Maposa, D. & Nemukula, M.M. 2020. Probabilistic flood height estimation of the Limpopo River at the Beitbridge using *r*-largest order statistics. *Applied Mathematics and Information Sciences* 14(2):191-204. DOI: 10.18576/amis/140203.

Levitin, G., Finkelstein, M.S. & Dai, Y. 2020. Mission abort policy optimization for series systems with overlapping primary and rescue subsystems operating in a random environment. *Reliability Engineering and System Safety* 193: 1-7. DOI: 10.1016/j.ress.2019.106590.

Levitin, G., Finkelstein, M.S. & Dai, Y. 2020. Optimal preventive replacement policy for homogeneous cold standby systems with reusable elements. *Reliability Engineering and System Safety* 203: 1-8. DOI: 10.1016/j.ress.2020.107135.

Levitin, G., Finkelstein, M.S. & Huang, H-Z. 2020. Optimal mission abort policies for multistate systems. *Reliability Engineering and System Safety* 193: 1-9. DOI: 10.1016/j.ress.2019.106671.

Levitin, G., Finkelstein, M.S. & Li, Y-F. 2020. Balancing mission success probability and risk of system loss by allocating redundancy in systems operating with a rescue option. *Reliability Engineering and System Safety* 195: 1-7. DOI: 10.1016/j.ress.2019.106694.

Levitin, G., Finkelstein, M.S. & Xiang, Y. 2020. Optimal aborting rule in multi-attempt missions performed by multicomponent systems. *European Journal of Operational Research* 283: 244-252. DOI: 10.1016/j.ejor.2019.10.042.

Levitin, G., Finkelstein, M.S. & Xiang, Y. 2020. Optimal abort rules for additive multi-attempt missions. *Reliability Engineering and System Safety* 205: 1-9. DOI: 10.1016/j.ress.2020.107245.

Levitin, G., Finkelstein, M.S. & Xiang, Y. 2020. Optimal multi-attempt missions with cumulative effect. *Reliability Engineering and System Safety* 203: 1-10. DOI: 10.1016/j.ress.2020.107091.

Pavolo, D. & Chikobvu, D. 2020. Determining cure time of rubber-covered mining conveyor belts using multi response surface methodology. *International Journal of Operations and Quantity Management* 26(1): 29-48. DOI: 10.46970/2020.26.1.2.

Shoko, C., Chikobvu, D. & Bessong, P.O. 2020. A Markov model for the effects of virological failure on HIV/AIDS progression in tuberculosis co-infected patients receiving antiretroviral therapy in a rural clinic in northern South Africa. *South African Medical Journal* 110(4): 313-319. DOI: 10.7196/SAMJ.2020.v110i4.13934.

Shoko, C., Chikobvu, D. & Bessong, P.O. 2020. Effects of antiretroviral therapy on CD4+ cell count, HIV viral load and death in a South African cohort: a modelling study. *Pakistan Journal of Biological Sciences* 23(4): 542-551. DOI: 10.3923/pjbs.2020.542.551.

Van der Merwe, A.J., Groenewald, P.C.N., Sjölander, M.R. & Meyer, J.H. 2020. A Bayesian-frequentists approach for detecting outliers in a one-way variance components model. *Communications in Statistics - Theory and Methods* 1-27. DOI: 10.1080/03610926.2020.1737127.

Van Zyl, M. & Van der Merwe, S. 2020. An empirical study of the behavior of the sample kurtosis in samples from symmetric stable distributions. *South African Statistical Journal* 54(2): 1-11. DOI: 10.37920/sasj.2020.54.2.9.

Chapters in Books

Mushori, S. & Chikobvu, D. 2020. Investigating the investment opportunities, uncertain implicit transaction costs and maximum downside risk in dynamic stochastic financial optimization. In: *Current Strategies in Economics and Management Vol 7.* K.F.A. Lo (Ed). Book Publisher International. pp 132-147.

STAFF (2020)

Head of Department: Mr FF Koning

Professors: Prof MS Finkelstein (contract), Prof R Schall (contract)
Senior Lecturers: Mr J Blomerus, Dr D Chikobvu, Mr F Koning, Dr L van der Merwe, Dr A Verster and Dr M von Maltitz
Lecturers: Mrs L da Silva, Mrs E Girmay, Miss Z Ludick, Mr D Naude, Miss W Oosthuizen, Dr M Sjölander, Dr S van der Merwe and Mr L Voges
Junior Lecturer: Mr M Moletsane
Programme Director: Dr M von Maltitz
Secretary: Mrs ME Mathee
Messenger: Mr W Baranye



DEPARTMENT OF
MATHEMATICS AND APPLIED MATHEMATICS

CONTACT DETAILS

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E: venterc@ufs.ac.za
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Qwaqwa Campus

Dr Ur Koumba
Department of Mathematics and Applied Mathematics

Faculty of Natural Sciences
University of the Free State
Private Bag X13
Phuthaditjhaba
9866 South Africa

T: +27 58 718 5303
E: koumbaua@ufs.ac.za
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OVERVIEW OF 2020

Dominated by the consequences of the COVID-19 pandemic, 2020 was a demanding year. The Department had to overcome many challenges with respect to teaching and learning and also in terms of staff cohesion and research collaboration. There was a will – so ways were found. Despite, or perhaps in part due to, the disruptive changes and adversity, new methods of creating and presenting learning material and assessing students were developed and implemented. Novel ways of communication, with students and staff, were also explored, and attending virtual workshops and conferences will at least to a certain extent stay part of the new normal. 2020 ended as a fruitful year with respect to students' success and in terms of deepened, expanded research.

ACHIEVEMENTS

Staff Achievements

Dr Elizabeth Maritz received a certificate of recognition as a #UFSTeachOn champion for her hard work and commitment towards teaching and learning in 2020.



Dr Elizabeth Maritz

Renier Jansen and Christiaan Venter both obtained their PhD degrees and on the 9 October 2020, participated in the UFS's first-ever series of virtual graduation ceremonies.

Prof Johan Meyer was inaugurated as a member of the Academy of Science of South Africa (ASSAf) during the annual award ceremony that was held virtually on 14 October 2020.

Student Achievements

The following students received the coveted CB van Wyk prizes for the best undergraduate in Mathematics and Applied Mathematics students at the 2020 Faculty Awards Ceremony:

- Ms M le Roux – best first-year student during 2019
- Ms M van Schalkwyk – best second-year student during 2019
- Mr P Schall – best third-year student during 2019

TEACHING AND LEARNING

On the Bloemfontein Campus the Department offered 23 undergraduate modules, of which 11 were also offered on the Qwaqwa Campus. The Bloemfontein Campus also offered 11 modules to honours and master's degree students.

During 2020, the special circumstances created by the coronavirus pandemic had a considerable influence on how teaching and learning were approached. Some modules were completed in a fully online manner, while others followed a blended learning approach in which some face-to-face lectures were still offered. Valuable experience was obtained with respect to novel ways of content development and distribution, as well as innovation with respect to assessment practices.

RESEARCH AND INNOVATION

Prof Tomas Vetrik had a fruitful year with his research in the field of graph theory. His favourite topics included metric dimension, partition dimension and topological indices. These topics have applications in chemistry and computer science, since graphs can represent various networks and chemical structures and lead to a variety of publications in these areas. He mostly used combinatorial and algebraic methods in his proofs. He was a (co) author of 10 papers in 2020.

Dr Elizabeth Maritz also conducted research in graph theory. As part of an interdisciplinary study, the graph theoretic concept of metric dimension was considered to determine the optimal placement of travelling wave fault location (TWFL) detectors, in order to accurately detect and locate faults on power grids. The power grid was represented as a weighted graph, and both an offline and online algorithm were presented to determine the number and placement of detectors, as well as to resolve the location of any fault within a certain error.

Dr Renier Jansen, a categorical topologist, studied dual closure operators and their interaction with left and right constant subcategories, and worked on writing articles from his PhD thesis. He also investigated Kurosh-Amitsur type radicals, as usually studied in algebra, on an arbitrary category to find links with his other research.

Dr Albert Kriel continued his research in numerical analysis, with specific focus on hyperbolic problems, and published a paper in *Numerische Mathematik*.

Prof Johan Meyer, an algebraist, investigated 0-primitivity in matrix near-rings, in particular whether the 0-primitivity of a matrix near-ring implies the 0-primitivity of the underlying near-ring. This a long-standing open problem and has been solved in certain restricted cases. He also investigated zero-symmetric simple near-rings with identity. Again, there is an open problem, namely whether such near-rings are always equiprime. The result is known to be true in some cases. The solution to this problem has implications for radical theory in near-rings. Furthermore, he continued the study of the so-called 1-2-3 problem. This concerns the cardinality of the symmetric difference of certain (finite) sets. There is a clear conjecture which is believed to be true by everybody working on this problem, but a proof in the general case is still lacking. The solution to this combinatorial problem has implications for coding theory. Prof Meyer was co-author of two papers published in 2020.

Dr Edgard Ngounda conducted research on numerical methods for partial differential equations (PDEs), in particular some analytical investigations and numerical experiments using finite differences, spline approximation and spectral methods for the parameter. He also investigated numerical methods for option pricing in the field of computational finance.

Dr Ur Koumba investigated the properties of Riesz operators defined on the ultrapowers of ordered Banach algebras (OBAs). His research interests in the field of mathematics focused more on operator and spectral theory in functional analysis through OBAs, topology, stochastic process, control theory, and optimisation. As Dr Koumba also holds a master's degree in financial economics, his topical research in financial mathematics aimed at providing new evidence and insights into the exchange rate dynamics by analysing exchange rate behaviour in relation to risk and uncertainty. He is amongst the few in South Africa who specialises in cryptocurrency portfolio optimisation. In 2020 Dr Koumba collaborated on and published a paper on the optimisation of mixed asset portfolios.



Dr Ur Koumba

Dr Narcisse Loufouma Makala conducted research on set-valued mappings, continuous selections, and their applications and Absolute Retracts (AR), Absolute Extensors (AE) and Paraconvex sets.

Dr Christiaan Venter researched students' inadequate understanding of the function concept and how to address this inadequate understanding by means of a newly developed intervention. This intervention was based on considering digital images as representing functions. A paper was published in *Pythagoras*.

Prof Jeandrew Brink investigated various theoretical aspects of testing general relativity. Her work entailed introducing properties of homogenous functions to describe geodesics around the Kerr Metric and investigating the resonant effects around black holes. Some of the implications are the proving of some empirically known results in the self-force problem and assisting in general perturbation theory around black holes.

ENGAGED SCHOLARSHIP

Prof Johan Meyer stayed active in mathematics Olympiads as vice-chairperson of the South African Mathematics Olympiad (SAMO) problems committee, and also contributing expertise to the work of the Pan African Mathematics Olympiad (PAMO). Prof Meyer also organised an online International Mathematical Olympiad (IMO) event hosted at the University of Cape Town in July. Locally, Dr Renier Jansen and Dr Christiaan Venter were actively involved with Nautilus Mathematics, which organises workshops in Olympiad-type mathematics for learners from the Free State and Northern Cape.

Most of our academics acted as reviewers for various journals and the National Research Foundation (NRF). Dr Venter served as reviewer for *Pythagoras*; Dr Elizabeth Maritz served as reviewer for *Discrete Mathematics Letters*; Prof Tomas Vetrik reviewed papers for *Acta Mathematica Hungarica*, *Discrete Applied Mathematics*, *Discussiones Mathematicae Graph Theory*, *AIMS Mathematics*, *Arabian Journal of Mathematics*, *Complexity*, *Discrete Dynamics in Nature and Society*, *Electronic Journal of Graph Theory and Applications*, *International Journal of Computer Mathematics*, *International Journal of Quantum Chemistry*, *Journal of Chemistry*, *Main Group Metal Chemistry*, *Opuscula Mathematica*, *Polycyclic Aromatic Compounds* and *UPB. Scientific Bulletin*; and Dr Edgard Ngounda served as reviewer for *Computational Economics*.

Prof Vetrik also served on the editorial boards of *Discrete Mathematics Letters* and *Open Journal of Discrete Applied Mathematics*.

Dr Ngounda was a member of the NRF virtual review panel for funding applications in the Black Academics Advancement Programme 2020, and on 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 Johan Meyer undertook a research visit, as part of a long-standing collaboration, to Prof W-F Ke from the Department of Mathematics at the National Cheng Kung University in Tainan, Taiwan.

POSTGRADUATE STUDENTS

In 2020, five students were enrolled for BSc Hons in Mathematics and Applied Mathematics. Three students were enrolled for a master's degree – one in Mathematics and two in Applied Mathematics. Only one student continued with PhD studies in 2020.

POSTDOCTORAL RESEARCH FELLOWS

The Department hosted one postdoctoral fellow, Dr Selvaraj Balachandran from India. Dr Balachandran completed a three-year stint in the Department at the end of 2020 and returned to India.

STAFF MATTERS

Dr Elizabeth Maritz joined the Department in January 2020. Mrs Marina Botha retired at the end of 2020.

Dr Ur Koumba was appointed as Subject Head on the Qwaqwa Campus from September 2020, and Dr Christiaan Venter was appointed as Academic Head of Department from November 2020.



Dr Christiaan Venter, new Head of Department

RESEARCH OUTPUTS

Research Articles

Ababio, K.A., Mba, J.C. & Koumba, U. 2020. Optimisation of mixed assets portfolio using copula differential evolution: A behavioural approach. *Cogent Economics & Finance* 8(1). DOI: 10.1080/23322039.2020.1780838.

Abas, M. & Vetrik, T. 2020. Metric dimension of directed Cayley graphs of metacyclic groups. *Theoretical Computer Science* 809: 61-72. DOI: 10.1016/j.tcs.2019.11.025.

Alfuraidan, M. R., Imran, M., Jamil, M. K. & Vetrik, T. 2020. General multiplicative Zagreb indices of graphs with bridges. *IEEE Access* 8:118725-118731. DOI: 10.1109/ACCESS.2020.3005040.

Alfuraidan, M. R., Vetrik, T. & Balachandran, S. 2020. General multiplicative Zagreb indices of graphs with a small number of cycles. *Symmetry* 12(4):514. 10.3390/sym12040514.

Deng, H., Vetrik, T. & Balachandran, S. 2020. On the harmonic index and diameter of unicyclic graphs. *Mathematical Reports* 22(1): 11-18.

Kriel, A.J. 2020. Entropy inequalities for fully-discrete E-schemes. *Numerische Mathematik* 144(2): 347-356. DOI: 10.1007/s00211-019-01089-9.

Masre, M., Fufa, S. A. & Vetrik, T. 2020. Distance-based indices of complete m-ary trees. *Discrete Mathematics, Algorithms and Applications* 12(4): 2050041. DOI: 10.1142/S179383092050041X.

Maxson, C.J. & Meyer, J.H. 2020. Rings of congruence preserving functions, II. *Communications in Algebra***.** DOI: 10.1080/00927872.2020.1812619.

Mazorodze, J. P., Mukwembi, S. & Vetrik, T. 2020. Gutman index, edge-Wiener index and edge-connectivity. *Transactions on Combinatorics* 9(4): 231-242.

Van der Merwe, A.J., Groenewald, P.C.N., Sjölander, M.R. & Meyer, J.H. 2020. A Bayesian-Frequentists approach for detecting outliers in a one-way variance components model. *Communications in Statistics - Theory and Methods***.** DOI: 10.1080/03610926.2020.1737127.

Venter, C. 2020. Learning the function concept by exploring digital images as functions. *Pythagoras* 41(1), a524. DOI: 10.4102/pythagoras.v41i1.524.

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Vetrik, T. 2020. On the metric dimension of directed and undirected circulant graphs. *Discussiones Mathematicae Graph Theory* 40: 67-76. DOI: 10.7151/dmgt.2110.

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STAFF (2020)

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: Ms H Oosthuizen, Mr JB Smit and Ms JS van Niekerk
Programme Director: Dr C Venter
Administrative Officer: Ms SM Venter

Qwaqwa Campus:
Subject Head: Dr UA Koumba
Senior Lecturer: Dr UA Koumba
Lecturers: Dr NR Loufouma Makala and Mr SP Mbambo
Junior Lecturer: Ms C Faber



DEPARTMENT OF

MICROBIAL, BIOCHEMICAL AND FOOD BIOTECHNOLOGY

CONTACT DETAILS

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OVERVIEW OF 2020

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. Research conducted in the Department finds application in three main areas, namely production of safe and novel food products, biocatalytic production of chemicals or bioremediation of chemical pollution, and improvement of human and animal health.

The main event of 2020, apart from the COVID-19 lockdown, was the Academic Review, which was initially planned for July, but eventually took place in September. Feedback from the reviewers was generally positive.

At the end of 2020, all approval processes were completed to sanction the reorganisation of the Faculty that will result in the closure of the Division of Food Science. As from 2021 the name of our Department will change to Microbiology and Biochemistry. Undergraduate modules in Food Science will be phased out and the Department will in future only teach Microbiology and Biochemistry.

ACHIEVEMENTS

Staff Achievements

Two staff members successfully reapplied for NRF-ratings in 2020. The Department is very proud of Prof Dirk Opperman who improved his rating from a Y1 to a B3 NRF-rating. Prof Martie Smit also improved her rating – from a C2 to a C1 NRF-rating.

Prof Carlien Pohl-Albertyn was appointed as Associate Editor of *Fungal Genetics and Biology* (impact factor 3.162) and to the editorial board of *Frontiers in Cellular and Infection Biology* (impact factor 4.123). She is also currently on the team of researchers writing the health sector response to the COVID-19 pandemic in South Africa for the Country Report for submission to Parliament. The authors of this report include representatives of the National Department of Planning, Monitoring and Evaluation, the Government Technical Advisory Centre, and the National Research Foundation (NRF).

Dr Julio Castillo has been invited to serve as Associate Editor for the *Journal of Geochemical Exploration* (impact factor 3.35, Q1) in the new area of this journal (Bioremediation and Biorecovery), as well as Review Editor for *Frontiers in Microbiology* (impact factor 4.2, Q1), as well as *Frontiers in Bioengineering and Biotechnology* (impact factor 3.6, Q1).

Prof Maryna de Wit was invited to serve as a co-editor for the *Journal of Food Quality* special edition on Tocols and Food Quality (impact factor 1.3).

TEACHING AND LEARNING

The Department was (until 2020) responsible for undergraduate teaching in three subjects – Biochemistry, Microbiology and Food Science – with many undergraduate students taking Biochemistry and Microbiology together as majors for their BSc degrees. On average, 100 students major in Microbiology each year and about 80 in Biochemistry.

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 and bioremediation, and improvement of human and animal health.

Safe and novel food products and processes

During 2020, Prof Celia Hugo and her research group continued their research on psychrotolerant bacteria in food, with an emphasis on the genus *Chryseobacterium*. A two-day Hazard Analysis Critical Control Point (HACCP) workshop was presented on 24 and 25 November by Entecom, a food safety and quality training and consultancy service provider. The workshop trained students in identifying and controlling food safety hazards in the food industry. Prof Hugo has been arranging these workshops for final year and postgraduate Food Science students since 2011.



Final-year and postgraduate Food Science students attending the HACCP workshop presented by Entecom (24 and 25 November)

During 2020 Prof Arno Hugo and his research group continued to work on a project, funded by Red Meat Research and Development South Africa (RMRD SA), on the reduction of sodium levels of traditional South African processed meat products. This research will ensure that these indigenous products stay relevant and meet the health requirements of the modern consumer. Biltong and dry sausage are also intermediate moisture meat products that are stable at room temperature and do not need refrigeration. Research on such products is important, since this technology is very relevant to consumers in rural Africa, who do not always have refrigeration facilities. Prof Hugo and his team also started with a new project on the possible utilisation of meat from lamb carcasses affected with wet carcass syndrome. This problem costs the farmers of the Northern Cape millions of rands annually.

Prof Maryna de Wit's research continued to focus on the functional uses of cactus pears (*Opuntia ficus-indica* and *Opuntia robusta*) in food applications. The effect of nitrogen fertilisation on the seed oil content, composition and quality are being investigated. Research on the functional hydrocolloid, mucilage, was also continued in order to contribute to the increased world-wide interest into this new hydrocolloid. The investigation into the use of the young cladodes (nopalitos) as vegetable source is also being done. In addition, the nutritional and physico-chemical properties of the Spekboom (*Portulacaria afra*) as human food are also being investigated.

Prof Garry Osthoff and his students in the Food Science Division added impala and tsessebe to their studies on milk composition of African non-dairy animals. Of importance was that the tsessebe is the fifth of the family Alcelaphinae to show that the whole family has a higher content of medium chain length milk fatty acids, compared with all other ruminants investigated thus far. This confirmed the phylogenetic property of this family. For many years the impala was considered a member of the family Alcelaphinae; however, this taxonomy was changed some 20 years ago and it was placed in a family of its own. The milk composition of impala also showed no comparison with that of the Alcelaphinae. Prof Osthoff and his students also ventured into a

little-studied field of milk – the metabolites. An MSc study on the milk metabolome of the giraffe was completed, and the research was extended to the African elephant and white rhinoceros, in order to study any phylogenetic differences between taxa.

Prof Osthoff and Prof Arno Hugo have been investigating the physical-chemical properties of milk fat for several years. Milk fat differs from adipose fat in the stereo-specific distribution of fatty acids. The milk fat of non-dairy species provides opportunities because it is not only the species-specific distribution that plays a role, but also the fatty acid types. In a cooperation with the Department of Food Science of the University of Wageningen (Netherlands), the triglyceride species and crystallographic behaviour of African elephant fat was investigated. It was known that the fatty acid composition of African elephant milk fat consists of a high content of medium chain fatty acids, specifically capric acid. It was found that tri-capric glycerol makes up 60% of the triglyceride species during early lactation, and increases to 80%. Simultaneously the crystal forms of these milk fats change from a combination of α and β' crystals to exclusively β' crystals.

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. On both farms, up-scaling was partially achieved by inoculating wood chip heaps of different wood varieties in excess of 30 tonnes. The degraded wood chips were found to contain high digestible protein, available energy and valuable compounds as supplemental animal fodder. Based on positive results related to health aspects, the effect of animal feed supplemented with spent mushrooms and dried mushrooms on ruminants was determined by considering growth, percentage fat, total fatty acids, fatty acid ratios, and colour of meat. Results indicated that ruminants from the experimental groups showed improved growth compared with the control groups. Consequently, a new opportunity emerged, not only as water saving through the harvesting of invader tree species, but also the beneficiation of harvested agri-waste materials via microbial digestion especially of value in draught affected areas.

Biocatalysis and bioremediation

The Applied and Environmental Microbiology Group (AEMG), led by Dr Julio Castillo, apply the knowledge gained from their work in extreme environments to develop remediation strategies for the treatment of polluted water for various industries. They also investigate the use of metal-mineral-microbe interactions for metal biorecovery, as well as the use of recyclable metals to stimulate the microbial production of secondary metabolites (e.g. anticancer and antimicrobial compounds).

The Technology Innovation Agency (TIA) has granted funding to Dr Castillo for a project titled 'Developing a bacterial consortium for improving the quality of mining-contaminated water'. One PhD and four master's students are expected to graduate from this project.

Promising results are emerging from the UFS-funded project titled 'Extreme environments as sources of antimicrobial compounds', led by Dr Castillo in collaboration with Prof Angel Valverde, Dr Olihile Sebolai, and Prof Motlalepula Matsabisa (the latter from the UFS Department of Pharmacology). Isolates from the hot spring water of Brandvlei and Calitzdorp have shown anti-microbial activity against pathogenic yeast and bacterial strains. The extracted bioactive compounds were tested against four cancer cell lines and the preliminary results showed significant inhibition of two cell lines, the prostate and leukaemia cell lines.

Until 2019 the Biocatalysis and Structural Biology Group of Prof Dirk Opperman and Prof Martie Smit focused almost exclusively on novel biocatalytic systems for the introduction of oxygen into molecules and the further conversion of these hydroxylated products. At the beginning of 2020, Dr Carmien Tolmie, a former PhD student and postdoctoral fellow in the group, joined the Department as a Lecturer, and part of the research group. She has started a new research project on structure-based drug design for novel antifungal drugs. The project will use X-ray crystallographic fragment screening to develop lead compounds targeting squalene synthase from *Candida albicans*. The group started 2020 on a high note with an article accepted by *Angewandte Chemie* – this represents their third article in a journal with impact factor above 11 since 2019.

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 being followed, namely a replication-deficient rotavirus vaccine through production of rotavirus proteins in yeast, as well as the 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). The investigation into the role of lipids during rotavirus replication is ongoing.

The work of the Clinical Biochemistry Group, led by Dr Frans O'Neill, focused on sterol metabolism in various fauna. The latest effort forms part of an interdisciplinary project in which a holistic approach to understand the rhinoceros biology and its interaction with the environment is investigated. The group is also investigating the purification and heterologous expression of reproductive hormones with a particular focus on equine chorionic gonadotropin (eCG).



Dr Frans O'Neill with a rhino during a sampling excursion

The Pathogenic Yeast Research Group of Prof Koos Albertyn, Prof Carlien Pohl-Albertyn, Dr Olihile Sebolai and Dr Onele Gcilitshana, 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 2020, several PhD students completed their research using state-of-the-art techniques, including transcriptome analyses, CRISPR-Cas9 gene editing as well as the use of several infection models, i.e. nematodes (*Caenorhabditis elegans*), wax moths (*Galleria mellonella*) and rats to study the role of fatty acids and novel drugs on these pathogenic yeasts.

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 Infectious bronchitis virus (a coronavirus of birds). They have also started work on the expression of genes from SARS-CoV-2. Discussions with Biovac were held on the possibility of producing a yeast based vaccine if proof of concept can be demonstrated. They are also using of the full genome sequences of *A. paragallinarum* to identify novel targets for sub-unit vaccine production. Work continued on the phage display libraries for the development of antibody fragments and antiviral peptides to neutralise Infectious bronchitis virus and Newcastle disease virus. Work on heterologous plant expression of the antiviral peptides against Newcastle disease virus, in collaboration with researchers from the University of Cape Town (UCT), will commence shortly.

In exciting research on resistance to disinfectants, a highly resistant bacterial strain isolated from dairy cows was sequenced. The data revealed around 600 novel genes, many of which can be found in clusters. Many known efflux pump genes were identified, and also a number of hypothetical proteins, which cluster with known resistance genes. During 2020, work was started on the evaluation of the efflux pumps from the highly resistant strain. The metabolic activities and the ability of this resistant strain to use the disinfectants as the sole carbon source were also investigated, as well as the transfer of resistance via plasmids. The transcriptomics work to investigate which genes are influenced when the bacterium is grown in the presences of the disinfectants is well advanced and sequencing data is expected in early 2021. It is hoped that novel, as yet unknown, mechanisms of resistance to disinfectants will be discovered.

ENGAGED SCHOLARSHIP

Prof Trudi O'Neill participated as a panellist in a Pre-Meeting Webinar of the Coalition for Operational Research on Neglected Tropical Diseases (COR-NTD) 2020. The webinar, hosted by the African Research Network for Neglected Tropical Diseases (ARNTD) on 10 November, addressed challenges in capacity building initiatives in Africa. The panel discussions included not only the identification of competency gaps in capacity development, such as writing skills and lack of institutional support, but also the fragmentation of capacity building efforts on the African continent.



Flyerf for the Webinar hosted by the African Research Network for Neglected Tropical Diseases (ARNTD)

NATIONAL AND INTERNATIONAL COLLABORATION

Despite the restrictions brought by COVID-19, in 2020 the Veterinary Biotechnology Group continued their collaborative projects with Dr Asgar, of Saife Vetmed in India, on various potential commercial products which are moving to the agreement-signing

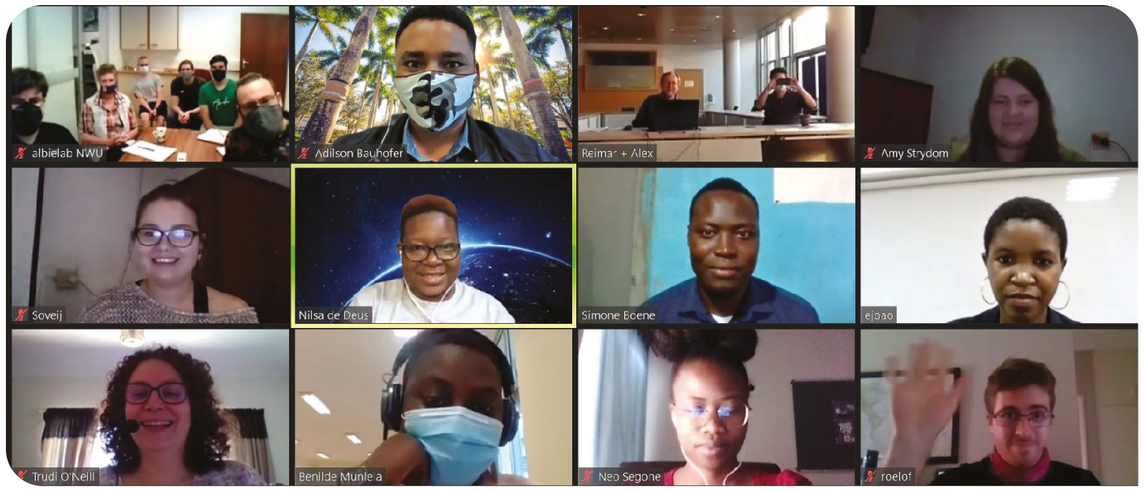
stage. There was also continued collaboration with Dr Gavakare, of Ventri Biologicals, the largest poultry vaccine manufacturer in India, on the development of effective vaccines against infectious coryza and also possible sub-unit vaccine development.

Prof Arno Hugo collaborated with the Agricultural Research Council (ARC), North-West University (NWU), University of Fort Hare and the University of Eswatini (formerly the University of Swaziland) regarding research on the effect of dietary intervention on the lipid component of meat from monogastric and ruminant animals.

Prof Dirk Opperman continued two ongoing collaborative projects with groups in the Netherlands (Prof Frank Hollmann and Dr Caroline Paul from Delft University of Technology) and Denmark (Dr Selin Kara from Aarhus University). These groups bring together different expertise in the field of Biocatalysis, including protein structure determination, directed evolution, and process development, and are currently focusing on flavin-dependent enzymes for practical biocatalysis. Prof Opperman is 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.

Dr Carmien Tolmie started 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.

Prof Trudi O'Neill continued to collaborate with Dr Martin Blasco and Dr Danilo Legisa from the Centre for Biotechnology of the Argentinean National Institute of Industrial Technology (INTI) in Buenos Aires, 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 collaborates with Dr Martin Nyaga from the UFS Next Generation Sequencing (NGS) Unit on this topic. The DFG-funded project titled 'Antigens and reassortant strains for rotaviruses circulating in Africa (AfRota)' initiated in 2018, continued and received a three-month COVID-19 extension from DFG. The project utilises the rotavirus reverse genetics system and aims to generate chimeric viruses that can be used in next-generation rotavirus vaccine development. A virtual annual partners' meeting was held via Zoom on 26 and 27 November. Attending partners included Prof Reimar Johne (Bundesinstitut für Risikobewertung [BfR], Germany), Prof Albie van Dijk (NWU) and Dr Nilsa de Deus (National Institute of Health, Mozambique) and their teams.



