ANNUAL REPORT 2019

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UNIVERSITY OF THE
FREE STATE
UNIVERSITEIT VAN DIE
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UFS

Natural and Agricultural Sciences

Annual Report 2019

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FOREWORD

MESSAGE FROM THE DEAN

In 2018 university life slowly returned to normality after the two previous turbulent years. This continued through 2019, which created an environment conducive to excellent teaching as well as the opportunity for research. This resulted in a very good year for the Faculty in terms of the number of published research articles and the number of postgraduate students who graduated. We therefore maintained the good output of research articles, books and conference proceedings, reaching in the region of 400 output units.

In 2017 the theme of our annual report was 'Academic Silos'. The 'silo effect' in academic circles describes the way that academics become isolated in their own little part of their academic neighbourhood and consequently experience very limited interaction with colleagues and other departments, resulting in duplication of efforts. This raised the question: "How does the academic break through the silo and form networks of relationships across departments and across faculties?" We are now two years down the line, and we need to ask how effective we have become.

Consolidation and the Chain of knowledge

It is all about **CONSOLIDATION – combining many separate people, things or ideas into one solid unit or making our efforts more focused and stronger**.

One definition of consolidation is to bring together separate parts into a single or unified whole, and that is what we as a faculty and the greater university strive towards. The Cambridge Dictionary describes it as follows: "To become, or cause something to become, stronger, and more certain". According to the American Dictionary it is "to bring together or unite things that were separate – to become or make something stronger or more successful". That is exactly what we want to achieve – to unite the knowledge of all in the Faculty.

This will result in a **CHAIN OF KNOWLEDGE** where different research ideas, projects and strategies are focused to place us as a faculty in the league of the big role players. A knowledge value chain is a sequence of intellectual tasks (research) by which knowledge workers (academics) build their employer's (UFS) unique competitive advantage and/or social and environmental benefit. The components of a research project are an example of such a knowledge value chain.

Today, there is growing recognition by researchers across the world of the importance of managing knowledge as a critical source for competitive advantage. Researchers in the field of sustainable competitive advantage have discovered that knowledge, which includes what the organisation knows, how it uses what it knows, and how fast it can know something new, is the only thing that offers an organisation a competitive edge. The stronger the links of the chain of knowledge, the stronger we will become. It is our responsibility to strengthen these links, which are made up of the different research groups and projects in the Faculty. Combining the silos of knowledge (knowledge which many academics guard so jealously) will strengthen these links significantly.

When reading through all the 2019 departmental reports, I get a real sense of consolidation emerging, built on a firm foundation that has been laid over the last few years, moving forward and doing things well, learning from the successes and mistakes that have gone before. Maybe it speaks of greater depth and not necessarily anything earth-shatteringly exciting as yet – just good, sound stuff. More and more the research groups in departments and across departments are working together to achieve results. It is also the view of industry that research groups should consolidate their efforts, including with other universities, in order to achieve optimal results. It is my view that we should appoint knowledgeable people to help us with this consolidation or research foci, and also to assist in minimising the administrative load of the academics, in order for them to concentrate on what they do best – research.

This year I also want to pay tribute to the support departments, i.e. the Centre for Microscopy, the Electronics and Instrumentation Divisions, the experimental farms, as well as the large equipment strategy, which assist us so effectively in developing the chain of knowledge. Substantial financial support has been invested in these entities, with huge success. The effectiveness of these entities has increased tremendously over the last few years, and this can be attributed to the dedication of the staff involved. Large scale developments are planned for the Centre for Microscopy and the experimental farms in 2020/2021, which will give us the edge over other institutions. The newly completed Sensory Laboratory will also assist in promoting world-class research in food security in South Africa.

The large equipment strategy of the Faculty, managed by Prof Jannie Swarts, has also resulted in most departments receiving state-of-the-art equipment that has enabled them to compete with the best in South Africa. As one example, the new microscope laboratory in Biology is the third largest and most modern laboratory of its kind in the world and the largest in Africa. The large equipment strategy is an ongoing venture, which requires a great deal of financial planning, and will carry on for as long as we can afford it.

As further evidence of the dedication of our staff, the historic Lamont-Hussey Telescope was restored and reassembled as an exhibit at the Planetarium, a wonderful testimony to the scientists who worked tirelessly to observe the night sky from the Lamont Hussey Observatory, now converted to a digital planetarium.

The Faculty also did very well on the international front and several departments had very active collaboration with

international universities. In this regard the departments of Microbial, Biochemical and Food Biotechnology, Plant Sciences, Chemistry and Physics lead the way.

On the local front, conferences were organised by the Department of Agricultural Economics (Agricultural Economics Association of South Africa [AEASA] Conference), while the Department of Soil, Crop and Climate Sciences hosted the Combined Congress 2019 representing four scientific societies – 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). In addition, the Centre for Environmental Management, in collaboration with the Technical University of Dresden, coordinated and obtained funding from the Volkswagen Foundation to present a Summer School on Aquatic Biomonitoring.

Staff and student achievements

There were significant achievements by our staff and students during 2019, *inter alia*:

- Dr Abiodun Ogundeji of Agricultural Economics was awarded a visiting research fellowship by the United Nations Children's Fund (UNICEF) (Transfer Project) through the UNICEF Office of Research - Innocenti's Fellowship Programme.
- Prof Frikkie Neser received the Livestock Registering Federation (LRF) award for lifetime service to the livestock industry.
- Prof Jonathan Noble completed his new book, titled *The Architecture of Peter Rich: Conversation with Africa,* to be published in 2020 by Lund Humphries, UK.
- Prof Jeanet Conradie was appointed as visiting professor in Inorganic and Materials Chemistry at the Department of Chemistry of The Arctic University of Norway (UiT).
- Prof Pieter Blignaut was appointed as Associate Editor of the *Journal of Eye Movement Research* (JEMR).
- Mr Louis Lagrange received the Energy Efficiency Educator of the year in Sub-Sahara Africa award from the South African Energy Efficiency Confederation (SAEEC).
- Ms Elizabeth Rudolph was elected chair of the Association of Polar Early Career Scientists of South Africa (APECSSA).
- Prof Arno Hugo received an Exemplary Award from the Pig Breeders' Society of South Africa.
- PhD student Christopher Rothmann was awarded the joint runner-up award for his company, LiquidCulture, in the Existing Tech Business category of the 2019 National Entrepreneurship Intervarsity competition, supported by Entrepreneurship Development in Higher Education (EDHE) and the Allan Gray Orbis Foundation.
- Prof Maryke Labuschagne was appointed to the editorial board of the *Journal of Cereal Scienc*e, a leading British journal on cereal chemistry. She was also appointed as Specialty Chief Editor for *Frontiers in Sustainable Food Systems*, a journal that is part of the Frontiers group of journals published in Switzerland.
- Prof Wijnand Swart was elected as President of the Southern African Society of Plant Pathology (SASPP).
- Dr Frank Chidawanyika, a Carnegie Research Fellow, received the Carnegie Cooperation of New York Scholar award at the African Studies Association meeting held in Boston, Massachusetts.

Academic performance

During the 2019 Bloemfontein graduations, the Faculty of Natural and Agricultural Sciences conferred 338 master's degrees – which is nearly 60% of the total for the Bloemfontein Campus – and 43 doctoral degrees. On the Qwaqwa Campus a further 11 master's and 4 doctoral degrees were awarded. Of the total Faculty student cohort, 31% are postgraduate students. The Faculty postgraduate pass rate for the year was 80.5%, while that at undergraduate level was 78.7%, both levels reflecting an improvement of more than 1%.

During 2019 the following academic outputs were delivered by the Faculty:

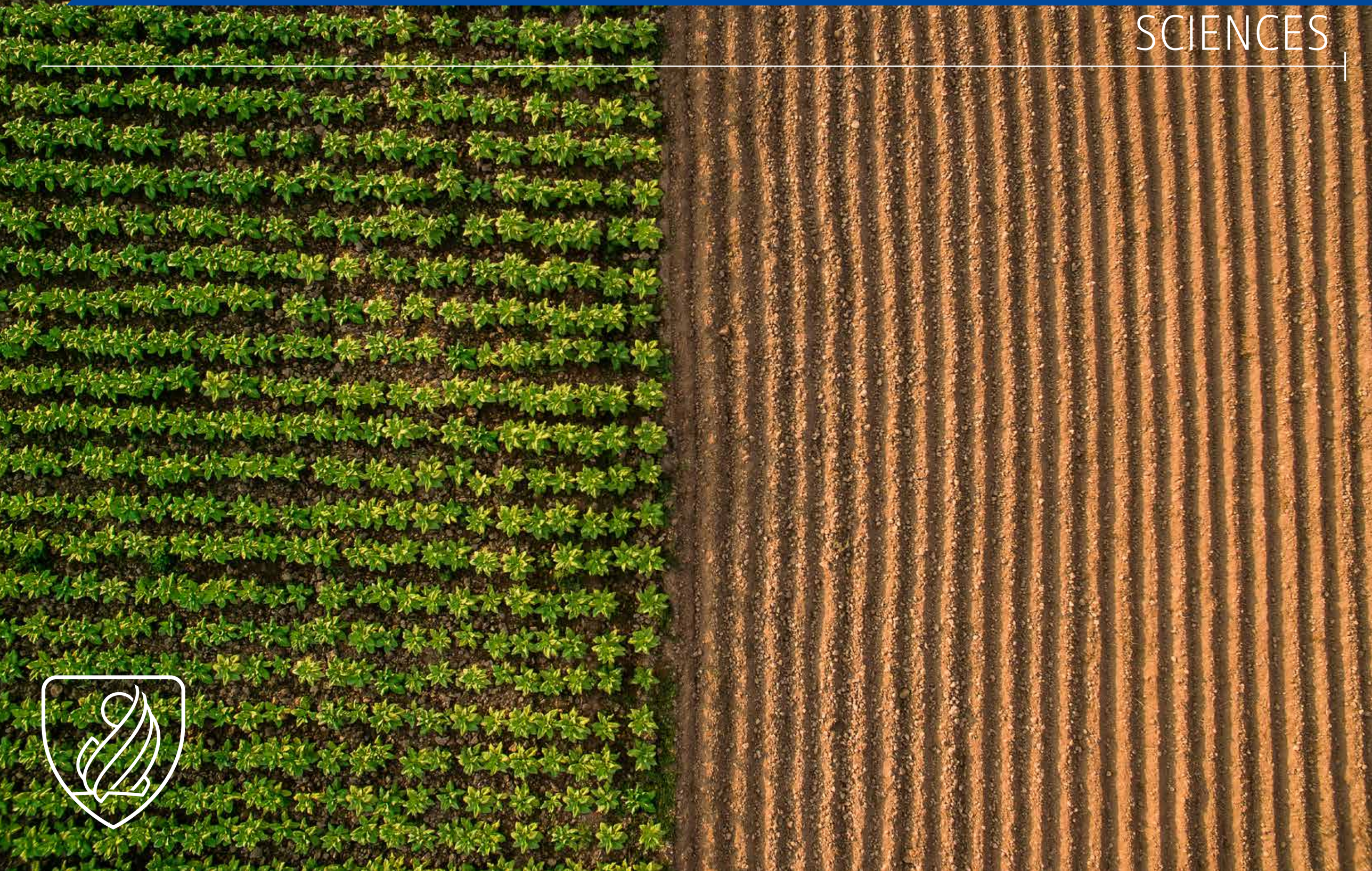
- 392 articles units were published, which is slightly less than the 408 of 2018, but still a significant improvement from the past. This comprises 33% of the total publication units of the University as a whole. The Faculty goal is to improve on this.
- Of the 17 departments at the UFS that published more than 20 article units (books included), 7 were from the Faculty. Of the 10 departments that published more than 20 articles, 6 were from the Faculty. Physics was again the top performer in the University.
- The number of NRF-rated researchers in the Faculty increased from 71 to 79, representing 47% of all NRF-rated academics at the University.

Prof Abdon Atangana from the Institute for Groundwater Studies and Prof Hendrik Swart from Physics were again our top performers.

It is my pleasure to present to you our 2019 Annual Report and extend my sincere gratitude to the staff and students for their selfless commitment to make this Faculty and the University great. 2019 was a very good year for the Faculty of Natural and Agricultural Sciences and the challenge is to improve even more on our academic activities in 2020, consolidate our efforts and strengthen our chain of knowledge. I want to conclude with the wise words of William Warburton – "Without enthusiasm, the adventurer could never kindle that fire in his followers which is so necessary to consolidate their mutual interest". Let's all be enthusiastic in 2020!

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

AGRICULTURAL
SCIENCES



DEPARTMENT OF

AGRICULTURAL ECONOMICS

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OVERVIEW OF 2019

The Department of Agricultural Economics performed well during 2019 and was involved in a range of activities. We appointed one new staff member and some of our staff were promoted. We hosted the Agricultural Economics Association of South Africa (AEASA) 2019 Conference, and were involved in many producer congresses and farmers' days. We also pride ourselves in the fact that a student from our Department, for the second year in a row, won the agricultural economics division of Old Mutual Agricultural Student of the Year competition. The Department is involved in a range of research activities and projects, some of which were concluded during 2019. We published 25 journal articles during the year and a further six articles were published in conference proceedings.

ACHIEVEMENTS

Staff Achievements

A number of our staff members, of whom we are very proud, received awards and prizes at our annual year-end function and prize-giving ceremony on 22 November 2019:

- Chairperson Trophy for Service to Department
  Dr Janus Henning
- HA Kotze Trophy for Outreach
  Prof Ashok Chapagain
- Theo Potgieter Trophy for Farmer Outreach
  Dr WA Lombard
- MF Viljoen Trophy for Research
  Dr Abiodun Ogundeji
- CS Blignaut Trophy for Teaching and Learning
  Dr Nicky Matthews
- LK Oosthuizen Trophy for Community Service
  Dr Yonas Bahta
- Staff's Staff Member of the Year
  Chrizna van der Merwe
- Plaas Media Popular Article of the year
  Primrose Madende

Student Achievements

The annual Old Mutual Agricultural Student of the Year competition was held in September 2019. The main objective of the competition was to enhance the careers of agricultural students and to motivate prospective students to pursue careers in the agricultural sector. In order to participate, students were required to critically reflect and produce an essay on the major issues within the agricultural sector. We are proud that a student in our Department, Michelle Marais, won the Agricultural Economics division of the competition, with her essay on 'Alternatives for land as a basis for agricultural financing'.

Michelle Marais (Winner Agricultural Economics) and Wian Visser (Winner Agronomy)

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

- Best Student Assistant Trophy
  Brent Jammer
- Johan Willemse Trophy for Student Ambassador
  Michelle Marais

TEACHING

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

Students from the Faculty (research assistants from Agricultural Economics Department and final-year Animal Sciences students) attended the Aldam Stockman School on 16 October 2019. Themes were centred on beef production and how precision agriculture can improve it. Numerous international speakers delivered presentations on precision agriculture in their contexts.

RESEARCH

Our research endeavours during 2019 focused on three broad themes, viz. (i) water-related research funded by the Water Research Commission (WRC), (ii) research on livestock economics, mainly funded by the Red Meat Research and Development South Africa (RMRD SA) and industry partners, and (iii) projects concerning drought. Many of the research projects are multidisciplinary, involving academics from different departments, such as the Department of Soil, Crop and Climate Sciences, the Department of Animal, Wildlife and Grassland Sciences, the Department of Computer Science and Informatics, and the Centre for Development Support.

Water-related research

Prof Ashok Chapagain and Dr Henry Jordaan are involved in research projects on water footprint assessment to inform sustainable water use for food and fibre production in South Africa. The team completed a project in which they explored the water

Group of UFS students attending the Aldam Stockman School

footprint of field and forage crops and derived crop products. They are currently also busy with a project, in collaboration with the South African Sugar Research Institute (SASRI), to assess the water footprint of fuel and fibre crops, with a special focus on sugarcane production. Dr Jordaan and Ms Pascalina Mohlotsane were also 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. In another collaborative project, Dr Janus Henning and Dr Henry Jordaan 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.

Prof Bennie Grové headed an interdisciplinary research team funded by the WRC. The research conducted by the team dealt with the development and application of a long-run hydro-economic risk simulation and optimisation-modelling framework to quantify the hydro-economic impact of water curtailments. This project was completed in 2019. Another research project for the WRC, led by Dr Nicolette Matthews and Prof Grové, aimed to develop a bio-economic model to develop guidelines for water and salt stress management within a precision agriculture framework.

Lastly, on the water theme, Dr Abiodun Ogundeji worked with Prof Andries Jordaan from DiMTEC on a project for the WRC, exploring farmers' coping and adaptation strategies to drought and other water-related risks in an environment of changing climate.

Livestock Economics

Our Livestock Economics unit was involved in various research projects related to the economics of livestock production in South Africa. Their research endeavours were mainly funded by the RMRD SA, the Red Meat Producers Organisation (RPO), and private agribusinesses. Research projects funded by RMRD SA included a project on predation in South Africa, of which Mr Walter van Niekerk was part.

Dr WA Lombard led two other projects funded by RMRD SA. The first considered the economic impact of stock theft and the factors affecting stock theft in South Africa, and the second focused on research on eye-tracking technology for red-meat marketing in the Mangaung Metropolitan Municipality.

Dr Frikkie Maré continued his research activities with the Sernick group on the economics and environmental impacts of beef production. Together with Mr Phillip Oosthuizen, from Sernick, a feedlot experiment was conducted with 600 Bonsmara bulls to test the economic and meat-quality impacts of different growth hormones and beta agonists at different administered rates and dates. Dr Maré, Dr Bahta and Mr Van Niekerk also conducted a follow-up research project for the RPO to assess the impact of the drought on livestock producers.

Drought-related research

Dr Yonas Bahta's research explored the dynamics of agricultural drought resilience that is dramatically influenced by social and gender inequalities. Whether people can survive or adapt or not during and after drought, is affected by their access to information, social capital, credit, productive resources, savings, available time and mobility – all of which can vary for men and women due to the fact that women are often not as empowered as men in certain domains. The level of empowerment and gender parity of smallholder female livestock farmers in the Northern Cape was investigatged, to assess the impact it has on their agricultural drought resilience. Different empowerment indexes are being used, such as the Abbreviated Women's Empowerment in Agriculture Index (A-WEAI). This project has been funded by the NRF-Thuthuka since 2018.

Miss Zimbini Coka worked on a research project with Prof Michael Aliber and Prof Luvuyo Wotshela, from the University of Fort Hare, which looks at the history of land and land issues in the former Ciskei. Part of this research was a continuation of her master's research and was based on an extensive series of interviews, some already conducted and some ongoing, combined with archival research. This study will explore a number of themes, of which the most sweeping is the socio-economic change experienced in and around lower Gqumashe over the past eight decades and more. The area is especially interesting because of its complex land history.

ENGAGED SCHOLARSHIP

The Department is dedicated to giving back to the farming community at large by providing the agricultural sector with relevant information. During 2019, this was done in various ways, including farmers' days, conferences arranged by farmers, and through 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 'Radio Sonder Grense' (RSG), as well as the occasional television show, such as 'Grootplaas'.

Dr Yonas Bahta and Lindie von Maltitz, a master's student in the Department, presented a paper and participated in a panel discussion on 'Do smallholder farmers have the potential to become commercial farmers?' at the 2nd congress of the Francis Baard Farmers and African Farmers' Association of South Africa (AFASA) on 25 July 2019, at Melkvlei Farm, Barkley West, Northern Cape. A popular article on this topic was also published in *Stock Farm*.

Lindie von Maltitz, Dr Yonas Bahta and students attending AFASA

At the VDAU Charity Event, from the left, Stefan Smith (Chairperson VDAU), Dr Gustav Gous (motivational speaker), Christelle Stoman (Secretary VDAU), Kabous Meiring (TV host) and Dr Frikkie Maré (UFS)
(Photo credit: Magda Stols, Stellalander)

Dr Frikkie Maré was one of the invited speakers at the Vaalharts District Agricultural Union's (VDAU) Charity Event in Hartswater. Approximately 200 people attended the evening, which was held to raise funds for two retirement homes in the district. He also addressed red meat producers at the both the Northern Cape and Free State RPO congresses and was an invited speaker at five other producer organisations.

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

The Department staged an exhibition at the ALFA Agricultural Expo, which was held on 17 -19 September 2019 at the Afridome in Parys, Free State.

Dr Frikkie Maré (first left in the front) and UFS students attending the ALFA Agricultural Expo

NATIONAL AND INTERNATIONAL COLLABORATION

Dr Abiodun Ogundeji was awarded a visiting research fellowship by the United Nations Children's Fund (UNICEF) Transfer Project through the UNICEF Office of Research - Innocenti's Fellowship Programme. He worked at the Food and Agriculture Organization (FAO) in Rome, Italy, under the supervision of Dr Alejandro Grinspun (Senior Economist - Social Protection). He is currently finalising a research paper titled 'The role of social protection in promoting agricultural production and reducing vulnerability to climate shocks: Macro level evidence from a panel of Asian countries'.

Dr Abiodun Ogundeji

Dr Ogundeji also attended a challenge fund research workshop organised by the World Bank titled 'Agriculture and Food Security Risk Financing in Southern Africa' in London from 7 to 8 August 2019. He presented a proposal titled 'AgriCloud SEMELA: Seasons and Economics Monitoring for Early Localized Action'. The proposal was developed in conjunction with Weather Impact, HydroLogic, Agricultural Research Council (ARC), and South African Weather Services.

Delegates at the World Bank workshop, from the left: Clement Kalonga (Directorate of Food, Agriculture and Natural Resources, SADC), Saskia van Pelt (Weather Impact), Abiodun Ogundeji (UFS) and John Luke Plevin (Financial Sector Specialist, Disaster Risk Finance Team, World Bank)

Prof Ashok Chapagain was invited by Prof Wang Zhijian from Hohai University, to attend a seminar on 'Transboundary water security/rights/management +6' organised by the International Water Rights Forum (IWRF) at Nanjing, China during the last week of November in 2019. Prof Chapagain also attended a workshop specifically organised to seek research collaboration on water footprint and virtual water between Hohai University and the UFS. The workshop was well-attended with an estimated attendance of more than 100 researchers from different disciplines.

OTHER ACTIVITIES

The Department hosted the 57th Conference of AEASA, which was held from 8 to 10 October at Ilanga Estate, Bloemfontein. The organising committee consisted of representatives from our Department and the Free State Department of Agricultural and Rural Development. The conference, with the theme 'Growing a Sustainable and Resilient Agriculture', was attended by approximately 230 delegates from South Africa, Lesotho, Namibia and New Zealand representing universities, private companies and government organisations.

Mr Kwekwe William Bulwane, MEC Free State Department of Agricultural and Rural Development, delivered the opening address at the conference, and Prof Chris Barrett from Cornell University was an invited speaker. The first day was an Industry Day, with speakers including Mr Nic Knoetze (CEO of the South African Association of Water Users Associations), Mr Corné Kruger (CFO of Senwes), Mr Louis de Kock (owner and CEO of Wildeklawer), Petro Naudé (project manager of the Sernick Emerging Farmers Programme), Mr Koos Janse van Rensburg (CEO of Vrystaat Koöperasie Beperk [VKB]) and of Dr Sifiso Ntombela (National Agricultural Marketing Council [NAMC]).

A number of prizes, presented by AEASA President, Prof Ferdi Meyer, were won by UFS staff and students:

- 3rd Prize for the Best Contributed Paper
  Dr Yonas Bahta
- 2nd Prize for the Best Student Essay
  Ms Chéri-Lynn Steyn
- Best Final-year Agricultural Economics student
  Ms Lize-Marie Botha

Cheri-Lynn Steyn (right) receiving her prize from Dr Ferdi Meyer, President of AEASA

Dr Yonas Bahta (right) receiving his prize from Dr Ferdi Meyer, president of AEASA

POSTGRADUATE STUDENTS

In 2019, a total of 52 students were registered for our three Honours programmes, with a further 16 master's students and 10 doctoral students making up the postgraduate student cohort.

In 2019, 23 Honours students graduated, while at master's level, six students graduated:

- T Tshibalo: MAgric (Agricultural Economics) – with distinction
- P de Wet: MAgric (Agricultural Management)
- M Masemola: MSc (Agricultural Economics) – with distinction
- A Ferreira: MSc (Agricultural Economics)
- RC Matlou: MSc (Agricultural Economics)
- L van der Walt: MSc (Agricultural Economics)

STAFF MATTERS

Dr Frikkie Maré was promoted to Senior Lecturer and Mrs Pascalina Mohlotsane to Lecturer. Mr Markus Monteiro was appointed as Junior Lecturer in the Department.

RESEARCH OUTPUTS

Research Articles

Badu-Gyan, F., Henning, J.I.F., Grové, B & Owusu-Sekyere, E. 2019. Examining the social, physical and institutional determinants of pineapple farmers' choice of production systems in Central Ghana. *Organic Agriculture* 9(3): 315-329.

Bahta, Y.T. & Enoch, O.S. 2019. Improving the income status of smallholder vegetable farmers through food policy intervention: The case of homestead food garden intervention. *Outlook on Agriculture* 48(3): 246-254.

Bahta, Y.T., Enoch, O.S. & Boipelo, T. E. 2019. Does women's empowerment through policy intervention reduce food insecurity in South Africa? *Development in Practice* 29(1): 3-14.

Cloete, P., Bahta, Y.T., Marunga, M. & Lombard, W.A 2019. Perception and understanding of agricultural extension: perspective of farmers and public agricultural extension in Thaba Nchu. *South African Journal of Agricultural Extension* 47(3): 14-31.

Ercin, E., Chico, D. & Chapagain, A.K. 2019. Vulnerabilities of the European Union's economy to hydrological extremes outside its borders. *Atmosphere* 10: 1-19.

Grové, B. 2019. Improved water allocation under limited water supplies using integrated soil-moisture balance calculations and nonlinear programming. *Water Resources Management* 33(1): 423-437.

Grové, B. & Du Plessis, M.C. 2019. Optimising intra-seasonal irrigation water allocation: Comparison between mixed integer non-linear programming and differential evolution. *Water SA* 45(1): 48-54.

Henning, J.I.F., Boughart, D.A., Jordaan, H. & Matthews, N. 2019. Factors affecting successful agricultural loan applications: The case of a South African credit provider. *Agriculture* 9: 1-15.

Hoekstra, A., Chapagain, A.K. & Van Oel, P. 2019. Progress in water footprint assessment: Towards collective action in water governance. *Water* 11: 1-8.

Hu, J., Huang, K., Ridoutt, B.G., Yajuan, Y. & Xu, M. 2019. Measuring integrated environmental footprint transfers in China: A new perspective on spillover-feedback effects. *Journal of Cleaner Production* 241: 1-12.

Huang, J., Ridoutt, B.G., Thorp, K.R., Wana, X., Lan, K., Liao, J., Tao, X., Wu, C., Huang, J., Chen, F. & Scherer, L. 2019. Water-scarcity footprints and water productivities indicate unsustainable wheat production in China. *Agricultural Water Management* 224: 1-8.

Jordaan, A.J., Bahta, Y.T. & Phatudi-Mphahlele, B. 2019. Ecological vulnerability indicators to drought: Case of communal farmers in Eastern Cape, South Africa. *Jamba: Journal of Disaster Risk Studies* 11(1): a591-1-a591-11.

Liang, L., Ridoutt, B.G., Lal, R., Wang, D., Wu, W., Peng, P., Hang, S., Wang, L. & Zhao, G. 2019. Nitrogen footprint and nitrogen use efficiency of greenhouse tomato production in North China. *Journal of Cleaner Production* 208: 285-296.

Liang, L., Ridoutt, B.G., Wu, W., Lal, R., Wang, L., Wang, Y., Li, C. & Zhao, G. 2019. A multi-indicator assessment of peri-urban agricultural production in Beijing. *China Ecological Indicators* 97: 350-362.

Liang, L., Wang, Y., Ridoutt, B.G., Lal, R., Wang, D., Wu, W., Wang, L. & Zhao, G. 2019. Agricultural subsidies assessment of cropping system from environmental and economic perspectives in North China based on LCA. *Ecological Indicators 96*: 351-360.

Lombard, W.A. & Bahta, Y.T. 2019. Economic impact and factors affecting sheep and goat theft in South Africa. *Acta Criminologica: African Journal of Criminology and Victimology* 32: 144-166.

Lombard, W.A. & Bahta, Y.T. 2019. Economic impact of livestock theft and stock theft control mechanisms in the Free State Province of South Africa. *International Journal of Agricultural Management* 8(3): 98-106.

Maré, F.A. & Jordaan, H. 2019. Industrially finished calves a water footprint-profitability paradox. *Water* 11: 1-17.

Matlou, R. & Bahta, Y.T. 2019. Factors influencing the resilience of smallholder livestock farmers to agricultural drought in South Africa: Implication for adaptive capabilities. *Jamba: Journal of Disaster Risk studies* 11: 1-7.

Muchopa, C.L., Bahta, Y.T. & Ogundeji, A.A. 2019. Tariff rate quota impacts on export market access of South African fruit products into the EU market. *Agrekon* 58(4): 426-450.

Ncube, A., Bahta, Y. T. & Jordaan, A.J. 2019. Coping and adaptation mechanisms used by Sub-Saharan African migrant women in South Africa. *Jàmbá: Journal of Disaster Risk Studies* 11(1): 1-13.

Ncube, A., Bahta, Y. T. & Jordaan, A.J. 2019. Exploring of short term, long-term survival mechanisms and Perception of Job Market by Zimbabwean migrant women in South Africa. *Ìrìnkèrindò: A Journal of African Migration* 10: 82-105.

Ridoutt, B., Motoshita, M. & Pfister, S. 2019. An LCA impact assessment model linking land occupation and malnutrition-related DALYs. *The International Journal of Life Cycle Assessment* 24: 1620-1630.

Ridoutt, B.G., Baird, D., Anastasiou, K. & Hendrie, G.A. 2019. Diet quality and water scarcity: Evidence from a large Australian population health survey. *Nutrients* 11(8): 1-15.

Vanham, D., Leip, A., Galli, A., Kastner, T., Bruckner, M., Uwizeye, A., Van Dijk, K., Ercin, E., Dalin, C., Chapagain, A.K., *et al.* 2019. Environmental footprint family to address local to planetary sustainability and deliver on the SDGs. *Science of the Total Environment* 693: 1-12.

Conference Contributions

Conference Papers/Posters

Bahta, Y.T. & Jordaan, H. 2019. *The economic impact of policy interventions to mitigate water use in irrigation agriculture in South Africa: Implication for adaptive capabilities*. Paper delivered at the 57th Annual Conference of the Agricultural Economics Association of South Africa Conference (AEASA), Bloemfontein, South Africa. 8-10 October 2019.

Bahta, Y.T. & Van Niekerk, H. 2019. *Resources use, technical efficiency of maize industry and performance of the South African economy*. Paper delivered at the 22nd International Farm Management Association Congress, Launceston, Australia. 3-8 March 2019.

Lombard W.A., Van Zyl J.H & Beelders T.R. 2019. *Red meat consumers' preferences: A case study of the Mangaung Metropolitan Municipality.* Paper delivered at the 22nd International Farm Management Association Congress, Launceston, Australia. 3-8 March 2019.

Lunguza, Z.P. & Matthews, N. 2019. *Economic trade-offs between allocating water for leaching where water tables are present.* Paper delivered at the 57th Annual Conference of the Agricultural Economics Association of South Africa Conference (AEASA), Bloemfontein, South Africa. 8-10 October 2019.

Luvhengo, U., Henning, J.I.F. & Bahta, Y.T. 2019. *Incorporating collective entrepreneurship and capacity development for emerging cooperative farming systems: The South African review.* Paper delivered at the 3rd International Conference on Food and Agricultural Economics (ECONAGRO), Alanya Antalya, Turkey. 25-26 April 2019.

Maltou, R. & Bahta, Y.T. 2019. *Estimating agricultural drought resilience of Smallholder livestock farmers in South Africa.* Paper delivered at the 22nd International Farm Management Association Congress, Launceston, Australia. 3-8 March 2019.

Maltou, R. & Bahta, Y.T. 2019. *Factors influencing the resilience of smallholder livestock farmers to agricultural drought in South Africa: Implication for adaptive capabilities.* Paper delivered at the 57th Annual Conference of the Agricultural Economics Association of South Africa Conference (AEASA), Bloemfontein, South Africa. 8-10 October 2019.

Maltou, R. & Bahta, Y.T 2019. *Impact of agricultural drought on the welfare of smallholder livestock farming households*. Poster presented at the 7th Annual SISC conference (ClimRisk19-Climate Risk), Trento, Italy. 23-26 October 2019.

Maré, F.A. 2019. *Managing the water footprint of beef through efficient production*. Paper delivered at the 51st SASAS Congress, Bloemfontein, South Africa. 10-12 June 2019.

Maré, F.A. & Jordaan, H. 2019. *The water-economy nexus of fattened calves: A water footprint – profitability paradox*. Paper delivered at the 57th Annual Conference of the Agricultural Economics Association of South Africa Conference (AEASA), Bloemfontein, South Africa. 8-10 October 2019.

Ojo, T.O., Ogundeji, A.A., Babu, S.C. & Alimi, T. 2019. *Estimating financing gaps in rice production in south-western Nigeria.* Paper delivered at the African Conference of Agricultural Economists (ACAE 2019), Abuja, Nigeria. 23-26 September 2019.

Tlalang, B.E., Bahta, Y.T. & Lombard, W.A. 2019. *Challenges and opportunities of homestead food garden in South Africa: A case of pumpkin production.* Paper delivered at the 22nd International Farm Management Association Congress, Launceston, Australia. 3-8 March 2019.

Van den Heever, M.J.J, Lombard, W.A & Jordaan, H. 2019. *How can the South African beef classification system be adapted to meet modern consumers' demands?* Paper delivered at the 22nd International Farm Management Association Congress, Launceston, Australia. 3-8 March 2019.

Von Maltitz, L. & Bahta, Y.T. 2019. Do smallholder farmers have the potential to become commercial farmers? Paper delivered at the 2nd Congress of Francis Baard Farmers and African Farmer' Association of South Africa (AFASA), Barkly West, South Africa. 25 July 2019.

Conference Proceedings

Bahta, Y.T. & Niekerk, H. 2019. Resources use, technical efficiency of maize industry and performance of the South African economy. In: *Proceedings of the 22nd International Farm Management Association Congress*, Launceston, Australia. 3-8 March 2019. pp: 1:1-16.

Lombard, W.A., Van Zyl, J.H. & Beelders, T.R. 2019. Red meat consumers' preferences: A case study of the Mangaung Metropolitan Municipality. In: *Proceedings of the 22nd International Farm Management Association Congress*, Launceston, Australia. 3-8 March 2019. pp: 1:1-18.

Maltou, R. & Bahta, Y.T. 2019. Estimating agricultural drought resilience of Smallholder livestock farmers in South Africa. In: *Proceedings of the 22nd International Farm Management Association Congress*, Launceston, Australia. 3-8 March 2019. pp: 1:1-13.

Maré, F.A. & Jordaan, H. 2019. The economic feed consumption of different cattle breeds in a cow-calf production system. In: *Proceedings of the 22nd International Farm Management Association Congress*, Launceston, Australia. 3-8 March 2019. pp: 1:1-18.

Tlalang, B.E., Bahta, Y. T. & Lombard. W.A. 2019. Challenges and opportunities of homestead food garden in South Africa: a case of pumpkin production. In: *Proceedings of the 22nd International Farm Management Association Congress*, Launceston, Australia. 3-8 March 2019. pp: 1:1-9.

Van den Heever, M.J.J., Lombard, W.A. & Jordaan, H. 2019. How can the South African beef classification system be adapted to meet modern consumers' demands? In: *Proceedings of the 22nd International Farm Management Association Congress*, Launceston, Australia. 3-8 March 2019. pp: 1:1-11.

STAFF (2019)

Head of Department: Dr F Maré

Senior Professor: Prof A Chapagain
Associated Professor: Prof B Grové
Affiliated Professor: Prof M Bergman
Senior Lecturers: Prof H Jordaan, Dr F Maré, Dr N Matthews, Dr A Ogundeji and Mr JJ van Staden
Lecturers: Dr J Henning, Dr WA Lombard, Ms P Mohlotsane, Mr P Mokhatla, Mr J Strauss and Mr W van Niekerk
Junior Lecturers: Ms Z Coka and Mr M Monteiro
Senior Researcher: Dr Y Bahta
Researcher: Ms P Madende
Research Assistants: Mr T Adetoro, Mr M Dayimane, Ms A Erasmus, Mr B Jammer, Ms P Languza, Ms C Lues, Ms M Marais, Mr G Mashego, Ms S Mbobo, Mr G Mkhize, Mr A Moatlhodi, Ms N Motaung, Mr A Oberholzer, Mr C Richards, Ms G Smythe, Ms S Songca, Ms C-L Steyn and Mr M van den Heever
Research Associates: Dr B Riddout and Dr D Strydom
Affiliated Researcher: Mr P Oosthuizen
Programme Director: Dr J Henning
Officers: Ms I Combrinck and Ms C van der Merwe

DEPARTMENT OF

ANIMAL, WILDLIFE AND GRASSLAND SCIENCES

CONTACT DETAILS

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OVERVIEW OF 2019

Good rains at the beginning of 2019 and an early start to the new season in the eastern and northern parts of the country, created excellent conditions for both crop and livestock farming. The lush green plains and hills of these parts are a far cry from the harsh realities of the drought of a year ago, and reminds us of how quickly nature can recover if conditions are ideal.

Unfortunately, the situation is quite the opposite in the western parts of the country, where the devastating drought that is still raging in these parts is taking its toll on both human and animal lives. Herds and flocks that were established over decades are being decimated, while the morale of their human caretakers is at an all-time low. Although the Department 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 outbreak of foot-and-mouth disease in Limpopo again highlighted the vulnerability of the red meat industry to factors outside the control of the farmer. It is estimated that the outbreak could cost the industry between 6 and 10 billion rand, and the loss of export markets could take extremely long to recover. One positive thing that came from the outbreak is that all role players in the industry recognised the importance of both a traceability system and a proper working veterinarian sector. This is something that lecturers from this Department have advocated for a very long time, and hopefully government and the private sector can take hands to roll out a traceability system before the end of 2020.