Participants of the DFG-virtual Zoom partners meeting, 26 and 27 November
Top row, from the left, Albie van Dijk and her research team at NWU, Aldilson Bauhofer (National Institute of Health, Mozambique), Reimar Johne and Alexander Falkenhagen (BfR, Germany) and Amy Strydom (UFS);
Middle row, from the left, Soveij van der Schyff (UFS), Nilsa de Deus, Simone Boene and Eva João (National Institute of Health, Mozambique), Trudi O'Neill (UFS), Benilde Munlela (National Institute of Health, Mozambique), Neo Segone (UFS) and Roelof Coertze (UFS)

The UFS (Dr Julio Castillo - AEMG) and the University of Limpopo (Dr Kgabo Moganedi - Department of Biochemistry, Microbiology and Biotechnology) have signed an agreement to collaborate on a project titled 'Developing a bacterial consortium for improving the quality of mining-contaminated water'.

Two collaboration agreements involving the AEMG have also been signed with industry partners, Golders Associates, for the implementation of pilot-scale BDAS systems (acid mine drainage treatment) to be installed in Parys Mountain Mine and Cwm Rheidol Mine, and with Manic Technology Holdings for a project on gold biorecovery from mine wastes.



Meeting of representatives of Manic Technology Holdings and the AEMG, 1: Willem Kruger, 2: Paul Louis Yamminat, 3: Natasha Mulder and 4: John Beach, with 5: Dr Julio Castillo and members of AEM group (September 2020)

In addition, three transnational collaborations have been established and will be carried out in 2020 and 2021:

- The project titled 'Mine Residues valorisation by Nitrate and Phosphate adsorbent and its circular use to feed microalgae treating urban wastewaters (MiReNiP4mAlgae' involves a collaboration between Dr Julio Castillo and Dr Manuel Caraballo Monge (University of Huelva, Spain). The Applied Environmental Microbiology Group will carry out all the bioinformatics analyses.
- The project titled 'Gases and outbursts from lamprophyric rocks in the Bushveld Complex: working towards predictive methods to improve underground mine safety is a multinational project involving the University of the Witwatersrand (Dr Grant Bybee), University of Exeter, UK (Prof J Coggan), Princeton University, USA (Prof TC Onstott), University of Toronto, Canada (Dr Barbara Sherwood Lollar), Impala Platinum Limited – Rustenburg, and UFS (Dr Julio Castillo). The Applied Environmental Microbiology Group will be responsible for the collection of samples 3 km underground and isolation of novel microorganisms from these samples.
- The project entitled 'Collaborative Research: Biogeochemical Processes in a Subsurface Hypersaline Environment near the Abiotic Fringe Zone' is another collaboration between Dr Castillo (UFS) and Prof TC Onstott (Princeton University). The Applied Environmental Microbiology Group will again be responsible for the collection of samples and isolation of novel microorganisms.

Dr Frans O'Neill continued his collaboration 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 UFS Faculty of Natural and Agricultural Sciences. 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 Garry Osthoff collaborated on mass spectrometry analyses of milk proteins with Dr Stoychev from the Council for Scientific and Industrial Research (CSIR).

POSTGRADUATE STUDENTS

In 2020 there were 25 students enrolled with the Department for BSc Honours – 18 for Microbiology, 6 for Biochemistry and 1 for Food Science. At the October 2020 virtual graduation 21 students from 2019 graduated with BSc Hons - 11 students majoring in Biochemistry, 4 students majoring in Food Science, and 6 students majoring in Microbiology.

In 2020 a total of 41 students were registered in the Department for master's degrees – 19 in Microbiology, 17 in Biochemistry and 5 in Food Science. During 2020 master's degrees were conferred on nine students:

- Carla Hill with MSc (Agriculture) in Food Science
- Alicia Freitag with MSc (Agriculture) in Food Science – with distinction
- Lauren Lorraine Schmidt with MSc (Agriculture) in Food Science
- Masabata Lydia Gavu with MSc in Food Science
- Precious Kelebogile Letebele with MSc in Biochemistry
- Elzette van der Walt with MSc in Biochemistry – with distinction
- Liese Kilian with MSc in Microbiology – with distinction
- Nyakalo Pilenyane with MSc in Microbiology
- Sheryllyn Clerissa Naidoo with MSc in Microbiology

Twenty-seven (27) students were registered in 2020 for doctoral degrees in the Department – 11 in Microbiology, 3 in Microbial Biotechnology, 7 in Biochemistry and 6 in Food Science.

During 2020, seven students were awarded doctoral degrees:

Du Preez, Louis Lategan
Thesis: The structure and position of the histone terminal domains as a function of linker histone variants and post-translational modifications – a molecular dynamics study
Promoter: Prof DJ Opperman

Fourie, Ruan
Thesis: Investigating the influence of arachidonic acid on *Candida albicans* and its interaction with *Pseudomonas aeruginosa*
Promoter: Prof CH Pohl-Albertyn

Kuloyo, Oluwasegun Olalekan
Thesis: Investigation into the mechanism of arachidonic acid increased fluconazole susceptibility in *Candida albicans* biofilms and application to drug repurposing
Promoter: Prof CH Pohl-Albertyn

Madu, Lynda Uju
Thesis: The repurposing of anti-malaria drugs as anti-cryptococcal drugs
Promoter: Prof OM Sebolai

Mochochoko, Bonang Michael
Thesis: The role of the iron reductive pathway in prostaglandin production, polymicrobial interaction and infection by *Candida albicans*
Promoter: Prof CH Pohl-Albertyn

Nde, Adeline Lum
Thesis: Polyphasic study, species description and significance of novel Chryseobacterium species isolated from poultry sources
Promoters: Prof CJ Hugo and Prof JD Newman

Ojo, Abidemi Oluranti
Thesis: Biodegradation of chlororethene compounds under microaerophilic conditions
Promoter: Dr JC Castillo Hernandez

POSTDOCTORAL RESEARCH FELLOWS

The Department of Microbial, Biochemical and Food Biotechnology hosted eight postdoctoral fellows during 2020. These were:

- Dr Roelof Coertze (South Africa)
- Dr Ana Ebrecht (Argentina)
- Dr Obinna Ezeokoli (Nigeria)
- Dr Olufemi Folorunso (Nigeria)
- Dr Rodolpho Aldo Machado (Brazil)
- Dr Adepemi Ogundeji (South Africa)
- Dr Amy Strydom (South Africa)
- Dr Marcele Vermeulen (South Africa)

STAFF MATTERS

Dr Carmien Tolmie, a former PhD student and postdoctoral fellow of Prof Dirk Opperman, started as a Lecturer in Biochemistry in January 2020.

Prof Angel Valverde, who at the end of 2019 left the UFS for a position with the Spanish National Research Council, was appointed as an Affiliated Associate Professor and continued to supervise students in the Applied Environmental Microbiology Group.

Dr Boucher, who at the end of 2019 resigned as Senior Lecturer to study medicine at the UFS, continued to work with the Veterinary Biotechnology Group as a Research Fellow.

RESEARCH OUTPUTS

Research Articles

Alayande, K.A., Pohl, C.H. & Ashafa, A.O.T. 2020. Evaluations of biocidal potential of *Euclea crispa* stem bark extract and ability to compromise the integrity of microbial cell membrane. *Journal of Herbal Medicine* 21: 100304.

Arita-Merino, N., Yener, S., Van Valenberg, H.J.F., Hugo, A. & Osthoff, G. 2020. Varying levels of medium-chain fatty acids affect triacylglycerol composition and crystallization behavior of African elephant milk fat. *European Journal of Lipid Science and Technology* 122: 2000119.

Awolusi, O.O., Ademakinwa, A.N., Ojo, A., Erasmus, M., Bux, F. & Agunbiade, M.O. 2020. Marine Actinobacteria bioflocculant: A storehouse of unique biotechnological resources for wastewater treatment and other applications. *Applied Sciences* 10: 7671.

Bothma, C., Cronjé, N., Koen, M. & Hugo, A. 2020 Product development and consumer acceptability of soup made from *Clarias gariepinus*. *CyTA - Journal of Food* 18: 572-579.

Cason, E.D., Mahlomaholo, B.J., Taole, M.M., Abong, G.O., Vermeulen, J-G., DeSmidt, O., Vermeulen, M., Steyn, L., Valverde, A. & Viljoen, B. 2020. Bacterial and fungal dynamics during the fermentation process of Sesotho, a traditional beer of Southern Africa. *Frontiers in Microbiology* 11: art 1451.

Delgado, A., Al-Hamimi, S., Ramadan, M.F., De Wit, M., Durazzo, A., Nyam, K.L. & Issaoui, M. 2020. Contribution of tocols to food sensorial properties, stability, and overall quality. *Journal of Food Quality* 2020: 8885865.

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Falkenhagen, A., Patzina-Mehling, C., Gadicherla, A.K., Strydom, A., O'Neill, H.G. & Johne, R. 2020. Generation of simian Rotavirus reassortants with VP4- and VP7-encoding genome segments from human strains circulating in Africa using reverse genetics. *Viruses* 12: 201.

Folorunso, O.S. & Sebolai, O.M. 2020. Overview of the development, impacts, and challenges of live-attenuated oral Rotavirus vaccines. *Vaccines* 8: 341.

Gryzenhout, M., Cason, E.D., Vermeulen, M., Kloppers, G.A.E., Bailey, B. & Ghosh, S. 2020. Fungal community structure variability between the root rhizosphere and endosphere in a granite catena system in Kruger National Park, South Africa. *Koedoe* 62: a1597.

Gryzenhout, M., Vermeulen, M., Pambuka, G. & Jacobs, R. 2020. First report of various *Fusarium* species from the Stevenson-Hamilton Supersite granite catena system in the Kruger National Park, South Africa. *Koedoe* 62: a1599.

Guarneri, A., Westphal, A.H., Leertouwer, J., Lusonga, J., Franssen, M.C.R., Opperman, D.J., Hollman, F., Van Berkel, W.J.H. & Paul, C.E. 2020. Flavoenzyme-mediated regioselective aromatic hydroxylation with coenzyme biomimetics. *ChemCatChem* 12: 1368–1375.

Hiscock, L., Bothma, C., Hugo, A., Van Biljon, A. & Janse Van Rensburg, W.S. 2020. Hedonic evaluation and check-all-that-apply (CATA) question for sensory characterisation of stewed vegetable *Amaranthus*. *Journal of Food Science and Technology* 57: 54-462.

Jamiu, A.T., Aruwa, C.E., Abdulakeem, I.A., Ajao, A.A. & Sabiu, S. (2020) Phytotherapeutic evidence against Coronaviruses and prospects for COVID-19. *Pharmacognosy Journal* 12: 1252-67.

João, E.D., Munlela, B., Chissaque, A., Chilaúle, J., Langa, J., Augusto, O., Boene, S.S., Anapakala, E., Sambo, J., Guimarães, E., Bero, D., Cassocera, M., Cossa-Moiane, I., Mwenda, J.M., Maurício, I., O'Neill, H.G. & De Deus, N. 2020. Molecular epidemiology of Rotavirus A strains pre- and post-vaccine (Rotarix®) introduction in Mozambique, 2012–2019: Emergence of genotypes G3P[4] and G3P[8]. *Pathogens* 9: 671.

Kobeni, S., Osthoff, G., Madende, M., Hugo, A. & Marabini, L. 2020. The dynamic changes of African elephant milk composition over lactation. *Animals* 10: 948.

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Conferences Contributions

Conference papers/Posters

Adedoja, T., Albertyn, J. & Pohl, C.H. 2020. *Influence of Polyunsaturated fatty acids on fluconazole susceptibility and efflux pump activity in Candida auris*. Paper presented at the World Antimicrobial Awareness Week 2020 Virtual Symposium, World Health Organization. 19-20 November 2020.

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STAFF (2020)

Head of Department: Prof M Smit

Professors: Prof J Albertyn, Prof R Bragg, Prof A Hugo, Prof G Osthoff, Prof T O'Neill, Prof C Pohl-Albertyn, Prof M Smit and Prof B Viljoen
Associate Professors: Prof M de Wit, Prof C Hugo, Prof D Opperman and Prof O Sebolai
Affiliate Professor: Prof F Hollmann
Affiliate Associate Professor: Prof A Valverde Portal
Senior Lecturers: Dr C Bothma, Dr K Myburgh and Dr F O'Neill
Lecturers: Dr O Gcilitshana, Ms L Steyn and Dr T Tolmie
Senior Researchers: Dr J Castillo-Hernandez and Dr G Kemp
Research Fellow: Dr C Boucher
Secretaries: Ms I Auld and Ms N Moshwaisi
Senior Officer - Professional Services: Mr S Marais
Officers - Professional Services: Ms Y Makaum, Ms E Roodt, Ms C van Rooyen and Ms A van Wyk
Officer: Ms A van der Westhuizen
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DEPARTMENT OF
PHYSICS

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OVERVIEW OF 2020

2020 has been an extraordinary year in many ways. Despite the uncertainty and 'new normal', the Department of Physics thrived as usual. Though we had to adjust to social distancing and sanitising, it did not keep us from performing on the 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 with 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.

RESEARCH AND INNOVATION

Although South Africa went into full lockdown due to the COVID-19 pandemic, 2020 was another successful year for the Department and our researchers continued to produce many International Scientific Indexing (ISI) accredited journal papers. The SARChI Research Chair alone produced 69 publications during 2020. A review paper by postdoctoral fellow Dr Govind Nair, published in *Progress in Materials Science,* received 48 citations within a year.

The pandemic certainly did not restrict our staff from performing. Dr Richard Harris participated in two international studies. The first was led by Prof Wolfgang Tremel, from the Department of Chemistry at Johannes Gutenberg-Universität Mainz, and included scientists from the petro-chemical industry in Saudi Arabia, as well as other academics from Spain and Germany. The work was published under the title 'Selective Synthesis of Monodisperse CoO Nanooctahedra as Catalysts for Electrochemical Water Oxidation' in *Langmuir*.

The second study was led by Prof Weichun Ye from Lanzhou University, and involved academics from the University of South Dakota. This study has also been published with the title 'Group-Targeting SERS Screening of Total Benzodiazepines Based on Large-Size (111) Faceted Silver Nanosheets Decorated with Zinc Oxide Nanoparticles' and has been selected as the journal cover for *Analytical Chemistry* to be published in 2021.

A great honour was bestowed on Dr Harris when he was invited to serve on the panel of an international workshop in Computational Toxicology, held from 27 to 31 January 2020 at the North-West University (NWU) Potchefstroom Campus. The panel was made up of international experts in this research field – Prof Elaine Faustman (University of Washington), Prof Roland Grafstorm (Karolinska Institutet), Prof Bette Meek (University of Ottawa), Prof Ponnadurai Ramasami (University of Mauritius), Dr Richard Harris (UFS), Prof Victor Wepener (NWU), Prof Harvey Clewell (USA, Principal Consultant at Ramboll, USA) and Dr Bruce Duncan (Principal Consultant at Bruce Duncan Environmental Consulting, USA).degrees. On average, 100 students major in Microbiology each year and about 80 in Biochemistry.



Dr Richard Harris and Prof Mary Gulumian, Head of the Toxicology and Biochemistry Section, National Institute for Occupational Health (NIOH)

Prof Ted Kroon also excelled as he received an improved NRF-rating (C2) and was appointed to the Editorial Advisory Board of *Quest* magazine.

ENGAGED SCHOLARSHIP

'Lengua' – A Solar Car for Team UFS

An interdepartmental team from the UFS planned to enter and participate in the 2020 Sasol Solar Challenge. This was initially scheduled to take place from 11 to 19 September 2020, but due to COVID-19 was rescheduled to 2022. However, the team has continued to prepare the solar car – 'Lengua' (meaning cheetah in Sotho).

For the challenge, Team UFS is building a self-propelled manned vehicle that utilises solar energy power systems to travel on public roads from Pretoria to Cape Town via a predefined route over eight days. Competing against 15 other local and international teams, the winner will be determined as the team that covers the furthest distance within the allotted time.

As this is the debut for Team UFS at such an event, the project is spearheaded by a core team of senior members, with additional members helping as required. It will consist of multiple approaches to the research, design and building of 'Lengua'. These will focus on the mechanical components, the power systems, energy storage, health and safety, marketing and outreach.



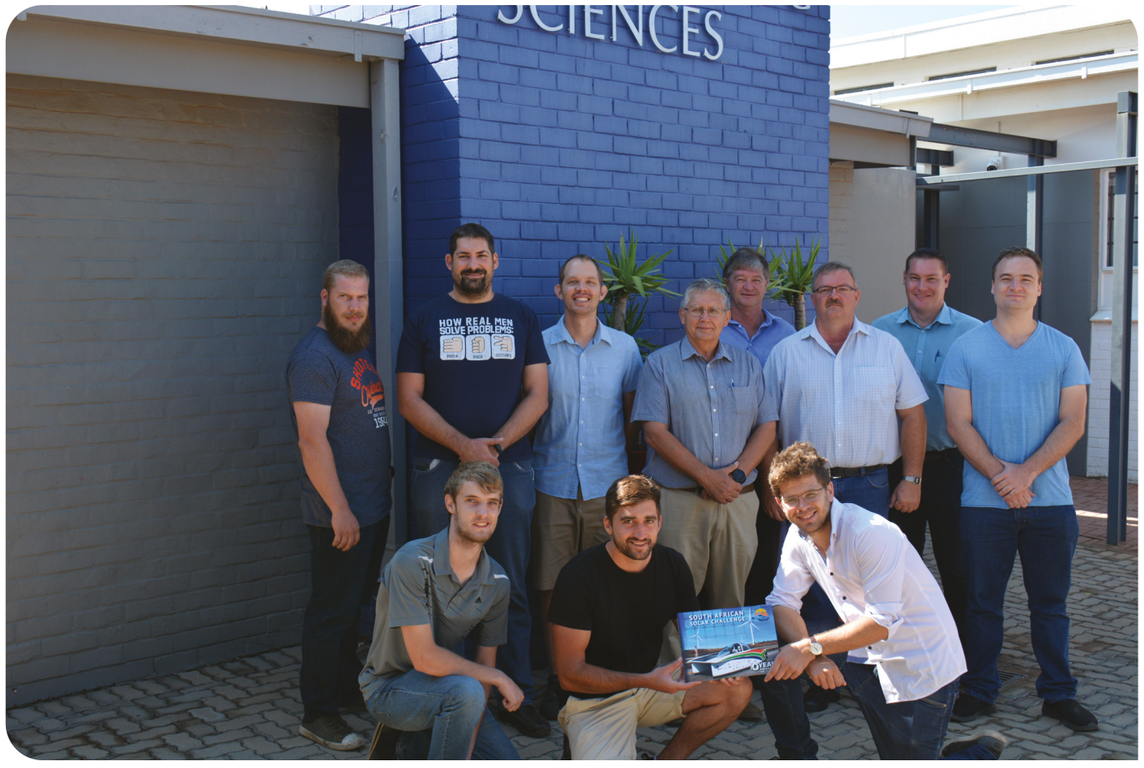
Delegates at the International Workshop on Computational Toxicology, 27-31 January 2020

The whole car has had to be designed from scratch – including a running chassis. The design limitations, as well as previous designs of other teams that did well or won, were taken into account. The proposed design is currently being finalised based on team skills, availability of materials, time available for building and testing, and finally, budget requirements. Dr Hendrik van Heerden, from the Department of Physics, has been planning the solar car project since 2019 and will finalise the car together with colleagues and students from the Department of Physics and the Department of Engineering Science, with assistance from the Instrumentation and Electronics Divisions, during 2021 and 2022 up until the competition event in September 2022.

The main aim of this project is to build capacity for, and development of, a solar powered vehicle (or electric vehicle – EV) and subsequent participation in the Sasol Solar Challenge. The ability of Team UFS to participate is possible due to recent developments in the Department of Physics – including research into photovoltaic technologies (solar cells), and well-established capacity in surface and material sciences as well as in the fields of photoluminescence and nano-materials (nano-materials in energy storage). Collaboration with the newly established Department of Engineering Sciences has increased capacity in the area of green and sustainable engineering, which is central to this project.

The construction of 'Lengua' thus spans a range of disciplines – mechanical, metallurgical, electrical, electronic and structural engineering – and can therefore be used for training in related fields of study in different departments. This project can then also become a strong base for student training and capacity building of all technological fields that can promote development into future visions and 4IR.

Not only is this a dream coming true, but it is also an opportunity for the UFS to show that they can do this. As Dr van Heerden said "We do not need the backing of a large and long-time established engineering department to build a car like this; a young and vibrant team can do just as much!"



Team UFS
Front, from the left: Fouché Blignaut (Mechatronic Engineering), Nathan Bernstein (Agricultural Engineering), Lucas Erasmus (Physics)
Middle, from the left: Barend Crous (Manufacturing and Instrumentation), Hendrik van Heerden (Physics - Team Leader), Antonie Fourie (Physics), Prof Danie Vermeulen (Dean of Faculty -Team Director), Prof Koos Terblans (HOD of Physics), Theo Gropp (Mechanical Engineering)
Back, from the left: Louis Lagrange (Agricultural Engineering - HOD of Engineering Sciences), Mark Jacson (Electronics)
Absent: Elfrieda van den Berg (Faculty Marketing Manager)

Two Observatories

The Department of Physics is responsible for both the Naval Hill Planetarium (formerly the Lamont-Hussey Observatory) and the Boyden Observatory. The two observatories work in synergy to educate and inform citizens about the natural sciences. Most people first visit the Naval Hill Planetarium, which is in the middle of the city, and follow up with a visit to the Boyden Observatory. The observatories are also important for the display and communication of South Africa's astronomical heritage.

Boyden is a venue that is ideal for small conferences, workshops and public evenings, including lectures by visiting academics, attracting a loyal and knowledgeable following. The planetarium offers a large hall adjacent to the facility, which is attractive for concerts, corporate events and larger functions.

School and public events and activities were restricted during the period from April to September at both the Boyden Observatory and the Naval Hill Planetarium. Nevertheless, the project team took advantage of the circumstances to attend to some repairs at the Naval Hill Planetarium, prepare the site at Boyden for the new Boots 6 telescope, affect some repairs at Boyden, work on the project to digitise and catalogue the Boyden collection, and pave an additional section of the Boyden road.

At the Planetarium the required preparations for social distancing during events and the sourcing of personal protective equipment (PPE) supplies, received attention. We installed automatic sanitiser dispensers and a screen at the reception counter. The UFS provided an online COVID-19 screening platform that provided prospective visitors with a QR code that is required for entrance into the Planetarium. The Planetarium re-opened on 2 October 2020.

The International Planetarium Society (IPS) Conference was scheduled to be held in Edmonton, Canada in June 2020. The Naval Hill Planetarium had been accepted as a participant to contribute to themes on the multi-disciplinary use of the planetarium, and fundraising and public relations for planetariums. However, due to COVID-19, the conference was held online (from 3 to 7 August) with people from the planetarium community all over the world presenting their talks and posters, including sessions on new planetarium technologies. The three UFS representatives, Prof Matie Hoffman (Physics), Mr Leon Snyman (Odeion School of Music) and Ms Patricia Lamusse (Institutional Advancement), took full advantage of the stimulating presentations, workshops and networking opportunities that formed part of the virtual conference.

Events such as these are particularly useful to gain insight into how colleagues operate their facilities, and on the latest trends and planetarium technology. The pandemic has disrupted operations over the entire world, but colleagues were inspiring in their relentless drive to innovate and explore the capacity of their facilities to communicate and motivate. The conference led to new insights and renewed support from the international planetarium fraternity, in which we share so many experiences despite the diversity of our contexts.

The Industrial Data Visualisation Laboratory Project

During 2020, we teamed up with other researchers at the UFS and helped to conceptualise and put together detailed plans to install a data visualisation facility at the planetarium site. Informed decision-making is a key aspect of any business, industry, or research endeavour. For engineers, town planners, and farmers, decision-making often takes the form of analysing multiple sets of spatial information. In order to incorporate spatial information into decision-making tasks, it is overlaid digitally and analysed, which is known as a visualisation technique.

The site of the Naval Hill Planetarium is ideal for the planned visualisation laboratory, which will be installed in a section of the Environmental Education Hall, thus bolstering the use of the facility and leveraging the 3-D capacity of the planetarium, by presenting 3-D visualisations.

Fundraising is advanced at this stage but, as with all activities, was somewhat curtained due to the pandemic. The visualisation facility will assist researchers and industry and support a longer-term UFS plan to promote research into planetary science, including Geology and Astronomy, and explore the connections with Chemistry and other natural science fields.

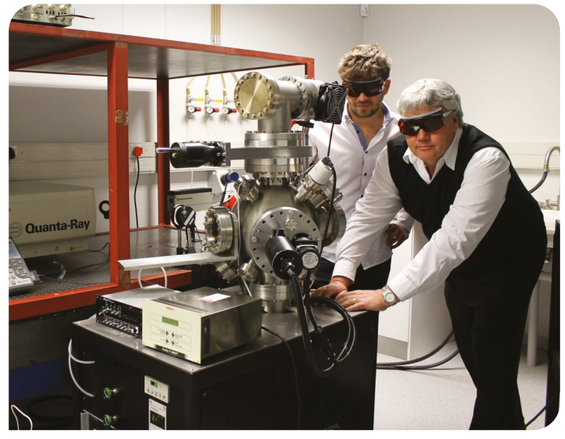
The CLNS3702 Community Service Module

This module is a special UFS module aimed at addressing scarce skills in teaching Science and Mathematics at schools through special workshops. The module is an elective for UFS science students in their third year, and involves teaching natural science subjects at underprivileged and dysfunctional schools. The students are taught pedagogy, community service, and cultural competence. The project enables students to gain practical hands-on teaching experience and exposes them to challenges at schools. Simultaneously, the learners benefit from the additional classes and an additional advantage is the contact between school learners and young students from similar backgrounds who are enrolled at university.

In 2020, eleven students enrolled for the module. Schools have prohibited face-to-face workshops due to the pandemic, and the workshops were therefore presented through video platforms.

POSTGRADUATE STUDENTS

During 2020 the Department delivered five PhD and four MSc graduates. There were 12 registered honours students, 17 registered master's students and 23 registered PhD students for 2020.



PhD student Lucas Erasmus (on the left) with Prof Hendrik Swart

On the Bloemfontein Campus, Murendeni Nemufulwi (Solid State Physics), Boitumelo Tladi (Nanoscience), V Makumbane (Nanoscience) and Helene Szegedi (Astrophysics) graduated with an MSc degree.

The following five students received their PhD degrees:

Hasabeldaim, Emad
Thesis: Luminescence properties of ZnO and ZnO:Eu^{3+} nanostructures and thin films.
Promoters: Prof HC Swart, Prof RE Kroon and Prof OM Ntwaeaborwa

Tshabalala, Zamaswazi
Thesis: Influence of Exposed Facets and Acid Treatment on the Sensitivity and Selectivity of Room Temperature TiO_2 Semiconductor Gas Sensing Properties.
Promoters: Dr D Motaung and Prof HC Swart

Shingange, Katekani
Thesis: The exploration of lanthanum-based complexes oxides: preparation, characterization and gas sensing properties.
Promotors: Prof GH Mhlongo and Prof HC Swart

Saeed, Nadir
Thesis: Luminescent properties of YOF phosphor for solar cell application.
Promoters: Prof E Coetsee-Hugo and Prof HC Swart

Hile, Donald
Thesis: Synthesis, growth and characterization of zinc selenide nanostructured thin films for applications in light emitting materials.
Promoters: Dr LF Kaoa and Prof HC Swart

POSTDOCTORAL RESEARCH FELLOWS

In 2020, the Department of Physics hosted fifteen postdoctoral fellows – thirteen involved in Solid-state Physics, and two in Astrophysics. Dr GK Inwati, Dr PP Sukul and Dr SJ Panchu joined the Solid-State Physics group as new postdocs, bringing new ideas and research to our laboratories.

The postdoctoral fellows in the Department of Physics are:

- Dr P Kumar, from India (Solid-state Physics)
- Dr C Tsai, from South Africa (Solid-state Physics)
- Dr NJ Shivaramu, from India (Solid-state Physics)
- Dr S Menon, 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 GK Inwati, from India (Solid-state Physics)
- Dr PP Sukul, from India (Solid-state Physics)
- Dr SJ Panchu, from India (Solid-state Physics)

STAFF MATTERS

Two staff members from the Qwaqwa Campus were promoted to Associate Professors – Prof Lehlohonolo Koao and Prof Richard Ocaya.

Prof Wiets Roos retired at the end of 2020 after a long and successful career.

RESEARCH OUTPUTS

Research Articles

Abdalla, H., Meintjes, P.J., Van Soelen, B. & et.al. 2020. Resolving the Crab pulsar wind nebula at teraelectronvolt energies. *Nature Astronomy* 4: 167-173. DOI: 10.1038/s41550-019-0910-0.

Abdelrehman, M.H.M., Craciun, V., Kroon, R.E., Yousif, A., Seed Ahmed, H.A.A. & Swart, H.C. 2020. Effect of background atmosphere and substrate temperature on SrO: Bi^{3+}(0.2 mol%) thin films produced using pulsed laser deposition with different lasers. *Physics B: Physics of Condensed Matter* 581: 411757. DOI: 10.1016/j.physb.2019.411757.

Abdelrehman, M.H.M., Kroon, R.E., Yousif, A., Seed Ahmed, H.A.A. & Swart, H.C. 2020. Photoluminescence, thurmoluminescence, and cathodoluminescence of optimized cubic Gd_2O_3:Bi phosphor powder. *Journal of Vacuum Science & Technology A* 38: 063207. DOI: 10.1116/6.0000567.

Abram, C., Panjikkaran, I.W., Ogugua, S.N. & Fond, B. 2020. $ScVO_4$:Bi^{3+} thermographic phosphor particles for fluid temperature imaging with sub-˚C precision. *Optics Letters* 45(14): 3893-3896. DOI:10.1364/OL.392088.

Ahemen, I., Kroon, R.E., Sha'Ato, R. & Dejene, F.B. 2020. Unusual blue and red luminescence properties of BaO-ZrO_2 nanocrystals. *Materials Research Express* 7: 026202. DOI: 10.1088/2053-1591/ab5ddc.

Balakrishna, A., Reddy, L., Ntwaeaborwa, O.M. & Swart, H.C. 2020. Remarkable influence of alkaline earth ions on the enhancement of fluorescence from Eu^{3+} ion doped in sodium ortho-phosphate phosphors. *Journal of Molecular Structure* 1203: 127375. DOI: 10.1016/j.molstruc.2019.127375.

Bedyal, A.K., Kumar, V. & Swart, H.C. 2020. Influence of an adjoining cation on the luminescence performance of the Dy^{3+} doped $A_3Gd(PO_4)_2$; (A=Na, K) phosphors. *Journal of Alloys and Compounds* 845: 156352. DOI: 10.1016/j.jallcom.2020.156352.

Bedyal, A.K., Kunti, A.K., Menon, S.G., Kumar, V. & Swart, H.C. 2020. Red emitting non-rare earth doped $LiMgBO_3$ phosphor for light emitting diodes. *Journal of Alloys and Compounds* 830: 154622. DOI: 10.1016/j.jallcom.2020.154622.