The long shadow of the adoption of the policy of land expropriation without compensation is creating uncertainty in the farming community. The urgency of the matter sparks many discussions and hopefully sanity will prevail. It is, however, important to realise that land redistribution to people without the proper training and financial backing is doomed to failure. This Department is therefore actively involved in training emerging- and communal farmers through short courses and a mentoring programme on its experimental farms.

ACHIEVEMENTS

Staff Achievements

Dr Hester O' Neil was promoted to Senior Lecturer. Prof Michiel Scholtz received a C1-rating from the National Research Foundation (NRF), and Jamie Paulse attained his master's degree (*cum laude*).

Dr Foch de Witt serves on the Board of the South African Society for Animal Science (SASAS).

Prof Frikkie Neser received the Livestock Registering Federation (LRF) award for lifetime service to the livestock industry.

Student Achievements

The team from the UFS, comprised of two students from the Department of Animal, Wildlife and Grassland Sciences and one from the Department of Agricultural Economics, came fourth in the student quiz held at the SASAS congress in Bloemfontein.

Frans Jordaan, a PhD student in Animal Breeding, won the prize for the best presentation at the 2nd International Conference on Tropical Animal Production, held in Thailand.

Dr Ockert Einkamerer (6th from the left, back row) with students during a practical excursion to Parys

RESEARCH

The Department is actively involved in both research and technology transfer in the industry 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 rancher's face.

The highly successful SASAS congress, which was held in Bloemfontein, was mainly organised by our Department. All staff members and several students attended, and all made either oral or posters contributions.

Final-year BSc (Agriculture) students participated in the annual African Livestock Trade Fair (ALFA) week and the Aldam Stockman School, where they obtained valuable industry exposure.

Nutrition practical

ENGAGED SCHOLARSHIP

The annual national Silage King competition, organised and owned by Plaas Media, took place from June to July 2019. As in previous years, the UFS was entrusted with sampling maize silage from contestants from all over South Africa. Two MSc (Agriculture) students, Evan MacDonald and Kobie van der Walt, were in charge of the sampling and logistics for the whole competition and in a space of three weeks they travelled 12 000 km while sampling a total of 77 bunkers.

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

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 resource-poor farmers.

A predator management information centre was established in the Department. This centre 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 industry more than two billion rand annually. All the livestock sectors are involved in this centre.

The Department, together with Food Sciences, was also heavily involved in the ALFA Beef Challenge, during which meat samples of several beef brands were analysed to ascertain the best beef in South Africa.

Dr Francois Deacon held a symposium on rhino conservation that was attended by delegates from abroad as well as industry. At this symposium a conservation plan was adopted for the Sumatra and Java Rhino with Indonesian Government officials, in which the University of the Free State will play a pivotal role. This is done in collaboration with the South African National Parks (SANParks), Provincial Nature Conservation officials and private individuals.

Prof Frikkie Neser was a judge at the 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 several farmers' days in South Africa and Namibia, while research trials sponsored by companies such as Voermol, Molatek, Nutri Feeds, Supreme Chicken, Sernick and the Agricultural Research Council (ARC) were completed.

Fourth-year Animal Science students attending a farmers' day in Parys

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 our research.

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.

Fourth-year excursion to Ramsem

Dr Foch de Witt and Dr Ockert Einkamerer, in collaboration with the technical committee of the Animal Feed Manufacturers Association (AFMA), were involved in evaluating the chemical quality of hominy chop by using different milling processes.

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

Students busy with wool classification

POSTGRADUATE STUDENTS

In 2019, 63 students were enrolled at postgraduate level – 17 Honours, 32 master's and 14 PhD students.

Four students graduated with the MSc (Agriculture) majoring in Animal Science, namely Benita Tonateni Elago, Mamolleloa Alice Kao, Jocobus Francois Macdonald, and Thandululo Mudzungwane.

One PhD was awarded:
Maquashu, Ayanda
Thesis: Characterisation and evaluation of reproductive performance in Bapedi sheep breed
Promoter: Dr HA O'Neill

STAFF MATTERS

Dr Errol Cason and Ms Rulien Grobler were appointed as Senior Lecturer and Lecturer, respectively, and Mr Kabelo Moopelwa was appointed as Technical Officer in the Department.

RESEARCH OUTPUTS

Research Articles

Basu, C., Deacon, F., Hutchinson, J. & Wilson, A. 2019. The running kinematics of free-roaming giraffes, measured using a low cost unmanned aerial vehicle (UAV) *Peer J7* (e6312): 1-21.

Cardoso, L., Tarouco, J., Macneil, M., Lobato, F., Dambrós, M., De Freitas, A., Devincenzi, T., Feijó, F. & Cardoso, F. 2019. Sample size and prediction of weight and yield of individual cuts from Braford steers pistol hindquarters. *Scientia Agricola* 77(4):1-8.

De Wit, M., Du Toit, A., Fouche, H.J., Hugo, A. & Venter, S. 2019. Screening of cladodes from 42 South African spineless cactus pear cultivars for morphology, mucilage yield and mucilage viscosity. *Acta Horticulturae* 1247(7): 47-56. DOI: 10.17660/ActaHortic.2019.1247.

Deacon, F. & Tutchings, A. 2019. The South African giraffe *Giraffa camelopardalis giraffa*: A conservation success story. *Oryx* 53(1): 45-48.

Grobler, S.M., Scholtz, M.M., Neser, F.W.C., Greyling, J.P.C. & Morey, L. 2019. Effect of controlled breeding on performance of beef cattle in Central Bushveld bioregion. *South African Journal of Animal Science* 49(6): 1013-1020.

Josling, G.C., Hugo, A., Fair, M.D. & De Witt, F. 2019. Long term effect of dietary lipid saturation on eggshell quality and bone characteristics of laying hens. *Poultry Science* 98: 3593-3601.

Josling, G.C., Lepori, A.A.H., Neser, F.W.C., Lubout, P. & Van Wyk, J.B. 2019. Evaluating horn traits of economic importance in sable antelope (*Hippotragus niger niger*). *South African Journal of Animal Science* 49(1): 40-49.

Lepori, A.A.H., Josling, G.C., Neser, F.W.C., Lubout, P. & Van Wyk, J.B. 2019. Multi-trait genetic evaluation for horn traits of economic importance in the Cape buffalo (*Syncerus caffer caffer*). *South African Journal of Animal Science* 49(2): 363-370.

MacNeil, M., Scholtz, M.M., Maiwashe, A. & Jordaan, F. 2019. Alternative models for genetic evaluation of feed intake by Afrikaner cattle. *South African Journal of Animal Science* 49(4):763-769.

Mendonça, F., Macneil, M., Leal, W., Azambuja, R., Rodrigues, P. & Cardoso, F. 2019. Crossbreeding in beef cow-calf production and efficiency: Evaluation of Angus, Caracu, Hereford and Nelore breed direct, maternal and heterosis effects. *Translational Animal Science* 3: 128 -1295.

Mokolobate, M.C., Scholtz, M.M. & Neser, F.W.C. 2019. Investigating novelty traits to improve cow-calf efficiency in South African Afrikaner, Angus and Charolais for climate-smart production. *South African Journal of Animal Science* 49(4): 605-611.

O'Neill, H.A. 2019. A review on the involvement of catecholamines in animal behaviour. *South African Journal of Animal Science* 49(1): 1-8.

Upperman, L., Kinghorn, B., MacNeil, M. & Van Eenennaam, A. 2019. Management of lethal recessive alleles in beef cattle through the use of mate selection software. *Genetics Selection Evolution* 51(36): 1-16.

Van der Westhuizen, L., MacNeil, M., Scholtz, M.M. & Neser, F.W.C. 2019. Identification of genomic regions contributing to wet carcass syndrome in sheep. *South African Journal of Animal Science* 49(5): 845-856.

Van der Westhuizen, L., MacNeil, M.D., Scholtz, M.M., et al. Genetic variability and relationships in nine South African cattle breeds using microsatellite markers**.** *Tropical Animal Health and Production* 52(1):177-184. DOI: 10.1007/s11250-019-02003-z.

Van der Westhuizen, L., Magwaba, T., Grobler, J.P., Bindeman, H., Van Marle-Koster, E. & Neser, F.W.C. 2019. Genetic variability in a population of Letelle sheep in South Africa. *South African Journal of Animal Science* 49(2): 281-289.

Van Niekerk, M.E., Deacon, F. & Grobler, J.P. 2019. The genetic status of the introduced giraffe population in Central South Africa. *Koedoe* 61(1): 1-7.

Zwane, A., Schnabel, R., Hoff, J., Choudhury, A., Makgahlela, M.L., Van Marle-Koster, E., Maiwashe, A. & Taylor, J. 2019. Genome-wide SNP discovery in indigenous cattle breeds of South Africa. *Frontiers in Genetics* 10(273): 1-16.

Conference Contributions

Conference Papers/Posters

Black, W.J., Deacon, F. & Zietsman, P. 2019. *Objective home range analysis of GPS collared ungulates using plants and soils as potential prediction indicators*. Paper delivered at the Southern African Wildlife Management Association (SAWMA) Conference, Wilderness, South Africa. 1-5 September 2019.

De Klerk, I., Einkamerer, O.B., Hugo, A., Ferreira, A.V. & Fair, M.D. 2019. *The effect of diet neutral-detergent fibre content on the meat quality of finishing lambs*. Poster presented at the 51st South African Association for Animal Science (SASAS), Bloemfontein, South Africa. 10-12 June 2019.

Deacon, F. 2019. *Experiences on effective tranquilization, capturing and collaring of wild giraffe in Africa.* Paper delivered at the 2019 International Giraffid Conference, Columbus, USA**.** 20-23 May 2019.

Deacon, F., Black, W. & Zietsman, P.C. 2019. *Objective home range analyses of GPS collared livestock using plants and soils as potential prediction indicators.* Paper delivered at the 51st South African Association for Animal Science (SASAS), Bloemfontein, South Africa. 10-12 June 2019.

Einkamerer, O.B., Hugo, A., Ferreira, A.V. & Fair, M.D. 2019. *The effect of diet acid-detergent fibre content on the production performance of finishing lambs*. Paper delivered at the 51st South African Association for Animal Science (SASAS), Bloemfontein, South Africa. 10-12 June 2019.

Grobler, S.M., Scholtz, M.M. & Neser, F.W.C. 2019. *Effect of heat stress on calving percentage of beef cattle in the Central Bushveld Bioregion*. Poster presented at the 51st South African Association for Animal Science (SASAS), Bloemfontein, South Africa. 10-12 June 2019.

Janecke, B.B. 2019. *Use of faecal nitrogen to indicate nutritional status and seasonal trends in wildlife species.* Paper delivered at the 51st South African Association for Animal Science (SASAS), Bloemfontein, South Africa. 10-12 June 2019.

Janse van Rensburg, A., Deacon, F. & Paulse, J. 2019. *Scrutinising aspects that are considerate during the development of a non-invasive BCS (Body Condition Score) for giraffes (Giraffa camelopardalis)*. Poster presented at the Southern African Wildlife Management Association (SAWMA) Conference, Wilderness, South Africa. 1-5 September 2019.

Jordaan, F.J., Scholtz, M.M., Neser, F.W.C., Mokolobate, M.C. & Theunissen, A. 2019. *Early warning systems are important for livestock industries to overcome climate change*. Paper delivered at the 2nd International Conference on Tropical Animal Production, Nakhon Ratchasima, Thailand. 9-12 July 2019. [Award for Best Presentation].

Jordaan, F.J., Scholtz, M.M., Neser, F.W.C., Mokolobate, M.C. & Theunissen, A. 2019. *The effect of weather patterns on growth of beef calves in warmer parts of the country.* Paper delivered at the 51st South African Association for Animal Science (SASAS), Bloemfontein, South Africa. 10-12 June 2019.

Kuhn, J., Visser, H., Schutte-Smith, M. & Deacon, F. 2019. *Non-invasive analytical methods for the analysis of heavy metals and minerals in Giraffes (Giraffa camelopardalis).* Paper delivered at the Southern African Wildlife Management Association (SAWMA) Conference, Wilderness, South Africa. 1-5 September 2019.

Macdonald, J.F., Einkamerer, O.B., Lepori, A., Hugo, A., Josling, G.C. & Fair, M.D. 2019. *The effect of fibre source on the digestibility and production performance of finishing lambs.* Paper delivered at the 51st South African Association for Animal Science (SASAS), Bloemfontein, South Africa. 10-12 June 2019.

Maqhashu, A., Mphaphathi, M.L., Sebei, P.J., Raphulu, T, Ramukhithi, F.V., Bovula, N., Mapholi, N.O., Nephawe, K.A., O' Neill, H.A. & Nedambale, T.L. 2019. *Reproduction performance of Bapedi ewes following oestrous synchronisation and natural mating in different conservation farms.* Paper delivered at the 51st South African Association for Animal Science (SASAS), Bloemfontein, South Africa. 10-12 June 2019.

Mdyogolo, S., Neser, F.W.C., MacNeil, M.D., Scholtz, M.M., & Makgahlela, M.L. 2019. *Genotype imputation within and across South African Afrikaner and Brahman cattle.* Poster presented at the Plant and Animal Genome Conference (PAC), San Deigo, USA. 12-16 January, 2019.

Mdyogolo, S., Neser, F.W.C., MacNeil, M.D., Scholtz, M.M. & Makgahlela, M.L. 2019. *Linkage disequilibrium and characterization of haplotype blocks in South African Brahman and Afrikaner breeds using medium and high-density genotypes*. Paper delivered at the 51st South African Association for Animal Science (SASAS), Bloemfontein, South Africa. 10-12 June 2019.

Meeske, R., Venter, R. & Einkamerer, O.B. 2019. *Silage in South Africa: What can improve?* Paper delivered at the 51st South African Association for Animal Science (SASAS), Bloemfontein, South Africa. 10-12 June 2019.

Mohlapo, T.D., Van der Westhuizen, H.C., De Klerk, J.D., Majola, S.E., Snyman, H.A. & Neser, F.W.C. 2019. *Reproduction performance of beef cattle before and after implementing a sustainable grazing system in a semi-arid grassland of southern Africa.* Paper delivered at the 51st South African Association for Animal Science (SASAS), Bloemfontein, South Africa. 10-12 June 2019.

Mudzungwane, T., O'Neill, H.A & Fair, M.D. 2019. *Proposing the use of percentile graphs to set minimum breed standards for scrotal circumference in Drakensberger bulls in performance testing.* Paper delivered at the 51st South African Association for Animal Science (SASAS), Bloemfontein, South Africa. 10-12 June 2019.

Mukwevho, R., Van der Walt, A.J & Deacon, F. 2019. *Exploring how extreme temperature events influence movement patterns of giraffes at Rooipoort Nature Reserve, Northern Cape Province.* Paper delivered at the Southern African Wildlife Management Association (SAWMA) Conference, Wilderness, South Africa. 1-5 September 2019.

Ngayo, M., Fair, M.D., Neser, F.W.C., Scholtz, M.M. & Van Niekerk, M. 2019. *Factors affecting productive herd life in Nguni cows*. Paper delivered at the 51st South African Association for Animal Science (SASAS), Bloemfontein, South Africa. 10-12 June 2019.

O'Neill, H.A. 2019. *Catecholamines and the definition of animal behaviour and stress responsiveness.* Paper delivered at the 51st South African Association for Animal Science (SASAS), Bloemfontein, South Africa. 10-12 June 2019.

O'Neill, H.A., Neser, F.W.C. & Elago, B.T. 2019. *Fibre quality influences faecal glucocorticoid metabolites of South African mutton merino sheep.* Paper delivered at the 70th Annual meeting of the European Federation of Animal Science, Ghent, Belgium. 26-30 August 2019.

Pyoos, C.M., Scholtz, M.M., MacNeil, M., Theunissen, A. Vermeulen, D.P. & Neser, F.W.C. 2019. *Predicted performance for pre-weaning traits and cow-calf efficiency in a beef crossbreeding program*. Poster presented at the 68th Annual Meeting European Association of Animal Production, Ghent, Belgium. 27-31 August 2019.

Pyoos, G.M., Scholtz, M.M., MacNeil, M.D., Theunissen, A. & Neser, F.W.C. 2019. *Cow-calf efficiency of a three-breed diallel of Afrikaner, Bonsmara and Nguni and topcrosses by Angus and Simmental sires*. Poster presented at the 51st South African Association for Animal Science (SASAS), Bloemfontein, South Africa. 10-12 June 2019.

Sako, T., O'Neill, H.A., Sedumedi, T., Jonker, T. & Fair, M.D. 2019. *Preliminary results: Means of the pH profile, dressing percentage and drip loss in meat of Tankwa goats.* Paper delivered at the 51st South African Association for Animal Science (SASAS), Bloemfontein, South Africa. 10-12 June 2019.

Scholtz, M.M., Chadyiwa, M.C., Jordaan, F.J., Pyoos, G.M., Theunissen, A., Bareki, N.P. & Neser, F.W.C. 2019. *Breeding strategies to lower the carbon footprint of livestock.* Paper delivered at the 51st South African Association for Animal Science (SASAS), Bloemfontein, South Africa. 10-12 June 2019.

Smit G.N., De Klerk J.N. & Schneider, M.B. 2019. *An assessment of woody biomass as a sustainable energy source in a bush thickened area of northern Namibia.* Paper delivered at the 51st South African Association for Animal Science (SASAS), Bloemfontein, South Africa. 10-12 June 2019.

Smit, G.N, Deacon, F. & Janse van Rensburg, G. 2019. *An assessment of woody biomass as a sustainable energy source in a bush thickened area of northern Namibia.* Paper delivered at the 51st South African Association for Animal Science (SASAS), Bloemfontein, South Africa. 10-12 June 2019.

Smit, Z.M., Deacon, F., Malan, P.J. & Smit G.N. 2019. *The impact of drought on the species composition, veld condition and forage availability of Witsand Nature Reserve and implications for game management*. Paper delivered at the 54th Congress of the Grassland Society of southern Africa, Upington, South Africa. 2-4 July 2019.

Smit, Z.M., Deacon, F., Malan, P.J. & Smit G.N. 2019. *The impact of drought on the species composition, veld condition and forage availability of Witsand and Nature Reserve and implications for game management.* Paper delivered at the 16th Kimberley Biodiversity Research Symposium, Kimberley, South Africa. 18 September 2019.

Stehn, I.J. & Smit, G.N. 2019**.** *Effect soil and sub habitat differentiation on the growth of Tarchonanthus camphoratus seedlings*. Paper delivered at the 16th Kimberley Biodiversity Research Symposium, Kimberley, South Africa. 18 September 2019.

Stehn, I.J. & Smit, G.N. 2019. *Effect soil and subhabitat differentiation on the growth of Tarchonanthus camphoratus seedlings*. Paper delivered at the 54th Congress of the Grassland Society of southern Africa, Upington, South Africa. 2-4 July 2019.

Taljaard, I.J., Deacon, F. & Einkamerer, O.B. 2019. *Nutrient effect on browsing preferences of Giraffa Camelopardalis in semi-arid savannas of South Africa*. Paper delivered at the Southern African Wildlife Management Association (SAWMA) Conference, Wilderness, South Africa. 1-5 September 2019.