Chernyakova, M., Malyshev, D., Blay, P., Van Soelen, B. & Tsygankov, S. 2020. Multiwavelength observations of PSR J2032+4127 during the 2017 periastron passage. *Monthly Notices of the Royal Astronomical Society* 495: 365-374. DOI: 10.1093/mnras/staa1181.

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Professors: Prof RE Kroon, Prof WD Roos and Prof JJ Terblans
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Senior Lecturers: Dr RA Harris and Dr B van Soelen
Lecturers: Dr S Cronje and Mr DP van Jaarsveldt
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Researcher: Dr M Duvenhage
Junior Researcher: Mr LJB Erasmus
Affiliate Associate Professors: Prof KT Hillie, Prof G Mhlongo and Prof DE Motaung
Research Associates: Prof JPK Hölsä, Dr V Kumar and Dr J Prakash
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Senior Officer – Professional Services: Dr HJ van Heerden
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OVERVIEW OF 2020

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. Due to COVID-19, 2020 was a difficult and challenging year for the Department, as surely is the case for all departments in the Faculty and the University. In spite of these challenging circumstances, Plant Sciences excelled in their teaching and learning approach and in the number of articles published and submitted during 2020. The Department also adapted to online meetings, postgraduate research proposals, and honours seminar days that included staff and students from both the Bloemfontein and Qwaqwa campuses. During 2020, 10 honours, 12 master's and 11 doctoral students obtained their degrees.

The Department of Plant Sciences on the Qwaqwa Campus started the year off on a high note by hosting the 46th Annual Conference of the South African Association of Botanists (SAAB 2020) from 7 to 10 January. Over 220 delegates representing 12 different nationalities attended. Delegates from the University of Pretoria commended the Local Organising Committee, saying that the "conference was very well organised and proved to be fantastic exposure for us to the excellent facilities and talented staff based on the Qwaqwa Campus", and that "it was one of the better SAAB meetings in recent years".



Delegates at the SAAB 2020 Conference, Qwaqwa Campus (7-10 January 2020)

ACHIEVEMENTS

Staff Achievements

The SARChI Research Chair in Disease Resistance and Quality in Field Crops, headed by Prof Maryke Labuschagne, has been renewed for another five years (2021-2025).

Dr Willem Boshoff, Prof Botma Visser and Prof Zakkie Pretorius won the prize for the best article, titled 'Hawerstamroes - Neem ingeligte besluite oor vatbaarheid van kultivars', in the January/February 2020 edition of *Wheat Focus*. The three researchers also won a prize for the best article '*Berberis* – 'n onbekende faktor in die stryd teen stam- en geelroes van koring in Suid-Afrika' in the March/April 2020 edition of *Wheat Focus*, and Dr Boshoff, Dr Cornel Bender and Prof Pretorius won the prize for the best article, titled 'Die voorkoms van roeswamme op rog, triticale en gars', in the May/June 2020 edition of *Wheat Focus*.

Prof Zakkie Pretorius, Research Fellow in the Department, was nominated for the 2019/2020 National Science and Technology Forum (NSTF)-South32 Awards. He was nominated in two categories, namely the 'Special Annual Theme Award: Research and Development (R&D) and Innovation in Plant Health', as well as in the 'Lifetime Category'. The Special Annual Theme Awards were made in recognition of the International Year of Plant Health (2020), declared by the United Nations (UN).

During the 13th Southern African Plant Breeders' Association (SAPBA) biennial conference held at the Future Africa Campus of the University of Pretoria from 8 to 11 March 2020, Prof Zakkie Pretorius received an Honorary Membership and Prof Liezel Herselman a Fellow Award in recognition of their services to and promotion of the objectives of the SAPBA and exceptional achievements / contributions to Plant Breeding. Dr Angeline van Biljon was elected to serve on the SAPBA executive committee for the next two years.

Prof Louis Scott was appointed as a member of the editorial board of the Elsevier journal *Quaternary Science Reviews*.

Dr Sandy-Lynn Steenhuisen served as chairperson for the local organising committee that successfully hosted the 46th Annual Conference of SAAB. Four exemplary plenary speakers were part of the conference programme – Prof Annah Moteetee (University of Johannesburg, South Africa), Prof Peter Linder (University of Zurich, Switzerland), Prof Felipe W Amorim (Institute of Biosciences, São Paulo State University [UNESP], Brazil), and the winner of the Best Young Botanist award at SAAB 2019, Mr Ryan Rattray (Genelethu, South Africa). The week culminated in a rather wet but enjoyable exploration of the Afromontane flora on the slopes of Sentinel Peak in the Maloti-Drakensberg.



Dr Martin Mandew, Qwaqwa Campus Principal, Dr Sandy Steenhuisen, Chairperson of the SAAB 2020 Local Organising Committee, and Prof Pearl Sithole, Qwaqwa Campus Vice-Principal: Academic and Research at SAAB 2020 (7 to 10 January)



Prof Felipe Amorim presenting the plenary lecture at SAAB 2020 (7 to 10 January)

Dr Steenhuisen was selected for the Department of Higher Education and Training (DHET) Future Professors Programme from the start of 2020. She was also appointed as an associate editor of the *American Journal of Botany* from August 2020.

Dr Cornél Bender, a Chief Officer: Professional Services in the Department, received her PhD in Plant Pathology.

Dr Lisa Rothmann (Lecturer – Units) was appointed as an Early Career Assistant Editor of *Phytopathology*.

Student Achievements

A number of students from Plant Breeding won prizes from SAPBA. Jenna Vos received the award for best second-year student in Plant Breeding, Charnè Viviers for best third-year student in Plant Breeding, and Robert Coertzen for the best fourth-year student in Plant Breeding, while Tondani Mishasha won the prize for best MSc student in Plant Breeding and Dr Ntombokulunga Mbuma won the prize for best PhD student in Plant Breeding.

Botany students who were awarded prizes at the Faculty's prize-giving function were Jo Cobbold, Carlo Visser and Emma Ferreira, who received Botanical Society of South Africa (Free State Branch) prizes for the best second-year, third-year and honours students in Botany, respectively.



Emma Ferreira conducting a vegetation survey in the Bokkeveld Plateau

In Plant Pathology, Lineo Maphobole received the incentive prize for Plant Pathology and Habofanoe Fosa received the award for the best final-year student in Plant Pathology.

Ms Sellwane Moloi, a PhD student of Dr Rudo Ngara, won the best poster prize in Plant Physiology at the SAAB Conference held at the Qwaqwa Campus in January 2020.

TEACHING AND LEARNING

Dr Boshoff presented an invited lecture titled 'Stem rust in wheat – the Southern African perspective' as part of an online seminar to MSc students taking the course Plant Breeding and Protection for Sustainable Production (BI1296) in the Department of Plant Protection Biology at the Swedish University of Agricultural Sciences. As part of the same online seminar, Dr Angeline van Biljon presented an invited lecture titled 'Nutritional improvement through biofortification'.

From 31 January to 7 February 2020 Dr Lize Joubert and Dr Andri van Aardt led the BTNY3712 excursion to Hogsback in the Eastern Cape. During the excursion, the third-year Botany students were trained in several vegetation survey, plant identification, research and specimen collection techniques.



Students surveying forest vegetation at Hogsback in February 2020, from the left, Justin Giddy, Jo Cobbold, Jaydon Dyers and Kirsten Nienaber



Students surveying fynbos vegetation at Hogsback in February 2020

After the practical fieldwork at Hogsback was completed, students were trained in scientific communication in the form of poster and oral presentations and written scientific reports. A total of 39 students successfully completed the module.

The new Zeiss Digital Classroom in Biology Lab 28, consisting of 60 iPads, 60 digital microscopes, 60 normal compound microscopes and a new audio-visual system, was used for the first time to train second-year Botany students in BTNY2616. The Digital Classroom promotes active student participation in class projects designed to teach skills in light microscopy, gathering, analysing and reporting data. The training using the Digital Classroom was very successful and more practicals will be designed around this system in future.

Amid the COVID-19 lockdown and restrictions, eco-physiology second-year students (BTNY2622) successfully completed a virtual online 'field excursion' under the supervision of Dr Gerhard Potgieter and Dr Makoena Moloi. Students were virtually introduced to the adaptations in different plants to grow and survive in the harsh Free State environment. Working interactively in online groups, they mastered the principles and data analyses of the techniques used to measure chlorophyll content and photosynthetic rate in plants under different environmental conditions.

Amid the COVID-19 pandemic, all lecturers successfully converted their lecturing material to support a blended approach to teaching. Everyone embraced new technologies to ensure the success of their students.

RESEARCH AND INNOVATION

SARChI Research Chair in Disease Resistance and Quality of Field Crops

The Research Chair completed a very successful first five-year cycle in 2020. The Chair has received funding for the next five-year cycle, and the team is excited about new projects commencing, and continued research on projects from the previous cycle.

In terms of research on quality in field crops, in 2020 three PhD students completed their degrees. One focused on possible yield reduction due to the presence of the quality protein maize (QPM) trait, which doubles the amount of the essential amino acids, lysine and tryptophan. A second thesis was on the introduction of foreign germplasm as a way to enhance wheat breeding in South Africa, and a third was on the improvement of acid soil tolerance in maize in Angola. Fourteen papers were published in accredited journals and four book chapters were published – three in crop quality and one in quantitative genetics as applied to drought resistance breeding in maize. Seven papers were presented at a national conference and one (a keynote presentation) at an international conference.

Research on quality of field crops was largely done in collaboration with the Consortium of International Agricultural Research Centres (CGIAR), specifically the International Maize and Wheat Improvement Centre (CIMMYT) in Kenya, Zimbabwe and Mexico, and the International Institute for Tropical Agriculture in Nigeria. The University of Cordoba in Spain was an important research partner on wheat quality. The main focus was on crop biofortification for iron, zinc, provitamin A, and lysine and tryptophan, especially under abiotic stress conditions, as well as gluten protein and quality of wheat under heat and drought stress.

In terms of research on disease resistance, two MSc students completed their dissertations on rust resistance breeding (both *cum laude*) and three PhD theses were completed on rust resistance breeding. Ten accredited papers were published on disease resistance in field crops, with a focus on wheat. Nine papers were published in the popular press, of which one (authored by Prof Boshoff) was awarded best paper in *Koring Fokus*.

As in the past, the disease resistance research was highly collaborative. International and local collaboration led to the following noteworthy achievements:

- The research of Dr Jianping Zhang at the Commonwealth Scientific and Industrial Research Organisation (CSIRO) in Canberra, Australia resulted in the cloning of two broadly effective stem rust resistance genes, *Sr26* and *Sr61*. Dr

Zhang completed a significant part of her work at UFS where Prof Pretorius and Dr Boshoff helped with rust phenotyping. This research has been submitted to a high impact journal and has been accepted pending revision.

- Research by Dr Hongwei Li from the Institute of Genetics and Developmental Biology of the Chinese Academy of Sciences, resulted in the establishment of wheat-*Thinopyrum ponticum* translocation lines, carrying a new source of resistance to stem rust. A paper from this research has been submitted to a high impact journal.
- Prof Botma Visser, Dr Howard Castelyn and MSc student Mr Wilku Meyer attended the BHC-Bioinformatics-Wheat-Genomics-III workshop. The workshop was sponsored by the British High Commission and the United Kingdom (UK) Science and Innovation Network. It provided hands-on training in bioinformatics, wheat genomics and sequencing technologies and was presented by Dr Burkhard Steuernagel (John Innes Centre, UK), Dr Robert Davey (Earlham Institute, UK) and Dr Diane Saunders (John Innes Centre, UK).

Botany: Plant physiology/biochemistry and molecular biology

Dr Gerhard Potgieter was involved in the evaluation of the bio-stimulant properties of certain secondary molecules isolated from various plant and animal sources. The use of these bio-stimulants, in addition to traditional agricultural practices, is to improve yield and quality of crops in existing cultivation areas. The research collaboration between Dr Potgieter (Eco-physiology) and Introlab (SA) continued during 2020. The bio-stimulant properties of Xcell Boost on different crops under certain stress conditions were evaluated.

Dr Potgieter was also involved in developing new approaches in vegetation management, identification of alien plant species and management of crop health using drone technology. These include Normalised Difference Vegetation Index (NDVI) data for plant health monitoring and red-green-blue (RGB) photography in identifying plants through remote sensing. Dr Potgieter collaborated with Dr Andri van Aardt using the unique colour- and form signatures of plants to describe a protocol to identify different plants from drone aerial footage. This will aid in vegetation surveys and management of alien plant invasions, especially in areas that are difficult to access. An MSc dissertation by Mawethu Ndiki titled 'Evaluating colour and form signature to identify invasive alien plant species' was submitted during December 2020 (co-supervisor Dr Van Aardt).

Prof Botma Visser collaborated with Dr Boshoff from Plant Pathology to genotype cereal rust species. During 2020, leaf rust of oat, barley, and wheat were genotyped. Prof Visser is also investigating a new potential fungicide that could control stripe rust of wheat.

Dr Lintle Mohase and her research team continued their research on plant-defence mechanisms in wheat during aphid, *Duiraphis noxia*, (and rust), infestations. She collaborated with a pathologist (Dr Boshoff) from the UFS, an entomologist at the Agricultural Research Council Small Grain (ARC-SG), Bethlehem (Dr Astrid Jankielsohn) and the Lesotho Agricultural Research Unit (wheat germplasm in Lesotho). Her research concentrates on aphid distribution in wheat-producing regions of South Africa and Lesotho, the impact of aphid infestations on yield and quality, mechanisms of host resistance, the impact of drought stress on plant responses to aphids, as well as the effect of commercial plant activators on crop protection against the aphid.

Dr Makoena Moloi's research is on plant-environment interactions – particularly abiotic stress physiology and ecophysiology. The current research involves the physiological, biochemical and morphological responses of edamame and cowpea to drought and high temperature stress. The research team is in the process of running the first drought trial. Another project involves the use of biostimulants/biofertilisers to mitigate drought stress in plants. They discovered that kelp and fish protein hydrolysate-derived biostimulant (Xcell Boost) enhanced the photosynthetic capacity of edamame when applied at higher concentrations. They also found that application of selenium improved the biochemical responses of edamame under drought stress. Further tests on Xcell Boost will be undertaken in 2021 to establish the best application method, as well as the effect of biostimulants on the yield and nutritional content of edamame.

Dr Rudo Ngara concluded her Royal Society and National Research Foundation (NRF) Thuthuka grants in November and December 2020, respectively. She continued with her research on investigating the complex responses of cereal crops, such as sorghum, wheat and maize, to a range of abiotic stress factors.

Dr Mpho Mafa's research is focused on plant cell-wall components, such as glycoside hydrolases (GHs), that are classified into different families based on their amino acid sequence and three-dimensional structural similarities in the Carbohydrate-Active Enzymes database (CAZymes: http://www.cazy.org). One of his research interests is to use these CAZymes to produce a value-added chemical that can be applied to induce plant immune responses against pathogens. They include oligosaccharides that are also known as Damage Associated Molecular Patterns (DAMPs). Dr Mafa also plans to investigate the defence role of the plant cell wall against South African biotypes of Russian wheat aphids. He is investigating whether there is a difference in the salivary proteins (with a specific focus to CAZymes) for the approximate five biotypes present in South Africa.

Botany: Phytomedicine and ethnobotany

Postgraduate students are working with Dr Pheello Mojau on the antimicrobial and antimycobacterial activities of *Populus x canescens* bark and leaves, *Acokanthera oblongifolia* stem and leaves, and *Dioscorea sylvatica* roots.

Botany: Plant taxonomy and molecular systematics

Dr Lize Joubert is leading a project titled 'The role of flower structure in the diversification of the genus *Nemesia* (Scrophulariaceae)' with Dr Mariëtte Jackson and Dr Andri van Aardt. 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. The study specifically focuses on the phylogenetic and taxonomic relationships between the ±77 *Nemesia* species that are endemic to southern Africa, and how a combination of ecological factors, floral key innovations, and interaction with pollinators has led to the diversification of the genus. Two MSc students and one BSc Honours student are being trained in this research project. Fieldwork was conducted in the Free State, Northern Cape and Western Cape, during which plant specimens, samples for molecular phylogenetic analysis, pollinator-, vegetation- and soil data were collected under the supervision of Dr Joubert and Dr Van Aardt.



Dr Andri van Aardt, Dr Lize Joubert and Ms Emma Ferreira collecting Nemesia in the Namaqualand klipkoppe

Pieter Bester, a collaborator on this project from the South African National Biodiversity Institute (SANBI), identified one of the collected specimens as a species new to science. The description of the new species will be published with a full taxonomic revision of the genus as part of the project outputs. All specimens collected were phylogenetically analysed under the supervision of Dr Jackson. With over half of the known species in the genus now included in the molecular phylogeny, this will form the basis for further expansion of the project to include detailed comparisons between closely related species.



The as yet undescribed Nemesia species from the Northern Cape

Dr Mariëtte Jackson leads the Molecular Systematics Research group. Various genera within the family Asteraceae are being studied to assess the phylogenetic relationships among these genera. A new field of research has begun which analyses fossil soil sediments from the fossil pollen collection of Prof Louis Scott, to obtain ancient DNA that can be used within phylogenetic studies.

Dr Jackson is also involved in a Plant Pathology MSc project in which fungi in sorghum kernels are being identified with molecular techniques. Dr Jackson also collaborates with Dr Joubert on the *Nemesia* project.

Botany: Palaeo-botany and ecology

Dr Andri van Aardt's research interest is in modern- and palaeoecology, studying sites such as Florisbad and Colbyn in terms of their palaeo-environments. This research is done in collaboration with several South African colleagues. In addition, she is working on a manuscript describing pollen morphology of *Acacia* species in collaboration with South African and International colleagues. A student is also investigating surface pollen and phytolith samples from transects in South Africa. Several of her students are busy with research on modern vegetation associations in the Golden Gate Highlands National Park (GGHNP), various national parks in the Eastern Cape, and areas surrounding Bloemfontein. She is also collaborating with Dr Joubert on the *Nemesia* project.

Prof Louis Scott collaborated in archaeological projects in Israel, from which two articles were published. He also submitted a manuscript for publication on the Pleistocene and Holocene past environmental research in the central interior, that appeared online during 2020 but will form part of a Special Issue of *Quaternary International*. This 2021 volume includes a paper in collaboration with Canadian colleagues on the environmental history at Kathu Pan in the Northern Cape. He also made progress with studies on fossil hyrax dung from Namibia and the environmental history of alluvial deposits in the Little Karoo.

Dr Sandy Steenhuisen on the Qwaqwa Campus undertook collaborative research on the use of sound recordings for assessing the biodiversity of birds in wetlands of the GGHNP in partnership with BirdLifeSA, the Afromontane Research Unit (ARU) and the Department of Zoology and Entomology on the Qwaqwa Campus. The Centre for Biological Control (CBC) at Rhodes University has again been an integral partner of the ARU and Dr Steenhuisen's research group, contributing supervision and expertise for research projects on the ecology of invasive species in the eastern Free Sate. For the first time for the ARU and Dr Steenhuisen's research group, SANBI was heavily involved in funding projects in the Department and training postgraduates in generating risk analysis reports of their study species, as part of the mandate of SANBI.

Plant Breeding: Molecular plant breeding

Prof Liezel Herselman's research continued to focus on marker-assisted disease resistance breeding, focusing specifically on rust resistance (stem, stripe, and leaf rust) and Fusarium head-blight (FHB) in wheat. A potential new source of stem rust resistance in two durum derived wheat lines was characterised and mapped in the same region as the stem rust resistance gene *Sr13*. Future work will focus on determining whether it is *Sr13* or another gene closely linked to *Sr13*. As part of the global efforts to develop wheat cultivars with durable wheat stem rust resistance, molecular marker analysis identified a considerable number of Ethiopian synthetic and elite wheat lines carrying economically important seedling and adult plant stem rust resistance genes. A genome-wide association study identified genetic regions linked to resistance against individual and multiple stem rust races, including novel regions associated with resistance to various

virulent stem rust races. These identified gene regions could play an important role in marker-assisted breeding for stem rust resistance.

Dr Adrè Minnaar-Ontong's research focused on breeding for resistance against fungal diseases across multiple crops with specialisation on resistance breeding against *Sclerotinia sclerotiorum* diseases in both sunflower and soybean. South African sunflower and soybean cultivars were evaluated for resistance to sclerotinia diseases to promote the improvement of disease control strategies. This research is funded by the NRF-Thuthuka (2019-2021) as well as GrainSA, and forms part of the South African Sclerotinia Research Network (SASRN) established in 2017. SASRN funds the maintenance of a *Sclerotinia sclerotiorum* culture collection, derived from a population genetics study on >1 000 isolates collected from eight of the nine South African provinces across multiple crops. This research was driven by Dr Minnaar-Ontong and her team (Dr Chrisna Steyn, postgraduate students and collaborators). A part of the population genetic study was completed as an MSc study in 2020, but will continue.

Another focal point in Dr Minnaar-Ontong's research includes the identification and characterisation of the *Fusarium* species responsible for sudden death syndrome (SDS) in South Africa, as well as the genetic analysis of soybean resistance against this pathogen. *Fusarium virguliforme* was identified and concluded as the causal species of SDS as part of an MSc study that was successfully completed in 2020. The outcome of this project contributed to the initiation of an SDS pre-breeding programme that started with the evaluation of commercial soybean cultivars for resistance. This research will contribute signficantly to soybean production of South Africa.

Dr Ansori Maré collaborated with Dr Boshoff (Plant Pathology) to identify new rust resistance sources in wheat using molecular markers and phenotypic evaluations to evaluate mapping populations. Selected wheat cultivars and lines from three different breeding backgrounds were identified to contain unknown rust resistance. The three breeding backgrounds included the CIMMYT rust resistance nursery, Morden Research and Development Centre – Agriculture and Agri-Food Canada and CM-82036/Avocet S. This research is funded by the NRF-Thuthuka and Winter Cereal Trust. Progress has also been made with cross breeding and molecular markers to enhance rust and FHB resistant wheat lines with additional resistance genes to ensure durable resistance in wheat.

Plant Breeding: Conventional breeding

Dr Rouxlene van der Merwe's research focused on breeding for resistance to pod dehiscence in vegetable type soybean. The research is being undertaken in collaboration with the Northeast Institute of Geography and Agroecology of the 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 Minnaar-Ontong, who is responsible for marker-assisted selection.

Dr Van der Merwe also made progress with 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 undertaken in collaboration with Dr Van Biljon, who assisted with sugar analysis, Prof Arno Hugo, who assisted with fatty acid analysis, and Dr Carina Bothma, who assisted with sensory tests.

Dr Van der Merwe continued her research on the characterisation of vegetable-type soybean cultivars in terms of drought stress tolerance. This project involves collaboration with Dr Van Biljon, who assisted with sugar analysis, Prof Hugo, who assisted with fatty acid analysis and Dr Moloi who assisted with physiological response analyses.

Plant Breeding: Wheat-quality and crop-nutritional value research

Prof Maryke Labuschagne and Dr Angeline van Biljon continued collaboration with Dr Carlos Guzman, of Cordoba University in Spain, and Dr Itria Ibba, of CIMMYT-Mexico, on bread and durum wheat quality, involving two PhD students. The collaboration is ongoing, with a focus on gluten proteins. Collaboration with CIMMYT in Harare and Kenya is also ongoing, involving Dr Thoko Ndhlela, Dr Jill Cairns, Dr Mike Olsen, Dr Cosmos Magorokosho and Dr Dagne Wegary. Four PhD projects on maize biofortification and stress tolerance breeding are included in the study.

Dr Van Biljon continued her research on the influence of abiotic stress on the nutritional profile and quality of various crops, as this information will contribute to the improvement of specific crops and lead to better food security. The research focuses on crops such as wheat, maize, vegetable-type soybeans, and butternut. The nutritional screening includes the study of storage protein through size exclusion- and reverse-phase high-performance liquid chromatography, as well as the determination of total starch, amylose, tryptophan, β-carotenoids, mineral content (especially iron and zinc), and the bioavailability of these minerals.

Dr Ntombokulunga Mbuma and Prof Labuschagne collaborated with researchers from the Agricultural Research Council (ARC). The research 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 also involves understanding the adaptability and stability of cowpea varieties under South African conditions. Two peer-reviewed manuscripts were published during 2020 from this collaboration, which is ongoing and focuses on improving cowpea genotypes for nutritional value under abiotic stresses such as drought and heat.

Plant Pathology: Cereal rust diseases

Dr Willem Boshoff was involved in the Winter Cereal Trust 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 2020 field trials were only possible in the Western Cape, with the support of Sensako staff; cereal varieties were rated with the assistance of Prof Pretorius. Data from these trials is annually included in the national wheat production guidelines of ARC-SG.



Plant Pathology: Soil microbial ecology

The soil microbial ecology group (SMEG) is run by Prof Wijnand Swart, and the focus of the group's research is on monitoring the rhizosphere microbiome as a bio-indicator of plant health. The group's research concentrates 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 focus on the rhizosphere microbiome. In so doing, innovative crop production and protection strategies are developed with specific emphasis on discovering beneficial microbes that can influence both plant and soil health.

Plant Pathology: Mycology

Despite the unusual challenges that COVID-19 placed on the travelling arrangements and access of students to the UFS Bloemfontein campus, the Pecan Research Group, under the leadership of Dr Gert Marais, managed to undertake a number of field trips. These included the Orange River (from Luckhof to Upington), Vaalharts, Schweizer-Reneke, Jacobsdal, as well as various other areas in Limpopo, Mpumalanga, Gauteng and KwaZulu-Natal. During these field trips, a total of six farmers' days were organised at which information on the latest findings from student projects were shared with pecan producers and other interested parties. This is part of a five-year research project between the South African Pecan Nut Producers Association (SAPPA) and the UFS. To support future pecan research at the UFS, a one-hectare pecan orchard was established on the Paradys Experimental Farm in Bloemfontein.

Four MSc studies were concluded during 2020, including studies on the screening of fungal candidates for the dry retting of kenaf, the use of essential oils to control crown and root rot of maize, confirming that the causative agent of pecan scab in South Africa is the fungus, *Cladosporium cladosporioides*, and that the fungus, *Neofusicoccum parvum*, causes dieback in pecans.

Plant Pathology: Epidemiology

The epidemiology programme was led by Dr Lisa Rothmann and supported by Prof Neal McLaren and Mrs. Marlese Meiring. The focus of the group is Sclerotinia stem and head rot of soybean and sunflower, as well as sorghum pathology. Prof McLaren, operating from the Western Cape, is a Research Fellow in the Department. He presented data science workshops at Stellenbosch University and the University of Pretoria and continued his research collaborations with the Agricultural Research Council-Grain Crops (ARC-GC), the Western Cape Department of Agriculture, and Sorghum Trust.

Sorghum research focused on grain-mold pathogens and mycotoxigenic fungi, as well as the effects of decortication on grain molds and mycotoxins. Applied epidemiology was used to identify grain mold and foliar disease driving variables and risk modelling. Ultimately, these studies aim at the identification and quantification of intervention technologies for the management of sorghum diseases. Field trials were conducted in collaboration with Dr Edson Ncube from the ARC-GC (Potchefstroom and Cedara). Research support from the Sorghum Trust continued during 2020.

Sclerotinia research focused on soybean and sunflower cultivar evaluations, with field trials in the eastern Free State and Mpumalanga. These trials aimed at identifying cultivars that can be included in pre-breeding programmes due to higher tolerance to Sclerotinia disease potential. This research was supported by the Sasol Trust, Oil and Protein Seeds Development Trust (OPDT) and Protein Research Foundation (PRF), under the initiative supported by GrainSA. A project in collaboration with Dr Derick van Staden, in Mpumalanga, investigated the potential of fungicide interventions for Sclerotinia stem rot of soybean under field conditions.

A study under the mentorship of Prof Emerson del Ponte, from the Plant Pathology Department from the Universidade Federal de Viçosa (Minas Gerais, Brazil) was completed in 2020. This study was aimed at analysing a ten-year Sclerotinia prevalence dataset from across South African soybean and sunflower production regions, using reproducible research practices and a statistical coding platform, R and R Studio.

ENGAGED SCHOLARSHIP

The Geo Potts Herbarium received a grant from the International Association of Plant Taxonomists to barcode and digitize the ±30 000 specimens held in its main collection. 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.



Magdil Pienaar and Emma Ferreira digitizing specimens in the Geo Potts Herbarium

Dr Moloi was invited to be a Co-Guest Editor for the journal *Plants* (ISSN 2223-7747).

Prof Labuschagne served as Speciality Chief Editor for *Frontiers in Sustainable Food Systems*, and Associate Editor for both *Cereal Chemistry*, and *Journal of Cereal Science*.

As part of reviving the African Pollen database – a repository that was inactive during the last decade – Prof Scott started submitting modern pollen data from South Africa and began editing papers as Guest Editor for a special volume that will appear in the book series *Palaeoecology of Africa - African Palaeoenvironments and Geomorphic Landscape Evolution*, to be published by CRC Press.

Dr Joubert and Dr Van Aardt collaborated with the UFS Department of Otorhinolaryngology and the Lung Institute at the

University of Cape Town on pollen monitoring in the atmosphere. These counts are done on a weekly basis and posted on the website: https://pollencount.co.za/. This informs allergy sufferers about the current risk.

Dr Rothmann continued her role in the international multi-disciplinary organisation Open Plant Pathology as the Social Media and Blog Editor to encourage Open Science practices in Plant Pathology.

The South African Sclerotinia Research Network, led by Dr Rothmann, creates and communicates social media content on the fungal pathogen *Sclerotinia sclerotiorum.* As COVID-19 caused havoc in the agricultural sector, as it did in many other sectors, only one in-person farmers' day was held prior to lockdown. All further research communication and engagement with producers and industry was conducted on an online platform, which can be accessed at https://www.sclerotinia.co.za/.

Dr Steenhuisen was a panellist in an Academy of Science of South Africa (ASSAf) webinar on multidisciplinary research, in November 2020.

Dr Mbuma accepted an invitation as a senior reviewer for *African Journal of Food, Agriculture, Nutrition and Development* (AJFAND).

NATIONAL AND INTERNATIONAL COLLABORATION

Dr Willem Boshoff and Prof Zakkie Pretorius collaborated with researchers from the USA (University of Minnesota), the Kingdom of Saudi Arabia (King Abdullah University of Science and Technology), the United Kingdom (John Innes Centre), Australia (CSIRO Agriculture and Food), and China (Institute of Genetics and Developmental Biology, Chinese Academy of Sciences). Two peer-reviewed papers were published during 2020 from these collaborations and one is under review.

In collaboration with Dr Jim Kolmer from the Department of Plant Pathology at the University of Minnesota, Prof Pretorius and Prof Visser contributed to a publication in *Heredity,* describing the global *Puccinia triticina* population using next-generation sequencing.

Prof Visser also collaborated with Dr Sam Markell (North Dakota State University, USA), Dr Anthony Young (University of Queensland, Australia), Dr Gary Kong (University of Canberra, Australia), and Dr Sue Thompson (University of Southern Queensland, Australia), leading to the successful completion of the MSc study by Mr Wilku Meyer on sunflower rust in South Africa. In this study, the first in 25 years, three new sunflower races were described for the first time in almost three decades, bringing the total to seven. This study laid the groundwork for continued collaboration to describe the global sunflower rust population.

Prof Visser and Dr Les Szabo (of the University of Minnesota) collaborated on a study describing the development of genetic lineages within the global wheat stem rust population. Prof Visser also collaborated with researchers at the ARC-SG in Bethlehem.

Dr Minnaar-Ontong and Dr Van der Merwe collaborated with researchers from the Northeast Institute of Geography and Agroecology at the Chinese Academy of Sciences, on breeding for resistance to pod dehiscence in a vegetable-type soybean. Dr Minnaar-Ontogn also collaborated with Syngenta (together with Dr Rothman) on breeding for resistance to Sclerotinia headrot in sunflowers, and with breeding companies from industry, and researchers from the University of Manitoba, Canada and the University of Nebraska, USA.

Prof Swart collaborated with Prof Pedro Crous, Director of the Westerdijk Fungal Biodiversity Institute in the Netherlands and Secretary-General of the International Mycological Association. Prof Crous is an Affiliated Professor in the Department of Plant Sciences (Division of Plant Pathology) and collaborated closely with Prof Swart in describing seven new species of fungi, published in Fungal Planet Description Sheets of the prestigious international journal, *Persoonia*.

Dr Mafa collaborated with Prof Brett Pletschke, the principal investigator of the Enzyme Science Programme (ESP) in the Department of Biochemistry and Microbiology at Rhodes University, and with Prof Yasien Sayed, the director at Protein Structure-Function Research Unit (PSFRU) in the School of Molecular and Cell Biology at the University of the Witwatersrand.

Dr Mohase collaborated with Dr Jankielsohn from the ARC-SG in Bethlehem, on the aphid diversity in South Africa and Lesotho and the Lesotho Agricultural Research Unit (on wheat germplasm in Lesotho).

Dr Van der Merwe continued her national collaboration with the Edamame Development Programme (EDP). This collaboration includes 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 continued collaboration with Prof Qiuying Zhang from the Northeast Institute of Geography and Agroecology of the Chinese Academy of Sciences. The project focuses on breeding for resistance to pod dehiscence in vegetable type soybean.

Dr Rothmann's research forms part of the the official Memorandum of Understanding (MoU) between GrainSA and the UFS which specifies that the Department of Plant Sciences "was signed for administrating the South African Sclerotinia Research Network, composed of a community of practice and a research consortium". The Network provides a platform for South African researchers, industry and producers to work together towards a management solution for Sclerotinia diseases in South Africa.

An official MoU between the UFS and the Universidade Federal de Viçosa, Minas Gerais, Brazil was signed. 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, Dr Edwige Moyroud from the Sainsbury Laboratory in Cambridge, and Dr Mario Fernandes-Mazuecos from the Spanish National Research Council, on the project titled '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 was due to visit to the UFS in 2020, but due to the international travel restrictions as a result of COVID-19, his visit has been postponed until September 2021, when Dr Glover is also scheduled to make her research visit to the UFS.

Dr Ngara continued her international collaboration with Dr Stephen Chivasa, Durham University, United Kingdom, on the Newton Advanced Fellowship-Royal Society grant, and nationally with Dr Nemera Shargie from ARC-GC in Potchefstroom, on a project funded by NRF-Thuthuka.

Prof Labuschagne continued research collaboration with the University of Cordoba in Spain, and CIMMYT (Mexico, Harare and Kenya) in 2020.

Dr Van Biljon's research was undertaken in collaboration with the ARC-SG, ARC-GC, Starke Ayres, and CIMMYT in Zimbabwe. She also collaborated with Dr Eric Alexandersson from the Swedish University of Agricultural Sciences in Alnarp, Sweden, who worked together on the South Africa – Sweden Bilateral Scientific Research Collaboration Programme 2018 -2020.

Dr Jackson continued her collaboration with Mrs Elmarie van Rensburg from the National Museum in Bloemfontein using molecular techniques to investigate the phylogenetic relationships of genera in the family Aizoaceae.

Prof Scott's and Dr Van Aardt's research and editorial work is undertaken in collaboration with several researchers from the USA, Canada, Spain, the UK, the Netherlands, France, Germany, Israel, and South Africa.

Dr Moloi collaborated with Dr Brigitta Tóth of the University of Debrecen in Hungary. They published two book chapters and research manuscripts in 2020.

Dr Marè collaborated with companies such as PANNAR, Sensako and the ARC-SG on various projects.

Dr Arun Gokul initiated a national collaboration between the Department of Plant Sciences and the Plant Sciences group of the Department of Biotechnology at the University of the Western Cape (UWC). This collaboration focuses on understanding the primary and secondary products produced by microorganisms associated with plants and the plants themselves. The research aims to test these compounds for plant growth promotion, bio-control of pathogens, and the bio-fortification of important agricultural crops.

Dr Mbuma and Prof Labuschagne 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 a maize project.

A research collaboration between Dr Potgieter (Eco-physiology) and Introlab (Pty) Ltd continued to evaluate the bio-stimulant properties of Xcell Boost on different crops under certain stress conditions.

Dr Marais collaborated with SAPPA and with Prof Bernard Slippers and Prof Wilhelm de Beer, from the Forestry and Agricultural Biotechnology Institute (FABI) at the University of Pretoria, to study diseases in the pecan industry in South Africa.

POSTGRADUATE STUDENTS

During 2020, 16 honours, 60 master's and 47 doctoral students were enrolled for postgraduate studies in the Department of Plant Sciences.

At the 2020 graduations, nine students graduated with the BSc Hons majoring in Botany (six on the Bloemfontein Campus and three on the Qwaqwa Campus), and one student graduated with the BSc Hons in Agriculture majoring in Plant Breeding.

Two students graduated with an MSc (Agriculture):
- Jolene Coertzen (Plant Pathology)
- Nicola Theron (Plant Pathology)

A further 10 students graduated with an MSc:
- Alec Edwards (Plant Pathology)
- Andani Mabirimisa (Plant Breeding – with distinction)
- Andrea Lessing (Plant Pathology)
- Diné Pretorius (Botany)
- Evandré Minnaar (Botany)
- Fanele Msani (Plant Breeding)
- Kholosa Maqolo (Plant Breeding – with distinction)
- Masefudi Pinkie Mojapelo (Plant Pathology)
- Raphael Banda (Plant Breeding – with distinction)
- Wilku Basie Meyer (Botany – with distinction)

Eleven candidates from the Department of Plant Sciences graduated with a PhD in 2020:

Amegbor, Isaac (Plant Breeding)
Thesis: Yield linkage drag in quality protein maize inbred lines and hybrids
Promoters: Prof MT Labuschagne and Dr A van Biljon

Anjejo, Mathewos (Plant Breeding)
Thesis: Genetics of stem rust resistance in selected wheat germplasm
Promoters: Prof L Herselman and Prof ZA Pretorius

Bender, Cornelia Magrietha (Plant Pathology)
Thesis: Stem rust resistance in South African wheat and triticale
Promoters: Prof ZA Pretorius and Dr WHP Boshoff

Chemonges, Martin (Plant Breeding)
Thesis: Genetics of stem rust resistance in South African winter wheat varieties
Promoters: Prof L Herselman, Prof ZA Pretorius and Dr WHP Boshoff

Chiipanthenga, Margaret (Plant Breeding)
Thesis: Drought tolerance in Malawian soybean germplasm
Promoters: Dr R van der Merwe and Prof MT Labuschagne

Du Toit, André (Plant Breeding)
Thesis: Introduction of foreign germplasm as a breeding strategy for the South African wheat industry
Promoter: Prof MT Labuschagne

Joubert, Sonia Mari (Plant Pathology)
Thesis: *Fusarium* spp. and associated mycotoxins in South African maize
Promoter: Prof NW McLaren

Masupha, Pitso Victor (Botany)
Thesis: Russian wheat biotypes in Lesotho: distribution, impact on wheat production and the role of phytohormones in host resistance
Promoter: Dr L Mohase

Nginamau, Dibanzilua (Plant Breeding)
Thesis: Development of maize hybrid varieties tolerant to acid soils for Angola
Promoters: Prof MT Labuschagne and Dr A van Biljon

Peprah, Bright Boakye (Plant Breeding)
Thesis: Genetic improvement of beta-carotene in cassava (*Manihot esculenta* Crantz)
Promoters: Prof MT Labuschagne and Dr A van Biljon

Rothmann, Lisa-Ann (Plant Pathology)
Thesis: The spatial quantification and hierarchy characterization of Sclerotinia prevalence from a decade of observations in soybean and sunflower
Promoter: Prof NW McLaren

POSTDOCTORAL RESEARCH FELLOWS

Dr Howard Castelyn (South Africa) was appointed as a postdoctoral fellow in the laboratory of Prof Visser to continue with the bio-informatic analysis of the adult wheat-stem rust interaction. He is currently in the second year of his term.

Dr Neila Abdi (Tunisia) was appointed as postdoctoral fellow in Plant Breeding in 2020, working on projects within the SARChI Chair.

Dr Nicholas Le Maitre (South Africa), under the supervision of Dr Steenhuisen, completed a year of his fellowship researching a variety of aspects of mountain flora, including the flowering phenology of *Rhodohypoxis* in collaboration with Dr Kelsey Glennon (University of Witwatersrand), introgression between indigenous and exotic *Celtis* species throughout South Africa, genetic diversity of *Protea* species populations, and the building and deployment of new AudioMoth sound recorders in the wetlands in GGHNP in order to determine seasonal changes in bird diversity using acoustics. The latter three projects are being undertaken in collaboration with the ARU.

STAFF MATTERS

Dr Lize Joubert and Dr Rudo Ngara were promoted to Senior Lecturers in the Department.

Dr Mpho Mafa was appointed as Lecturer in Botany on the Bloemfontein Campus.

Dr Arun Gokul was appointed as Senior Lecturer in Botany on the Qwaqwa Campus.

Ms Dipuo Mosea was appointed as Professional Officer in Botany on the Qwaqwa Campus. She was previously an Academic Facilitator in the Department.

Ms Orpah Taylor was appointed as Senior Assistant Officer in Plant Breeding and Ms Khetha Mbatha was appointed as Assistant Officer in Plant Pathology.

Ms Zelda van der Linde (Assistant Officer) resigned in February 2020.

Dr Gerhard Potgieter (Senior Lecturer) took early retirement at the end of November 2020, after 36 years of service and Mr Dirk Jansen took early retirement at the end of December 2020, after more than 40 years of service.



RESEARCH OUTPUTS

Research Articles

Adejumobi, O.A., Omobowale, T.O., Oyagbemi, A.A., Adedapo, A.A., Yakubu, M.A. & Ashafa, A.O.T. 2020. *In vitro* antioxidant, anti-inflammatory and antihypertensive activities of methanol leaf extract of *Peasea americana*. *Federation of American Societies for Experimental Biology Journal* 34(51): 1-1.

Adeniran, L.A. & Ashafa, A.O.T. 2020. *In vitro* anti-Inflammation and selective cytotoxicity of Vero and HepG2 cells by phenolic extract from roots of *Hermannia geniculata* Eckl and Zehl. *Academic Journal of Life Sciences* 6(6): 61-66.

Adeniran, L.A., Ogundajo, A.L. & Ashafa, A.O.T. 2020. Pharmacological activities of Hermannol (9-(7-methyloctyl)-9H-xanthene-2,3-diol), a new Xanthene derivative isolated from the roots of *Hermannia geniculata* Eckl. & Zeyh. *South African Journal of Botany* 135: 330-335.

Adeniran, L.A., Uwazie, N.J. & Ashafa, A.O.T. 2020. *In-vitro* anti-inflammation, selective cytotoxicity and inhibition of iNO from LPS stimulated RAW 264.7 macrophages activities of flavonoids from *Hermannia geniculata* Eckl and Zeyh roots extract. *Pharmacognosy Magazine* 16(70): 345-349.

Adeyeoluwa, T.E., Balogun, F.O. & Ashafa, A.O.T. 2020. *In vitro* comparative assessment of the inhibitory effects of single and combined spices against glucose-synthesizing enzymes. *Tropical Journal of Pharmaceutical Research* 19(6): 1209-1214.

Balogun, F.O. & Ashafa, A.O.T. 2020. Green-synthesized zinc oxide nanoparticles from aqueous root extract of *Dicoma anomala* (Sond.) mitigates free radicals and diabetes-linked enzymes. *Nanoscience & Nanotechnology-Asia* 10: 927-938.

Boshoff, W.H.P., Pretorius Z.A., Terefe, T. & Visser, B. 2020. Occurrence and pathogenicity of *Puccinia coronata* var *avenae* f. sp. *avenae* on oat in South Africa. *Crop Protection* 133: 105144. DOI: 10.1016/j.cropro.2020.105144.

Boshoff, W.H.P., Visser, B., Lewis, C.M., Adams, T.M., Saunders, D.G.O., Terefe, T., Soko, T., Chiuraise, N. & Pretorius, Z.A. 2020. First report of *Puccinia striiformis* f. sp. *tritici*, causing stripe rust of wheat, in Zimbabwe. *Plant Disease* 104: 290. DOI: 10.1094/PDIS-07-19-1395-PDN.

Brown, L.R., Van Aardt, A.C. & Janecke, B.B. 2020. A tribute to Pieter Johannes (Johann) du Preez. *Koedoe* 62(2): a1640. DOI: 10.4102/koedoe.v62i2.1640.

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Books/Chapters in Books

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Research Reports

Adams, L.D. 2020. *Risk Analysis for Pyracantha angustifolia*. Report compiled for South African National Biodiversity Institute (SANBI).

Smit, A. & Van der Merwe, R. 2020. *Evaluation of three commercially available soybean inoculants for use on Edamame production in South Africa*. Report delivered to Stimuplant (Pty) Ltd.

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Visser, B. 2020. *Evaluating the potential of ComCat as a safener to protect grain sorghum against S-metolachlor herbicide damage*. Report delivered to Agraforum-SA, Bainsvlei, Bloemfontein.

Conference Contributions

Conference Papers/Posters

Adams, L.D., Martin, G.D., Clark, V.R., Downs, C.T., Thabethe, V., Raji, A. & Steenhuisen, S. 2020. *The effect of birds on seed dispersal and germination of invasive firethorn*. Paper delivered at the 46th Annual Conference of the South African Association of Botanists (SAAB), University of the Free State, Qwaqwa Campus, South Africa. 7-10 January 2020.

Amegbor, I.K., Van Biljon, A., Tarekegne, A., Shargie, N. & Labuschagne, M.T. 2020. *Genetic analysis for grain yield and quality traits of CIMMYT quality protein maize inbred lines*. Paper delivered at the 13th Southern African Plants Breeders' Association (SAPBA) Symposium, University of Pretoria, South Africa. 8-11 March 2020.

Anderson, J., Van der Niet, T., Johnson, S.D., Steenhuisen, S. & Cozien, R.J. 2020. *How to train your dragon: Flower colour and nectar scent lure lizard pollinators to the Drakensberg's Hidden flower*. Paper delivered at the 46th Annual Conference of the South African Association of Botanists (SAAB), University of the Free State, Qwaqwa Campus, South Africa. 7-10 January 2020.

Cozien, R., Van der Niet, T., Steenhuisen, S. & Johnson, S.D. 2020. *Caught in a snap: Elusive ecological interactions revealed through the use of motion trigger camera traps*. Poster presented at the 46th Annual Conference of the South African Association of Botanists (SAAB), University of the Free State, Qwaqwa Campus, South Africa. 7-10 January 2020.

Herselman, L., Maré, A., Boshoff, W.H.P. & Pretorius, Z.A. 2020. *Wheat pre-breeding for rust and Fusarium head blight resistance at the University of the Free State.* Paper delivered at the 13th Southern African Plants Breeders' Association (SAPBA) Symposium, University of Pretoria, South Africa. 8-11 March 2020.

Labuschagne, M.T. 2020. *Genetic biofortification of crops in Africa, the current situation and the way forward.* Paper delivered at the 13th Southern African Plants Breeders' Association (SAPBA) Symposium, University of Pretoria, South Africa. 8-11 March 2020.

Labuschagne, M.T. 2020. *Research-industry linkages for the promotion of biofortified maize and wheat*. Keynote paper delivered at Nutritious Maize: Technologies, Development and Availability in South Asia. International Webinar organised by CIMMYT, supported by USAID. 20-22 July 2020.

Malepe, C.B.B., Gryzenhout, M. & Marais, G.J. 2020. *Fusarium species associated with pecan (Carya illinoinensis) in South Africa*. Paper delivered at the 46th Annual Conference of the South African Association of Botanists (SAAB), University of the Free State, Qwaqwa Campus, South Africa. 7-10 January 2020.

Mapaura, A., Canavan, K., Richardson, D.M., Clark, V.R. & Steenhuisen S. 2020. *Nassella tussock invasion in South Africa: an overview*. Paper delivered at the 46th Annual Conference of the South African Association of Botanists (SAAB), University of the Free State, Qwaqwa Campus, South Africa. 7-10 January 2020.

Mapaura, A., Canavan, K., Richardson, D.M., Clark, V.R. & Steenhuisen S. 2020. *The impact of the invasive grass Nassella trichotoma (Nees) Arech. on the plant species richness, diversity and composition in Karoo Escarpment Grassland, Sneeuberg Centre of Floristic Endemism*. Paper delivered at the Congress of the Grassland Society of Southern Africa (GSSA), Online. 30 June-2 July 2020.

Mbuma, N.W., Labuschagne, M.T. & Gerrano, A. 2020. *Assessment of genetic variability among cowpea genotypes for nutritional value*. Paper delivered at the 13th Southern African Plants Breeders' Association (SAPBA) Symposium, University of Pretoria, South Africa. 8-11 March 2020.

Miles, C., Van Biljon, A., Booyse, M. & Labuschagne, M. 2020. *The influence of different milling procedures on Mixsmart parameters and their relationships with primary wheat quality criteria*. Poster presented at the 13th Southern African Plants Breeders' Association (SAPBA) Symposium, University of Pretoria, South Africa. 8-11 March 2020.

Moloi, D. & Ngara, R. 2020. *Screening wheat varieties for drought tolerance using physiological and growth parameters.* Poster presented at the 46th Annual Conference of the South African Association of Botanists (SAAB), University of the Free State, Qwaqwa Campus, South Africa. 7-10 January 2020.

Moloi, K., Martin, G. Clark, V.R. & Steenhuisen, S. 2020. *A review of the invasive genus Cotoneaster medik (Rosaceae) in southern Africa*. Poster presented at the Grassland Society of Southern Africa (GSSA) Conference. Online. 30 June-2 July 2020.

Moloi, M.J., Zungu, M.S. & Van der Merwe, R. 2020. *Ascorbate peroxidase: a possible tool for drought tolerance selection in edamame.* Poster presented at the 46th Annual Conference of the South African Association of Botanists (SAAB), University of the Free State, Qwaqwa Campus, South Africa. 7-10 January 2020.

Mosea, D. & Ngara, R. 2020. *Effects of polyethylene glycol-induced osmotic stress on the viability of sorghum cell suspension cultures.* Poster presented at the 46th Annual Conference of the South African Association of Botanists (SAAB), University of the Free State, Qwaqwa Campus, South Africa. 7-10 January 2020.

Msani, F., Zhou, M.M. & Van Der Merwe, R. 2020. *The effect of tramline and continuous row spacing on breeding and genetic parameters of sugarcane populations*. Paper delivered at the 13th Southern African Plants Breeders' Association (SAPBA) Symposium, University of Pretoria, South Africa. 8-11 March 2020.

Muthego, D. & Ngara, R. 2020. *Gene expression analysis of sorghum cell suspension cultures in response to exogenous abscisic acid*. Poster presented at the 46th Annual Conference of the South African Association of Botanists (SAAB), University of the Free State, Qwaqwa Campus, South Africa. 7-10 January 2020.

Ngwenya, S. & Ngara, R. 2020. *Proteomic changes of sorghum cell suspension cultures in response to combined heat and osmotic stresses*. Poster presented at the 46th Annual Conference of the South African Association of Botanists (SAAB), University of the Free State, Qwaqwa Campus, South Africa. 7-10 January 2020.

Phakela, K., Van Biljon, A., Wentzel, B., Guzmán, C. & Labuschagne, M. 2020. *Proteomic analysis of abiotic stress influence on durum wheat gluten composition*. Paper delivered at the 13th Southern African Plants Breeders' Association (SAPBA) Symposium, University of Pretoria, South Africa. 8-11 March 2020.

Swart, W.J. 2020. *Climate change and the phytobiome: Implications for plant and soil health* (Plenary Lecture). Inaugural Arable Farming Symposium of the North-West Department of Agriculture and Rural Development (DARD), Potchefstroom, South Africa. 19 March 2020.

Szabo, L.J., Johnson, J.L., Visser, B., Olivera, P.D. & Jin, Y. 2020. *Elucidating the evolutionary history of Puccinia graminis f. sp.* tritici *lineages through analysis of allelic variation of selected genes.* Paper delivered at the 2020 Borlaug Global Rust Initiative (BGRI) Technical Workshop. Online. 7-9 October 2020.

Van Biljon, A., Olckers, S-L., Osthoff, G. & Labuschagne, M.T. 2020. *The relationship between starch, amylose and zein protein fractions of quality protein maize grown under different nitrogen conditions.* Paper delivered at the 13th Southern African Plants Breeders' Association (SAPBA) Symposium, University of Pretoria, South Africa. 8-11 March.

Wentzel, B., Van Biljon, A., Miles, M., Booyse, M. & Labuschagne, M.T. 2020. *How useful is SDS-sedimentation as an indication of baking quality in a breeding programme?* Poster presented at the 13th Southern African Plants Breeders' Association (SAPBA) Symposium, University of Pretoria, South Africa. 8-11 March 2020.

STAFF (2020)

Head of Department: Prof L Herselman

Bloemfontein Campus:
Professors: Prof MT Labuschagne and Prof WJ Swart
Associate Professors: Prof L Herselman and Prof B Visser
Senior Lecturers: Dr WHP Boshoff, Dr L Joubert, Dr GJ Marais, Dr A Minnaar-Ontong, Dr L Mohase, Dr MJ Moloi, Dr GP Potgieter, Dr A van Biljon and Dr R van der Merwe
Lecturers: Dr M Jackson, Dr MS Mafa, Dr NW Mbuma and Dr AC van Aardt
Lecturer (units): Dr LA Rothmann
Junior Lecturer: Dr A Maré
Affiliated Professor: Prof PW Crous
Affiliated Associate Professor: Prof M Zhou
Research Associates: Dr ME Cawood, Prof NW McLaren, Prof ZA Pretorius, Dr A Venter and Prof JHT Venter
Mentor: Prof L Scott
Programme Director: Prof B Visser
Chief Officer - Professional Services: Dr CM Bender
Officers - Professional Services: Mr HP Pretorius and Ms M Pienaar
Senior Assistant Officers: Ms MP Mbingeleli, Dr C Steyn and Mrs OML Taylor
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Qwaqwa Campus:
Subject Head: Dr S Steenhuisen
Associate Professor: Prof AOT Ashafa
Senior Lecturers: Dr A Gokul, Dr R Ngara and Dr S Steenhuisen
Lecturers: Dr PJ Mojau and Mr TR Pitso
Research Associates: Dr LV Komoreng, Dr RJ McKenzie, Prof RO Moffett, Dr TM Mokotjomela, Dr T Ramakuwela and Dr JD Vidal Jr
Officers - Professional Services: Ms D Mosea and Mr NP Mzizi



DEPARTMENT OF
ZOOLOGY AND ENTOMOLOGY

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OVERVIEW OF 2020

The year 2020 had a slow start and almost got to get put on hold.

From November 2019 to the end of January 2020, Prof Linda Basson and Gerhard de Jager (PhD student) were part of the South African National Antarctic Programme (SANAP) on board the *SA Agulhas II* Research Vessel of South Africa, on the SANAE 2019/2020 Antarctic Annual Relief Voyage.

At the end of February 2020 Prof Liesl van As had a meeting in Gaborone with colleagues from the University of Botswana and the Okavango Research Institute on the continuation of the collaborative project, which already began in 1997.

Field trips were undertaken by the Arachnology Group of Prof Charles Haddad, to the farm 'Bankfontein' in the western Free State, to investigate the predation ecology of jumping spiders. The group also continued with the sampling protocol usually carried out by third-year Entomology students to complete a five-year survey of spider biodiversity in the Grassland-Nama Karoo transition zone.

ACHIEVEMENTS

Staff Achievements

Prof Daryl Codron was promoted to Associate Professor and he improved his NRF-rating to B3, while Prof Charles Haddad advanced to a C1 NRF-rating in December 2020. In addition, Prof Haddad was awarded an NRF-grant under the Foundational Biodiversity Information Programme (FBIP) to investigate spider biodiversity patterns in the Desert and Succulent Karoo Biomes of western South Africa and provide DNA barcodes for approximately 500 specimens.

An article by Prof Neil Heideman in *The Conversation* (November 2020), titled 'How predators may have shaped the way some southern African lizards survive and reproduce', received more than 5 000 reads in the week it was published. *The Conversation* is a weekly scientific newsletter sponsored by a consortium of South African universities (including UFS) which aims to broadly share scientific information.

Student Achievements

Gerhard de Jager (Aquatic Ecology / Parasitology Group) was appointed as the Chief Scientist for the SANAE 2019/2020 Antarctic Annual Relief Voyage for Leg I and Leg II. He had to coordinate all the research activities on board the *SA Agulhas II* for the duration of the voyage and integrate them with the ship's other activities in direct liaison with the ship's captain, Captain Gavin Sindercomb.

Zhongning Zhao (Herpetology Research Group) was awarded the PhD degree, under the supervision of Prof Neil Heideman and Prof Paul Grobler (Genetics), two years after his study was upgraded from master's to doctoral level.

Rune van der Merwe (Terrestrial Ecology Research Group) was awarded a competitive research grant from the Palaeontological Scientific Trust (PAST) for her MSc research.

TEACHING AND LEARNING

The Biology Undergraduate Laboratory on the Bloemfontein Campus, the largest and most advanced digital microscopy laboratory in Africa and the third largest in the world, was officially launched in January 2020. This is a shared facility between the Department of Plant Sciences and the Department of Zoology and Entomology and was made possible through the initiative of Prof Jannie Swarts (project leader of the drive to renew the Faculty's laboratory and research equipment), together with the Dean, Prof Danie Vermeulen. The Laboratory includes 120 new Zeiss compound microscopes and 60 Zeiss dissection microscopes, with 60 of the compound microscopes having built-in, state-of-the-art cameras that connect to iPads. The undertaking also included a major upgrade of the audio-visual facilities.

Speaking at the launch, Prof Francis Petersen, UFS Rector and Vice-Chancellor, said "The UFS wants to be more cutting-edge at teaching at the undergraduate level. We need to think differently – technology needs to be infused into our practices. The new equipment allows for engagement in the classroom. Studies needs to be interactive and engaging. Diverse input is crucial, and interaction is very important. Teaching and engagement are growing at the undergraduate level, creating the class of the future".

COVID-19 made for a challenging year for students and staff. We all had to adapt very quickly to the blended learning approach. The way in which all rose to the challenge, is reflected in the words of colleagues on the Qwaqwa Campus:

- "I managed to teach the 75 students in BIOL2614 on the Qwaqwa Campus, with only two not completing and seven with distinctions. It was a serious challenge to teach a large class like that alone. The materials received from Dr Voua Otomo helped a lot" (Dr Mpho Ramoejane**).**
- "The biggest achievement for me this year would be managing to find my feet in the midst of COVID regulations, starting a new job (on the Qwaqwa Campus) remotely has not been easy. I have managed to revise and revamp ZOOL3744 to meet the scope as stipulated in the rule book of the University. Without any materials from previous years, I created a curriculum for ZOOL6824 (Veterinary Parasitology) that worked for both the students and myself. Working closely with Mrs Van As and Ms Kheswa made a huge difference in dealing with first-year students" (Dr Nthatisi Nyembe).
- "I initiated a new practical approach in the ecotoxicology module. The initiative, called 'Environmentally mine', encouraged students to identify environmental issues in the Qwaqwa area and to present them in a five-minute mini-documentary. Thereafter, the two best documentaries were selected for mini lab projects, which were carried out by the students and the results presented in two final documentaries. The initiative was a success and the students and I enjoyed this new approach, that will surely be repeated again in 2021" (Dr Patricks Voua Otomo).
- "To adapt to Lockdown in 2020, I had to make a plan to ensure that the ZOOL3714 (Introduction to Animal Behaviour) students gained experience in the observation of animal behaviour while confined to their homes. I designed a project on moth behaviour in relation to light pollution and temperature, as students were living in areas ranging from cities to deep rural parts of the country. Students learned to collect, share, and analyse data, benefiting from lectures over WhatsApp and having a virtual open-door policy" (Prof Aliza le Roux).

RESEARCH AND INNOVATION

Bloemfontein Campus Research Groups

Aquatic Ecology / Parasitology

As part of the project titled 'Initial Study of marine symbionts and parasites along the Good Hope line and around the Fimbul Ice Shelf, Queen Maud Land region of Eastern or Greater Antarctica', Prof Linda Basson and Gerhard de Jager formed part of SANAP on board the *SA Agulhas II* Research vessel, on the SANAE 2019/2020 Antarctic Annual Relief Voyage, from 10 December 2019 to 29 February 2020. They were invited by Prof Isabelle Ansorge, Head of Oceanography at the University of Cape Town (UCT), to join her research team in order to determine whether the collaboration could broaden the fields of research normally carried out on board the *SA Agulhas II* in Antarctica, by including various parasitological aspects. As part of this exploratory trip, Prof Basson and Mr De Jager joined the oceanographers on board to collect various hosts from the Southern Ocean and to screen them for parasites. Very little research of this nature has been done on the parasites of fish and nothing on invertebrates in this ocean. Similarly, no research of any kind on aquatic parasites has been done at Penguin Bukta, the point where the *SA Agulhas II* normally anchors to send supplies and support to the South African base, SANAE IV, situated at Vesleskarvet in Queen Maude Land.



Prof Linda Basson and Gerhard de Jager on the poupe deck of the SA Agulhas II with a handmade plankton net for collecting marine samples



Christmas Day 2020 - Prof Linda Basson and Gerhard de Jager in Antarctica
Photo credit: Alex Oelofse, AMSOL (photo used with permission)

After COVID-19 regulations were lifted to Level 3, Prof Basson and Mr De Jager undertook a ten-day field trip to Reebok, on the Cape south coast, to continue with intertidal collections that form part of Mr De Jager's PhD project.

As part of her additional involvement in wetland ecology, Dr Candice Jansen van Rensburg was joined by Prof Liesl van As and Dr Leon Barkhuizen from the Free State Department of Economic, Small Business Development, Tourism and Environmental Affairs (FSDESTEA), to collect plankton samples from the Krugersdrift Dam – specifically for the projects of Didintle Mosiea (honours student) and Aneke Kruger (master's student). Another three field trips to Kalkfontein Dam, Sandveld, Soetdoring and Erfenis Dam Nature Reserves, were also undertaken to focus on Ms Kruger's fieldwork.



Aneke Kruger busy with plankton sampling at Sandveld Nature Reserve, Bloemhof Dam.

Pieter Swanepoel, aquaculture specialist and part-time PhD student, employed by the Free State Department of Agriculture and Rural Development (FSDARD), continued with his fieldwork at Gariep Dam in July 2020.