Van der Westhuizen, H.C., Mohlapo, T.D., De Klerk, J.D., Majola, S.E., Snyman, H.A. & Neser F.W.C. 2019. *Reproduction performance of beef cattle before and after implementing a sustainable grazing system in a semi-arid grassland of southern Africa*. Paper delivered at the 51st South African Association for Animal Science (SASAS), Bloemfontein, South Africa. 10-12 June 2019.

Van der Westhuizen, L., MacNeil, M.D., Scholtz, M.M. & Neser, F.W.C. 2019. *Identification of genomic regions contributing to wet carcass syndrome in sheep.* Paper delivered at the 51st South African Association for Animal Science (SASAS), Bloemfontein, South Africa. 10-12 June 2019.

Van Niekerk, M., Neser, F.W.C. & Ducrocq, V. 2019. *Reranking of EBV's of SA Holstein sires using different models under two production systems*. Paper delivered at the 68th Annual Meeting of the European Association of Animal Production, Ghent, Belgium. 27-31 August 2019.

Van Niekerk, M.E., Deacon, F. & Grobler, P.J. 2019. *The genetic status of the introduced giraffe population in Central South Africa.* Paper delivered at the Southern African Wildlife Management Association (SAWMA) Conference, Wilderness, South Africa. 1-5 September 2019.

Conference Proceedings

Maqhashu, A., Mphaphathi, M.L., Sebei, P.J., Raphulu, T, Ramukhithi, F.V., Nthakheni, N.D., Bovula, N., Mapholi, N.O., Nephawe, K.A., O' Neill, H.A. and Nedambale, T.L. 2019. Influence of age and body condition score on oestrous synchronization response in Bapedi. In: *Proceedings of All Africa Conference in Animal Agriculture.* Accra, Ghana. 28 July-2 August 2019.

Scholtz, M.M., Mokolobate, M.C., Pyoos, G.M, Jordaan, F.J, Theunissen, A. & Neser, F.W.C. 2019. Ruminant production systems in sub-Saharan Africa to mitigate global warming. In: *Proceedings of the 2nd International Conference on Tropical Animal Science and Production* (Ed: S. Khempaka). Suranari, Thailand. 8-12 July 2019.

STAFF (2019)

Head of Department: Prof FWC Neser

Professors: Prof FWC Neser and Prof GN Smit

Senior Lecturers: Dr ED Cason, Dr F Deacon, Dr FH de Witt and Dr MD Fair

Lecturers: Dr OB Einkamerer, Ms R Grobler, Dr BB Janecke, Ms GC Josling, Dr PJ Malan and Dr HA O'Neill

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 A Maiwashe, Prof M Makgahlela, Prof TL Nedambale, Prof MM Scholtz, Prof H Snyman and Prof JB van Wyk

Programme Director: Dr MD Fair

Veterinarian: Dr L Meiring

Technician: Ms JAM van der Merwe

Senior Assistant Officer: Ms NAK Green

Officer: Mr KR Moopelwa

Assistant Officer: Ms CJ Williams

Technical Assistants: Mr NK Long and Mr SA Rowles

Messenger: Ms MV Moses

Cleaner: Ms NM Mokoallo

DEPARTMENT OF

SOIL, CROP AND CLIMATE SCIENCES

CONTACT DETAILS

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OVERVIEW OF 2019

In 2019 the Department of Soil, Crop and Climate Sciences played a key role in teaching and learning, academic research and the provision of community services in the soil-plant-atmosphere continuum. Some key activities and events in 2019 included:

- Following the recommendation of the external review committee report of 2018, the Department embarked on a review of the undergraduate curriculum in 2019. The review is expected to be completed in 2020.
- The Department laid the foundation for a new qualification for a structured Master of Science, specialising in Climate Change. The new qualification will start in 2021.
- Academic staff and students won several prizes for outstanding research presentations at national conferences and competitions.
- The Department continued to be engaged in a broad range of research supported by different private and public donors. Noteworthy is the intensified collaboration with Grain SA in research and capacity building.
- Departmental staff made extended research visits to TU Dresden (Germany), Wageningen UR (the Netherlands), Rothamsted (UK) and the Federal University of Rural Rio de Janeiro (Brazil).

ACHIEVEMENTS

Staff Achievements

In January 2019, the UFS Bloemfontein Campus hosted the Combined Congress 2019 representing four scientific societies – 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). Dr Gert Ceronio was chairperson of the local organising committee, which also included staff members Dr Coetzer, Dr Van der Watt, Dr Allemann and Mrs Henning. Staff and students made five presentations at the Congress. A photosynthesis workshop was also hosted in collaboration with Campbell Scientific on 25 January 2019 with 15 attendees from industry and universities.

Dr Elmarie van der Watt was elected as secretary of the SASCP.

Dr James Allemann won the CropLife award for the best presentation in Weed Science with a paper titled 'Evaluation of metham sodium for the control of volunteer potatoes'. He was also awarded the Dave Annecke research award for outstanding research in the field of Weed Science.

Dr James Alleman receiving the award for best presentation in Weed Science

Prof Linus Franke won the prize for the best scientific presentation at the Potatoes South Africa research symposium. Furthermore, he was appointed as editor-in-chief of the *South African Journal of Plant and Soil* in 2019.

Student Achievements

Miss Ingrid Allemann won the Syngenta award for the best student presentation in Weed Science with a paper titled 'Impact of drought on the allelopathic effects of Amaranth'.

Ingrid Alleman receiving the Syngenta award

Lindokuhle Xolani Dlamini (supervisor Dr E Kotzé) received the prize for best poster presentation at the 2019 Conservation Symposium held in KwaZulu-Natal, with the title 'Soil carbon dynamics of a montane fire-climax grassland, Cathedral Peak, Drakensberg, South Africa'.

Three Agronomy students competed in the Old Mutual Agricultural Student of the Year Competition 2019 on the Bloemfontein Campus. Mr Wian Visser, final-year BSc (Agriculture) Agronomy student, was the top scorer in Crop Production. Participating with the UFS in this competition, were Stellenbosch University (producing the overall winner in the Animal Science section), University of Fort Hare, North-West University, and the University of Pretoria. As with last year's competition, the students first had to compete in an initial round at their respective universities, after which eleven finalists proceeded to the final round held during the ALFA Expo at the Afridome in Parys.

Participants in the Old Mutual Agricultural Student of the Year Competition, from the left: Mr W Visser, Miss Q Mazwi and Mr J Fick

Grain SA awarded bursaries for strong academic postgraduate students within previously disadvantaged groups. One Honours, Karabo Calvin Leputo, and two MSc (Agriculture) candidates, Bandile Simelande and Uviwe P Njombela, were awarded bursaries.

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

TEACHING

Following the recommendation of the external review committee which visited the Department in 2018, we embarked on a review of the undergraduate curriculum in 2019. The aim of the review is to streamline the undergraduate curricula, reduce overlap in teaching between modules, further separate the curriculum of the BAgric from the BSc, and to give more emphasis in the curriculum to contemporary themes, such as the environmental impacts from farming. In addition, horticulture as a specialisation of crop production has been expanded in the curriculum. The review of the curriculum is expected to be completed in 2020 and implemented from 2021.

The micrometeorology (CLIM4814/6814) students visited field trials conducted by Dr Tesfuhuney in Thaba 'Nchu and Mr Tharaga at the Ionia Cherry Farm near Ficksburg. Some of these students also attended a sap flow workshop at the University of KwaZulu-Natal in July. Students in the CLIM2714/3754 class attended a presentation by Prof Matie Hoffmann at the Naval Hill Planetarium titled 'Our Fragile Planet'.

Students visiting the micrometeorological tower at Ionia Cherry Farm, Ficksburg

RESEARCH

Soil Science

Prof Cornie van Huyssteen spent a two-month sabbatical visit at the Federal University of Rural Rio de Janeiro (UFRRJ), in Brazil. During this visit he worked on a manuscript to relate the South African soil taxonomy to the World Reference Base (WRB) for soil resources. Prof Van Huyssteen also attended two field workshops during his sabbatical visit – one in Mongolia and the other in north-eastern Brazil.

Other projects being conducted by his students include research on soil properties of ephemeral pans in the Northern Cape Province; response of wetland indicator grass species to degree of soil water saturation; identifying wetland soil properties aiding the dormancy of Rift Valley Fever vectors in central South Africa; the pedogenesis of soils with retic properties in South Africa; and the adsorption of As and Se in soil material as influenced by pH and iron oxide content.

Prof Johan van Tol was awarded a one-month research fellowship by TU Dresden in Germany. During this time the collaboration resulted in a joint research proposal and two journal articles. Johan is also leading a tri-lateral National Research Foundation (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. In addition, he is leading a project funded by the Department of Environmental Affairs - Natural Resource Management (DEA-NRM) on developing soil rehabilitation norms for selected catchments. Dr Elmarie Kotzé and Dr Makhosazana Aghoghovwia are part of this project team.

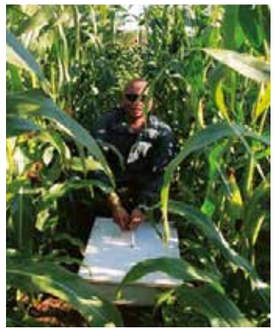
Prof Chris du Preez acted as supervisor and mentor for more than ten students during 2019, and was also examiner for three postgraduate students and examiner for ten national and international manuscripts. He produced three peer-reviewed publications, six peer-reviewed publications and delivered seven papers at national and international conferences.

Crop Sciences

In 2019, the research on cactus pear, led by Dr Gesine Coetzer, continued with success. The establishment of a gene bank of 42 cultivars on West Campus, as well as research on the effect of different nitrogen sources and application rates, is ongoing. Natural product screening to identify plants producing potential fungicides, pharmaceuticals, insecticides and herbicides continued during the year, and produced some encouraging results. In collaboration with Entomology, two plants were identified with good repellency activity against *Lucilia* spp. New projects also started 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.) is also being investigated.

Management guidelines for technology transfer to decrease salinisation of irrigated land with precision agriculture continued, as well as research on various factors affecting sunflowers emergence – such as herbicides, temperatures and fertilisation practices. Together with Grain SA, different maize cultivars will be evaluated in terms of growth and yield response at different locations. In collaboration with AB-InBev, the effect of different water shortage regimes will the tested on sorghum.

Mr Jerry Dlamini spent six months doing fieldwork for his PhD at Rothamsted Research, North Wyke, United Kingdom. His research involves measurements of greenhouse gas emissions (nitrous oxide [N_2O], methane [CH_4] and carbon dioxide [CO_2]) from croplands and buffers.



Left image: Jerry Dlamini beside one the longest running agricultural experiments in the world, the Broadbalk situated in Rothamsted Research Station
Right Image: Jerry Dlamini sampling greenhouse gas using the static chamber technique in a maize field

Agro-meteorology

Prof Linus Franke received a visiting scientist grant to visit Wageningen University in the Netherlands in January 2019, where he led a mini-symposium on the role of farming systems' research in land reform.

Research on resource use efficiencies of potato-based systems in the North West and the Sandveld in the Western Cape continued in 2019. The results of this work highlighted the importance of irrigation scheduling techniques to reduce water and nutrient leaching from sandy soils, and have been communicated through various platforms (such as *CHIPS* magazine and conference presentations). New work on the agronomy of hybrid potato grown from true seed has been initiated.

Mr Stephan Steyn conducted research, funded by Iphakade, on 'Assessing climate-related fire danger across the Central Grassland Biome of South Africa', for his PhD.

Mr Charles Tharanga continued his research on the 'Measurements of evapotranspiration and water use efficiency of sweet cherry trees in the Eastern Free State'. The project, which is for his PhD, has been running since 2016, and is funded by the NRF-Thuthuka. Mr Tharaga attended the Scintillometry training course from 1 to 5 April, at Kipp and Zonen in Delft, the Netherlands.

Dr Weldemichael Tesfuhuney and the students under his supervision conducted research on crop-water relations. Field trials on the effects of cover crops on soil water storage and yield of maize under in-field rainwater harvesting (IRWH) continued at the Kenilworth Experimental Farm in Bainsvlei.

ENGAGED SCHOLARSHIP

As part of the research funded by the Water Research Commission (WRC) on the 'Uptake of knowledge, technology and practices for improving water productivity in rainfed cropping systems', Dr Tesfuhuney and his team have implemented a project in two villages in the vicinity of Thaba 'Nchu. The main activity of the community project was conducting field demonstrations of integrated rainwater harvesting and maize-bean intercropping systems. The aim was also to interact with farmers, extension officers, researchers and policy advisors to discuss the intensification of knowledge uptake for improved water saving techniques.

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

Prof Franke was a panel member of the NRF-rating committee assigning ratings to scientists in the field of earth sciences in 2019. He also serves as the editor-in-chief of the *South African Journal of Plant and Soil*.

NATIONAL AND INTERNATIONAL COLLABORATION

The Department has extensive research collaborations with universities in South Africa (particularly the University of Pretoria, Stellenbosch University and the University of Fort Hare) and other institutions such as the Agricultural Research Council (ARC), Weather SA and the WRC. Internationally, the Department has on-going research collaboration with Wageningen University (the Netherlands), Technical University Dresden (Germany), and the International Maize and Wheat Improvement Centre (CIMMYT) in Zimbabwe.

The Department also undertakes research projects with private sector partners such as Agraforum, SAB, AB-InBev, Grain SA, Potatoes SA, South African Sugarcane Research Institute (SASRI), SeedCo (Zimbabwe) and Solynta (the Netherlands).

Prof Franke visited the Regional Universities Forum for Capacity Building in Agriculture (RUFORUM) in Uganda to contribute to the development of a proposal for an intra-Africa mobility grant in soil science and meteorology. A collaborative project with Wageningen University on the role of soil C in conservation agriculture led to a workshop in December 2019, where key role players in conservation agriculture in South Africa were invited to develop a research agenda on conservation agriculture in South Africa.

POSTGRADUATE STUDENTS

In 2019, a total of 7 students were enrolled for the Honours degree, 48 for the MSc, and 17 for the PhD.

In terms of graduations, Tshiamo Setsipane, Thato Gail Lebuchwane, Tlhokomelo Motema, and Diandra Steenkamp graduated with the MSc degree.

Two PhDs were awarded in 2019:

Mengistu, Achamyeleh Girma
Thesis: Application of SWAT model to evaluate the water balance of an arid catchment
Promoter: Prof LD van Rensburg

Labeja, Richard
Thesis: Effects of climate change scenarios on maize and finger millet production in northern Uganda
Promoter: Prof AC Franke

POSTDOCTORAL RESEARCH FELLOWS

The Department hosted four postdoctoral research fellows during 2019:

- Dr Palo Francis Loke, from Lesotho
- Dr Sabelo Mvimbela, from Swaziland
- Dr Zaid Bello, from Nigeria
- Dr Tendai Chibaradaba, from Zimbabwe

STAFF MATTERS

After his retirement in 2018, Prof Chris du Preez was appointed on a part-time basis as an Associate Researcher. Prof Johan van Tol was promoted in the beginning of 2019 to Associate Professor.

Dr Nester Mashingaidze joined the Department as Senior Lecturer on 1 September 2019. Prior to this, she was a lecturer in the Department of Agronomy at Midlands State University, Zimbabwe from 2016 to 2019. She did her postdoctoral research on Farming Systems Analysis in East Africa with the International Institute of Tropical Agriculture (IITA) and the Farming Systems Ecology Group at Wageningen University. Her key research areas include weed ecology and management, conservation agriculture, nutrition-sensitive agriculture, sustainable agriculture and rural development, and farming system analysis. She will take over duties from Dr James Allemann, who recently retired.

Dr Nester Mashingaidze

RESEARCH OUTPUTS

Research Articles

Chichongue, O., Pelser, A., Van Tol, J.J., Du Preez, C. & Ceronio, G. 2019. Factors influencing the adoption of conservation agriculture practices among smallholder farmers in Mozambique. *International Journal of Agriculture Extension* 7(3): 277-291. DOI:10.33687/ijae.007.03.3049.

Descheemaeker, K., Ronner, E., Ollenburger, M., Franke, A.C., Klapwijk, C., Falconnier, G.N., Wichern, J. & Giller, K.E. Which options fit best? Operationalizing the socio-ecological niche concept. *Experimental Agriculture* 55(S1): 169-190. DOI: 10.1017/S0014479716000048X.

Flynn, T., Van Zijl, G.M., Van Tol, J.J., Botha, C., Rozanov, A., Warr B. & Clarke, C. 2019. Comparing algorithms to disaggregate complex soil polygons in contrasting environments. *Geoderma* 352: 171-180.

Franke, A.C., Baijukya, F., Kantengwa, S., Reckling, M., Vanlauwe, B. & Giller, K.E. 2019. Poor farmers – poor yields: Socio-economic, soil fertility and crop management indicators affecting climbing bean productivity in Northern Rwanda. *Experimental Agriculture* 55(S1): 14-34. DOI: 10.1-17/S00014479716000028.

Kermah, M., Franke, A.C., Ahiabor, B.D.K., Adjei-Nsiah, S., Abaidoo, R.C. & Giller, K.E. 2019. Legume-maize rotation or relay? Options for ecological intensification of smallholder farms in the Guinea Savanna of Northern Ghana. *Experimental Agriculture* 55(5): 673-691. DOI: 10.1017/S0014479718000273.

Lebenya R.M., Van Huyssteen, C.W. & Du Preez, C.C. 2019. Carbon stocks in aboveground biomass of eight-year-old Pinus and Eucalyptus species planted in sub-humid grassland soils. *Australian Forestry*. 82(2): 70-78.

Mabuza, B.B. & Van Huyssteen, C.W. 2019. Effect of degree and duration of water saturation on iron, manganese, and exchangeable cations in wetland soils of Maputaland, KwaZulu-Natal, South Africa. *South African Journal of Plant and Soil*. 36(4): 279-287.

Mavimbela, S.S.W., Ololade, O.O., Van Tol, J.J. & Aghoghovwia, M.P. 2019. Characterizing landfill leachate migration potential of a semi-arid duplex soil. *Heliyon* 5(10). DOI: 10.1016/j.heliyon.2019.e02603.

Parwada, C. & Van Tol, J.J. 2019. Effects of litter quality on macroaggregates reformation and soil stability in different soil horizons. *Environment, Development and Sustainability* 21: 1321-1339. DOI: 10.1007/s10668-018-0089-z.

Parwada, C. & Van Tol, J.J. 2019. Influence of litter source on soil splash rates and organic carbon loss in different soil horizons. *WaterSA* 45(1): 12-19.

Stolk, A. & Van Huyssteen, C.W. 2019. Clay and iron oxide contents of prismacutanic B, G, soft plinthic B, and E horizons described during the land type survey of South Africa. *South African Journal of Plant and Soil*. 36(3): 165-172.

Van Tol, J.J. & Le Roux, P.A.L., 2019. Hydropedological grouping of South African soil forms. *South African Journal of Plant and Soil*. 36(3): 233-235. DOI: 10.1080/02571862.2018.1537012.

Van Zijl, G.M., Van Tol, J.J., Le Roux, P.A.L. & Tinnefeld, M. 2019. A hillslope based digital soil mapping approach, for hydropedological assessments. *Geoderma* 354(6). DOI: 10.1016/j.geoderma.2019.113888.