Pieter Swanepoel busy with fish collections at Gariep Dam



Pieter Swanepoel setting gill nets at Gariep Dam

Applied Agricultural Entomology
Laboratory work was conducted by Div Fourie as part of the continuing investigation into pyrethroid resistance developing in the stinkbug complex, which is damaging sub-tropical fruit and nuts in the Nelspruit region, Mpumalanga. This is an ongoing project undertaken in collaboration with the Agricultural Research Council (ARC) in Nelspurit. Further fieldwork is planned for the start of 2021.

Arachnology
In March, just prior to the national lockdown, sampling at Bankfontein was undertaken by Prof Charles Haddad and Ruan Booysen (MSc student) to complete a five-year dataset on spider biodiversity in three microhabitats in three biotopes. The data has in the past been generated as part of the annual third-year Entomology excursion; however, this had to be cancelled at the last minute due to the university closure. This study will allow us to determine the proportion of the local biodiversity (i.e. including all species sampled by arachnologists) sampled using a standardised protocol by students, of which spiders form a by-catch component.

Etho-ecology
Klinette Sutherland (MSc student supervised by Hennie Butler) continued to monitor, by means of camera-traps, the feeding preferences of various antelope species. 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.

Kristen Darker (MSc student) investigated enzootic geophagy by elephants (*Loxodonta africana*) in relation to geochemical composition of mineral licks in the Addo Elephant National Park. Daily and seasonal data of elephants consuming soil at lick sites was monitored by means of camera-traps. Soil samples were also collected to determine the chemical composition of such soil. Dung was collected in order to calculate the amount of soil that elephants consume.

Environmental Entomology and Dipterology
Research undertaken by the group led by Dr Vaughn Swart included studies on the systematics of Afrotropical water snipe flies (Diptera: Athericidae). Investigations were also undertaken of interspersed arboreal biotopes along different topographical conditions within Afromontane grasslands and their potential as conservation hotspots. Soil biota as bioindicators of fire disturbances in montane grassland areas within the Golden Gate Highland National Park (GGHNP) were monitored, as well as ecological aspects of arthropod soil meso-fauna in nut orchards in the Hartswater area. The phylogenetic analysis of South African *Aedes* Meigen, *Anopheles* Meigen and *Culex* L. (Culicidae) based on COI, ITS2 and ND4 sequences were done, which coincide with optimising DNA profiling techniques for identification of mosquito species in the Free State.

Herpetology
As part of her PhD research on the ecology of padloper tortoises, Tamson Foster (supervised by Prof Neil Heideman) undertook several field trips in November and December to the Trompsburg area. She was assisted by Dr Joaquín Verdú-Ricoy and Dr Zhongning Zhao (Postdoctoral Fellows) as she successfully tagged 14 female specimens with radio transmitters in order to track them and obtain data on their activity and movement patterns. Tracking has thus far been successful, and males, which are less easy to find, were also found and tagged during the last field trip.



Leopard tortoise with attached radio transmitter



Tamson Foster measuring a tortoise tagged in Trompsburg area



Dr Candice Jansen van Rensburg collecting soil samples at Erfenis Dam

A major phylogenetic revision of the limbless lizard subfamily Acontinae, using DNA markers, is approaching the manuscript stage. Participants are Prof Neil Heideman, Dr Zhongning Zhao, Dr Joaqíun Verdu-Ricoy and Adriaan Jordaan, together with collaborators Dr Shelley Edwards (Rhodes University) and Werner Conradie (Bayworld Museum, Port Elizabeth).

A study to try and compare mutation rates of the corona virus globally, using GenBank sequences, is currently being undertaken by Dr Zhao in collaboration with Fanie Riekert from the High-Performance Computing (HPC) unit.

Prof Heideman and Dr Verdu-Ricoy processed the collection of the reduced limbed skink *Mochlus sundevallii* in the Ditsong Museum of Natural History, Pretoria, to analyse the reproductive cycle, size dimorphism and predation pressure. The collaborators on this project are Lemmy Mashinini (Herpetology curator at the Museum) and Prof Jackie Goedhals from the UFS School of Clinical Medicine.

Insect Physiological Ecology

Gerald Chikowore (PhD student of Dr Frank Chidawanyika) undertook several field trips to Clarens to collect data for his research project on invasive alien plants, funded by the Department of Environmental Affairs (DEA).

Dr Chidawanyika conducted research in Zimbabwe with another PhD student, Stephen Musasa, on toxicity of cynobacteria bioactive compounds on invasive agricultural pests. Field trips were largely reduced due to COVID-19 travel restrictions.

Nematology

Research in the group of Dr Candice Jansen van Rensburg focuses on plant-parasitic and free-living freshwater nematodes occurring in nature reserves in the Free State, aiming to increase current knowledge on free-living nematodes, especially from aquatic ecosystems and nature reserves. Dr Leon Barkhuizen (FSDESTEA) assisted Dr Jansen van Rensburg during field surveys to Kalkfontein Dam, Sandveld, Soetdoring and Erfenis Dam Nature Reserves as part of a collaborative project.

Terrestrial Ecology

Research in the laboratory of Prof Daryl Codron focused on patterns of resource use and how these shape the ecological dynamics and evolutionary adaptations of primarily mammalian faunas. Emphasis is on stable isotope analysis for reconstructing trophic niche dynamics over multiple space and time scales, as well as on the theoretical principles underpinning this approach. Current projects aim specifically to quantify trophic niche overlaps among coexisting species, as well as individual-level niche variations. In addition to this, comparative investigations of various life history traits enable to us to understand how animals are constrained to certain trophic niches.

During 2020, two MSc students completed isotopic analysis of the bulk of the materials required for their projects. This new data represents the first longitudinal niche records for individuals living in sympatric herbivore and carnivore populations, in a range of natural environments. Results show the effects, or lack thereof, of life history variation on the evolution of individual niche variation, being more prominent among carnivores than herbivores, but not according to a body size gradient as predicted. Dr Aileen van der Mescht joined the lab as a postdoctoral fellow, expanding our research activities to include not only dietary but also 'acoustic' niches of animals, studying the variation in Chiropteran soundscapes over a variety of environmental gradients.

Studies of mammalian tooth wear in controlled feeding experiments conducted at the University of Zurich, Switzerland (initially by Prof Codron in 2017), came to fruition during 2020. Results have already revealed that dental wear is inconsistent along cheek tooth rows, but instead is influenced by species-specific dental arrangements and in different ways by external versus internal dietary abrasives. Thus, for the first time, we provided confirmatory evidence that the attrition-abrasion debate should not be viewed as a dichotomy, but as the interaction between two contrasting environmental effects.

Tick Research Unit

The evaluation of resistance development of *Rhipicephalus decoloratus* (African blue tick) and *R. microplus* (Asian blue tick) with data collected on commercial farms over a 20-year period, was finalised and reviewed in three articles summarised into the PhD of Ellie van Dalen, ready for submission in 2021.

One of the articles also addressed the introduction and invasion of the alien species *R. microplus* and possible displacement of *R. decoloratus* on these commercial farms, with the conclusion that the closed farming systems used by commercial producers in South Africa can offer solutions to prevent dispersion of alien species. It also stressed the importance of regular testing to stay aware of tick resistance development and control inefficiencies.

Although the usual field trips to a farm in the Eastern Cape were hampered due to COVID-19, collaboration with the producer ensured regular monthly collection of blue ticks from his cattle, in order to continue monitoring the invasion of *R microplus* on his farm.

Qwaqwa Campus Research Groups

Ecotoxicology Research Group

The initial focus of the research group of Dr Patricks Voua Otomo was on terrestrial ecotoxicology, using earthworms, potworms and snails as model organisms. It has now expanded to also include exploring aquatic issues where frogs and snails are used as model organisms.

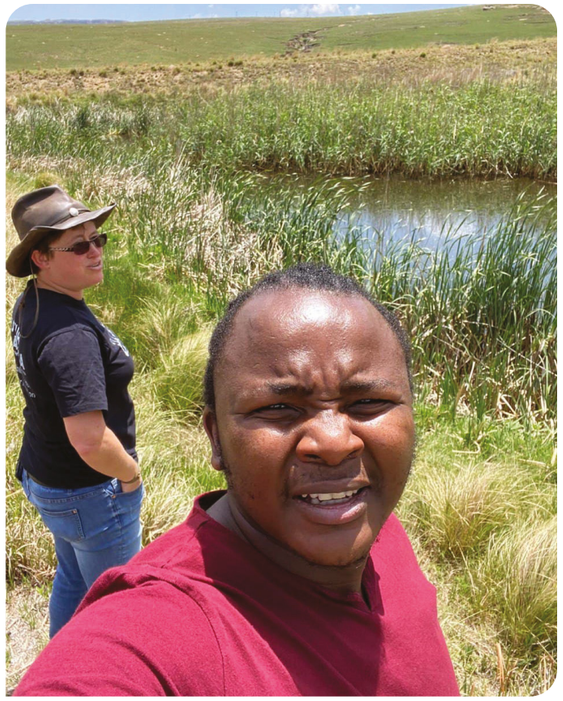
Twelve honours and four master's students have graduated from the Ecotox Lab since 2016. In 2020, eleven postgraduate students – three honours, five master's and three doctoral students – actively conducted research in the Lab.

Mammal Cognition Research

Several students from the research group led by Prof Aliza le Roux graduated in early 2020 and continued to work on publications from their theses.

Alex Botha (PhD) finalised fieldwork and analyses for his thesis on jackal movement and feeding ecology and submitted a manuscript for external peer review.

Most of the fieldwork in 2020 focused on acoustic diversity in a large wetland in Qwaqwa, where two students, Toka Mosikidi and Sphindile Dlamini, are describing avian species and behaviour in this high-altitude wetland. Some of the acoustic recorders burned down in late 2019, and others were washed away in floods in late 2020, but so far, Murphy's law has only applied to the instruments and not the students involved in this research.



Prof Aliza le Roux and Dr Mpho Ramoejane in the wetlands in GGHNP (January 2020).

Until his appointment as full-time lecturer, Dr Mpho Ramoejane (postdoctoral fellow) assisted with a number of fieldwork excursions.



Dr Mpho Ramoejane at Sentinel Peak

ENGAGED SCHOLARSHIP

Prof Charles Haddad was involved in the editing and coordination of a Festschrift issue in *Zootaxa* in honour of leading taxonomic expert on jumping spiders, Prof Wanda Wesołowska (Poland), together with departmental Research Associate Dr Yura Marusik (Russia), Sarah Crews (USA), Francesco Ballarin (Italy), and Galina Azarkina (Russia). The 383-page issue included 17 contributions, with a monograph on Afrotropical Ballinae spiders

by Prof Haddad and collaborator Galina Azarkina being the largest contribution (78 pages).

Prof Aliza le Roux was active on the council of the Zoological Society of Southern Africa, in which role she published a popular press article on the COVID pandemic. She was external examiner on a PhD thesis for the University of Venda and a master's dissertation for Nelson Mandela University. She was also invited to join the editorial board of *Scientific Reports*, in the new Registered Reports section.

Dr Patricks Voua Otomo is a member of the editorial board of *Bulletin of Environmental Contamination and Toxicology* (*BECT*)



Dr Patricks Voua Otomo

Academics from the Department were involved in reviewing articles for a range of scientific publications, including, *inter alia*:

- Prof Linda Basson: *Environmental Pollution*, *Acta Amazonica*, *Parasitology International*, *Molecular Phylogenetics and Evolution* and Aquaculture as well as one NRF application.
- Dr Frank Chidawanyika*: Journal of Pest Management Science*, *Phytoparasitica, Journal of Thermal Biology*, *Biological Control Journal. Appointed Guest Editor for Frontiers in Insect Science.*
- Dr Candice Jansen van Rensburg: *Diseases of Aquatic Organisms* and three NRF applications.
- Prof Liesl van As: *African Zoology* and also processed articles as journal sub-editor of the *African Journal of Aquatic Sciences*.
- Prof Aliza le Roux: *Behavioural Ecology* and the *International Journal of Primatology* and reviewed an application for rating for the NRF.
- Dr Patricks Voua Otomo reviews on average five to ten papers per year for *BECT* and several other journals in the field of Environmental Toxicology.

NATIONAL AND INTERNATIONAL COLLABORATION

National

Prof Linda Basson collaborated with Prof Louis du Preez, School of Environmental Sciences and Development, North-West University (NWU), on trichodinids collected in Madagascar from frogs. Prof Du Preez also assisted with an honours project in 2020 in which a student worked on ciliates from intestine of frogs. Prof Basson also collaborated with Prof Nico Smit (Water Research Group [Ecology], Unit for Environmental Sciences and Development, NWU) on research on the Pongola River, with Dr Gavin Snow (School of Animal, Plant and Environmental Sciences, University of the Witwatersrand [Wits]) on phytoplankton data collected in Antarctica, and with Prof Bettine van Vuuren (Department of Zoology, University of Johannesburg) on e-DNA data collected in Antarctica.

In 2020, Dr Frank Chidawanyika collaborated in research on the biological control of weeds with Dr Grant Martin and Prof Martin Hill (Rhodes University Centre for Biological Control), Dr Costas Zachariades and Dr David Simelane (ARC Plant Health Protection) and Prof Marcus Byrne (Wits). He also collaborated with Dr Mduduzi Ndlovu (University of Mpumalanga) on arthropod dynamics in response to vegetation management in Kruger National Park.

Prof Daryl Codron collaborated with Dr Falko Buschke (UFS Centre for Environmental Management) and Dr Andri van Aardt (UFS Department of Plant Sciences); both collaborations resulted in journal articles published in 2020.

Prof Neil Heideman collaborated with Prof Emeritus Retha Hofmeyer (University of Western Cape, who passed away early in 2020) and Dr Mike Bates (National Museum, Bloemfontein), on the padloper tortoise project. Prof Paul Grobler of the Department of Genetics was also involved in the project. On the Acontinae project he collaborated with Dr Shelley Edwards (Rhodes University) and Werner Conradie (Bayworld Museum, Port Elizabeth), and with Lemmy Mashinini (Ditsong Museum, Pretoria) and Prof Jackie Goedhals (School of Clinical Medicine, UFS) on the *Mochlus* project. He also worked with Fanie Riekert from the HPC Unit on the coronavirus project.

Dr Milad Rashidifard and Prof Hendrika Fourie (both from NWU), assisted Dr Candice Jansen van Rensburg with molecular techniques for nematode species descriptions.

Prof Liesl van As collaborated with Dr Leon Barkhuizen (FSDESTEA), and, as part of the MoU with CapeNature, with Pierre de Villiers. As part of the MoU with the South African Institute of Aquatic Biodiversity (SAIAB), Prof Van As collaborated with Prof Olaf Weyl, who sadly passed away in November 2020. However, the collaboration with SAIAB will continue.

Mrs Ellie van Dalen continued collaborating with Corne Mostert, the product manager for Virbac Animal Health (SA), on the testing of resistance of tick collections from clients experiencing control breakdown in the field. After the merger of Bayer Animal Health with Elanco, collaboration with the new company was successfully established. Dip sample concentration testing for both Elanco and Zoetis Animal Health continued despite difficulties experienced with COVID-19 regulations.

Dr Nthatisi Nyembe collaborated with Prof Oriel Thekisoe (School of Biological Sciences, NWU) and Prof Lesetja Lengoabe (School of Pharmacology, NWU).

Dr Mpho Ramoejane collaborated with Dr Gavin Gouws, Prof Olaf Weyl (deceased November 2020) and Dr Ernst Swartz from SAIAB, Makhanda.

Dr Patricks Voua Otomo collaborated on a large Water Research Commission (WRC) project with Mrs Marinda Avenant, from the UFS Centre for Environmental Management.

International

Prof Linda Basson formed 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, although the official launch would have been in June 2020 in Italy. A collaborative research proposal (Parasitism prevalence different regions under Mediterranean climates [France – South Africa]) was submitted to the NRF, with Prof Delphine Thibault of the L'Institut Médirranéen d'Océanologie, Aix-Marseille Université in France.

Prof Basson also collaborated on various trichodinid-related projects with:

- Prof Richard Snyder (Eastern Shore Laboratory, Virginia Institute of Marine Science, USA) on trichodinids collected from anemones in the USA.
- Prof Rogelio Aguilar Aguilar and Ms Alma Islas-Ortega (National Autonomous University of Mexico, Mexico) on certain trichodinids collected in South Africa and in Mexico.
- Dr Gustavo Valladao (Veterinarian, Specialist in Aquaculture and Adjunct Professor for Laboratory of Parasitology and Pathology of Aquatic Organisms at Nilton Lins University, Brazil) on trichodinids collected from frogs in Brazil.

Dr Frank Chidawanyika collaborated with Prof C Nyamukondiwa (Botswana International University of Science and Technology [BIUST]), on stress physiology of economically important pests, with Prof Regan Early and Prof Jason Chapman (University of Exeter, UK) on landscape drivers of fall armyworm (FAW) dispersal patterns, and with Prof Toby Bruce (Keele University, UK) on chemical ecology of parasitoids important for controlling FAW.

Prof Daryl Codron was involved in various collaborations that resulted in the publication of ten journal articles and one book chapter in 2020 – namely with Prof Marcus Clauss (University of Zurich, Switzerland), Prof Matt Sponheimer (University of Colorado at Boulder, USA), and Dr Liora Kolska Horwitz (Hebrew University of Jerusalem, Israel).

Prof Charles Haddad undertook collaborative research with Stano Pekár (Czech Republic) on spider predation ecology, with Galina Azarkina (Russia) and Wanda Wesołowska (Poland) on jumping spider taxonomy, and with Daniele Polotow (Brazil) on prowling spider taxonomy.

As part of the MoU, Prof Liesl van As continued her research with the Okavango Research Institute (Maun) at University of Botswana (UB) and with Prof Maxwell Barson (UB).

Prof Aliza le Roux collaborated with Dr Nick Friedman from Okinawa Institute of Science and Technology, Japan, working on a joint grant application for research on acoustic diversity in wetland environments. Collaboration commenced with the National University of Lesotho (NUL) on wetland biodiversity, which resulted in a successful British Ecological Society grant to the NUL collaborators. Prof Le Roux has continued working with the University of Minnesota and several South African collaborators in a camera-trap project using camera-trap grids posted in several reserves across the country, focusing on medium-sized mammals.

Dr Ntathisi Nyembe collaborated with Dr Keisuke Suganuma (Obihiro University of Agriculture and Veterinary Medicine, Japan), and Dr Mpho Ramoejane collaborated with Dr Brian Sidlauskas (Oregon State University, USA).

Dr Patricks Voua Otomo collaborated on a Thuthuka-sponsored project with Dr Norah Basopo of National University of Science and Technology, Zimbabwe, and Dr Ozekeke Ogbeide from the University of Benin, Nigeria.

POSTGRADUATE STUDENTS

In 2020 the following postgraduate students were enrolled in the Department of Zoology and Entomology:

- Honours: Eight in Zoology and one in Entomology on the Bloemfontein Campus, and five in Zoology on the Qwaqwa Campus
- MSc: Five in Zoology and five in Entomology on the Bloemfontein Campus, with a further two in Zoology on the Qwaqwa Campus
- PhD: Eleven in Zoology and eight in Entomology on the Bloemfontein Campus, and three in Zoology on the Qwaqwa Campus

In 2020, a total of ten students graduated with the honours degree on the Bloemfontein Campus (six in Zoology and four in Entomology). Two students graduated with the honours in Zoology on the Qwaqwa Campus.

At master's level, five students graduated – Anke de Scmidt and Tiaan le Roux (in Zoology), and Ruan Booysen (with distinction), Wendy Madiope and Abré Marias (in Entomology). All the candidates were based on the Bloemfontein Campus

Two students graduated with the PhD in Zoology in 2020:

Jumba, Keafon (Qwaqwa Campus)
Thesis: Social, ecological and personality factors influencing bat-eared fox foraging behaviour.
Promoter: Prof A le Roux

Zhao, Zhongning (Bloemfontein Campus)
Thesis: A phylogenetic analysis of the tent tortoise *Psammobates tentorius* (Bell, 1828) species complex using molecular and morphological markers
Promoter: Prof N Heideman (Co-promoter: Prof P Grobler)

A further three students graduated with the PhD in Entomology:

Botham, Jason (joint Bloemfontein and Qwaqwa Campus)
Thesis: Investigation of interspersed forest patches along different topographical conditions within Afromontane grasslands and their potential as conservation hotspots
Promoter: Dr V Swart (Co-promoters: Prof C Haddad and Dr E Bredenhand)

Sebata, Sicelo (Bloemfontein Campus)
Thesis: Spider ecology in southwestern Zimbabwe, with emphasis on the impact of holistic planned grazing practices
Promoter: Prof C Haddad (Co-promoters: Prof S Foord and Dr M FitzPatrick)

Van der Merwe, Sylvia (joint Bloemfontein and Qwaqwa Campus)
Thesis: Soil biota as buiindicators of levels of erosion and fire disturbances in Afromontane grassland areas within the Golden Gate Highlands
Promoter: Dr V Swart (Co-promoters: Dr E Bredenhand and Prof C Haddad)

POSTDOCTORAL RESEARCH FELLOWS

The Department of Zoology and Entomology hosted four postdoctoral fellows in 2020:

- Dr J Verdu Ricoy, from Spain, supervised by Prof Heideman
- Dr Z Zhao, from China, supervised by Prof Heideman
- Dr R Mutamiswa, from Zimbabwe, supervised by Dr Chidawanyika
- Dr A van der Mescht, from South Africa, supervised by Prof Codron

STAFF MATTERS

Dr Frank Chidawanyika resigned at the end of 2020, to take up employment at the International Centre for Insect Physiology and Ecology (ICIPE) in Kenya.

Mr Luthando Bopheka was appointed as a Professional Officer on the Bloemfontein Campus.

On the Qwaqwa Campus, Dr Nthatisi Nyembe and Dr Mpho Ramoejane were both appointed as Lecturers. Dr Johann van As served as Acting Subject Head of the Department (January-July 2020), after which Dr Patricks Voua Otomo was appointed as the new Subject Head, for the next five years.

RESEARCH OUTPUTS

Research Articles

Ackermans, N,L., Martin, L.F, Codron, D., Hummel, J., Kircher, P.R., Richter, H., Kaiser, T.M., Clauss, M. & Hatt, J-M. 2020. Mesowear represents a lifetime signal in sheep (*Ovis aries*) within a long-term feeding experiment. *Palaeogeography, Palaeoclimatology Palaeoecology* 553: 109793.

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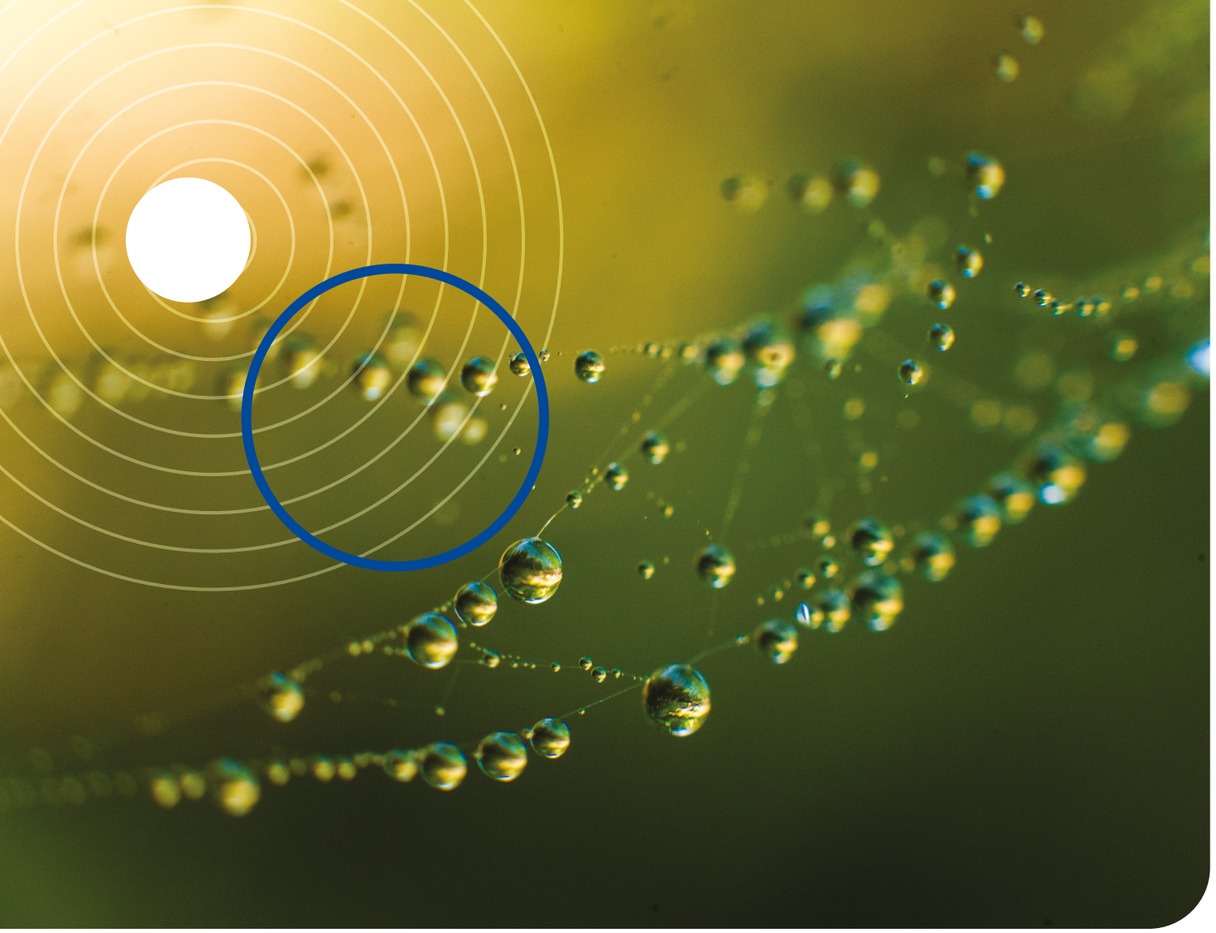
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Conference Contributions

Conference Papers/Posters

Le Roux, A., Mathibane, A.N. & Nowak, K. 2020. *On the urban edge: a small primate's landscape of fear in an anthropogenic habitat.* Paper delivered at the Conference of the Animal Behaviour Society (Virtual conference). 28-31 July 2020.

Modise, S.A. & Bredenhand, E. 2020. *Possible adaptation of the Biotope Quality Index to flowering plants data by using composite scaling towards weighed disturbance*. Paper delivered at 46th Annual South African Association of Botanists, Qwaqwa, South Africa. 7-10 January 2020.

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STAFF (2020)

Head of Department: Prof LL van As

Bloemfontein Campus
Distinguished Professor: Prof LJ Fourie
Professors: Prof L Basson and Prof NJL Heideman
Associate Professors: Prof D Codron, Prof CR Haddad and Prof LL van As
Senior Lecturers: Dr F Chidawanyika and Dr VR Swart
Lecturers: Mr HJB Butler, Ms L Heyns, Dr C Jansen van Rensburg, and Ms EMP van Dalen
Junior Lecturer: Mr DV Fourie
Research Associates: Dr LM Barkhuizen, Dr M Bates, Dr J Botha, Dr EA Hugo-Coetzee, Dr RJ Pretorius, Dr C Scheepers and Dr Y Marusik
Programme Director: Dr C Jansen van Rensburg
Officer - Professional Services: Ms NW Mokhethi
Senior Assistant Officers: Mr B Maasdorp and Ms SAM Teele
Technicians: Mr PMohasi and Mr T Lesaona

Qwaqwa Campus:
Subject Head: Dr J van As (to July) and Dr P Voua Otomo
Associate Professor: Prof A Le Roux
Senior Lecturers: Dr E Bredenhand and Dr P Voua Otomo
Lecturers: Dr N Nyembe, Dr M Ramoejane, Dr J van As and Ms M van As
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OVERVIEW OF 2020

The year 2020 was accompanied with a great deal of success for the Centre for Environmental Management (CEM), in spite the COVID-19 pandemic. Research outputs have grown steadily over more than a decade – the eight research reports and two accredited articles produced in 2005 increased to 150 research reports, 60 book chapters and 336 articles in accredited journals by the end of 2020, of which four book chapters and 58 accredited articles were produced during 2020.

Even though the CEM's initial mandate was to coordinate the Master 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 hopes to establish itself as the thought-leader in southern African environmental and water management. This will create a hub where the best and brightest postgraduate students can come together to begin solving tomorrow's environmental problems.

This year marked the beginning of two new Master of Science degrees. Both are structured and were mostly presented online due to the pandemic. The CEM is currently presenting the following programmes:

- In Environmental Management:
  - Master of Science majoring in Environmental Management
  - PhD in Environmental Management
- In 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

ACHIEVEMENTS

Staff Achievements

Prof Paul Oberholster was invited by the Department of Water and Sanitation (DWS) to be a member of the Project Steering Committee for the Development of the National Eutrophication Strategy (March 2020). Prof Oberholster was also nominated and listed as a finalist for the 2019/2020 National Science and Technology Forum (NSTF) South32 Awards (Science Oscars): Category NSTF-Water Research Commission Award (June/July 2020).

Dr Falko Buschke has been rated as an NRF-Y2 researcher since February 2020.

The PhD degree was conferred on Dr Surina Esterhuyse in 2020. The title of her PhD thesis was 'Towards a regulatory framework to protect groundwater resources during and as a result of unconventional oil and gas extraction' and her promoters were Prof Danie Vermeulen (UFS) and Prof Jan Glazewski (University of Cape Town). She was also invited to contribute to the regulatory requirements for shale gas development in a consultative workshop held at Kievits Kroon on the development of a shale gas action plan for South Africa. Dr Esterhuysen also served on the Editorial Board of *Water International*.

Dr Olusola Ololade was invited to be coordinator and lead investigator on two research projects –'Assessment of the ecological and environmental degradation and possible restoration in the Welkom mining area' and 'Assessment of the Water-Energy-Food Nexus Agenda within sectoral departments and policies in South Africa'. Dr Ololade was a co-project leader of a UFS-CUT collaborative project 'Impacts of urban development on environmental sustainability: Case study of Mangaung Metropolitan Municipality'. She also participated as a panellist and keynote speaker for The Water Show Africa on *Water Wars: An uncertain future with population growth and climate change*, an online event held on 3 November 2020.

Dr Nico Avenant (Research Fellow) is part of the Zoological Society of Southern Africa (ZSSA) local organising committee that will host the 2021 International Congress of Zoology (ICZ) in Cape Town.

Other CEM Research Fellows had notable achievements in 2020. The late Dr James Brink was a co-author on a paper in *Nature* (580:372-375). In May 2020, Dr Daan Toerien was elected as an Honorary Member of the Stilbaai Chamber of Commerce, for services rendered to them. He served on the Editorial Board of *Cogent Social Sciences*, and his article 'Tourism and poverty in rural South Africa: A revisit' was one of *South African Journal of Science*'s most popular research reads in 2020.

Prof Anthony Turton (Affiliated Professor) participated as a panellist and keynote speaker for The Water Show Africa on *Regulation and policy: Driving forward collaborative development and innovation*, held on 3 November 2020.

Student Achievements

Ms Zama Sithole, Master of Environmental Management student, received the Best Speaker Award at the annual Environmental Law Association (ELA) Student Conference (virtual conference) held from 7 to 9 September 2020.



Ms Zama Sithole received the Best Speaker Award at the annual Environmental Law Association Student Conference

RESEARCH AND INNOVATION

Prof Paul Oberholster was involved in three collaborative projects in 2020. One project, titled 'Alternative low cost solution to rural sewage wastewater treatment using phycoremediation', is a collaboration between the Council of Scientific and Industrial Research (CSIR), the UFS and four Southern African Development Community (SADC) countries. The objectives of the study are to reduce the health risks that Waste Water Treatment Works (WWTW) pose to communities and to reduce poverty through innovation, to improve the operational efficiency of pond-based WWTFs, and implement biotic cultures to pond systems to reduce pathogens and nutrients. The project will also develop operational guidelines and procedures for the roll-out to other WWTWs in SADC countries and transfer technology and build local capacity to support local entrepreneurs and local government. The participation of local communities to assess and reduce health risks and the cooperation of local government to assess and implement options, are essential contributors to the success of the project.

Another project, undertaken in a collaboration between the CSIR, the UFS, Sasol Group Technology and Sasol Mining, aims to determine the source of water seepage to the Leeuspruit stream, wetlands and Rietspruit stream at Sasol's defunct Sigma Coal mine at Sasolburg, Free State. The focus of the project is to determine the source, pathway and receptors of a mixture of pollutants.

The third project involves a collaboration between the UFS and Coaltech to asses different supporting organic materials for the enhancement of anaerobic microorganisms in sub-surface constructed wetlands receiving acid mine drainage.



Dr Melusi Thwala (Research Fellow – on the left) and Ms Beatrice Otunola (PhD student) collecting samples to determine the effects of different anthropogenic activities on soil and water quality

The CEM, in collaboration with the Disaster Management Training and Education Centre for Africa (DiMTEC), the Department of Zoology and Entomology on the Qwaqwa Campus, 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 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. The project is coordinated by Mrs Marinda Avenant of CEM.

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.



Charissa Worthmann and Zimkhitha Mehlamakhulu sampling water at Loch Logan (February 2020)



Lischan du Randt collecting water samples at Loch Logan

Dr Nico Avenant was involved with the National Museum's effort to be more accessible to disabled people. He was mentioned in three publications linked to this effort, namely 'Museum ups accessibility, interaction' (in *Bloem News*, 10 December), 'Museum gee geleentheid vir persone met gestremdhede' (in *Bloemfontein Courant*, 10 December), and 'Museum creates easy access for disabled' (in *Mangaung Issue*, 16 December).

Dr Avenant served on the Editorial Board of *Integrative Zoology*, the journal of the International Society of Zoological Sciences (2006 - present; current Impact factor 2.140; Q1), as Section Editor of *African Zoology* (small mammals; 2014 - present; current Impact factor 0.962; Q3), and on the Executive Committee of the International Conference on Rodent Biology and Management (2006 - present).

Various staff members and research fellows were interviewed on radio, including:

- Dr Surina Esterhuyse - *The prospect of fracking in South Africa*. An interview with Pienaar Lochner on Pretoria FM's radio programme on the Natural Sciences https://www.pretoriafm.co.za/ek-wil-weet-pienaar-en-die-wetenskaplikes-junie-2020/
- Mrs Marthie Kemp - *Dendrochronology and its link to climate and environmental changes*. An interview with Pienaar Lochner on Pretoria FM's radio programme on the Natural Sciences https://www.pretoriafm.co.za/ek-wil-weet-pienaar-en-die-wetenskaplikes-julie-2020/
- Prof Anthony Turton - *Using sewage to test for Covid-19*. Podcast Radio interview on *Breakfast with Rifilwe Moloto* https://omny.fm/shows/midmorning/using-sewage-to-test-for-covid-19

NATIONAL AND INTERNATIONAL COLLABORATION

Dr Falko Buschke led the second year of the bilateral project 'Socio-ecological resilience in agricultural landscapes (SERIAL)', a collaborative project with the Vrije Universiteit Brussel (VUB), Belgium. The project, which focuses on the Rooiberge-Riemland Key Biodiversity Area in the eastern Free State, has so far produced one published paper, three master's dissertations and one conference presentation, with more outputs anticipated in the first half of 2021. This project is funded by the Flemish Interuniversity Council (VLIR), and includes collaboration with BirdLife South Africa.

During lockdown, Dr Buschke initiated a collaboration between the University of the Witwatersrand, Gothenburg University (Sweden) and Sapienza University (Italy). This collaboration focuses on global indicators of biodiversity changes. In November 2020, he presented an online seminar at the Gothenburg Global Biodiversity Centre, which covered the progress made in this project.

Falko Buschke was also a partner on a multi-university collaboration to assess the biodiversity and ecosystem functioning of wetlands in the Karingani Private Nature Reserve in southern Mozambique. The project includes researchers from UFS, Eduardo Mondlane University (Mozambique), and KU Leuven (Belgium). The first research outputs from the project were submitted for publication in January 2021.



Dr Falko Buschke (back row third from the left) and Dr Tom Pinceel, KU Leuven (back row second from the right) with members of the research team in Karingani Private Nature Reserve, Mozambique (2019/20)

POSTGRADUATE STUDENTS

In 2020, a total of 27 students were registered for the Postgraduate Diploma in Integrated Water Management, while 45 were registered for the Master of Environmental Management, and 5 for the PhD in Environmental Management.

Seventeen (17) students were registered for the two new Master of Science degrees – nine majoring in Environmental Management, and eight majoring in Integrated Water Management.

In 2020 the CEM awarded 24 PGDip Integrated Water Resource Management qualifications, and 20 Master in Environmental Management degrees.

Two students were conferred with PhD degrees:

Esterhuyse, Surina
Thesis: Towards a regulatory framework to protect groundwater resources during and as a result of unconventional oil and gas extraction
Promoters: Prof D Vermeulen and Prof J Glazewski

Uugwanga, Martha
Thesis: Heavy metal pollution from abandoned mines in Namibia: A case of oamites and klein aub mine sites
Promoter: Prof NA Kgabi

POSTDOCTORAL RESEARCH FELLOWS

The Centre for Environmental Management hosted two postdoctoral research fellows during 2020 - Dr Israel Orimoloye from Nigeria, and Dr Ernestine Atangana from Cameroon.

RESEARCH OUTPUTS

Research Articles

Adedeji, O., Olusola, A., James, G., Shaba, H.H., Orimoloye, I.R., Singh, S.K. & Adelabu, S. 2020. Early warning systems development for agricultural drought assessment in Nigeria. *Environmental Monitoring and Assessment* 192(12): 1-21 (Article # 789). DOI: 10.1007/s10661-020-08730-3.

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Williamson, R. & Esterhuyse, S. 2020. Expected wastewater volumes associated with unconventional oil and gas exploitation in South Africa and the management thereof. *Bulletin of Engineering Geology and the Environment* 79(2): 711-728. DOI: 10.1007/s10064-019-01579-y.

Chapters in Books

Mader, A.E., Eslamian, S. & Turton, A.R. 2020. Biological Remediation Using Wetland Systems: A Hydro-geochemical Perspective. In: *Advances in Hydrogeochemistry Research*. S.S. Eslamian & F. Eslamian (Eds). Nova Science Publishers, Inc. New York, USA. pp. 21-54.

Oberholster, P., Munyayi, R.C., Turton, A. & Du Plessis, A. 2020. Overview. In*: Sanitation and Wastewater Atlas of Africa*. Abidjan, Nairobi and Arendal: AfDB, UNEP and GRID-Arendal. pp. 9-35.

Ndlela, L.L., Oberholster, P.J., Madlala, T.E., Van Wyk, J.H. & Cheng, P.H. 2020. Determination of the ecotoxicity changes in biologically treated Cyanobacteria *Oscillatoria* and *Microcystis* using indicator organisms. In: *Current Microbiological Research in Africa*. A.L.K. Abia & G.R. Lanza (Eds). Springer Cham. pp. 257-281.

Toerien, D.F. 2020. Power Laws and the Demographic-Socioeconomic-Entrepreneurial Nexus of United States Counties. In: *Advances in Sociology Research. Volume 32*. J.A. Jaworski (Ed). Nova Science Publishers, Inc., New York. pp. 65-115.

Conference Contributions

Conference Papers/Posters

Bergman, D.L., Avenant, N.L., Bodenchuk, M.J. & Steenkamp, E. 2020. *Developing Alternatives to Protect Domestic Sheep from Predation in South Africa*. Paper delivered at the 29th Vertebrate Pest Conference, Santa Barbra, USA. 2-5 March 2020.

Bessah, E., Raji, A.O., Taiwo, O.J., Agodzo S.K., Ololade, O.O., Strapasson, A. & Larbi, I. 2020. *Extreme changes of daily rainfall and temperature patterns in a tropical sub-humid basin: A statistical downscaling assessment for the 21st century*. Paper delivered at the 1st Climate Change Virtual 2020 (Online). 18-19 September 2020.

Devereux, E.J., Paine, O.C.C., Ryder, C., Wigley-Coetsee, C., Codron, D., Codron, J., Sponheimer, M. & Henry, A.G. 2020. *Investigating habitat quality across a savanna biome: hominin dietary implications of plant nutritional properties from the southern African lowveld.* Poster presented at The Ecological Society of America (ESA) Annual Meeting (Virtual meeting). 3-6 August 2020.

Devereux, E.J., Paine, O.C.C., Ryder, C., Wigley-Coetsee, C., Codron, J., Codron, D., Sponheimer, M. & Henry, A.G. 2020. *Hominin dietary implications of plant nutritional properties from the southern African Lowveld*. Paper delivered at the 89th annual meeting of the American Association of Physical Anthropologists, Los Angeles, USA. 15-18 April 2020.

Ololade, O.O. 2020. *Implementation of the WEF Nexus in the agricultural sector: A climate change mitigation and environmental protection approach*. Paper delivered at The Water Show Africa 2020 (Online), South Africa. 3 November 2020.

Orimoloye, I.R., Belle, J.A. & Ololade, O.O. 2020. *Remote sensing of drought disaster events over Free State Province, South Africa*. Paper delivered at the 2020 Applied Geography Conference (AGC) (Online), USA. 18-20 October 2020.

Orimoloye, I.R., Ololade, O.O. & Belle, J.A. 2020. *Space-based drought disaster risk and climate change assessments: Strategies for environmental conservation*. Paper delivered at the 2020 UNU Summer Academy on World Risk and Adaptation Futures: Social Protection. Bonn, Germany. 21-25 September 2020.

Sithole, Z. & Ololade, O.O. 2020. *Shortcomings of the South African Legislative Framework in Addressing Communal Artisanal Small-scale Mining: A Blaauwbosch Case Study.* Paper delivered at the Environmental Law Association (ELA) Student Conference (Virtual conference), Pretoria, South Africa. 7-9 September 2020.

Senbore S, Oke, S., Malebo, N. & Ololade O. 2020. *Guidelines on assessment of urban development impact on water Security and environmental Sustainability*. Paper delivered at the 3rd WaterEnergyNexus Conference, Djerba, Tunisia. 1-5 December 2020.

Serfontein, S.S., Aghoghovwia, M.P., Ololade, O.O.& Mavimbela, S. 2020. *The treatment of heavy metals in very acidic waste water by activated carbon*. Poster presented at the Combined Congress of the Soil Science Society of South Africa (SSSSA), the South African Society of Crop Production (SASCP), the Southern African Weed Science Society (SAWSS), and the Southern African Society for Horticultural Sciences (SASHS), UFS, Bloemfontein, South Africa. 20-23 January 2020.

Conference Proceedings

Bergman, D.L., Avenant, N.L., Bodenchuk, M.J. & Steenkamp, E. 2020. Developing Alternatives to Protect Domestic Sheep from Predation in South Africa. In: *Proceedings of the 29th Vertebrate Pest Conference, 2-5 March 2020.* D.M. Woods (Ed). University of California, Davis, USA.

STAFF (2020)

Director: Prof PJ Oberholster

Senior Lecturers: Dr FT Buschke and Dr OO Ololade
Lecturers: Mrs MF Avenant, Dr S Esterhuyse and Mr F Sokolic (units)
Affiliated Professors: Prof NA Kgabi and Prof AR Turton
Research Fellows: Dr NL Avenant, Dr NB Collins,
Dr PL Gründling, Dr JR Henschel, Dr SA Mitchell, Dr TWD Pinceel, Prof MT Seaman, Dr M Thwala, Dr DF Toerien, Prof BJ Vanschoenwinkel and Dr PC Zietsman
Professional Officer: Dr AT Vos
Senior Officer – Professional Services: Mrs ME Kemp
Course Coordinator: Mrs V Padayachee
Senior Assistant Officer: Mrs DM Kolesky
Research Assistants: Ms L du Randt and Ms Z Mehlomkhulu
NRF Intern: Ms A Madasa
Messenger: Mr PS Thabiri



CENTRE FOR MICROSCOPY

CONTACT DETAILS

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OVERVIEW OF 2020

The Centre for Microscopy is a faculty-based research facility that primarily supports researchers in gathering structural information using the scanning electron microscope (SEM) and transmission electron microscope (TEM). While the Centre mainly supports the University of the Free State (UFS), other local and international institutes also utilised the facilities available at the Centre in 2020, such as the Central University of Technology (CUT).

In 2020 our staff supported 55 researchers and students at the Centre, covering a range of disciplines involving microscopy research. The total microscope hours amounted to a total of 391 hours for all the electron microscopes combined. The usage hours for individual microscopes and departments are indicated Table 1 below.

2020 was also an exciting year for the Centre as it was fortunate to have acquired four new items of research equipment − a high resolution TEM, an SEM, a focused ion beam (FIB) SEM, and a confocal microscope. In order to accommodate the new equipment, which will arrive in 2021, the Centre was renovated in November 2020.

ACTIVITIES

The microscope usage hours by department are indicated in the following table.

Table 1: Use of microscopes (2020)

UFS Department	Usage hours		
	SEM	TEM	Total
Cardiothoracic Surgery	2	2	4
Chemistry	10	10	20
Consumer Science	2	-	2
Institute for Groundwater Studies	3	-	3
Microbiology	13	-	13
Physics	251	34	285
Plant Sciences	4	-	4
Zoology and Entomology	40	-	40
External Researchers/Projects			
Central University of Technology (CUT)	11	9	20
TOTAL USAGE	**336**	**55**	**391**

The number of users during each of the past four years, is reflected below.

Table 2: Number of users (2017-2020)

2017	2018	2019	2020
59	51	86	55

The SEM remains the more popular microscope, with an annual usage of 633 hours, while for the TEM the average usage hours is 102 hours. The SEM is attractive for researchers due to its ability to deliver impressive dimensional images compared to the TEM. The latter is very sample-specific as it requires nano-scaled or ultra-thin samples in order to utilise the full capacities of the system, which takes time and specialist handling to prepare.

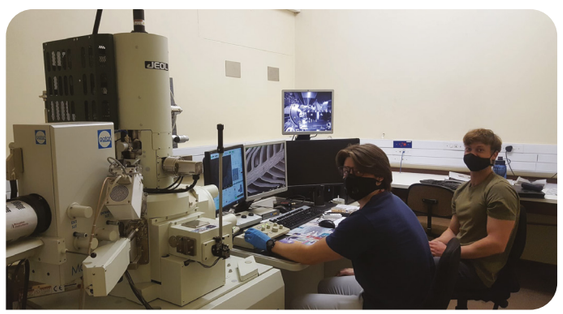
Variations in the number of users and usage are typically due to users who have either started or completed their projects. However, this year the Centre saw a significant decline in the usage hours and number of users due to the COVID-19 pandemic, which resulted in the Centre being closed for four months, and then again in November for renovations.

TEACHING AND LEARNING

In addition to operating research equipment, the Centre's staff are also involved in presenting practical sessions for different departments in the Faculty. The practical sessions consist of a tour through the Centre, during which the staff guide the students through the various preparations involved for microscopy and the basic operations of the research equipment.

Despite the challenges in 2020, the Centre for Microscopy managed to continue with the annual practical SEM sessions for the honours students from the Department of Zoology and Entomology (ZLGY6814 and ENTO6814). Prof Linda Basson introduced her students to the principles of electron microscopy and the preparation techniques involved. The students then collected and prepared their own SEM specimens, and were shown how to operate the SEM. This provided them with the experience of how to us a microscope worth millions of Rands to study their samples. For many this will be a once in a lifetime opportunity, and for others who will continue their studies, it is the first introduction to many more SEM sessions.

This is reflected in the words of John Hastings, one of the honours students: "In the beginning of 2020, I started my Honours degree in Zoology with limited knowledge, but with a passion for microscopy. Due to Prof Basson's initiative in training the Honours class in preparing specimens for scanning electron microscopy, we were given the opportunity to learn under the guidance of Ms Hanlie Grobler of the Centre for Microscopy. I am grateful to Prof Basson for the opportunity to gain skills in this area of expertise. The assistance and enthusiasm of Ms Grobler, as well as her patience, to show the students how to use the SEM and then to provide each student with an opportunity to work on the SEM themselves, opened up a wonder world for all of us. It is now safe to say that this has become one of my favourite places to spend the day. This is not only a great escape from reality, but has also aided me in observing the finer surface details of the microorganisms (trichodinids) that I am working on. Due to the transparent nature of these organisms in their live state, these details cannot be observed through a compound microscope."



Zoology and Entomology honours students, Jade Hastings and Brandon Stuart, at the JEOL JSM-7800F SEM

RENOVATIONS

In November the Centre underwent expansions and renovations to accommodate the new equipment set to arrive in the first quarter of 2021. Special attention was given to the rooms that would house the new equipment, in order to meet their strict requirements such as, being magnetic field and vibration free. To achieve this a complete rewiring of the electrical cable and installation of a new foundation was needed.



Expansion and renovation of the hallway as seen from the main entrance



Preparation of the new foundation for the high resolution TEM.

USER SUPPORT

In November the Centre underwent expansions and renovations to accommodate the new equipment set to arrive in the first quarter of 2021. Special attention was given to the rooms that would house the new equipment, in order to meet their strict

requirements such as, being magnetic field and vibration free. To achieve this a complete rewiring of the electrical cable and installation of a new foundation was needed.

RESEARCH OUTPUTS

Research Articles

Krishnan, R., Menon, S., Lee, E., Welman, M. & Swart, H.C. 2020. Color tunable cathodoluminescence properties of RE_2WO_6: Ln^{3+} (RE, Ln= Er^{3+} and Tm^{3+}) phosphor and its microscopic imaging. *Materials Research Bulletin* 134.

Purcell, W., Sinha, M.K., Vilakazi, A.Q. & Nete, M. 2020. Selective precipitation study for the separation of iron and titanium from ilmenite. *Hydrometallurgy* 191: 105242.

Sinha, M.K., Purcell, W. & Van Der Westhuizen, W.A. 2020. Recovery of manganese from ferruginous manganese ore using ascorbic acid as reducing agent**.** *Minerals Engineering* 154: 106406.

STAFF (2020)

Director: Prof JJ Terblans

Junior Researcher/Lecturer: Mr E Lee
Senior Officer: Ms H Grobler
Assistant Officer: Ms P Nonkululeko



DISASTER MANAGEMENT

TRAINING AND EDUCATION CENTRE FOR AFRICA

CONTACT DETAILS

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OVERVIEW OF 2020

The Disaster Management Training and Education Centre for Africa (DiMTEC) focuses on 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. These are multidisciplinary programmes which are very high in demand, not only in South Africa but throughout Africa and beyond.

The 2020 academic year was very challenging due to the outbreak of COVID-19 and the various levels of national lockdown. This challenge put the resilience of DiMTEC and the whole University to the test, and DiMTEC staff were very active in the response to COVID-19, within the UFS structures, the Free State and nationally. As it was for the rest of the University, DiMTEC had to intensify the blended method of learning and teaching. We were very fortunate to have physically held the first contact session for the Post Graduate Diploma and the master's students in January 2020, and had held the block course with the United Nations University (UNU) in February 2020, before the national lockdown level 5 was implemented in March 2020. It was then relatively easy to continue teaching and learning online for the rest of the year.

Despite the impact of COVID-19, DiMTEC is proud to report that the academic year was completed without any major hiccup. The number of students for all the programmes increased compared to 2019. There were more publications in 2020 than in 2019 and one staff member, Olivia Kunguma, obtained her PhD; thus all the permanent academic staff of DiMTEC are PhD holders.

There were a various international engagements during 2020 – in person during the first two months of the year and thereafter switched to virtual engagements. A great deal of preparation was made to receive the first cohort of African students under the Intra Africa Mobility Grant Project.

DiMTEC also completed the Environmental Pulse survey organised by the UFS Department of Human Resources, in order to gauge the working environment at DiMTEC – with very good results.

Several strategic documents were completed in 2020 and the first revamped DiMTEC Advisory Board meeting was held in 2020.

All in all, 2020 was a good year for DiMTEC.

ACHIEVEMENTS

Olivia Kunguma obtained her PhD in Disaster Management.

ENGAGED SCHOLARSHIP

During the COVID-19 lockdown, DiMTEC staff members played their part in volunteering service and outreach. Dr Alice Ncube worked with non-governmental organisations (NGOs), such as Towers of Hope, Meals on Wheels Community Services Bloemfontein, and Anchor of Hope, to distribute food parcels to the vulnerable migrants and refugees in Bloemfontein, whose livelihoods were affected.

Dr Johannes Belle served on the Free State Provincial Joint Operation Centre (PROVJOC), that is responsible for the strategic planning for the management of COVID-19 in the Free State, and Dr Belle, Mr Sebastian Nyam and Miss Vallery Poto were among the first group of provincial volunteers to carry out contact tracing following the outbreak of COVID-19 at the The Divine Restoration Church in Bloemfontein.



At the national symposium on agricultural water management, hosted by DiMTEC on 24 November 2020, from the left, Emily Mathi (Agbiz), Chantel Ilbury (Mind the Fox), Prof Abdiodun Ogundeji (UFS Department of Agricultural Economics), and Prof Andries Jordaan IRésilience Globale Pty Ltd and DiMTEC)

NATIONAL AND INTERNATIONAL COLLABORATION

The block course on Disaster Risk Management for Sustainable Development, presented in collaboration with the United Nations University Institute for Environment and Human Security (UNU-EHS) and the Vrije Universiteit Amsterdam, was held at DiMTEC from 17 to 28 February 2020. The overall goal of the block course was to highlight the complexity and importance of vulnerability and resilience in the field of disaster management, development, and risk reduction. There has been a recent shift in focus to the Sendai Framework for Disaster Risk Reduction (SFDRR), the Paris Agreement, and the 2030 United Nations Agenda for Sustainable Development with the Sustainable Development Goals (SDGs). Activities as part of the course included lectures, group presentations, simulations, and field research addressing issues of community vulnerability and resilience.



2020 block course participants setting out to conduct a rapid vulnerability assessment at Caleb Motshabi informal settlement on the outskirts of the Mangaung Metropolitan Municipality

DiMTEC and the National University of Public Services (NUPS) in Budapest, Hungary have collaborated on Erasmus+ Mobility Programme since 2016. As part of the programme DiMTEC received Prof Agoston Restas as a guest presenter during the above-mentioned block course. He also visited the Nelson Mandela Bay Fire House and Disaster Management Centre.



From left, Mr Cedric Schmidt (Station Commander, South End Fire), Prof Agoston Restas (NUPS), Mrs Ronwyn Kelly (Leading Fire Fighter) and Mrs Germie Van Coppenhagen (UFS-DiMTEC Erasmus Coordinator)

The University of the Free State led by Dr Johanes Belle from DiMTEC, is part of a consortium of five African universities that were awarded the highly competitive Intra Africa Mobility grant sponsored by the European Union. Under the Fostering Research and Intra-African Knowledge transfer through Mobility and Education (FRAME) Project, the consortium was awarded 1.3 million Euros. This project will ensure cross-mobility of master's and doctoral students and staff within the African continent. FRAME focuses on the food, energy and water nexus and the UFS departments involved are DiMTEC, Agricultural Economics, and Soil, Crop and Climate Sciences. The consortium includes the Namibia University of Science and Technology (Namibia), University of the Free State (South Africa), Kwame Nkrumah University of Science and Technology (Ghana), University of Buea (Cameroon), Hawassa University (Ethiopia), and University of Twente (the Netherlands). Dr Belle attended the Kick off Meeting of the Intra Africa Academic Mobility Scheme in Brussel-Belgium from 6 to 7 February 2020.



Dr Johannes Belle and the FRAME team

POSTGRADUATE STUDENTS

The table below summarises the number of students for the three programmes offered at DIMTEC for 2019 and 2020.

Programme	Registered Students	
	2019	2020
PGDip	49	50
Master's	59	61
PhD	16	11

In 2020, 29 students graduated with the Post Graduate Diploma in Disaster Management and 16 with Master of Disaster Management, namely:

- Choche, MC
- Jansen, SM
- Khoza, M
- Kumang, MP
- Lunga, NE
- Makhubu, T
- Masinge, G
- Mohlala, MW
- Mohlakoana, DG
- Mokati, JTW
- Mothapo, MA
- Mpinke, B
- Nangula, SNN
- Nkgudi, MS
- Nxumalo, M
- Zungu, N

The PhD in Disaster Management was conferred on the following candidate:

Thinda, K.T
Thesis: Modelling land reform beneficiaries' choice of Disaster Risk Reduction and strategies in response to climate variation
Promoter: Prof A Ogundeji Co-promoter: Dr JA Belle

STAFF MATTERS

Dr Belle was appointed to the Senior Executive Group (SEG) of the UFS for the strategic planning and management of academic and other activities at the University following the COVID-19 lockdowns and declaration of the state of disaster in South Africa from March 2020.

RESEARCH OUTPUTS

Research Articles

Belle, J.A. & Gamedze, N.N. 2020. Behavioral factors contributing to the transmission of HIV and AIDS amongst young women of Mbabane in Swaziland. *African Health Sciences* 19(3): 1-3.

Belle, J.A., Saungweme, K.E. & Ojo, T.O. 2020. An evaluation of groundwater vulnerability to pollution in Ga-segonyana municipality area, Kuruman, Northern Cape in South Africa. *Groundwater for Sustainable Development* 1: 1-20. DOI: 10.1016/j.gad.2020.100389.

Emmanuel, E., Fogne Appiah, N., Agyemang, P., Abunde Neba, F., Nyam, Y.S., Ndip, G. & Ndam, D. 2020. Simplex Lattice Strength Optimization of Lime-micro Silica Stabilized Coir Fiber-reinforced Soil. *Journal of Natural Fibers* 1: 1-17.

Mlenga, D.H., Jordaan, A.J. & Mandebvu, B. 2020. Integrating standard precipitation index and normalised difference vegetation index for near-real-time drought monitoring in Eswatini. *Jamba-Journal of Disaster Risk Studies* 11: 1-9. DOI: 10.4120/jamba.v111.917.

Mnika, N., Chauque, M., Ncube, A., Jordaan, A., Boersma, K. & Szarzynski, J. 2020. Unity is strength: Gaining local perspectives on emergency response and disaster management in South Africa. *UNU-EHS 1 (1-5)*.

Ncube, A. 2020 Refugees and migrants in Bloemfontein, South Africa during the coronavirus pandemic: An update from Refugees in Towns (RIT). https://www.refugeesintowns.org/covid19.

Ncube, A., Bahta, Y.Y. & Jordaan A.J. 2020. Job Market Perceptions of African Migrant Women in South Africa as an Initial and Long-Term Coping and Adaptation Mechanism. *Journal of International Migration and Integration* 21(4): 1165-1185. DOI: 10.1007/s12134-019-00704-w.

Nyam, Y.S., Kotir, J. H., Jordaan, A. & Ogundeji, A. A. 2020. Identifying behavioural patterns of coupled water-agriculture systems using system archetypes. *Systems Research and Behavioral Science* 1-19. DOI: 10.1002/sres.2753.

Nyam, Y.S., Kotir, J.H., Jordaan, A.J., Ogundeji, A.A., Adetoro, A.A. & Orimoloye, I.R. 2020. Towards Understanding and Sustaining Natural Resource Systems through the Systems Perspective: A Systematic Evaluation. *Sustainability* 12(23): 9871.

Nyam, Y.S., Kotir, J.H., Jordaan, A.J., Ogundeji, A.A. & Turton, A.R. 2020. Drivers of change in sustainable water management and agricultural development in South Africa: a participatory approach. *Sustainable Water Resources Management* 6(4): 1-20.

Nyam, Y.S., Matthews, N. & Bahta, Y.T. 2020. Improving livelihoods of smallholder farmers through region specific strategies: a case study of South African sheep production. *Agrekon* 59(1): 1-15.

Orimoloye, I.R., Belle, J.A. & Ololade. O.O. 2020. Exploring the emerging evolution trends of disaster risk reduction research: a global scenario. *International Journal of Environmental Science and Technology* 1: 1-20. DOI: 10.1007/s13762-020-02847-1.

Orimoloye, I.R., Belle, J.A., Olusola, A.O., Busayo, E.T. & Ololade, O.O. 2020. Spatial assessment of drought disasters, vulnerability, severity and water shortages: a potential drought disaster mitigation strategy. *Natural Hazards* 105: 2735-2754. DOI: 10.1007/s11069-020-04421-x.

Orimoloye, I.R., Ekundayo, T.C., Ololade, O.O. & Belle, J.A. 2020. Systematic mapping of disaster risk management research and the role of innovative technology. *Environmental Science and Pollution Research* 1 (1 – 18). DOI: 10.1007/s11356-020-10791-3.

Thinda, K.T., Ogundeji, A.A., Belle, J.A. & Ojo, T.O. 2020. Determinants of relevant constraints inhibiting farmers' adoption of climate change adaptation strategies in South Africa. *Journal of Asian and African Studies* 1: 1-18. DOI: 10.1177/0021909620934836.

Thinda, K.T., Ogundeji, A.A., Belle, J.A. & Ojo. T.O. 2020. Understanding the adoption of climate change adaptation strategies among smallholder farmers; Evidence from land reform beneficiaries in South Africa. *Land Use Policy* 1: 1-10. DOI: 10.1016/j.landsepol.2020.104858.

Books/Chapters in Books

De Jager, A., Peláez, S., Belle, J.A., Blauhut, V., Krausmann, E., Nikolić, N., Pilli-Sihvola, K., La Notte, A. & Cortina, J. 2020. Environment and eco-system services. In: *Science for Disaster Risk Management 2020: acting today, protecting tomorrow*. A. Casajus Valles, M. Marin Ferrer, K. Poljanšek & I. Clark (Eds). Disaster Risk Management Centre, Publications Office of the European Union, Luxembourg. ISBN 978-92-76-18182-8, doi:10.2760/571085, JRC114026

Ncube, A. & Mkwananzi, F. 2020. Gendered Labour migration in South Africa: A capability approach lens. In: *Migration at Work: Aspirations, Imaginaries & Structures of Mobility*. F. Seiger, C. Timmerman, N. Salazar & J. Wets J. (Eds). Leuven University Press. pp. 65-90.