Chapters in Books

Du Preez, C.C., Kotzé, E. & Van Huyssteen, C.W. 2019. Soils, agriculture and food. In: *The Geography of South Africa – Contemporary Changes and New Directions*. J. Knight & C.M. Rogerson (Eds). Cham: Springer. pp 111-124.

Du Preez, C.C., Kotzé, E. & Van Huyssteen, C.W. 2019. Southern African soils: their properties and susceptibility. In: *Southern African Landscapes and Environmental Change*. P.J. Holmes & J. Boardman (Eds). New York: Routledge. pp 29-52.

Van Huyssteen, C.W., Du Preez C.C. & Holmes P.J. 2019. Agriculture and a changing biophysical environment. In: *Southern African Landscapes and Environmental Change*. P.J. Holmes & J. Boardman (Eds). New York: Routledge. pp 228-248.

Conference Contributions

Conference Papers/Posters

Amelung, W., Du Preez, C.C., Kogel-Knaber, I., Hounkpatin, O. & Sandhage-Hofmann, A. 2019. *Subsoil controls of soil organic carbon sequestration in former arable soils.* Paper delivered at the Initiative Conference, Poitiers, France. 17-20 June 2019.

Dlamini, L.X., Kotze E. & Feig, G. 2019. *Soil carbon dynamics of a montane fire-climax grassland, Cathedral Peak, Drakensberg, South Africa*. Paper delivered at the Conservation Symposium, St. Ives, South Africa. 4-8 November 2019. [Award for Best Poster Presentation].

Harrison R. & Van Tol, J.J. 2019. *Interactions between dissolved organic carbon and hydropedology*. Paper delivered at the Conservation Symposium, St. Ives, South Africa. 4-8 November 2019.

Le Roux, P.A.L., Van Tol, J.J. Bouwer, D. & Van Zijl, G.M. 2019. *Hydropedology, what makes it different*. 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. 21-24 January 2019.

Mamera, M. & Van Tol, J.J. 2019. *Application of hydropedological information to conceptualize pollution migration from dry sanitation systems in the Ntabelanga catchment area, South Africa.* 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. 21-24 January 2019.

Mavimbela, S.S.W., Ololade, O.O., Van Tol, J.J. & Aghoghovwia, M.P. 2019. *Leachate migration potential of a duplex soil type at the Bloemfontein Southern solidwaste landfill.* 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. 21-24 January 2019.

Sandhage-Hoffman, A., Loffler, J., Kotze, E., Weijers, S., Wingate, V., Wundram, D., Weihermuller, L., Pape, R., Du Preez, C.C. & Amelung, W. 2019. *Bush encroachment and related soil properties in different tenure based management systems of semi-arid rangelands: A case study in different tenure and management systems of the Kalahari, South Africa.* Paper delivered at the Jahrestagung der Deutschen Bodenkundlichen Gessellschaft, Bern, Switzerland. 24-30 August 2019.

Scott, D.A., Bach, E.M., Du Preez, C.C., Six, J. & Baer, S.G. 2019. *Role of soil microbes in physical sequestered carbon during restoration*. Paper delivered at the Annual Meeting of Ecological Society of America, Louisville, USA. 11-16 August 2019.

Seepamore, M.K., Du Preez, C.C. & Ceronio, G.M. 2019. *Impact of long-term production management practices on wheat grain yield under a semi-arid climate.* 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. 21-24 January, 2019.

Van Huyssteen, C.W. & Anjos, L.H. 2019. *Towards harmonising the South African and Brazilian soil classification systems with the World Reference Base.* Paper delivered at the Soil Science Society of America (SSSA) International Annual Meeting, San Antonio, USA. 10-13 November 2019.

Van Tol, J.J. & Le Roux, P.A.L. 2019. *Hydropedological grouping of South African soil forms.* 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. 21-24 January 2019.

Venter, A.E. & Du Preez, C.C. 2019. *Amount of monoammonium phosphate needed to increase extractable soil P in alkaline and calcareous sandy soils.* 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. 21-24 January 2019.

STAFF (2019)

Head of Department: Prof AC Franke

Professors: Prof CW van Huyssteen and Prof LD van Rensburg

Associate Professors: Prof AC Franke and Prof JJ van Tol

Senior Lecturers: Dr J Barnard, Dr G Ceronio, Dr G Coetzer, Mrs L de Wet, Dr E Kotzé, Dr N Mashingaidze, Mr S Steyn, Dr W Tesfuhuney and Dr E van der Watt

Lecturers: Dr AP Aghoghovwia and Mrs N Mathinya

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

Officer: Mr B Tshabang

Messenger: Mr E Moeti

BUILDING
SCIENCES

DEPARTMENT OF ARCHITECTURE

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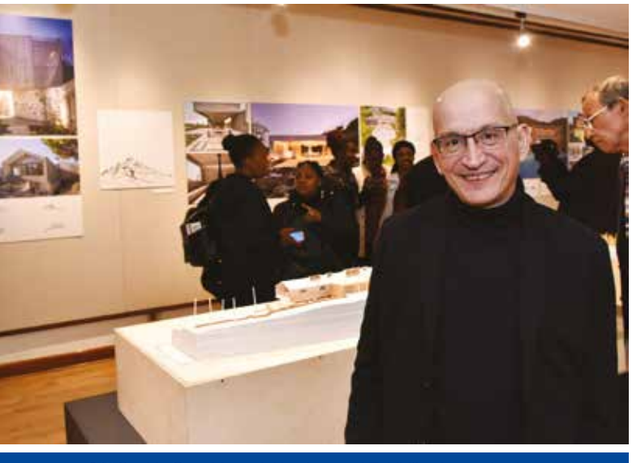
OVERVIEW OF 2019

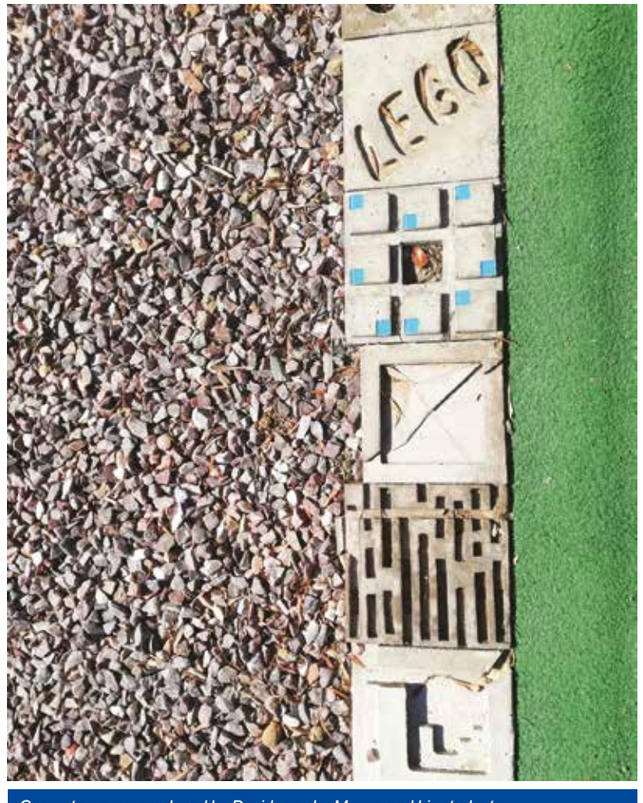
The 2019 academic year presented many challenges, but it was once again a busy and productive year with many rewards for the staff and students of the Department of Architecture. We welcomed Prof Jonathan Noble as the new Head of Department.

We hosted the 31st Sophia Gray Memorial lecture, delivered by Jon Jacobson of Metropolis, the first student to receive the new Master in Architecture with specialisation in Design degree. The lecture was titled 'in [de]finite'. The accompanying exhibition at Oliewenhuis was well-attended and critically acclaimed.



31st Sophia Gray Memorial Lecture and Exhibition Laureate, Jon Jacobson

Physical upgrades to the departmental infrastructure were also completed this year. The space to the north of the building was upgraded with new paving, for which Mr David van der Merwe and students produced concrete pavers. Other upgrades included new data projectors and screens in the design studios.



Concrete pavers produced by David van der Merwe and his students

ACHIEVEMENTS

Staff Achievements

At the annual Faculty welcoming event in February 2019, Mrs Wanda Verster Odendaal and Mr Jako Olivier received the 2018 Faculty Award for best lecturers in curriculum innovation. The Dean, Prof Danie Vermeulen, and Ms Elzmarie Oosthuizen, the Faculty Teaching and Learning Manager, presented the award.

Mrs Odendaal also received accreditation as a Grade II cultural historian (architecture) from the South African Society for Cultural History (SASCH) in February, as well as recognition in the form of a research support award from Prof Corli Witthuhn, the Vice-Rector: Research, Innovation and Internationalisation.

Mr Kobus du Preez and Dr Hendrik Auret received a South African Institute of Architects (SAIA) Free State regional award for architecture, for the temporary installation of a reflective prism on the University red square in front of the MT Steyn statue.

The reflective prism installation at the MT Steyn statue

Student Achievements

MArch (Professional) student, Mr S Diedericks, received the Free State Corobrik Student of the Year regional prize. Mr R Roode received the second prize and Ms G Linder-Haber received the third prize, and the prize for the best use of masonry was awarded to Ms M le Roux.

From the left: Ms M le Roux, Mr S Diedericks, Mr G Pillay (Corobrik Sales Manager, Central South Africa), Ms G Linder-Haber and Mr R Roode

The third-year BArch students took up the challenge and competed in the PG Bison design competition and in the PPC Imaginarium. Lunell Greyling and Rohan Cloete were the two finalists for the PG Bison competition. Suzani van der Merwe was the runner-up for the PPC competition with her project, 'Finding identity within the Grid'. The project explored how we can establish urban communities for people that do not have shared memories of that specific place.

BArchHons student, Margaux Loubser's project, 'Scrivum', was selected out of 84 submitted projects as the Green Award winner in the Pavilosta Poet Huts international competition.

Professional architects, Pieter Matthews and Jon Jacobson, became the first two students to present their work in the newly developed Master in Architecture with specialisation in Design degree. Jon Jacobson received his degree *cum laude* at the June graduation ceremony, and Pieter Matthews received his degree during the December graduation.

The MArch (Professional) class of 2018 did very well, with four students earning their degrees with distinction during the June graduations.

TEACHING

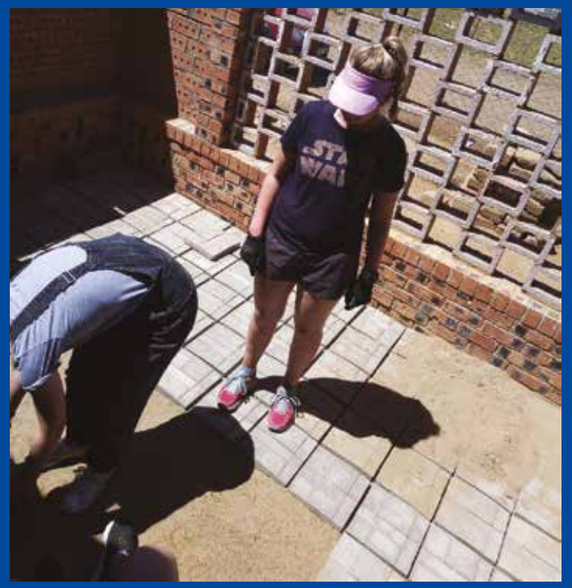
The first- and second-year BArch students toured to Pretoria during the first week of August and the first- and third-year students visited the Eastern Free State, including Clarens and Ficksburg. The BArchHons class attended the International Union of Architects (UIA) conference in Johannesburg.

First- and second- year student tour to Clarens and Ficksburg

ENGAGED SCHOLARSHIP

In 2019 Mr Hein Raubenheimer and Prof Gerhard Bosman continued with the finalisation of the Community Service Learning (CSL) project 'An experimental earth-constructed dwelling in Mangaung'. Student involvement on site was facilitated within the existing CSL-modules of the Department of Architecture. As part of their design and construction modules, small groups of students spent time with community builders and lecturers on site.

In August 2019, the first-year class designed, made and installed 28 sq m of concrete paving at the experimental house under the supervision of Ms Annemarie Wagener. This made a considerable difference to the comfort of the family as less dust now enters the house. The children can also safely play under the sunscreen constructed in the enclosed courtyard.



Installing concrete paving at experimental house

RESEARCH

Our Head of Department, Prof Jonathan Noble completed his new book, titled *The Architecture of Peter Rich: Conversation with Africa*, to be published in 2020 by Lund Humphries, UK. The book has been a five year-long research project.

Research publications of 2019 are listed in the relevant section below.

Students in the second- and third-year engaged with alternative construction methods, such as tyre and cob construction, as part of the Earth Unit activities linked to projects with Dr Anita Venter from the Centre for Development Support.

Architecture students during the construction of an earth constructed building in Roodewal, Bloemfontein-Mangaung

The Mangaung experimental project, which was featured on the UFS web landing page, received several material and cash donations from suppliers, manufacturers and alumni of the Department of Architecture. Local artisans, Diphapang Machabe, April Milela, Kabelo Lando and Petrus Letsoara assisted with the project.

Programme Director, Mr Kobus du Preez, represented the SAIA (Free State) and the Department during career open days at schools in the Free State. He also served on the task team involved with the debate and relocation regarding the Pres Steyn Statue on the UFS Bloemfontein Campus, and is a council member of the Free State Provincial Heritage Resources Authority.

Research Assistant, Wanda Verster Odendaal, continued to serve on the editorial advisory board of *Architecture SA: Journal for the South African Institute of Architects.*

During the Free State Arts Festival, the Department hosted the annual Winter School for Grade 11 and 12 learners who are considering architecture as a career. In 2019 it was under the direction of Mr David van der Merwe. This event has been a core supplement to departmental marketing activities since 2006.

2019 Winter School

NATIONAL AND INTERNATIONAL COLLABORATION

Prof Jonathan Noble travelled to Adelaide, Australia, where he attended the Practice Research Symposium in May 2019. The symposium provided the opportunity to strengthen the support networks for the new PhD (Architecture with Design) degree programme at the UFS.

The Earth Unit continued with responsibilities as a UNESCO Earth Architecture member, by participating in the scientific committees of international conferences hosted by UNESCO partners.

Prof Bosman participated in and presented a lecture at the Reed Cob International Summer Workshop (held in collaboration with an architectural practice, CAS Studio in partnership with the FCT/Nova University of Lisbon), at the Caparica Campus, Almada, Portugal (22-27 July 2019). There were 45 participants from 9 different countries that participated in different earth construction techniques workshops, and structural performance and weathering laboratory tests.

OTHER ACTIVITIES

Mr Jan Ras and Mr Kobus Du Preez organised the events around the August architecture activities at the UFS and assisted Jon Jacobson with his exhibition in the Oliewenhuis Art Museum for the 31st annual Sophia Gray Memorial Lecture and Exhibition.

Prof Jonathan Noble organised the symposium for the PhD (Architecture with Design) programme.

POSTGRADUATE STUDENTS

At the 2019 graduations, 37 students graduated with the Bachelor of Architecture Honours (BArchHons) degree, and 34 with the Master of Architecture (Professional) (MArch) degree, with four attaining the degree with distinction. The Master of Architecture with specialisation in Design (MArch) saw its first three graduates.

Trish Emmet and Anneke Wolvaardt, completed their dissertations for the MArch by research and received their degrees during the June graduation ceremony.

PhD student Yolanda van der Vyver, completed her thesis on 'A critical interpretation of the temporal impact of landscape, space and power on the built environment of church square, Pretoria'. Her promoter was Prof WH Peters.

POSTDOCTORAL RESEARCH FELLOWS

Dr Hendrik Auret, the postdoctoral research fellow hosted by the Department of Architecture, was a very active and involved member of the Department in 2019. He was part of a radio interview on 'Radio Sonder Grense' (RSG) on the topic of 'African Cities and identity' following the State of the Nation Address by President Ramaphosa. He also served on the Free State Provincial Heritage Resources Authority Permit Committee and supported the conservation of the Free State built environment and played a significant role in the MT Steyn statue debate. In addition, he taught in the BArch and BArchHons programmes and assisted with MArch (Professional) and PhD with design supervision.

STAFF MATTERS

Dr Hendrik Auret was appointed as Senior Lecturer, and will commence duties in January 2020.

Mr Jamie Mitchell, *alumnus* of the Department, joined the Department as a contract staff member in technical drawing in the first year of the BArch programme, in which he presented SketchUp as a computer-drafting tool. Mr Shaun Moffat, also an *alumnus*, presented photography in the first-year on contract basis.

Mr Zack Wessels, after nine years as Lecturer in the Department, accepted a full-time position in practice, where he will focus on design and project management. He completed his tenure with the Department in September 2019.

Mrs Wanda Verster Odendaal, after eight years at the Department as Assistant Officer, also accepted a new position as a lecturer at a different institution; her tenure ended in October 2019.

RESEARCH OUTPUTS

Research Articles

Auret, H.A. 2019. Care, place and the Sophia Gray laureates: Architecture as an art of care. *Architecture SA: Journal of the South African Institute of Architects* 96: 37-46.

Auret, H.A. 2019. Care, place and the Sophia Gray laureates: Architecture as an art of life. *Architecture SA: Journal of the South African Institute of Architects* 97: 30-38.

Auret, H.A. & Roodt, A.J. 2019. The history and promise of King Edward VII Park, Bloemfontein: Resoluteness, restraint and regions concern. *South African Journal of Art History* 34(1): 1-20.

Bosman, G. & Pittaway, D. 2019. New perspectives towards social acceptability of earth-constructed buildings. *International Journal of Architecture and Urban Studies* 4(2): 77-84.

Peters, W.H. & Raubenheimer, H. 2019. Rooted in purpose, time and place: The architecture of Henk de Bie & Van Wijngaarden in Bloemfontein of the 1960s. *Architecture SA: Journal of the South African Institute of Architects* 95: 39-48.

Chapters in Books

Peters, W.H. 2019. Die Planstadt Graaff-Reinet von 1785 im Grossen Karoo in Suedafrika und die Typologie des Karoohuis. In: *Die neuen Haeuser in den neuen Staedten und Doerfern. Neuerungen im Hausbau unter dem Einfluss der Landesherren und ihrer Baumeister zwischen 1650 und 1830.* E. Onnen & T. Spohn (Eds). Arbeitskreis für Hausforschung, Band 69. pp. 221-229.

Creative Output

Pretorius, H.B. 2016 (submitted 2019). New UFS Visitor's Centre, Bloemfontein campus.

Conference Contributions

Conference Papers/Posters

Auret, H.A. 2019. The responsibility of architecture: beauty, justice and the call of care. Beauty and Justice Conference, Bloemfontein, South Africa. 8 August 2019.

Auret, H.A. & Roodt, A. 2019. The history and promise of King Edward VII Park, Bloemfontein: resoluteness, restraint and regions of concern. National Conference of the South African Journal of Art History, Pretoria, South Africa. 11 May 2019.

Du Preez, J.L. 2019. Lessons from the review process of the MT Steyn statue. The 120-year commemoration of the Anglo-Boer (South African) war International conference, Bloemfontein, South Africa. 9-11 October 2019.

Du Preez, J.L. & Auret, H.A. 2019. Transforming monuments amid shifting regions of concern. National Conference of the South African Journal of Art History, Pretoria, South Africa. 10 May 2019.

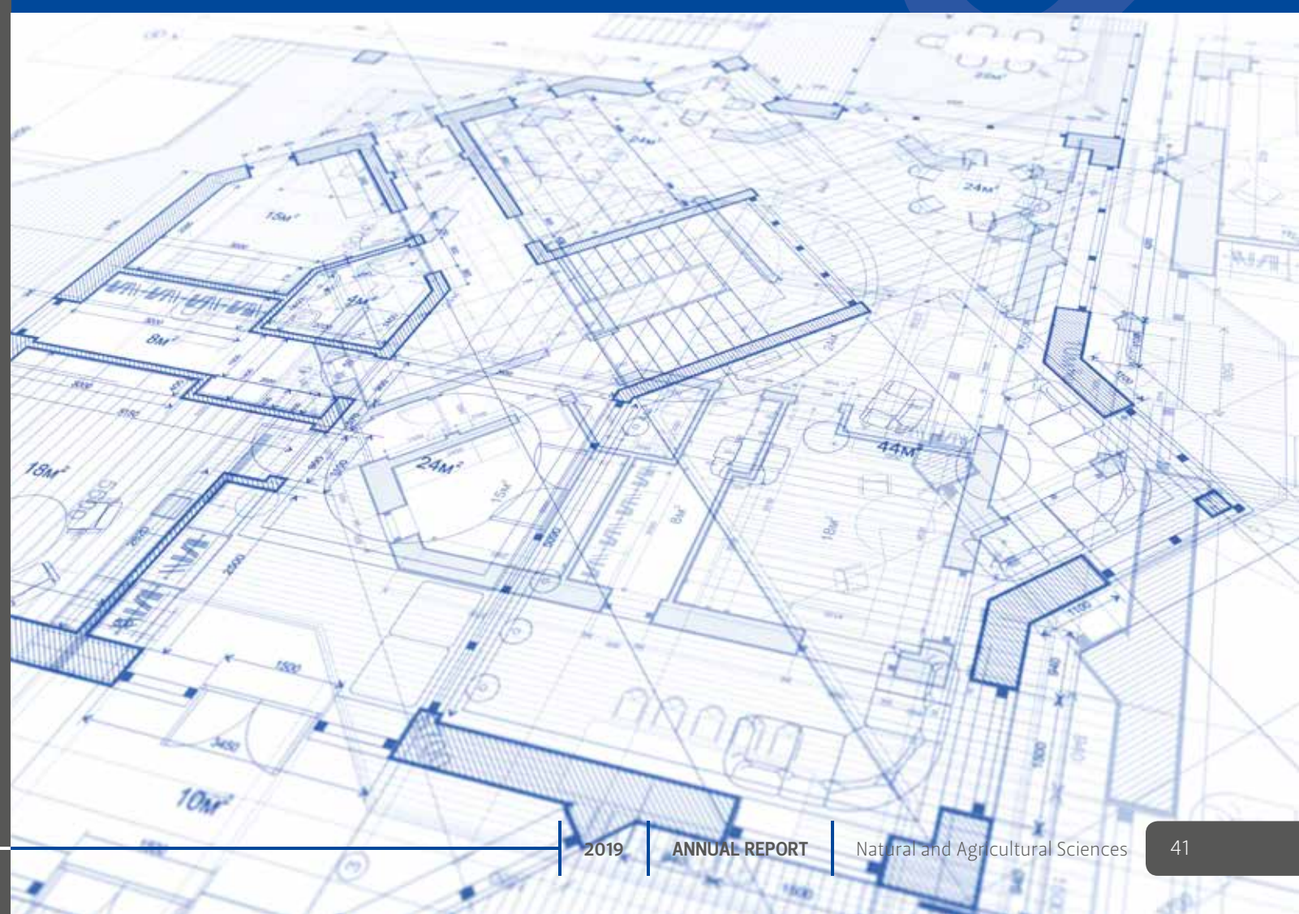
Emmett, P. 2019. Evaluating architectural change on the east coast of Africa. The 'Tradition and Transformation' conference of the Art Historical Work Group of South Africa, Pretoria, South Africa. 10-11 May 2019.

Van der Vyver, Y. 2019. The role of sculptural tradition in (political) power transformations: the self-contradictoriness of psychosocial repetition. The 'Tradition and Transformation' conference of the Art Historical Work Group of South Africa, Pretoria, South Africa. 10-11 May 2019.

STAFF (2019)

Head of Department: Prof JA Noble

Associate Professor: Prof G Bosman
Senior Lecturers: Mrs MM Bitzer, Mr JL du Preez and Ms A Wagener
Lecturers: 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: Dr HA Auret, 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
Programme Director: Mr JL du Preez
Secretary: Mrs Y Pretorius
Assistant Officer - Professional Services: Mrs WV Odendaal
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 2019

Having gone through three programme accreditation visits in less than 24 months, 2019 was ushered in as a year to reflect a little more on the work that had been done to date and start to strategise on the direction to take in order for the Department to reach greater heights. Strategic planning and thinking became central to the Department's quest to become the department of choice in the built environment. Therefore, much effort and time went into planning as well as developing and/or improving initiatives and processes to contribute to raising the Department's profile, visibility and value-creating capabilities.

Among other things, activities included better management of the website, improving the quality of learning and teaching and enhancing student learning experiences through various means, such as encouraging increased use of e-learning platforms. For example, out of the top eleven modules which utilised Blackboard the most in the Faculty, four were from the Department of Quantity Surveying and Construction Management. 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 will open doors to its first cohort of students in 2021. The research outputs also showed a steady improvement and efforts were made to maintain an upward trend.

The Department thanks its team of dedicated staff and students for their collaborative efforts and support in making 2019 a productive year.

ACHIEVEMENTS

Student Achievements

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

- Miss J Smith: Best first-year student in the BSc (Quantity Surveying) programme
- Miss T Cogle and Miss N Moss: Best second-year student in the BSc (Quantity Surveying) programme (shared prize)
- Mr B Hoffman: Best third-year student in the BSc (Quantity Surveying) programme
- Miss X Mangese: Best fourth-year student in the BSc Honours (Quantity Surveying) programme and Best all-round student in any year of study (Quantity Surveying)
- Mr B Erasmus: Best student in the BScHons (Construction Management) programme
- Miss G Bothma: Best fourth-year student in Descriptive Quantification
- Miss Z Stabpelberg: Best first-year student in the BSc (Construction Management) programme
- Miss L van Coppenhagen: Best third-year student in the BSc (Construction Management) programme
- Ms A Geyer: Best student in Quantity Surveying Research Report
- Miss L van Wyk: Best student in Construction Management Research Report
- Ms KR Tshwane: Best student in Research Mini Dissertation on the MLPM programme

Prof Kahilu Kajimo-Shakantu (second row third from the right) with Faculty prize-winners from the Department

TEACHING

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 BSc Construction Management and BSc Quantity Surveying undergraduate degrees for both residential (full-time) and compact learning (part-time) students. In the 2019 academic year, 22 students were enrolled for the BSc Construction Management, and 145 were enrolled for the BSc Quantity Surveying.

During the year, a number of site visits around Bloemfontein were undertaken to provide students with exposure to construction activities in order to enhance their classroom learning experiences.

The third annual Winter School was held from 8 to 12 July 2019. It is organised primarily for third- and fourth-year students, and the focus was on various career paths in the built environment with guest speakers from industry, lecturers, specialist building material demonstrations, site visits and software application.

For the structured master's programme, delivery was by means of three block contact sessions, with the rest of teaching and learning activities taking place via e-learning platform (Blackboard).

RESEARCH

Two research groups, led by Mr Hendri du Plessis and Mr Henry Deacon, received Faculty Central Research Fund grants for research in Innovation (4IR) and Construction Project Management respectively.

Hendri du Plessis

Henry Deacon

ENGAGED SCHOLARSHIP

In 2019, the Department of Quantity Surveying and Construction Management, in collaboration with the UFS Department of Architecture, was involved with KidzCareTrust on a design and build project of a youth centre. During the course of the year, both departments worked on the design and cost estimation of the centre.

POSTGRADUATE STUDENTS

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

The number of students enrolled in the various programmes was as follows:

- BScHons: 167
- MLPM: 39 (for both specialisations)
- MSc: 6
- PhD: 5

At the 2019 graduation ceremonies, the following degrees were conferred:

- BScHons (Construction Management): 4
- BScHons (Quantity Surveying): 60
- MLPM (Project Management): 1
- MLPM (Property Valuation): 2

POSTDOCTORAL RESEARCH FELLOWS

The Department was pleased to welcome Dr Timothy Ayodele and Dr Patience Tunji-Olayeni, both from Nigeria, as postdoctoral research fellows.

Dr Ayodele was awarded the 2019 Outstanding Reviewer Emerald Literati Award for his reviews for the *Journal of Financial Management of Property and Construction*.

STAFF MATTERS

The Department was sad to lose three members of staff during the year. Mrs E Jacobs, a Lecturer and Programme Director, emigrated at the end of November, while Mr R Seedat, a Lecturer, joined the private sector, and Mrs P Mosala transferred to another department within the University. The contributions made to the Department specifically and the University at large by each of them, are highly appreciated.

The Department was pleased to welcome Ms M Mohapi as a Service Worker.

RESEARCH OUTPUTS

Research Articles

Afolabi, A.O., Opawole, A., Babalola O., Ojo, G.K. & Kajimo-Shakantu, K. 2019. Performance analysis of small and medium sized construction firms in Oyo State, Nigeria. *Acta Structilia* 26(1): 66-96.

Alao, O., Jagboro, G., Opawole, A., & Kadiri, D. 2019. Assessment of resuscitation strategies of abandoned projects: A case study of public tertiary education institutions' buildings in Osun State, Nigeria. *Acta Structilia* 26(1): 167-200.

Du Plessis, H. 2019. Facilitation of construction project management through building contracts: A South African perspective on the locally developed suites of contracts. *Acta Structilia* 26(1): 120-147.

Ojo, G.K., Adeyeye, M., Opawole, A. & Kajimo-Shakantu, K. 2019. Gender differences in workplace stress response strategies of quantity surveyors in Southwestern Nigeria. *International Journal of Building Pathology & Adaptation* 37(5): 718-732.

Opawole, A., Jagboro, G.O., Kajimo-Shakantu, K. & Olojede, B.O. 2019. Critical performance factors of public sector organizations in concession-based public-private partnership projects. *Property Management* 37(1):17-37.

Opawole, A., Kajimo-Shakantu, K., Alao, O.O. & Ogbaje, C.P. 2019. Risk factors associated with procuring university hostel facilities through buildoperate-transfer model. *Journal of Engineering, Design and Technology* 17(1):136-154.

Ngxito, B., Kajimo-Shakantu, K. & Opawole, A. 2019. Assessment of alternative building technologies for pre-tertiary educational infrastructure delivery in the Eastern Cape Province, South Africa. *Management of Environmental Quality* 30(5): 1152-1170.

Conferences Contributions

Conference Papers/Posters

Amoah C. 2019. *Tender evaluation and selection model for the procurement of public works in Ghana*. Paper delivered at the 11th International Research Conference - South African Council for the Quantity Surveying Profession (SACQSP), Johannesburg, South Africa. 16-17 September 2019.

Amoah C. & Kotze, P.J. 2019. *Rainwater harvesting: An important element of water sustainability in Bloemfontein.* Paper delivered at the 13th Built Environment Conference - Association of Schools of Construction of Southern Africa (ASOCSA), Durban, South Africa. 2-3 September 2019.

De Bruin, E. & Du Plessis, H. 2019. *Innovation in the South Africa built environment: A 3D printing perspective.* Paper delivered at the 13th Built Environment Conference - Association of Schools of Construction of Southern Africa (ASOCSA), Durban, South Africa. 2-3 September 2019.

Du Preez O. 2019. *Conciliation as an effective alternative to negotiation in the JBCC Dispute Clause*. Paper delivered at the 11th International Research Conference - South African Council for the Quantity Surveying Profession (SACQSP), Johannesburg, South Africa. 16-17 September 2019.

Geyer A. & Kajimo-Shakantu, K. 2019. *Assessment of socio-economic and environmental implications of optimizing renewable energy use in industrial facilities*. Paper delivered at the 11th International Research Conference - South African Council for the Quantity Surveying Profession (SACQSP), Johannesburg, South Africa. 16-17 September 2019.

Kajimo-Shakantu, K., Swart, L. & Muleya, F. 2019. *Small to medium sized construction firms' health and safety investment practices in Kwa-Zulu Natal: A Pilot Study*. Paper delivered at the 1st Association of Researchers in Construction Safety, Health, and Well-Being (ARCOSH) Conference, Cape Town, South Africa. 3-4 June 2019.

Kajimo-Shakantu, K. & Xhala, C.N. 2019. *Towards improved Private Public Partnerships in the delivery of sustainable infrastructural projects*. Paper delivered at the 6th International Conference on Development and Investment in Infrastructure - Strategies for Africa (DII), Livingstone, Zambia. 24-26 July 2019.

Muleya, F., Nakamba, M., Mutale, L. & Kajimo-Shakantu, K. 2019. *Health and safety welfare of site workers on construction and mining related projects in Zambia*. Paper delivered at the 1st Association of Researchers in Construction Safety, Health, and Well-Being (ARCOSH) Conference, Cape Town, South Africa. 3-4 June 2019.

Ndzandzeka, Y. & Amoah C. 2019. *Using alternative construction method to alleviate the backlog of school buildings in the Eastern Cape*. Paper delivered at the 13th Built Environment Conference-Association of Schools of Construction of Southern Africa (ASOCSA), Durban, South Africa. 2-3 September 2019.

Olojede, B.O., Jagboro, G.O., Opawole, A. & Kajimo-Shakantu, K. 2019. *Examining the roles of public sector organizations in public-private partnership infrastructure procurement in Southwestern Nigeria*. Paper delivered at the 13th Built Environment Conference-Association of Schools of Construction of Southern Africa (ASOCSA), Durban, South Africa. 2-3 September 2019.

Opawole, A., Okeya, C.O., Alao, O.O., Babalola, O. & Kajimo-Shakantu, K. 2019. *Assessment of human resource management practices amongst quantity surveying consulting firms.* Paper delivered at EDMIC 2019 – Drivers & Dynamics of Change in the Built Environment. Ile-Ife, Nigeria. 20-22 May 2019.

Phakoa, K. & Amoah C. 2019. *Project manager's perspective on factors contributing to project cost and time overruns in Lesotho construction industry*. Paper delivered at the 11th International Research Conference - South African Council for the Quantity Surveying Profession (SACQSP), Johannesburg, South Africa. 16-17 September 2019.

Theron, J., Jacobs, E. & Deacon, H. 2019. *Green Office Buildings contributing to the productivity and job satisfaction of staff members.* Paper delivered at the 13th Built Environment Conference-Association of Schools of Construction of Southern Africa (ASOCSA), Durban, South Africa. 2-3 September 2019.

Tshaka, S. & Deacon, H. 2019. *Employer-related causes of schedule overruns on public sector construction projects: The case of the Eastern Cape, South Africa.* Paper delivered at the 13th Built Environment Conference-Association of Schools of Construction of Southern Africa (ASOCSA), Durban, South Africa. 2-3 September 2019.

Van Wyk, L & Kajimo-Shakantu, K. 2019. *An assessment of the adoption of innovative technologies in the South African construction industry*. Paper delivered at the 13th Built Environment Conference-Association of Schools of Construction of Southern Africa (ASOCSA), Durban, South Africa. 2-3 September 2019.

Xhala, C.N., & Kajimo-Shakantu, K. 2019. *Key lessons in the financing of public infrastructure in South Africa and the Czech Republic.* Paper delivered at the International Council for Building (CIB) World Building Congress, Hong Kong, China. 17-21 June 2019.

STAFF (2019)

Head of Department: Prof K Kajimo-Shakantu

Lecturers: Dr C Amoah, Mrs T Bremer, Mr AH Deacon, Mr H Du Plessis, Mrs M-M Els, Mrs E Jacobs, Mr PM Oosthuizen, Mr R Seedat and Ms TL van Schalkwyk
Junior Lecturer: Mrs C Ferreira
Research Fellow: 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 P Mosala

DEPARTMENT OF

URBAN AND REGIONAL PLANNING

CONTACT DETAILS

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OVERVIEW OF 2019

Mr Thomas Stewart initiated a National Students Conference on Human Settlements, which was held from 13 to 15 October 2019 in Bloemfontein. The aim of the conference was to be nationally inclusive, interactive, engagingly educational and serve as an effective knowledge sharing experience for Human Settlements students. Students from Nelson Mandela University, the University of the Witwatersrand and the University of Kwa-Zulu Natal attended the conference. The keynote address was delivered by Ms Motshidise Koloi, the Member of the Executive Council for the Free State Department of Public Works, Infrastructure and Human Settlements, and the Dean of Student Affairs, Mr Pura Mgolombane, delivered an inspiring address to the students. During the conference the students had the opportunity to learn from fellow students and institutions about their Human Settlements programmes and research. Collaborative research prospects were explored towards a deeper understanding of Human Settlements challenges, policies and practices and friendships and connections were forged within the fraternity.

Students and staff attending the National Students Conference on Human Settlements

Mr Thomas Stewart, Ms Motshidise Koloi and Mr Pura Mgolombane

Mr Stuart Denoon-Stevens, the Principal Researcher of the South African Planning Education Research (SAPER) project funded as a 'Higher Education in Africa grant' by the British Economic and Social Research Council (ESRC) and the South African National Research Foundation (NRF), presented a mini-conference on 'What I wish I knew', on 28 November 2019 in Sandton. The purpose of the gathering was to reflect on practice learning as individual practitioners within the context of lifelong learning. The participants engaged with 'voices from practice', which emanated from the 219 interviews conducted by SAPER.

ACHIEVEMENTS

Staff Achievements

Prof Verna Nel was elected as the chairperson of the Education and Training Committee of the South African Council for Planners (SACPLAN) and she also served on the SACPLAN Rules Committee.

Mr Kgosi Mocwagae attained his SACPLAN professional registration, and Prof Maléne Campbell was allocated an NRF-rating.

Student Achievements

The departmental winners of the 2019 Flash Fact competition were Mr Kgosi Mocwagae, who presented on his PhD research on the Qwaqwa water crisis, and Ms Londiwe Mzolo, who presented on her master's dissertation on non-motorised transport.

TEACHING

The first cohort of students of the new Bachelor of Spatial Planning (specialising in Human Settlements), graduated during the June 2019 graduation ceremony.

RESEARCH

The University of the Free State's interdisciplinary study group on mining and communities focuses on mining towns. Methodologically a household survey and qualitative interviews are conducted. As part of the third survey on platinum mines in Rustenburg, more than 970 questionnaires have been completed. Collaborating researchers were invited to present papers on 'Mining and the future of Rustenburg' at a workshop held in Bloemfontein in November 2019. Prof Deanna Kemp, the Director of the Centre for Social Responsibility in Mining at Queensland University, facilitated the workshop and was the plenary speaker. Prof John Owen, of the same institution, peer-reviewed the chapters presented at the workshop and provided scholarly inputs during the site visits to mining towns.