Orimoloye, I.R., Ololade, O.O. & Belle, J.A. 2020. Spatio-environmental distribution of drought disaster events: A space-based approach using Terra-MODIS Vegetation Index. In: *Remote Sensing Applications in Disaster Management*. R. Singh (Ed). UK, Taylor and Francis.

Conference Contributions

Conference Papers/Posters

Belle, J.A. 2020. *Climate Change and Preparedness.* Paper delivered at the Conference of the Institute of Risk Management (Virtual Conference). 17 November 2020.

Belle, J.A. 2020. *The application of Eco-DRR/CCA to build local resilience: a case study of Moolmanshoek Wetland; Free State Province in South Africa.* Paper delivered at the Conference of the Digital Global Summit of the Global Network for Disaster Risk Reduction (GNDR), (Virtual Conference). 6-22 October 2020.

Belle, J.A. 2020. *Migration in cross-cultural context: The case of covid-19 in South Africa.* Paper delivered at the 45th Natural Hazard and Applications Workshop. Natural Hazard Center, University of Colorado, USA. (Virtual Conference).12-15 July 2020.

Ncube, A. & Heunis, C. 2020. *The impact of the COVID-19 pandemic on tuberculosis and HIV/AIDS epidemic control programmes in South Africa: focus on Maluti-A-Phofung local municipality*. Paper delivered at The Global Mountain Sustainability Forum 2020: COVID-19 Sustainability and governance. (Virtual Conference). 506 Occtober 2020.

Nyahwo, M., Hlalele, B.M. & N. Ncube. 2020. *Investigating the socio-economic impacts of climate-induced drought risks on resettled women farmers in Mashonaland Central Province Zimbabwe.* Paper presented at the 5th International Electronic Conference on Water Sciences. (Online). 16-30 November 2020.

Nyam, Y.S. 2020. *Towards understanding the sustainability of agricultural systems in South Africa during a global pandemic. A system dynamics approach.* Paper delivered at the 8th Annual South African System Dynamics Conference (Virtual Conference). 18-19 November 2020

Nyam, Y.S., Kotir, J.H., Jordaan, A.J. & Ogundeji, A.A. 2020. *An application of participatory modelling approach for sustainable water resources management and agricultural development in the Breede River catchment Area.* Paper delivered at the 3rd Asia Pacific System Dynamics Conference in Brisbane, Australia. (Virtual Presentation). 2-4 February 2020.

Orimoloye, I.R., Belle. J.A. & Ololade, O.O. 2020. *Remote sensing of drought disaster events over Free State Province, South Africa.* Applied Geography Conference (Online). 18-20 October 2020.

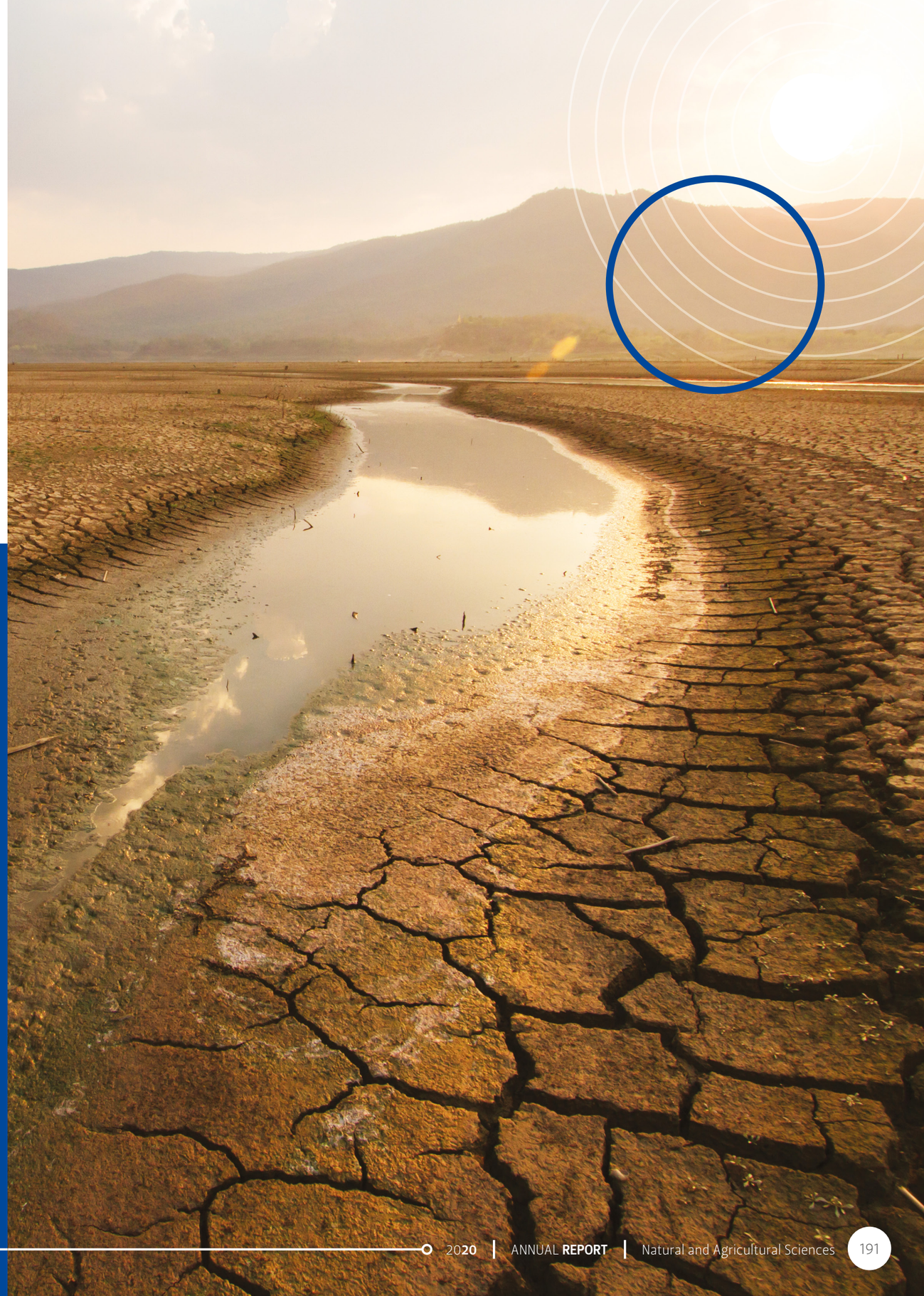
Orimoloye, I.R., Belle, J.A. & Ololade, O.O. 2020. *Space-based drought disaster risk and climate change assessments: Strategies for environmental conservation.* Paper delivered at the UNU Summer Academy on World Risk and Adaptation Futures: Social Protection, Bonn, Germany (Online) 21-25 September 2020.

STAFF (2020)

Head of Department: Dr JA Belle

Professors: Prof AJ Jordaan, Prof R Bragg (UFS affiliated), Prof B Grové (UFS affiliated) and Prof F Renaud (UFS affiliated)
Senior Lecturers: Dr JA Belle, Dr M Coetzee, Dr A Ncube, Dr C Barker (affiliated), Dr H Booysen (UFS affiliated) Dr E du Plessis (UFS affiliated), Dr B Falko (UFS affiliated), Dr M Khangale (affiliated), Dr T Kama (UFS affiliated), Prof A Ogundeji (UFS affiliated) and Dr M Tesfuhuney (UFS affiliated)

Lecturers: Ms O Kunguma, Ms L De Wet (UFS affiliated), Mr W Ellis (UFS affiliated), Dr N Matthews (UFS affiliated) and Mr M Serekoane (UFS affiliated)
Junior Lecturers: Mrs D Banyane, Ms M Joubert, Ms Z Poto, Ms L Nogabe (affiliated), Mr M Procter (affiliated)
Affiliated Professors: Prof A Ozuno, Prof F Renaud and Prof J Szarzynski
Programme Director: Dr JA Belle
Senior Assistant Officer: Dr A van Straten
Officer: Mrs G van Coppenhagen
Research Assistant: Mr YS Nyam
Auxiliary Staff: Ms CS Mkhafu



INSTITUTE FOR GROUNDWATER STUDIES

CONTACT DETAILS

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OVERVIEW OF 2020

The year 2020 was filled with huge challenges and difficulties due to the COVID-19 pandemic. Despite the circumstances, the Institute for Groundwater Studies (IGS) achieved substantial success in 2020.

ACHIEVEMENTS

Staff Achievements

Eelco Lukas successfully completed his PhD degree under the supervision of Prof Danie Vermeulen.



Dr Eelco Lukas

Student Achievements

The IGS Dux Prize for the Best MSc student in Geohydrology was awarded to Ms A Magingi, who achieved a final mark of 88%. The title of her dissertation was 'Modelling a conversion from confined to unconfined flow'. The prize-giving took place online.

RESEARCH AND INNOVATION

The IGS has a proud record of research over the past years. This is demonstrated by the number of postgraduate degrees awarded to students, as well as in the large number of published articles in accredited journals.

A number of independent specialists and researchers – including Dr Fanie de Lange, Mr Marius Smit, Mr Thomas Viljoen and PhD students Anton Lukas and Jean van Niekerk from IGS – in partnership with specialists from Carin Bosman Sustainable Solutions (CBSS), have been appointed by the Petroleum Agency of SA (PASA) to design a regional groundwater monitoring network for the Central Karoo. A 2016 report by the Council for Scientific and Industrial Research (CSIR) titled 'Shale Gas Development in the Central Karoo: A Scientific Assessment of the Opportunities and Risks', recommended that "a comprehensive understanding of groundwater conditions is required prior to the commencement of exploration to ensure proper interpretation of changes in groundwater over time. Monitoring data would also be used for calibration and verification of prediction and assessment models, for evaluating and auditing the success of management plans, and for assessing the extent of compliance with prescribed standards and regulations."

A monitoring network therefore needs to be established and implemented to ensure an understanding of baseline groundwater conditions in the Central Karoo. This project will establish a groundwater monitoring network that will cover an area of more than 180 000 sq km and will be undertaken over a period of 24 months. It will culminate in the publication of a regional groundwater monitoring network design for the Central Karoo, which will be subjected to local and international peer review. Once established, it will inform decision-making on the adjudication of applications for potential shale gas exploration activities received by PASA, and will also be used for future monitoring of groundwater in this area, irrespective of whether such applications are approved or not.

Selection of locations that will form part of the groundwater monitoring network will, to a large extent, be determined by the management questions that need to be addressed by the network. Therefore, once these management questions have been collected from stakeholders, the project team will undertake geohydrological, geophysical, and water-quality assessments to determine the suitability of existing boreholes to provide answers to prioritised management questions. Where no suitable boreholes can be found, recommendations relating to the drilling of additional boreholes for future monitoring purposes, will be made. The project team is therefore inviting suggestions from relevant decision-makers and interested stakeholders regarding any existing boreholes or network of boreholes in the Central Karoo, in order to ensure that these existing options can be investigated for inclusion in the monitoring network.



POSTGRADUATE STUDENTS

Our postgraduate degrees are designed to produce innovative students, competent researchers, and well-informed academics who can meaningfully contribute to the industry through their research expertise and comprehensive knowledge. Each year IGS receives an overwhelming number of applications, including from throughout Africa. In 2020 we enrolled 24 students at honours level, 52 MSc students and 21 PhD candidates.

During 2020, we awarded a total of 33 postgraduate degrees in Geohydrology, with 17 students receiving BSc Hons degrees, 14 MSc degrees, and two PhD degrees.

The following students obtained their master's degrees, four with distinction:

- Bengeza, Thandilizwe
- Combrinck, Andre
- Gerber, Andre Francois
- Gibson, Kirsty
- Kadhila, Alina Ndapewa Inekel'Omuwa
- Kennedy, Lizel (with distinction)
- Khoza, Mahatima Gandi (with distinction)
- Lukas, Anton (with distinction)
- Mabasa, Ntsako Alice (with distinction)
- Mpetle, Matsatsi
- Murray, Kes John
- Nomatiti, Putuma Siyasanga
- Thwala, Kedibone
- Van Wyk, Wilna Anet

The following doctoral students graduated:

Gomez Arias, Alba
Thesis: Hydrogeochemical assessment, water treatment and revalorization of dumps, tailings and drainages produced at Phalaborwa Industrial Complex
Promoter: Prof D Vermeulen

Lukas, Eelco
Thesis: Recharge flooding of collieries in South Africa
Promoter: Prof D Vermeulen

STAFF MATTERS

Dr Modreck Gomo was promoted to Associate Professor.

RESEARCH OUTPUTS

Research Articles

Abro, K., Qureshi, S. & Atangana, A. 2020. Mathematical and numerical optimality of non-singular fractional approaches on free and forced linear oscillator. *Nonlinear Engineering* (Online) 9(1): 449-456.

Allwright, A.J. & Atangana, A. 2020. Augmented upwind numerical schemes for a fractional advection-dispersion equation in fractured groundwater systems. *Discrete and Continuous Dynamical Systems-Series-S* 13(3): 443-466.

Atangana, A. 2020. Extension of rate of change concept: From local to nonlocal local operators with applications. *Results in Physics* 19: 103515-1-103515-52.

Atangana, A. 2020. Fractional discretization: The African's tortoise walk. *Chaos Solitons & Fractals* 130: 109399-1-109399-24.

Atangana, A. 2020. Modelling the spread of COVID-19 with new fractal-fractional operators: Can the lockdown save mankind before vaccination? *Chaos Solitons & Fractals* 136: 109860-1-109860-38.

Atangana, A. & Akgul, A. 2020. Can transfer function and Bode diagram be obtained from Sumudu transform. *Alexandria Engineering Journal* 59(4): 1971-1984.

Atangana, A., Akgul, A. & Owolabi, K. 2020. Analysis of fractal fractional differential equations. *Alexandria Engineering Journal* 59(3): 1117-1134.

Atangana, A. & Araz, S. 2020. Extension of Atangana-Seda numerical method to partial differential equations with integer and non-integer order. *Alexandria Engineering Journal* 59(4): 2355-2370.

Atangana, A., Bouallegue, G. & Bouallegue, K. 2020. New multi-scroll attractors obtained via Julia set mapping. *Chaos Solitons & Fractals* 134: 109722-1-109722-11.

Atangana, A. & Goufo, E. 2020. Cauchy problems with fractal-fractional operators and applications to groundwater dynamics. *Fractals* 28(8): 2040043-1-2040043-21.

Atangana, A. & Goufo, E. 2020. Some misinterpretations and lack of understanding in differential operators with no singular kernels. *Open Physics* 18(1): 594-612.

Atangana, A. & Jain, S. 2020. Models of fluid flowing in non-conventional media: new numerical analysis. *Discrete and Continuous Dynamical Systems-Series-S* 13(3): 467-484.

Atangana, A., Khan, M.A. & Fatmawati, F. 2020. Modeling and analysis of competition model of bank data with fractal-fractional Caputo-Fabrizio operator. *Alexandria Engineering Journal* 59(4): 1985-1998.

Atangana, E. & Atangana, A. 2020. Facemasks simple but powerful weapons to protect against COVID-19 spread: Can they have sides effects? *Results in Physics* 19 (article 103425).

Atangana, E., Chiweshe, T.T., Oberholster, P.J. & Deysel, L. 2020. Evaluation of the absorbance capacity of elements in meat effluent, and their mathematical models by using shrimp chitosan cross-linked glutaraldehyde. *Alexandria Engineering Journal* 59(4): 2567-2574.

Atangana, E., Oberholster, P.J., Chiweshe, T.T. & Deysel L. 2020. Polysaccharides based adsorbent used for the assessment and modeling of metals ions in Olifant's River Catchment, South Africa. *Journal of Polymers and the Environment* 28: 3079-3109.

Chaharpashlou, R., Saadati, R. & Atangana, A. 2020. Ulam–Hyers–Rassias stability for nonlinear Ψ -Hilfer stochastic fractional differential equation with uncertainty. *Advances in Differential Equations* Article 339: 1-10.

Chiweshe, T.T., Atangana, A. & Deysel, L. 2020. Determination on the stability of Osmium(VI) Hexachloride ICP-OES Standards in HCl Acid Matrix. *Bulletin of the Chemical Society of Ethiopia* 34(1): 193-202.

Ghanbari, B. & Atangana, A. 2020. A new application of fractional Atangana–Baleanu derivatives: Designing ABC-fractional masks in image processing. *Physica A-Statistical Mechanics and its Applications* 542: 123516-1-123516-25.

Ghanbari, B. & Atangana, A. 2020. An efficient numerical approach for fractional diffusion partial differential equations. *Alexandria Engineering Journal* 59(4): 2171-2180.

Ghanbari, B. & Atangana, A. 2020. Some new edge detecting techniques based on fractional derivatives with non-local and non-singular kernels. *Advances in Difference Equations* Article 435: 1-19.

Gomo, M. 2020. Effects of Artefacts on Natural Gradient Single-Borehole Tracer Dilution Tests. *Natural Resources Research* 29(3): 2227-2235.

Gomo, M. 2020. On the practical application of the Cooper and Jacob distance-drawdown method to analyse aquifer-pumping test data. *Groundwater for Sustainable Development* 11: 100478-1- 1004788.

Goufo, E. & Atangana, A. 2020. Dynamics of traveling waves of variable order hyperbolic Liouville equation: Regulation and Control. *Discrete and Continuous Dynamical Systems - Series S* 13(3): 645-662.

Ibrahim, K.O. Gomo, M., Oke, S. & Yusuf, M. 2020. A new method for estimating hydraulic conductivity in un-screened concrete-lined large-diameter hand-dug wells. *Groundwater for Sustainable Development* 11: 100443-1-100443-10.

Janecke, B.B., Van Tol, J.J., Smit, I., Van Aardt, A.C., Riddell, E., Seaman, MT., Swart, W.J., Du Preez, P.J. & Le Roux, P.A.L. 2020. Biotic and abiotic connections on a granitic catena: Framework for multidisciplinary research. *KOEDOE* 62(2): a1600-1-a1600-11.

Kachhia, K. & Atangana, A. 2020. Electromagnetic waves described by a fractional derivative of variable and constant order with non singular kernel. *Discrete and Continuous Dynamical Systems-Series S*: 1-15. DOI: 10.3934/dcdss.2020172

Khan, M.A. & Atangana, A. 2020. Modeling the dynamics of novel coronavirus (2019-nCov) with fractional derivative. *Alexandria Engineering Journal* 59(4): 2379-2389.

Khan, M., Atangana, A., Alzahrani, R. & Fatmawati, F. 2020. The dynamics of COVID-19 with quarantined and isolation. *Advances in Difference Equations* 425-1-425-22.

Kumar, S. & Atangana A. 2020. A numerical study of the nonlinear fractional mathematical model of tumor cells in presence of chemotherapeutic treatment. *International Journal of Biomathematics* 13(3): 2050021-1-2050021-17.

Ligavha-Mbelengwa, L. & Gomo, M. 2020. Investigation of factors influencing groundwater quality in a typical Karoo aquifer in Beaufort West town of South Africa. *Environmental Earth Sciences* 79 (article196).

Mukhwathi, U. & Fourie, F.D. 2020. The influence of angled survey lines on 2D ERT surveys using the Wenner (α) array with implications for groundwater exploration in Karoo rocks. *Journal of African Earth Sciences* 168: 103875-1-103875-10.

Mwetulundila, A. & Atangana, A. 2020. Applying the Forchheimer equation to model an artificially recharged fractured aquifer. *Alexandria Engineering Journal* 59(4): 2115-2130.

Owolabi, K.M., Atangana, A. & Akgul, A. 2020. Modelling and analysis of fractal-fractional partial differential equations: Application to reaction-diffusion model. *Alexandria Engineering Journal* 59(4): 2477-2490.

Panda, S., Karapinar, E. & Atangana, A. 2020. A numerical schemes and comparisons for fixed point results with applications to the solutions of Volterra integral equations in dislocated extended b - metric space. *Alexandria Engineering Journal* 59(2): 815-827.

Qureshi, S. & Atangana, A. 2020. Fractal-fractional differentiation for the modeling and mathematical analysis of nonlinear diarrhea transmission dynamics under the use of real data. *Chaos Solitons & Fractals* 136: 109812-1-109812-14.

Riaz, M., Atangana A. & Abdeljawad, T. 2020. Local and Nonlocal Differential Operators: A comparative study of heat and mass transfers in MHD Oldroyd-B fluid with ramped wall temperature. *Fractals* 28(8): 2040033:1-2040033:20.

Riaz, M.B., Siddiqui, I., Saeed, S. & Atangana, A. 2020. MHD Oldroyd-B Fluid with Slip Condition in view of Local and Nonlocal Kernels. *Journal of Applied and Computational Mechanics* 6(S1): 1540-1551.

Singh, D., Sultana, F., Pandey, R. & Atangana, A. 2020. A comparative study of three numerical schemes for solving Atangana–Baleanu fractional integro-differential equation defined in Caputo sense. *Engineering with Computers* 2020: 1-20.

Swart, W.J. & Seaman, M.T. & Le Roux, P.A.L. & Janecke, B.B. 2020. A tribute to Frederick (Fred) J. Kruger. *KOEDOE* 62(2): a1639-1.

Sweilam, N., Al-Mekhlafi, S., Assiri, T. & Atangana, A. 2020. Optimal control for cancer treatment mathematical model using Atangana–Baleanu–Caputo fractional derivative. *Advances in Difference Equation* Article 334: 1-21.

Books/Chapters in Books

Books

Hemen, D., Shmet Ocak, A. & Atangana, A. (Eds). 2020. *Fractional Order Analysis: Theory, Methods and Applications*. New York, Hoboken: John Wiley & Sons, Inc.

Chapters in Books

Atangana, A. & Akgul, A. 2020. Analysis of New Trends of Fractional Differential Equations. In: *Fractional Order Analysis: Theory, Methods and Applications*. D. Hemen, A. Ahmet Ocak & A. Abdon (Eds). New York, Hoboken: John Wiley & Sons, Inc. pp. 91-111.

Riaz, M.B., Atangana, A. & Saeed, S. 2020. MHD-free Convection Flow Over a Vertical Plate with Ramped Wall Temperature and Chemical Reaction in View of Nonsingular Kernel. In: *Fractional Order Analysis: Theory, Methods and Applications*. D. Hemen, A. Ahmet Ocak & A. Abdon (Eds). New York, Hoboken: John Wiley & Sons, Inc. pp. 253-282.

Conference Contributions

Conference Proceedings

Lourens, P.J.H., Erasmus, M., Hansen, R.N. & Allwright, A.J. 2020. Groundwater Nitrate Bioremediation of a Fractured Rock Aquifer System in South Africa. In*: Proceedings of the postponed 14th. International Mine Water Association (IMWA) Congress – Mine Water Solutions,* Christchurch, New Zealand, 9-13 November 2020. J. Pope, C. Wolkersdorfer, L. Sartz, A. Weber & K. Wolkersdorfer (Eds). IMWA. pp. 140-145.

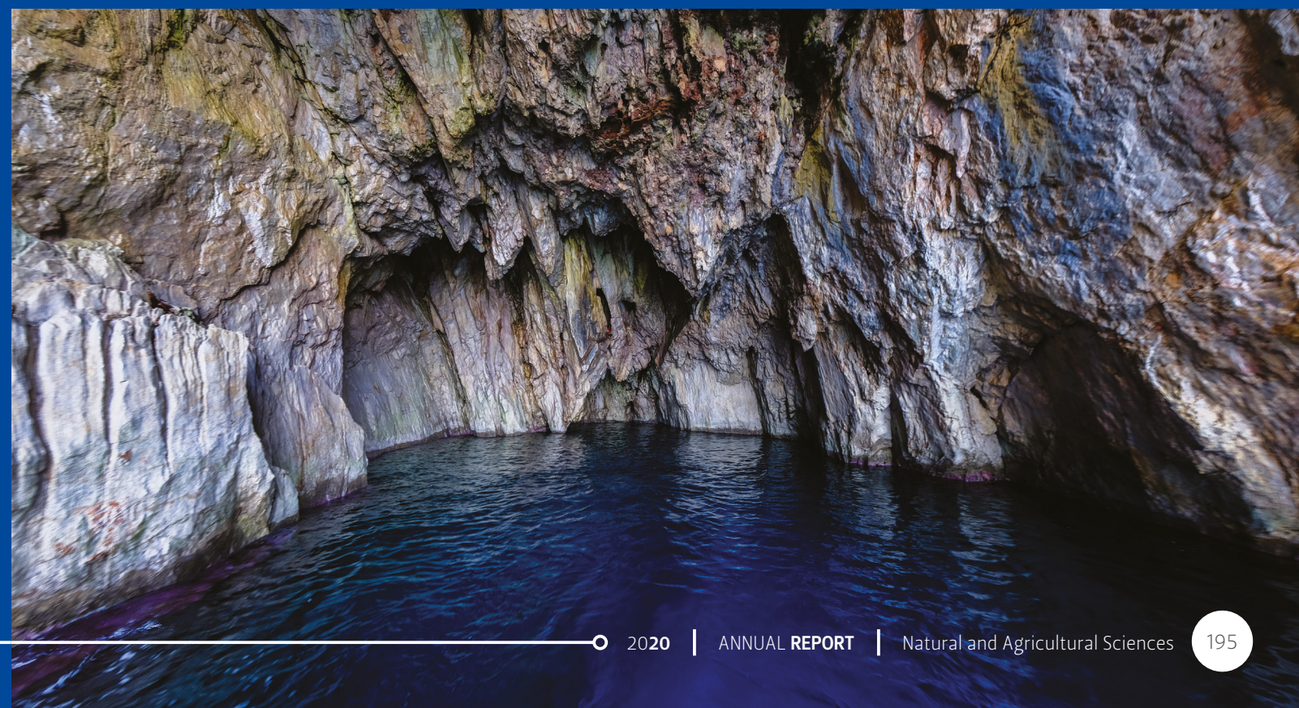
STAFF (2020)

Director: Dr E Lukas

Professor: Prof A Atangana
Associate Professor: Prof M Gomo
Senior Lecturer: Dr F Fourie
Lecturers: Dr SS de Lange and Mr PJH Lourens
Lecturer: Dr A Allwright.
Affiliate Associate Professor: Prof KT Witthüser
Affiliated Researcher: Prof JF Botha

Academic Manager: Dr A Allwright
Chief Officer - Financial Manager: Mrs L Rust
Officer - Professional Services: Mrs A Rossouw
Messenger/Cleaner: Mrs P Mosala

IGS Laboratory:
Deputy Director (IGS Laboratory): Dr L-M Deysel.
Officer: Ms WC Geyer and Ms Letebele
Senior Officer: Mrs N Koagile
Junior Assistant Analyst: Ms A Hadebe and Ms B Moruri
Assistant Officer: Dr T Hill
Cleaner: Mrs X Adoons



PARADYS EXPERIMENTAL FARM

DEPARTMENT OF ANIMAL SCIENCE

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OVERVIEW OF 2020

2020 has been one of our most challenging years due to COVID-19 and lockdown regulations; however, the Paradys Experimental Farm managed to perform exceedingly well. We were fortunate to be classified as an essential service and continued with our daily activities. Though we could present fewer farmers' days and student practicals, we were able to focus more on the research and farming aspects of the farm.

Construction commenced on the brewery facility, cheese factory, and container park for offices and laboratories. These projects should be completed early in 2021 and will add another dimension to the farm's activities.

The farm also acquired 100 pregnant Dohne merino ewes for the wool project and the start of the Dohne Merino flock on the farm. The ewes lambed during October, adding another 98 animals. The South African Mutton Merino (SAMM) flock was placed under the magnifying glass and only the best animals were mated; these ewes will lamb during the UFS recess period.

The Afrikaner stud had a conception of 88% and the commercial group a conception of 86%. The dairy had a very fruitful year as our herd produced 14 heifers for replacement stock and seven bulls, that were sold to farmers as breeding and oxen stock.

We managed to produce over 17 000 bales of teff, and due to this bountiful harvest we donated a portion of our bales to the farmers affected by the devastating fires in the western part of the Free State.



Teff bales donated to farmers in the Herzogville area

We also had a fire on the farm, resulting in the loss of 520 hectares. The surrounding farming community and local Fire Department assisted in preventing further loss of property.



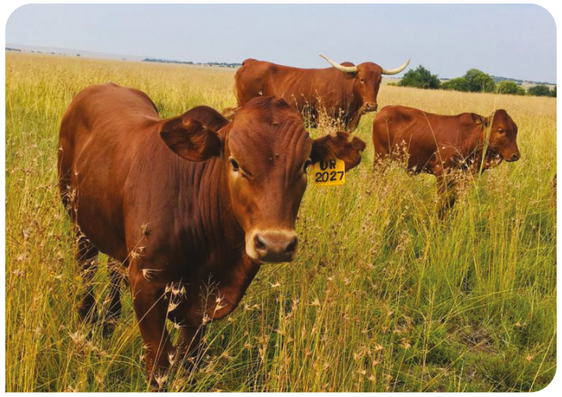


Fire and fire damage on Paradys

RESEARCH AND INNOVATION

The collection of data on the Afrikaner cattle breed continued in the following areas:

- Fertility: The age at which the animals reach puberty and the average fertility of the herd as a whole are recorded.
- Growth: As the production system is based on an ox production system, the animals are weighed regularly to analyse the quality and quantity of veld-fed beef. The animals are also given various types of production lick to determine the effect this has on their growth and feed conversion, as well as their gestation period.
- DNA sampling: DNA is collected from all the animals born on the farm, as part of the national Afrikaner Cattle Breeder's Society, to determine certain genetic markers for growth, milk quality and quantity, weaning weight, maternal and reproductive traits.
- Genetic baseline: The Afrikaner herd on the farm also acts as a genetic baseline for the Afrikaner breed as they are genetically diverse and well-adapted to the environment. Animals that were sold from Paradys have adapted extremely well to other areas of the country, which in itself is a rare occurrence.
- Crossbreeding: During the past four years, the Afrikaner maternal line has been crossbred with Simmentaler and Simbra in order to get a terminal breed, called the Afrisim, that increases the weaning weight and provides an alternative market for selling wearers to feedlots. Currently we are using an Angus bull as part of our terminal crossbreeding plan and the opportunity to breed some Afrikus cattle.
- Selective breeding: The main herd has been selectively bred, using excellent bull stock, to improve the genetic composition of the herd and especially the birth-weight and weaning weight of calves (higher weights) – thereby ensuring optimal producing animals.





Cattle that form part of the Afrikaner stud

In terms of the dairy herd, the following data was collected:

- Fertility: Data on the mating of heifers and cows using artificial insemination (AI) was collected, thus ensuring a good inter-calving period and outstanding genetics.
- Feed to milk conversion: This involved collecting data on the feeding of production animals for cost-effective milk production.
- Feeding of calves for early weaning and rapid growth.

Data on feeding trials on cattle and sheep included:

- Feeding of weaned lambs: Different types of feed are tested on the lambs, for feedlot purposes, to research the effect they have on the growth of the animals and feed conversion (amount of weight gained / amount of feed ingested).
- Feeding of bulls for slaughter: Data was collected to research the economic viability of feeding Afrikaner bulls for slaughter and determining their feed conversion.
- Lick supplementation: Animals are given various types of production lick to research the effect they have on the animals' growth and condition, and to determine the economic viability of supplementing lick during the winter.