The following research collaborators presented their research at the workshop:

- Prof Lochner Marais, Centre for Development Support (CDS), UFS
- Prof Verna Nel, Department of Urban and Regional Planning, UFS
- Mr JP Geldenhuys, Department of Economics, UFS
- Prof Tina Kotze, Business School, UFS
- Dr Cornelie Crous, School of Accounting, UFS
- Dr Lejone Ntema, Human Sciences, University of South Africa
- Mr Jan Cloete, CDS, UFS
- Mr Molefe Lenka, CDS, UFS
- Dr Johan van Zyl, CDS, UFS
- Dr Petrus Nel, Department of Industrial Psychology, UFS
- Mr Stuart Denoon-Stevens, Department of Urban and Regional Planning, UFS
- Mr Thomas Stewart, Department of Urban and Regional Planning, UFS
- Dr Sethulego Matebesi, Department of Sociology, UFS
- Dr Rory Pilossof, Department of Economics, UFS
- Mr Antonie Pool, Department of Economics, UFS
- Prof Maléne Campbell, Department of Urban and Regional Planning, UFS
- Prof Philippe Burger, Department of Economics, UFS
- Dr Deidré van Rooyen, CDS, UFS
- Dr Anmar Pretorius, Department of Economics, North-West University
- Prof Derick Blaauw, Department of Economics, North-West University

Investigators of the Rustenburg mining town project, from the left: Prof Lochner Marais, Mr Stuart Denoon-Stevens, Dr Deidré van Rooyen, Prof Maléne Campbell

ENGAGED SCHOLARSHIP

As part of the Applied Regional Project module, Dr Thulisile Mphambukeli and Mr Kgosi Mocwagae took the final-year master's students on an educational drive around the Mangaung township in Bloemfontein and to the earmarked central location of the Airport Development Node. Students were then introduced to the economic and social complexities of Botshabelo and Thaba 'Nchu, with the trip ending in Lesotho. At the Maseru City Council, the Chief Town Planner, Mrs Palesa Lekau, an alumnus of the UFS Department of Urban and Regional Planning, addressed the students. The industrial and residential areas of the city were visited before returning to Bloemfontein. Officials of the Mangaung Metropolitan Municipality and consulting Town Planners were invited to attend the presentations of the students' findings and proposals.

NATIONAL AND INTERNATIONAL COLLABORATION

Staff members and postgraduate students attended the South Africa-Sweden Research and Innovation Week from 6 to 8 May at the Nelson Mandela University in Port Elizabeth and from 8 to 10 May at the University of Stellenbosch. Proceedings of the Sustainable Urbanisation of the South Africa-Sweden University Forum (SASUF) symposium at the Nelson Mandela University were published, in collaboration with SASUF. Mr Thomas Stewart and Prof Maléne Campbell served on the review panel of the proceedings, while Mr Thomas Stewart also chaired one of the sessions. A paper by Dr Thulisile Mphambukeli and Mr Abraham Matamanda was accepted for inclusion in the proceedings.

Prof Verna Nel collaborated on the SASUF project on 'Spatial challenges from peri-urban expansion of small rural towns in South Africa' from September to November 2019. The team consisted of the following other members:

- Dr Emaculate Ingwani (University of Venda) – Team leader
- Prof Nils Ekelund (University of Malmö) – Team Leader
- Prof Trynos Gumbo (University of Johannesburg)
- Lucia Ketsi (UFS – PhD student)
- Mthembi Chauque (UFS – MSc student)
- Moses Malengoane (University of Venda – Bachelor of Urban and Regional Planning [BURP] student)
- Luminosa Gurure (University of Venda – BURP student)
- Shonisani Phaswana (University of Venda – BURP student)

POSTGRADUATE STUDENTS

The UFS Bachelor of Spatial Planning Honours (BSPHons), in conjunction with the Master of Urban and Regional Planning (MURP) with coursework, are jointly accredited with the SACPLAN. Therefore, graduates who have attained both these qualifications are able to register as professional planners with SACPLAN once they have completed their practical training. In 2019 a total of 42 students enrolled for the BSPHons, and 56 for the MURP.

Members of staff and final-year students of the 2019 MURP class

The April graduation ceremonies saw Bachelor of Spatial Planning Honours degrees conferred on 29 students and Spatial Planning Honours degrees (specialising in Human Settlements) conferred on a further two students.

At the June graduation ceremony on the Bloemfontein Campus, degrees were conferred on eight students who graduated with a Master of Urban and Regional Planning (for Professional registration) and on a further two students at the December 2019 ceremony.

Dr Tshepo Motsepe, the First Lady of South Africa, attending the MURP (for Professional registration) graduation ceremony of her bursary holder, Mr Thapelo Chacha. From the left: Mr T Stewart, Prof MM Campbell, Mr T Chacha, Dr T Motshepe, Prof FW Petersen (Vice-Chancellor) and Prof PD Vermeulen (Dean)

Also at the June graduation ceremony, the MURP (for extended research) was conferred on Mr Rodney Motlogeloa, and Mr Charles Mukumba graduated with the Master of Land and Property Development Management in Housing.

The following two students graduated with a PhD in Urban and Regional Planning, conferred at the June graduation ceremony:

Matamanda, Abraham
Thesis: Exploring emerging human settlement forms and urban dilemmas nexus: Challenges and insights from Hopely Farm, Harare, Zimbabwe
Promoter: Dr TN Mhambukeli

Muleya, Nicholas
Thesis: Sensation and perception: an exploration of human multi-sensory experiences and preferences to enhance public space planning, policy and practice in the City of Bulawayo, Zimbabwe
Promoter: Prof MM Campbell

POSTDOCTORAL RESEARCH FELLOWS

Dr Abraham Matamanda was appointed as a postdoctoral research fellow in 2019. He attained his MSc at the University of Zimbabwe and graduated with his PhD from this Department in 2018. Dr Matamanda has authored and co-authored more than 35 peer reviewed articles and several chapters in edited books.

STAFF MATTERS

Mr Thomas Stewart was promoted to Senior Lecturer.

RESEARCH OUTPUTS

Research Articles

Chirisa, I., Chivambe, A., Mukarwi, L. & Matamanda, R.A. 2019. Spatializing class struggles of post-colonialism and post modernism: Of the messing and cleaning in the city of Harare. *Critical Planning Journal* 24: 134-149.

Chirisa, I., & Chivenge, M. 2019. The concept urban resilience: Contextualising to Zimbabwe. *Journal of Urban Systems and Innovations for Resilience in Zimbabwe* 1(1&2): 1-19.

Chirisa, I. & Matamanda, A. 2019. Forces shaping urban morphology in Southern Africa today: Unequal interplay among people, practice and policy. *Journal of Urbanism: International Research on Placemaking and Urban Sustainability 1*: 354-372.

Marais, L., Cloete, J., Van Rooyen, D., Denoon-Stevens, S. & Nel, V. 2019. Place attachment and social disruption in Postmasburg, a rapidly growing South African mining town. *GeoJournal* 84(1): 71-83.

Matamanda, R.A. 2019. Battling the informal settlement challenge through sustainable city framework: Experiences and lessons from Harare, Zimbabwe. *Development Southern Africa*: 1-15. DOI: 10.1080/0376835X.2019.1572495.

Matamanda, A. R., Chirisa, I., Dzvimbo, M. A. & Chinozvina, Q. L. 2019. The political economy of Zimbabwean urban informality since 2000 – a contemporary governance dilemma. *Development Southern Africa:* 1-14.

Matamanda, R. A., Chirisa, I., Mangara, F. & Dzvimbo, M. A. 2019. The ecological politics surrounding the downsizing and downgrading of public park: A reflection on the history of change of the Harare Gardens in Zimbabwe. *Case Studies in the Environment*. DOI: 10.1525/cse.2019.001958.

Steÿn, D. 2019. Different values lead to alternative approaches to the land debate in South Africa. *Stads-en Streekbeplanning / Town and Regional Planning / Meralo ya Ditoropo le Mabatowa* 75: 104-111.

Chapters in Books

Banhire, T., Muziri, C. & Matamanda AR. 2019. Groundwater management in Greater Harare, Zimbabwe. In: *The sustainability ethic in the management of the physical, infrastructural and natural resources of Zimbabwe*. I. Chirisa (Ed). Bamenda: Langaa Research and Publishing Common Initiative Group. pp. 283-300.

Campbell, M. 2019. Mbombela: A growing provincial capital and tourism destination. In: *Space and Planning in Secondary Cities: Reflections from South Africa*. L. Marais & V. Nel (Eds). Stellenbosch: AFRICAN SUN MeDIA. pp. 92-106.

Chirisa, I. & Matamanda, AR. 2019. The spatial and physical planning considerations and implications of border management in Zimbabwe. In: *Dynamics of contemporary border management in Zimbabwe: Challenges, benefits and prospects*. S. Muqayi & C. Manyeruke (Eds). London: Adonis & Abbey Publishers Ltd. pp. 61-80.

Chirisa, I., Matamanda, AR & Mukarwi, L. 2019. Shifting physical boundaries and implications for Harare since 1890. In: *The sustainability ethic in the management of the physical, infrastructural and natural resources of Zimbabwe*. I. Chirisa (Ed). Bamenda: Langaa Research and Publishing Common Initiative Group. pp. 61-82.

Chirisa, I., Mukarwi, L. & Matamanda, AR. 2019. Resilience, resistance and risings in African cities: Cases of civil responses to the Non Responsiveness and Unilateralism by the State to Urban Challenges. In: *Urban crisis and management in Africa: A festschrift for Prof. Akin Mabogunje*. I.O. Albert & T. Lawanson (Eds). Texas: Pan-African University Press. pp. 335-349.

Marais, L., Du Plessis, D., Nel V. & Cloete, J. 2019. Secondary cities and spatial transformation in South Africa. In: *Space and planning in secondary cities: Reflections from South Africa.* L. Marais & V. Nel (Eds). Stellenbosch: AFRICAN SUN MeDIA. pp. 1-24.

Marais, L., Nel, V. & Cloete, J. 2019. Complexity Theory and Spatial change in ten secondary cities. In: *Space and planning in secondary cities: Reflections from South Africa*. L. Marais & V. Nel (Eds). Stellenbosch: AFRICAN SUN MeDIA. pp. 265-286.

Nel, V. 2019. Planning in complex spaces: An orderly and predictive world. In: *Space and planning in secondary cities: Reflections from South Africa*. L. Marais & V. Nel (Eds). Stellenbosch: AFRICAN SUN MeDIA. pp. 25-40.

Nel, V. & Drummond, J. 2019. Mahikeng: A remote provincial capital with a turbulent past. In: *Space and planning in secondary cities: Reflections from South Africa.* L. Marais & V. Nel (Eds). Stellenbosch: AFRICAN SUN MeDIA. pp. 87-114.

Toba, L. & Campbell, M. 2019. Factors influencing urban open space encroachment: The case of Bloemfontein, South Africa. In: *Smart and sustainable built environment (SASBE)*. L. Thomas (Ed). Australia: Springer. Chapter 20.

Toba, L. & Campbell, M. 2019. Homelessness by choice and by force. In: *Encyclopedia of the UN Sustainable Development Goals*. W.L. Filho, P.G. Özuyar, A.M. Azul, L. Brandli, U.Azeiteiro & T. Wall (Eds). Springer Nature: online.

Research Reports

Nel, V. 2019. *Emalahleni Case Study*. Report for Intermediate Cities Management study for South African Cities Network.

Conference Contributions

Conference Papers/Posters

Campbell, M., Drewes, E. & Brand, A. 2019. *Corridor development in a South African coal mining region*. Paper delivered at the Regional Studies Association Russian Division Workshop: Regional Networks and Economic Space Development. RSA Russia Division Workshop, Yekaterinburg, Russia. 14-16 November 2019.

Matamanda, A. R & Mphambukeli, T. N. 2019. *Planning for co-production through innovative technology in informal and 'city-edge' human settlements in the Global South: The case of Hopley Farm, Harare, Zimbabwe*. Paper delivered at the South Africa Sweden University Forum 2019 Symposium, Port Elizabeth, South Africa. 6 May 2019.

Nel, V. & Denoon-Stevens, S. 2019. *Decolonising land use management in South Africa*. Paper delivered at the International Conference of the International Geographical Union (IGU) Commission on Geography of Governance 'Local and Urban Governance: Trends, Challenges, and Innovations in a Globalizing World', Praia, Cape Verde. 4-7 September 2019.

Nel, V., Oranje, M. & Smit, E. 2019. *Governing mining-based municipalities in South Africa*. Paper delivered at the International Conference of the International Geographical Union (IGU) Commission on Geography of Governance 'Local and Urban Governance: Trends, Challenges, and Innovations in a Globalizing World', Praia, Cape Verde. 4-7 September 2019.

Tshazi, Q. & Mphambukeli, T.N. 2019. *Safety and Security as a component of equity planning for student housing: A Case Study of Brandwag, Willows and Universitas Suburbs in Bloemfontein, Free State*. Paper delivered at the South Africa Sweden University Forum 2019 Symposium, Port Elizabeth, South Africa. 6 May 2019.

STAFF (2019)

Head of Department: Prof MM Campbell

Professor: Prof VJ Nel
Associate Professor: Prof MM Campbell
Senior Lecturers: Mr MD Mokoena, Dr TN Mphambukeli and Mr T Stewart
Lecturers: Mr S Denoon-Stevens and Mr KG Mocwagae
Programme Director: Mr S Denoon-Stevens
Research Associates: Prof I Chirisa and Prof JJ Steyn
Senior Assistant Officer: Ms A Mgwele
Secretary: Mrs MC Hugo
NRF Intern: Mr M Chauque

NATURAL
SCIENCES

DEPARTMENT OF CHEMISTRY

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OVERVIEW OF 2019

The Department of Chemistry continues to support the strategic priorities of the UFS and the Faculty of Natural and Agricultural Sciences which is demonstrated by a steady increase in postgraduate students, as prescribed by the Integrated Transformation Plan (ITP) set up by the UFS top management. The Department of Chemistry is present on all three UFS campuses, with the South Campus concentrating on the extended BSc programme, as well as the University Access Programme (UAP), with approximately 240 students in total; the Qwaqwa Campus catering for 230 local residential students and specialising in Polymer Science research; and the Bloemfontein Campus teaching approximately 780 undergraduate students and conducting research in all four classic divisions in Chemistry, namely Analytical, Inorganic, Organic, and Physical Chemistry. The management committee of the Department consists of Prof Walter Purcell (Departmental Chairperson), Prof Karel von Eschwege, Dr Ernie Langner and Dr Susan Bonnet, while Mr Khotso Mpitso is the Subject Head on the Qwaqwa Campus.

In 2019, the postgraduate students on the Bloemfontein Campus included 20 Honours, 40 MSc and 21 PhD candidates, as well as 7 postdoctoral research fellows from as far afield as India, Nigeria, Sudan and Cameroon.

The research productivity of the personnel and students is clearly demonstrated by the research outputs of 2019, with 68 research articles published in national and international accredited journals and 76 presentations made at local and international conferences, while 2 PhD and 12 MSc students graduated from the Department.

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

ACHIEVEMENTS

Staff Achievements

Dr Marietjie Schutte-Smith received the Faculty award for the 'Best module' and Mrs Tessa Swarts received the award for the 'Best Support Staff' in the Faculty of Natural and Agricultural Sciences.

Prof Jeanet Conradie was appointed as visiting professor in Inorganic and Materials Chemistry at the Department of Chemistry of The Arctic University of Norway (UiT). She was also a co-author of an article displayed on the front page of *Inorganic Chemistry* Volume 58 No 12 (Shan, W., Desbois, N., Pacquelet, S., Brandes, S., Rousselin, Y., Conradie, J., Ghosh, A., Gros, C. & Kadish, K. 2019. Ligand noninnocence in cobalt dipyrrin−bisphenols: Spectroscopic, electrochemical and theoretical insights indicating an emerging analogy with corroles. *Inorganic Chemistry* 58: 7677-7689).

In December 2019, Dr Anke Wilhelm received a Y2-rating and Prof Vladimir Azov a C2-rating from the NRF.

Dr Alice Brink's publication, co-authored with Prof John Helliwell, which appeared in the journal from the International Union of Crystallography, was recommended in *F1000Prime* as being of "*special significance in its field*" (Brink, A. & Helliwell, J. 2019. Why is interoperability between the two fields of chemical crystallography and protein crystallography so difficult? *IUCrJ* 6(5): 788-793. {Vicens Q: *F1000Prime Recommendation of [Brink A and Helliwell JR, IUCrJ 2019 6(5):788-793]. In F1000Prime, 07 Oct 2019; 10.3410/f.736544810.793565710*}).

Dr Brink was invited to join the Free State branch of GCRF START (Global Challenges Research Fund Synchrotron Techniques for African Research and Technology) in association with the Department of Biochemistry.

Prof André Roodt was invited to serve on a special Panel Discussion at the NRF conference on Applied Systems Analysis and Africa, held in Pretoria on 3 and 4 December 2019. He was also asked to act as a guest editor for a special issue of the *South African Journal of Science and Technology/Suid-Afrikaanse Tydskrif vir Natuurwetenskap en Tegnologie*, on 'Structure/Reactivity Relationships of Materials'. Prof Roodt was also elected honorary member of the Croatian Crystallographic Society.

The installation of the X-ray Diffractometer system (worth thirteen million rands) – led by Prof Roodt (PI) and Dr Brink (Co-PI) within the Crystallographic Laboratory – was completed and installed in October 2019.

Prof Danie Vermeulen (Dean), Prof Francis Petersen (Vice-Chancellor), Dr Alice Brink, Prof Corli Witthuhn (Vice-Rector) and Prof André Roodt at the installation of the new X-ray Diffractometer

Student Achievements

Two students from the Conradie group (Emmie Chiyindiko and NGS Mateyise) won poster prizes for the best poster presented in Symposium 14, Molecular Electrochemistry at the 70th Annual Meeting of the International Society of Electrochemistry.

Mr FJF Jacobs (Inorganic Chemistry) presented at the Workshop on Biophysics and Structural Biology at Synchrotrons held in Cape Town, and was awarded the Outstanding Poster Prize. Jacobs was also awarded an independent bursary to attend the HTCC 4 - Hot Topics in Contemporary Crystallography in Dubrovnik, Croatia.

Shaun Redgard (Team Captain), together with Edward Lee (Department of Physics) and Chantelle Booysen (Department of Haematology and Cell Biology), were crowned winners of the 2019 International Natural Sciences Tournament (INST), the ninth in the series, of which the final stage was held at the Tallinn University of Technology (TalTech) in Tallinn, Estonia, from 1 to 5 February 2019.

At the annual Faculty prize-giving ceremony, the following students received prizes as best students (2018) in the different categories: Mr T Theunissen (second-year student), Mr G Swart (Merck prize for best third-year student), Miss Z Bezuidenhoudt (best Honours), and Miss RMN Moragoa (PETLabs prize for best MSc thesis), and Dr DV Kama (Bruker prize for PhD thesis).