Data on crop production trials included:

- Planted pastures (irrigation): Various types of perennial grasses have been planted to research the production potential under irrigation of the grass and dry matter production.
- Planted pastures (dry land): Various types of perennial grasses have been planted to research the production potential of the grass in normal rainfall areas and as a method of improving the natural veld's fodder flow.
- Dry land production of teff, sorghum, oats, and wheat for effective fodder production under various plant population densities.





Planted oats and maize

ENGAGED SCHOLARSHIP

Paradys Experimental farm was involved in various activities and initiatives aimed at training for the community. All COVID-19 regulations (such as screening, sanitising and masks) were strictly adhered to, and attendees were divided into small groups to ensure social distancing. Training initiatives in 2020 included:

- The correct handling of animals: Showing and illustrating the correct manner in which to handle animals without causing stress or injury.
- Breeding goals: Determining the type of production system needed and then advising on the best possible breed and breeding plan to use in order to achieve it.
- Vaccinations of animals: Training people on the correct manner in which to vaccinate and the type of vaccinations to be administered.
- Branding and marking of animals: Training people on the correct manner and way of marking and branding animals.
- Stockmanship: Training people to improve farming with and producing livestock.
- Practical days for schools: Schools visit the farm to familiarise the learners with the practical aspects of farming and the farming industry.
- Short courses: In 2020 a short course on faecal egg count was presented to small stock farmers.

Although fewer farmers' days than usual could be presented, we still managed to organise some on the farm for the general public and students to create awareness and provide information about certain goods and services, and marketing. In 2020, due the restrictions as a result of COVID-19, presentations were more focused on students, who attended the practical sessions as part of their academic training. These sessions included topics such as:

- Lucerne (crop for cultivated pastures)
- Pig production
- Branding of animals
- Agricultural engineering (irrigation systems)
- Feed catalogue (various feeds and supplying companies)
- Animal health week

STAFF (2020)

Farm Manager: Mr J Barnard
Lecturer: Mr L Kruger
Research Assistants: Mr B Madyibi, Mr OM Mavhungu and Mr NN Mkhonza
Assistant Officer: Ms AM Smith
Farm Workers: Mr MA Khoele, Ms MA Kubheka, Mr TF Kubheka, Mr LE Maqala, Mr PM Morirhela, Mr YS Motswari, Mr KP Ramatekoane, Ms EM Sebonyane and Mr PM Somi



ACADEMIC
SUPPORT DIVISIONS

ELECTRONICS DIVISION

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OVERVIEW OF 2020

The year 2020 started promisingly, but soon took a turn with the outbreak of COVID-19 and the imposed lockdown that followed. About ten days into the lockdown we were informed that there were essential services to be performed and we received permission to partially re-open with limited personnel, according to regulations. As Head of the Division, I would like to make use of this opportunity to formally thank the personnel of the Electronics Division, who assisted me, for their selfless assistance to the Instrumentation Division during these trying times.

The University had to comply with COVID-19 protocols for returning staff and students, and hundreds of sanitiser stands, holders and screens had to be built and installed on all three campuses. By the beginning of May most of the personnel were allowed to return, with altered hours to accommodate all. After the personnel returned, the year continued in a more normal way. However, compared to 2019, during 2020 we lost 1 273 possible working hours as a result of COVID-19.

WORK ACTIVITIES

A total of 346 work requisitions were received in 2020, representing 1 418 pieces of apparatus. Sixteen (16) of these requisitions were for development and installation projects. Some were new and others were extensions of existing systems, as well as upgrading of older systems, as indicated in Table 2. Of a possible 5 481 working hours (based on 7.5 hours per day per person present), 5 435 were actively used (i.e. 99.2%).



Mark Jackson

Table 1 below illustrates the time spent on work for the 40 departments and divisions which made use of the services of the Electronics Division in 2020 (in descending order of the department for whom most time was spent).

Table 1: Use made of the Electronics Division by departments and divisions (2020)

Client	Total Time Spent (Hours)	% Time Spent
Physics	756	13.91%
Soil, Crop and Climate Sciences	619	11.39%
Chemistry	556	10.23%
Biotechnology	451	8.30%
Internal Administration	390	7.18%
Animal Science	380	6.99%
External Work	358	6.59%
Qwaqwa Campus	207	3.81%
Institute for Groundwater Studies (IGS)	197	3.62%
Protection Services	189	3.48%
Centre for Microscopy	174	3.20%
Engineering Sciences	173	3.18%
Plant Sciences	166	3.05%
Electronics Division	129	2.37%
University Estates	92	1.69%
Mathematics and Applied Mathematics	92	1.69%
Instrumentation Division	91	1.67%
Office of the Dean	55	1.01%
Zoology and Entomology	54	0.99%
Facilities Air-conditioning & Technical	51	0.94%
South African Doping Control Laboratory (SADoCoL)	43	0.79%
Kovsie Act	33	0.61%
Medical Virology	30	0.55%
Faculty of Health Sciences	24	0.44%
Geography	19	0.35%
Geology	19	0.35%
Industrial Psychology	16	0.29%
Sport Science	15	0.28%
Drama & Theatre	14	0.26%
Computer Science and Informatics	11	0.20%
Agricultural Economics	6	0.11%
Architecture	5	0.09%
Medical Physics	5	0.09%
School of Biomedical Sciences	3	0.06%
Flippie Groenewoud	3	0.06%
Finances	2	0.04%
Genetics Centre for Environmental Management (CEM)	2	0.04%
Urban and Regional Planning	2	0.04%
Postal & Documentation	2	0.04%
Housing & Residence Affairs	1	0.02%
Total	**5 435**	**100.00%**

A total of 1 264 hours were spent on development (23.25%), 3 781 hours on maintenance (69.57%), and 390 hours on administration (7.18%).

Work for the Faculty of Natural and Agricultural Sciences amounted to 4 554 hours (83.8%), while 881 (16.2%) hours were spent on work for departments/divisions outside the Faculty.

Table 2 below provides information on the projects completed in 2020 per department/division.

Table 2: Completed projects (2020)

Department/Division	Apparatus
Soil, Crop and Climate Sciences	6 x Rainfall loggers 4 x Assess control expansions 1 x Security system at Kenilworth Experimental Farm 1 x Extraction system for drying cabinets
Institute for Groundwater Studies	4 x Access control expansions 1 x Camera system
Zoology and Entomology	1 x Dual video intercom system installation 1 x Access control
Animal Sciences	1 x Time and attendance system
Centre for Microscopy	15 x Maglocks
Chemistry	3 x Access control expansions
Computer Science and Informatics	1 x Eye tracker
Office of the Dean	1 x Upgrade to CCTV System
Physics	1 x Ball miller
South Campus	1 x Panic security system
University Estates	1 x Installation of new security barriers

By the end of 2020, there was one unfinished project – Electrolysis apparatus for the Department of Chemistry



Innes Basson



Adriaan Hugo

STAFF (2020)

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

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OVERVIEW OF 2020

The Instrumentation Division had a challenging year as a result of COVID-19. We were faced with challenges such as being understaffed and personnel contracting the virus. The Division was nevertheless able to build a prickly pear cutter for agriculture. This machine cuts the prickly pear leaves into small pieces which are then used as animal feed. In addition, a fine seed planter was built for the Paradys Experimental Farm.

Sanitiser stands and screens were designed and built for all three campuses in preparation for the return of personnel and students. (Refer to Table 2 below for the amounts).

The income for the year amounted to R1 371 266 and we were able to repay an amount of R605 000 on our University loan. As a Division we worked tirelessly to replenish our stock levels and used our resources (time and funds) to repair faulty equipment and build essential new equipment.

The Division is thankful to the University as our primary client, as well as the various departments for their continued support.

WORK ACTIVITIES

A total of 286 work requisitions were received in 2020, 17 of which were for development projects. Some were new and others were extensions of existing instruments, as well as the upgrading of older instruments – as reflected in Table 2.

Table 1 below illustrates the time spent on work for the 33 departments which made use of the services of the Instrumentation Division in 2020.

Table 1: Use made of the Instrumentation Division by departments and divisions (2020)

Department/Division	Total Time Spent (Hours)	% Time Spent
Physics	786	15.44%
University Estates	753	14.79%
Animal Sciences	499	9.80%
External Work	455	8.94%
Chemistry	403	7.92%
Internal Administration	390	7.66%
Kovsie Act	259	5.09%
Instrumentation Division	226	4.44%
Soil, Crop and Climate Sciences	174	3.42%
Biotechnology	166	3.26%
Institute for Groundwater Studies (IGS)	150	2.95%
Computer Science and Informatics	110	2.16%
National Control Laboratory (NCL)	84	1.65%
Geology	64	1.26%
Zoology and Entomology	63	1.24%
Facilities Air-conditioning and Technical	52	1.02%
Student Training	48	0.94%
Centre for Environmental Management (CEM)	47	0.92%
South African Doping Control Laboratory (SADoCoL)	39	0.77%
Fine Arts	38	0.75%
Medical Virology	38	0.75%
Plant Sciences	36	0.71%
Office of the Dean	35	0.69%
Genetics	33	0.65%
Centre for Microscopy	32	0.63%
Drama and Theatre	30	0.59%
Electronic Division	28	0.55%
Consumer Sciences	24	0.47%
Sport Sciences	11	0.22%
Protection Services	10	0.20%
Pharmacology	3	0.06%
Animal Research Centre	2	0.04%
Geography	2	0.04%
Total	**5 090**	**100.00%**

Work for the Faculty of Natural and Agricultural Sciences amounted to 4 635 hours (91%), while 455 (9%) hours were spent on work for departments/divisions outside the Faculty.

The table below provides a list of the completed projects in 2020 per department/division.

Table 2: Completed projects (2020)

Department/Division	Apparatus
Physics	3 x UV-Vis sample holders 4 x Sets of sample holders 1 x 60” Mounting frame 1 x Thin film sample holder 1 x 60” Collimator
Animal Sciences	1 x Rhino blood pressure simulator 1 x Rebuild seed planter 1 x Rebuild tipper wagon
Soil, Crop and Climate Sciences	1 x Rebuild poison sprayer 1 x Prickly pear leaf cutter
University Estates	483 x Foot sanitizers 382 x Perspex screens 428 x Wall mount sanitizer holders
Biotechnology	10 x Pipette holders
Plant Sciences	24 x PVC columns
Chemistry	1 x Electrolysis apparatus
Computer Science and Informatics	1 x Eye tracker
Institute for Groundwater Studies	1 x Bailer
National Control Laboratory	1 x Stainless steel shelving



Lucas Odendaal with the sanitizers developed for the University



Wicus Storm with the poison sprayer built for the Department of Soil, Crop and Climate Sciences



Prickly pear leaf cutter built for the Department of Soil, Crop and Climate Sciences

The unfinished projects at the end of 2020, are listed in Table 3 below.

Table 3: Unfinished projects (2020)

Department/Division	Apparatus
Kovsie Act	10 x Eco cars
Physics	1 x Instrument lift
Soil, Crop and Climate Sciences	1 x Maize stalk cutter



Barry Crous and Mark Jackson building the Eco car for Kovsie Act

STAFF (2020)

Head of Division: Mr AB Hugo

Assistant Head: Mr BJ Crouse
Control Technicians: Mr MJ Kruger, Mr L Odendaal and Mr JPW Rautenbach
Technical Assistant: Mr WJR Storm, Mr K Zacarias
Technical Aide: Mr L Mokoena
Secretary: Ms A Kasper (shared with the Electronics Division)

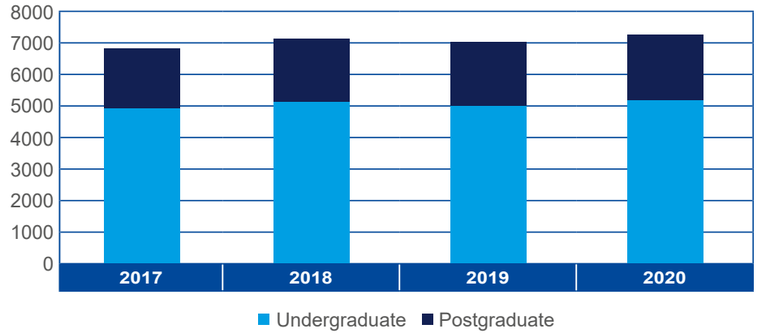


FACULTY STATISTICAL

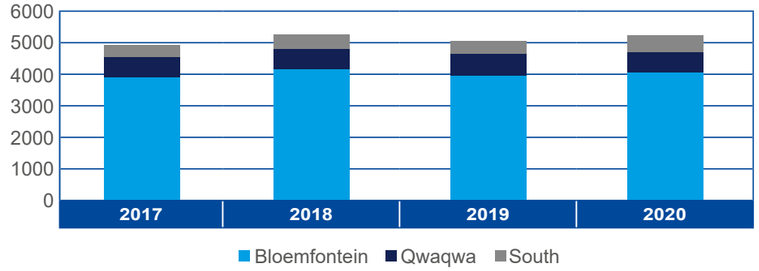
DATA

STUDENT STATS

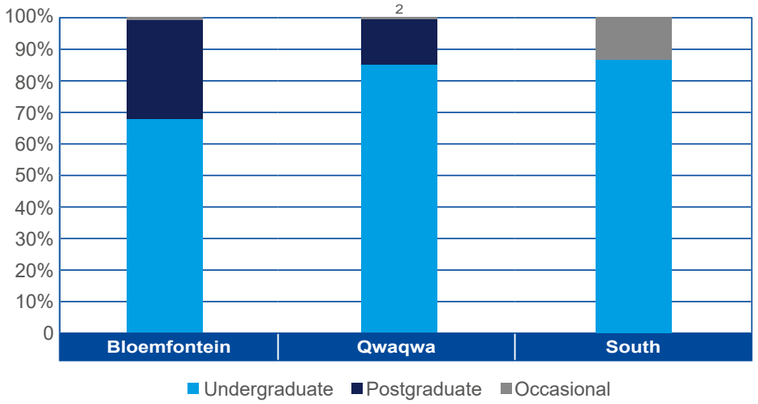
REGISTRATIONS BY STUDY LEVEL (2017 – 2020)



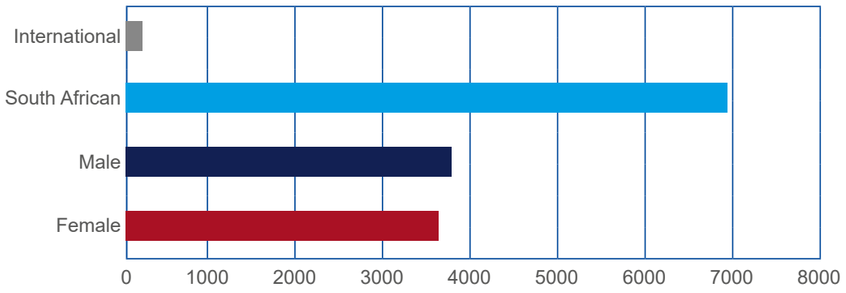
UNDERGRADUATE REGISTRATIONS BY CAMPUS (2017 – 2020)



TOTAL REGISTRATIONS PER CAMPUS BY LEVEL OF STUDY (2020)



STUDENT NUMBERS BY NATIONALITY AND GENDER (2020)



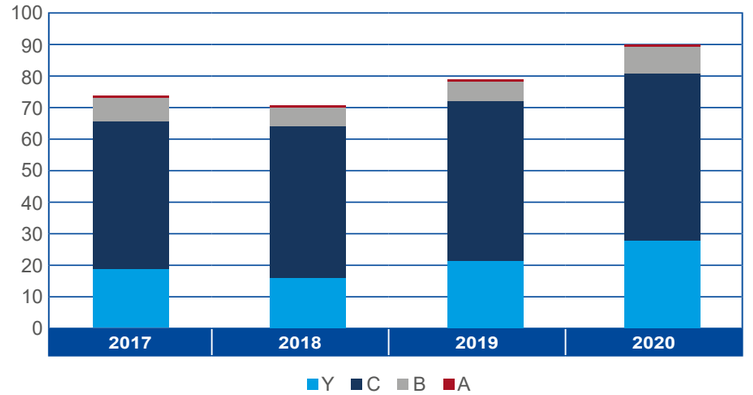
STUDENT STATS

GRADUATIONS BY QUALIFICATION LEVEL (2017 – 2020)

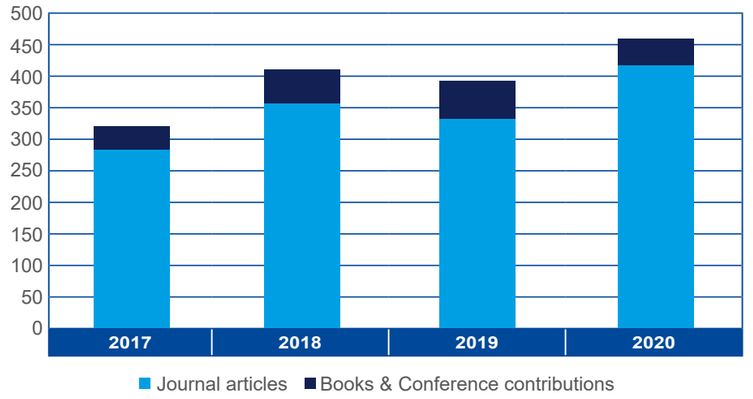
	2017	2018	2019	2020
Total Undergraduate	734	878	844	951
Total Postgraduate	717	842	853	723

RESEARCH STATS

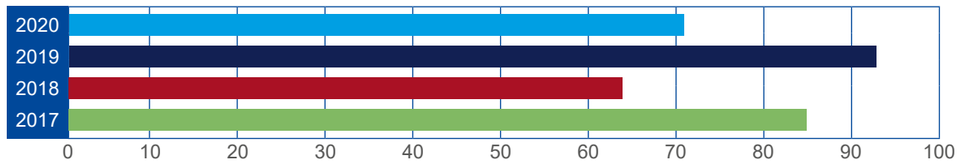
NRF RATED RESEARCHERS (2017 – 2020)



RESEARCH OUTPUTS (2017 - 2020)



POSTDOCTORAL RESEARCH FELLOWS (2017 - 2020)



ACRONYMS

LIST OF ACRONYMS

0 - 9

4IR	Fourth Industrial Revolution

A

AB InBev	Anheuser-Busch InBev
ACCESS	Alliance for Collaboration on Climate and Earth System Science
ADM	Agricultural derivatives market
ADRI	Agricultural Drought Resilience Index
AE	Absolute Extensors
AEE	Association of Energy Engineers
AEMG	Applied and Environmental Microbiology Group
AERC	African Economic Research Consortium
AFMA	Animal Feed Manufacturers Association
AfRota	Antigens and Reassortant strains for rotaviruses circulating in Africa
AFTA	Animal Food Manufacturers Association
AHCI	Agriculture Human Capital Investment Study
AI	Artificial insemination
AJFAND	African Journal of Food, Agriculture, Nutrition and Development
AMD	Acid Mine Drainage
AP	Admission Point
APECSSA	Association of Polar Early Career Scientists of South Africa
APN	African Peacebuilding Network
AR	Absolute Retracts
ARC	Agricultural Research Council
ARC-GC	Agricultural Research Council-Grain Crops
ARC-SG	Agricultural Research Council-Small Grain
ARNTD	African Research Network for Neglected Tropical Diseases
ARU	Afromontane Research Unit
ASCOSA	Association of Schools of Construction of Southern Africa
ASSA	Actuarial Society of South Africa
ASSAf	Academy of Scientists of South Africa

B

BAgric	Bachelor of Agriculture
BArch	Bachelor of Architecture
BArchHons	Bachelor of Architecture Honours
BCI	Brain-Computer Interface
BfR	Bundesinstitut für Risikobewertung/Federal Institute for Risk Assessment
BIOGRIP	Biogeochemistry Research Infrastructure Platform
BIUST	Botwana International University of Science and Technology
BRICS	Brazil, Russia, India, China and South Africa
BSc	Bachelor of Science
BSc (Agriculture)	Bachelor of Science in Agriculture
BSL2	Biosafety Level 2
BTG	Bridge the Gap

C

CA	Conversational agent
CASS	Chinese Academy of Social Sciences
CAZymes	Carbohydrate-Active Enzymes
CBC	Centre for Biological Control
CBSS	Carin Bosman Sustainable Solutions
CCDC	Cambridge Crystallographic Data Centre
CDDE	Centre for Digital and Data Engineering
CDS	Centre for Development Support
CEM	Centre for Environmental Management
CENSARDE	Centre for Sustainable Agriculture, Rural Development and Extension
CET	Centre for Exploration Targeting
CGIAR	Consortium of International Agricultural Research Centers (formerly Consultative Group for International Agricultural Research)
CHE	Council for Higher Education
CHPC	Centre for High Performance Computing
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
CMBG	Centre for Mineral Biogeochemistry
COR-NTD	Coalition for Operational Research on Neglected Tropical Diseases
COVID	Coronavirus disease
CPD	Continuous Professional Development
CPRR	Competitive Programme for Rated Researchers
CPUT	Cape Peninsula University of Technology
CRF	Central Research Fund
CSE	Computer Science Education
CSI	Computer Science and Informatics
CSIR	Council for Scientific and Industrial Research
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CSL	Community Service Learning
CTL	Centre for Teaching and Learning
CUT	Central University of Technology

D

DAFF	Department of Agriculture, Forestry and Fisheries
DAMP	Damp Associated Molecular Pattern
DEA-NRM	Department of Environmental Affairs - Natural Resource Management
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
DIRAP	Directorate for Institutional Research and Academic Planning
DNA	Deoxyribonucleic Acid
DRD	Directorate Research Development
DSS	Decision Support System
DSSC	Dye-sensitized solar cells
DWS	Department of Water and Sanitation

E

eCG	Equine chorionic gonadotropin
ECLA	Electronic Computer Literacy Assessment
EDP	Edamame Development Program
EDS	Energy Dispersive Spectroscopy
EGU	European Geosciences Union
EJISE	Electronic Journal of Information Systems Evaluation
ELA	Environmental Law Assessment
EM	Effective Microbe
EMPA	Electron microprobe analyser
EnSci	Engineering Sciences
ESP	Enzyme Science Programme
EU	European Union
EV	Electric vehicle
EVT	Extreme Value Theory

F

FABI	Forestry and Agricultural Biotechnology Institute
FAO	Food and Agriculture Organization
FAW	Fall armyworm
FBIP	Foundational Biodiversity Information Programme
FET	Further Education and Training
FHB	Fusarium head-blight
FIB	Focused ion beam
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
FSDoH	Free State Department of Health
FSL	Forensic Science Laboratory
FWO	Fonds Wetenschappelijk Onderzoek – Vlaanderen (Research Foundation – Flanders)

G

GBI	Green Building Index
GC-MS	Gas chromatography-mass spectroscopy
GCRF-START	Global Challenges Research Fund – Synchrotron Techniques for African Science and Technology
GFAAS	Graphite Furnace Atomic Absorption Spectroscopy
GFZ	GeoForschungs Zentrum
GGHNP	Golden Gate Highlands National Park
GH	Glycoside hydrolasis
GIS	Geographic information systems
GMI	Green Manufacturing Index
GPR	Gaussian Process Regression
GRPI	Genetic Resources Policy Initiative
GSSA	Geological Society of South Africa
GWK	Griekwaland Wes Korporatief Ltd

H

H2020-MSCA-RISE 2019	Horizon 2020 Marie Skłodowska-Curie Actions Research and Innovation Staff Exchange 2019
HAART	Highly Active Antiretroviral Therapy
HACCP	Hazard Analysis Critical Control Point
HCI	Human-Computer Interaction
HMF	Hans Merensky Foundation
HoD	Head of Department
HPC	High Performance Computing
HPW	Habitable Planet Workshop
HSRC	Human Sciences Research Council

I

ICDP	International Continental Scientific Drilling Programme
ICIPE	International Centre for Insect Physiology and Ecology
ICP	Inductively Coupled Plasma
ICP-MS	Inductively Coupled Plasma Mass Spectroscopy
ICP-OES	Inductively Coupled Plasma Optical Emission Spectroscopy
ICSD	Inorganic Crystal Structure Database
ICT	Information and Communications Technology
ICZ	International Congress of Zoology
IDC	Industrial Development Corporation
IEEEVR	IEEE Virtual Reality
IFAMA	International Food and Agribusiness Managements Association
IFPRI	International Food Policy Research Institute
IGS	Institute for Groundwater Studies
IITA	International Institute of Tropical Agriculture
ILRI	International Livestock Research Institute
IMO	International Mathematical Olympiad
INRA	Institut National de la Recherche Agronomique
INTI	National Institute of Industrial Technology
IoT	Internet of Things
IPS	International Planetarium Society
IPTA	International Pulsar Timing Array
IRF	Individual Research Fellowship
ISE	International Society of Electrochemistry
ISI	International Scientific Indexing
ISSRC	International Society for the Study of Rural Crime
IT	Information Technology
ITSL	Information Technology Service Learning

J

JEMR	Journal of Eye Movement Research
JSE	Johannesburg Stock Exchange

K

KIC	Knowledge Interchange and Collaboration
KZN	KwaZulu-Natal

M

MAGIC	Merensky Group for Airborne Geological Image Classification
MAgric	Master of Agriculture
MArch	Master of Architecture
MCR	Mangaung Concerned Residents
mDIS	ICDP drilling information management system
MDM	Master of Disaster Management
merSETA	Manufacturing, Engineering and Related Services Skills Education Training Authority
METF	Minerals Education Trust Fund
MINSA	Mineralogical Association of South Africa
MLPM	Master of Land and Property Development Management
MOF	Metal Organics Framework
MoU	Memorandum of Understanding
MRM	Mineral Resource Management
MSA	Master of Sustainable Agriculture
MURP	Master of Urban and Regional Planning

N

NAGOCAT	Nanoporous Gold Catalysts
NCL	National Control Laboratory
NDVI	Normalised Difference Vegetation Index
NEP	National Equipment Programme
NFOEB	National Forensic Oversight and Ethics Board
nGAP	New Generation of Academics Programme
NGO	Non-governmental organisation
NGS	Next Generation Sequencing
NIHSS	National Institute for the Humanities and Social Sciences
NLP	Natural Language Processing
NMR	Nuclear Magnetic Resonance
NMU	Nelson Mandela University
NRF	National Research Foundation
NSTF	National Science and Technology Forum
NUL	National University of Lesotho
NUPS	National University of Public Service
NWU	North-West University
NZG	National Zoological Garden

O

OBA	Ordered Banach algebra
OLED	Organic light emission device
OPDT	Oil and Protein Seeds Development Trust
OSG	Operational Support Group

P

PAMO	Pan African Mathematics Olympiad
PASA	Petroleum Agency SA
PAST	Palaeontological Scientific Trust
PCT	Patent Cooperation Treaty
PDE	Partial differential equation
PGDip	Postgraduate Diploma
PGDip(SA)	Postgraduate Diploma in Sustainable Agriculture
PGE	Platinum-group elements
PI	Primary / Principal investigator
PMC	Predator Management Information Centre
PNNL	Pacific Northwest National Laboratory
PoW	Proof-of-Work
PPE	Personal protective equipment
PPS	Professional Provident Society
PRF	Protein Research Foundation
PROVJOC	Provincial Joint Operation Centre
PSFRU	Protein Structure-Function Research Unit

Q

QPM	Quality protein maize

R

R&D	Research and development
REI	Research, Education and Investment
RGB	Red-Green-Blue
RISE	Research and Innovation Staff Exchange
RMRD SA	Red Meat Research and Development South Africa
RPL	Recognition of Prior Learnig
RPO	Red Meat Producers Organisation
RRI	Responsible Research and Innovation
RRING	Responsible Research and Innovation Networking Globally
RSG	Radio Sonder Grense
RUFORUM	Regional Universities Forum for Capacity Building in Agriculture

S

SAAB	South African Association of Botanists
SAB	South African Breweries
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
SAFEX	South African Futures Exchange
SAIA	South African Institute of Architects
SAIAB	South African Institute of Aquatic Biodiversity
SAICSIT	South African Institute of Computer Scientists and Information Technologists
SAIP	South African Institute of Physics
SALDi	South African Land Degradation Monitor
SAMM	South African Mutton Merino
SAMEA	South African Monitoring and Evaluation Association
SAMO	South African Mathematics Olympiad
SANAP	South African National Antarctic Programme
SANBI	South African National Biodiversity Institute
SANParks	South African National Parks
SANSA	South African National Space Agency
SANSA	South African National Survey of Arachnida

SAPBA	South African Plant Breeders' Association
SAPER	South African Planning Education Research
SAPPA	South African Pecan Nut Producers Association
SAPS	South African Police Service
SARChI	South African Research Chairs Initiative
SASAS	South African Society for Animal Science
SASCP	South African Society of Crop Production
SASHS	Southern African Society for Horticultural Sciences
SASRI	South African Sugarcane Research Institute
SASRN	South African Sclerotinia Research Network
SAWMA	Southern African Wildlife Management Association
SAWSS	Southern African Weed Science Society
SCAR	Scientific Committee on Antarctic Research
SciELO	Scientific Electronic Library Online
SCOBY	Symbiotic colony of bacteria and yeast
SDG	Sustainable Development Goal
SDS	Sudden Death Syndrome
SEG	Senior Executive Group
SEM	Scanning electron microscope
SERIAL	Socio-ecological resilience in agricultural landscapes
SFDRR	Sendai Framework for Disaster Risk Reduction
SLE	Senior Lecturer Equivalent
SMEG	Soil and Microbial Ecology Group
SPP	Society of Porphorins and Phthalocyanines
SRT	Smart Resource Trading for the Future
SSAG	Society of South African Geographers
SSAJRP	Swiss-South Africa Joint Research Programme
SSRC	Social Science Research Council
SSSSA	Soil Science Society of South Africa
START	Synchrotron Techniques for African Research and Technology
STR	Short tandem repeat
SWAT	Soil and Water Assessment Tool

T

TEM	Transmission electron microscope
TIA	Technology Innovation Agency
TTF	Tetrathiafulvalene
TWFL	Travelling wave fault location

U

UAP	University Access Programme
UAV	Unmanned aerial vehicle
UB	University of Botswana
UCT	University of Cape Town
UFS	University of the Free State
UIA	International Union of Architects
UJ	University of Johannesburg
UK	United Kingdom
UKZN	University of KwaZulu-Natal
UN	United Nations
UNESCO	United Nations Education, Scientific and Cultural Organization
UNESP	Universidade Estadul Paulista / São Paulo State University
UNU	United Nations University
UNU-EHS	United Nations University Institute for Environment and Human Security
UPI	University Partnership Initiative
URERU	Urban Real Estate Research Unit
US	United States
USA	United States of America
UV/Vis	Ultraviolet-visible
UWC	University of the Western Cape
UX	User experience

V

VLIR	Vlaamse Interuniversitaire Raad /Flemish Interuniversity Council
VR	Virtual reality
VUB	Vrije Universiteit Brussel

W

Wits	University of the Witwatersrand
WRC	Water Research Commission
WUR	Wageningen University and Research
WWTF	Waste Water Treatment Works

Z

ZEF	Centre for Development Research
ZSSA	Zoological Society of Southern Africa

ISSUED BY
Faculty of Natural and Agricultural Sciences
University of the Free State

EDITORIAL COMPILATION
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DESIGN & LAYOUT
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DOING OUR
PART IN THE
FIGHT AGAINST
COVID.