TEACHING

The undergraduate students on the Bloemfontein Campus are trained in theory and practical aspects of all four classical Chemistry divisions (Analytical, Inorganic, Physical, and Organic) from the first to the third year of study. There are approximately 600 first-year students, 100 second-year, and 50 third-year students. Practicals for the first-year students and those who access the Bloemfontein stream programmes from the programmes on the South Campus, are organised, prepared, and controlled by Ms Magda Meyburgh and Ms Jeanette Mmope. Another laboratory in the Chemistry building was converted into an additional first-year laboratory to eliminate the need for evening practicals.

The Honours course involved the teaching of 20 students in all four divisions of Chemistry, which included the Forensic Science students who only followed the Analytical modules.

The teaching of Chemistry modules on the South Campus is managed by Ms Rina Meintjes, assisted by three full- and three part-time facilitators. They also manage the Chemistry first-year teaching activities on the Qwaqwa Campus (90 students), as well as the Chemistry enrolment and courses at Further Education

and Training (FET) colleges such as the Goldfields FET College in Welkom (12 students). A total of 173 students were enrolled at the beginning of 2019 in the first-year Chemistry modules for the BSc Extended Programme on the South Campus, while 64 were enrolled in the UAP programme, which is designed to prepare students with low Admission Point (AP) scores for acceptance/ enrolment for mainstream courses on the Bloemfontein Campus.

Dr Uwe Siegert was appointed as laboratory manager of the new multi-disciplinary laboratory opened in 2018, and trained the South Campus students in the practical aspects of Chemistry during 2019. In future all the students following Chemistry and Biology on the South Campus will perform their practicals in this laboratory, eliminating the need for daily commuting between the campuses, thus also alleviating the pressure on the laboratories on the Bloemfontein Campus.

Teaching on the Qwaqwa Campus also involves the theory and practical aspects of all four classic Chemistry disciplines 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 6 students, which involved the teaching of subjects applicable to Polymer Science, aligned with the research focus of the Campus.

RESEARCH

Analytical Chemistry

Prof Karel von Eschwege (C3-rated) continued to serve as division head, with Prof Walter Purcell (C3-rated), Dr Rebotsamang Shago and Professional Officer Dr Marianne Conradie-Bekker (Y2-rated and UFS Prestige Scholar) forming part of the division. The division also included one PhD and five MSc students, and one postdoctoral research fellow. Two MSc students graduated in this period. The division was involved in four publications in international journals, three book chapters, attended five conferences, and made three oral and three poster contributions. Mr Benji Nkabiti was appointed as Lecturer in Analytical Chemistry as part of the New Generation of Academics Programme (nGAP).

The group focuses on a number of analytical and inorganic projects. The analytical projects relate to the dissolution, quantification and method validation of a number of inorganic and ore samples such as zircon, tantalite and ilmenite, to establish methods to accurately quantify and separate the different elements therein. These projects are conducted in collaboration with the Nuclear Energy Corporation of South Africa's (NECSA) Advanced Metals Initiative (AMI). The group is also involved in green energy source research, as well as in mineral recycling projects involving Li recovery from spent batteries, and PGE recovery from autocatalysts.

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. Other techniques, such as X-ray Diffraction and X-ray Fluorescence (XRD, XRF), Differential Scanning Calorimetry (DSC) and Thermal Gravimetric Analysis (TGA), are also utilised. Elements which are currently being investigated are niobium, tantalum, zirconium, hafnium, all the platinum-group elements (PGE), rare earth elements, as well as lithium beneficiation. Numerous samples were analysed for private individuals, as well as local and national companies.

In terms of inorganic chemistry projects, the group focuses on kinetic and structural studies of organometallic complexes of Ir (I) and Rh (I) oxidative addition reactions, Zr (IV) and Hf (IV) fluoride complexes. All of these studies utilised X-ray crystallography, infrared (IR) spectroscopy, UV/vis, Nuclear Magnetic Resonance (NMR) and computational methods.

In yet another thrust, the group is involved in the investigation of chemical reactions that exhibit multiple chromisms in different transition metal complexes, with potential applications in a variety of sensors and molecular switching devices. Charge transfer complexes (involving iron, ruthenium and osmium), with potential applications in dye-sensitised solar cell technology and photocatalytic reduction of water to hydrogen gas, or carbon dioxide to carbon monoxide syngas, are studied on an ongoing basis. Techniques such as ultra-fast femtosecond pulsed Laser, UV/visible, IR, NMR, Cyclic-Voltammetry, single-molecule Langmuir-Blodgett thin films, Quantum Computational Chemistry (Amsterdam Density Functional [ADF] and Gaussian), and X-ray Crystallography are employed. The Analytical Chemistry division was responsible for the element analyses for other groups in the departments of Chemistry, Geology, Physics, and Microbiology.

Inorganic Chemistry

This division consists of two separate research groups which are independently headed by Prof André Roodt (B2-rated) and Prof Deon Visser (C2-rated).

The research in the ***Roodt Group*** was supported by grants under the prestigious Swiss South Africa Joint Research Programme (SSAJRP: 2017-2020), NRF Rated and Unrated Researcher programmes and from SASOL. Members of the group include Dr Johan Venter, Dr Alice Brink (SASOL grantholder and UFS Prestige Scholar; Y1-rated) and Dr Marietjie Schutte-Smith (NRF grantholder; UFS Prestige Scholar; Y2-rated). Research was further supported by Dr Truidie Venter (NRF grantholder) as Chief Officer - Professional Services. The group also included four postdoctoral research fellows, two MSc and eight PhD students. The Roodt Group was involved in 19 publications and group members attended numerous conferences and presented 25 oral and poster contributions during the year. The joint NRF National Equipment Programme application by Prof André Roodt and Dr Alice Brink resulted in the installation of a new state-of-the-art X-ray Diffractometer to the value of R12.9 million, during October 2019.

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 ***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. In 2019, eight articles were published, and two MSc students finished their studies – both within one year. Currently four MSc and four PhD students were involved and the research group presented oral presentations on five occasions at national conferences.

Organic Chemistry

Headed by Dr Susanna Bonnet, this division includes Prof Vladimir Azov, Dr Anke Wilhelm, Dr Charlene Marais and Dr Linette Twigge as lecturing staff, with Mr Rudi Swart as Professional Officer and Prof Ben Bezuidenhoudt as Research Fellow.

Members of the Organic Chemistry group at the Frank Warren Organic Chemistry Conference (7-11 July 2019)
Front from the left: Dr Anke Wilhelm, Dr Susan Bonnet and Prof Vladimir Azov
Middle from the left: Mr Mohale Mabaleha, Ms Kirsten Ehlers, Ms Jani Faber, Mr George Erasmus and Ms Andrea Davies
Back from the left: Ms Tsebo Molahloe, Mr Jaco van Rooyen and Dr Anwar Noreljaleel

The division consists of three distinct research directions. The ***Phytochemistry Group*** (Dr Bonnet and Dr Wilhelm) focuses on the isolation and synthesis of natural products and compounds with therapeutic potential and testing of these compounds in a zebra fish model. The zebrafish bioassay, managed by Dr Wilhelm, is fully operational and the first positive results were presented at The Frank Warren Conference. Toxicity and activity results have also been compiled in the dissertations of three students.

The ***Process Chemistry Group*** (Dr Marais and Prof Bezuidenhoudt) investigates new methodologies for the synthesis of organic compounds with the emphasis on catalyst development and evaluation for industrial and other processes. The third direction (Prof VA Azov) concentrates on ***Supramolecular Chemistry*** and deals with the investigation of self-assembly, molecular recognition and switching properties of molecular systems containing tetrathiafulvalene (TTF) building blocks.

Members of the Organic Chemistry division published 12 papers in international journals – three by the Phytochemistry group, two by the Process Chemistry group, four by Dr Twigge and three by Prof Azov. Eight MSc and seven PhD students completed their studies in 2019.

Physical Chemistry

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.

Prof Swarts and Prof Conradie both held two NRF research grants (Rated Researcher and Competitive Rated Researcher) and Dr Müller received a research grant from the UFS central research fund. The Swarts, Erasmus and Langner groups were funded by research grants from Syngaschem BV and Prof Erasmus and Dr Langner were also funded by SASOL. Dr Langner received funding from the Central University of Technology (CUT)/UFS Joint Research Programme.

Postgraduate students in this division included 14 MSc and 7 PhD students, as well as 6 postdoctoral research fellows. The division was involved in 36 publications, and made 40 oral and poster contributions at conferences.

The ***Swarts Group*** focuses on synthetic and physical chemistry aspects of multinuclear metallocenes, and concentrates on porphyrin and phthalocyanine compounds bearing metallocene substituents such as titanocene, zirconocene, ferrocene, ruthenocene, and osmocene derivatives, especially in association with late transition metals; electrochemical, kinetic, and thermal analyses of these complexes; medicinal aspects of these complexes; and industrial studies on carboxylato complexes and heterogeneous catalysis of systems supported on two-dimensional matrices in collaboration with SASOL.

The research in the ***Conradie 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 Jeanet Conradie (middle) with Dr Alhadji Malloum (left) and Miss Nandi Mateyise (right) at the 13th CHPC Conference at Birchwood, Johannesburg

The ***Moskaleva Group*** investigates surface reactivity of solids at the atomic level using first-principles quantum-chemical methods, molecular dynamics, statistical theory, microkinetic modelling, and thermodynamics. Currently, her group works on the topics related to heterogeneous catalysis and electrocatalysis.

The ***Erasmus Group***, on the other hand, focuses on heterogeneous catalysis of especially model catalysts on flat surfaces and materials characterisation with XPS techniques, while the ***Langner Group*** studies Metal Organic Frameworks (MOFs), especially for medical application, catalysis, gas adsorption and desorption studies, and thermal analysis thereof.

Dr Müller's research concentrates on Polymer chemistry, anti-cancer research, with the synthesis of possible chemotherapeutic drugs in the form of polymers, nano-particles and organometallic compounds. All newly synthesised compounds are tested in-house for anti-cancer activity.

Other research-related activities

The Department of Chemistry, together with Bruker South Africa, hosted the 2019 Bruker NMR User's Meeting, attended by 35 NMR users from various academic and industrial institutions from around South Africa. Participants in the meeting presented their individual NMR research, while Dr Rainer Kerssebaum (Bruker's Liquid-state NMR specialist) and Dr Gerhard Althoff-Ospelt (Bruker's Solid-state NMR specialist) presented workshops on NMR tips and tricks, as well as new techniques in their respective fields. Prof Conradie presented a talk on 'Trends in ^{103}Rh NMR of Rh-β-diketonatocomplexes', and Dr Bonnet on 'Isolation and characterization of glucosylatediridoids from *Aptosimumelongatum*'.

Delegates at the 2019 Bruker NMR User's Meeting, from the left: Dr Susan Bonnet, Prof Karel von Eschwege, Dr Linette Twigge, Prof Jeanet Conradie, Dr Rainer Kerssebaum (Bruker, Germany), Dr Anke Wilhelm and Pari Antalis (Bruker, South Africa)

The International FreeStatePhyChem Symposium, held on 12 August 2019, was organised by Prof Conradie and Prof Moskaleva. The Symposium aimed to strengthen the international collaborations of the Department and to foster interest and engagement of students in physical chemistry research. The programme was very intensive, with keynote lectures delivered by Prof Jiří Ludvík from Heyrovský Institute of Physical Chemistry in the Czech Republic, Prof Gunther Wittstock from Carl von Ossietzky University of Oldenburg in Germany, and our own Prof Jannie Swarts.

Delegates at the opening of the FreeStatePhyChem Symposium on 12 August 2019, from the left: Prof Walter Purcell (UFS Head of Chemistry), Prof Gunther Wittstock (Carl von Ossietzky University of Oldenburg, Germany), Prof Jiří Ludvík (Heyrovský Institute of Physical Chemistry, Czech Republic), Prof Irena Hoskovcová, (University of Chemistry and Technology, Prague, Czech Republic), Prof Corli Witthuhn (UFS Vice-Rector: Research, Innovation and Internationalisation) and Prof Danie Vermeulen (Dean of the Faculty of Natural and Agricultural Sciences)

Dr Ernie Langner, together with Dr Wynand Nel from the Department of Computer Science and Informatics, organised the annual '*Studentesimposium in die Natuurwetenskappe*' of the Suid-Afrikaanse Akademie vir Wetenskap en Kuns (SAAWK). It was held on the Bloemfontein campus from 31 October to 1 November 2019 and was attended by 90 postgraduate students and lecturers from the UFS, University of Johannesburg (UJ), North-West University (NWU), University of Pretoria, University of Stellenbosch and University of the Western Cape (UWC).

Prof André Roodt hosted the 2nd Symposium on Reaction Mechanisms (ReMec 2) from 28 October to 1 November 2019. The Symposium started at the SA Forensic Service Laboratories in Pretoria, after which it moved to the SASOL1 site in Sasolburg for a morning session, then to the UFS Qwaqwa Campus, and concluded at the UFS Bloemfontein Campus. Dr Johan Venter, Dr Alice Brink and Dr Marietjie Schutte-Smith, as well as Prof Roger Alberto (University of Zürich) were members of the organising and scientific committees. Group members and students presented 20 invited lectures, including two keynote addresses (Prof Alberto and Prof Roodt), both during the conference and during the SASOL1 visit. During the symposium discussions were conducted at SASOL, Qwaqwa Campus as well as the National Analytical Forensic Services (NAFS) and PETLabs.

Prof André Roodt and Prof Roger Alberto (in front) with the ReMec 2 travelling group on the Qwaqwa Campus

Dr Alice Brink continued to manage the X-ray Crystallographic facility for the Department as well as the international databases – the Cambridge Crystallographic Data Centre (CCDC) and the Inorganic Crystal Structure Database (ICSD).

Dr Linette Twigge, Manager of the NMR facility, assisted more than 20 postgraduate students from the different research groups with delicate and advanced multi-nuclear NMR experiments.

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.

Staff of the Organic Chemistry division acted as reviewers for the following internationally acclaimed journals: *Journal of Natural Products* (Prof Bezuidenhoudt, Dr Bonnet, Dr Wilhelm and Dr Marais), *Journal of Organic Chemistry* (Prof Azov and Prof Bezuidenhoudt), *Phytochemistry* (Dr Bonnet), *Phytochemistry Letters* (Dr Bonnet and Dr Wilhelm), *Natural Product Communications* (Dr Wilhelm), *Chemistry-A European Journal* (Prof Azov), *ChemPlusChem* (Prof Azov), *Journal of Molecular Liquids* (Prof Azov), *New Journal of Chemistry* (Prof Azov), South African Journal of Chemistry (Prof Azov), as well as NRF-rating and funding applications (Prof Azov).

Prof Karel von Eschwege responded extensively to several private sector requests on especially sustainable energy, including a radio talk show regarding latest developments in energy storage. He also acted as reviewer for NRF-rating and funding applications, several journal publications and external PhD theses.

In the Inorganic Chemistry division Dr Alice Brink acted as a reviewer for *Acta Crystallographic C*, *Journal of Coordination Chemistry* and *Crystallographic Reviews*. She also acted as reviewer for NRF funding applications. Prof Roodt acted as reviewer for the NRF and as member of the Editorial Board of the *Journal of Coordination Chemistry*, and acted as a reviewer for that journal and *Inorganic Chemistry*, *Crystal Growth and Design*, *Crystal Engineering Communications*, *Dalton Transactions*, *Organometallics*, and *Inorganica Chimica Acta*.

In the Physical Chemistry division, Prof Conradie served as the Physical Chemistry Editor for the *South African Journal of Chemistry*. She also acted as a reviewer for the NRF and reviewed manuscripts for *Inorganica Chimica Acta*, *Journal of Molecular Structure*, *ACS Omega (ACS)*, *Dalton (RSC)*, *Arabian Journal of Chemistry*, *Journal of Organometallic Chemistry*, *New Journal of Chemistry (RSC)* and the *South African Journal of Chemistry*. Prof Swarts acted as reviewer for publications in *Organometallics*, *Inorganic Chemistry*, *Inorganica Chimica Acta*, *Polyhedron* and *Journal of Coordination Chemistry*. He also managed the large equipment plan for the Faculty of Natural and Agricultural Sciences, with R40 million worth of research equipment being purchased for the Faculty in 2019. Prof Moskaleva acted as reviewer for *Nature Communications*, *Chemistry – A European Journal*, *Angewandte Chemie – International Edition*, *Journal of Physical Chemistry C*, *ChemCatChem*, *Catalysts* and *Journal of Molecular Catalysis*. Prof Erasmus acted as a reviewer for the NRF and as reviewer for the *SA Journal of Chemistry*, *ACS Applied Chemistry* and *International Journal of Experimental Spectroscopic Techniques*. Dr Müller acted as a reviewer for the NRF and for *Inorganica Chimica Acta*, *Inorganic Chemistry and Transition Metal Chemistry*.

NATIONAL AND INTERNATIONAL COLLABORATION

The Analytical Chemistry division collaborated extensively with private companies as well as with Dr Ettienne Snyders from NECSA, and Prof Herman Potgieter from the School of Chemical and Metallurgical Engineering at the University of the Witwatersrand and Dr Sanja Potgieter-Vermaak from Manchester Metropolitan University.

Prof Karel von Eschwege has ongoing collaboration with the Universities of Stellenbosch and Pretoria. The former involves a multi-disciplinary research project with the Laser Research Institute, studying electronic transitions and transfers, as well as fast isomerizations of light sensitive molecular assemblies, in real time. Together with the University of Pretoria, highly ordered single-molecule thin films are grown of photo-sensitive materials, for potential applications in energy transfer and/or photo-catalytic reactions.

The Bezuidenhoudt Group collaborated with Chemical Process Technologies (Pretoria), Wildlife Pharmaceuticals (Nelspruit), and with PETLabs Pharmaceuticals on the synthesis of compounds with medical applications.

Dr Bonnet and Dr Wilhelm renewed their contract with Dr Leon van Kralingen from the Wattle Industry and delivered five confidential reports. They are instrumental in the development of new industrial strategies for the company. They published an article on previous investigations on sulfitation of black wattle in 2019. They also collaborate with Prof M Hamburger from the University of Basel, Switzerland, and Prof S Hering from the University of Vienna, Austria, on phytochemical projects. In addition, they have ongoing collaboration with Prof V Wepener and Dr T Botha from NWU on the zebra fish project.

Prof Azov continued to participate in a large international collaboration involving scientists from Purdue University, Pacific Northwest National Laboratory (PNNL), University of Leipzig and the University of Bremen, related to the gas phase chemistry of dodecaborates. He also continued his collaboration with Dr S Kunz (University of Bremen) on creation of stereoselective heterogeneous catalysts, with Dr M Zeller (Purdue University) and Prof Vande Velde (University of Antwerp) on crystallography of organic molecules. In addition, a new collaboration has been initiated with Prof U Hennecke and Prof S Ballet at Vrije Universiteit Brussel in Belgium in the field of peptide-based materials – supported with a joint NRF-FWO (National Research Foundation-Research Foundation Flanders) grant.

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 2019. An international Patent Cooperation Treaty (PCT) Patent was granted on this work in June 2019. 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. The Roodt Group hosted Prof Alberto and five delegates from the University of Zürich.

Dr Brink collaborated 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 Department of Pharmacology, the University of Pretoria and the University of Missouri (USA) is being established in association with Dr Truidie Venter.

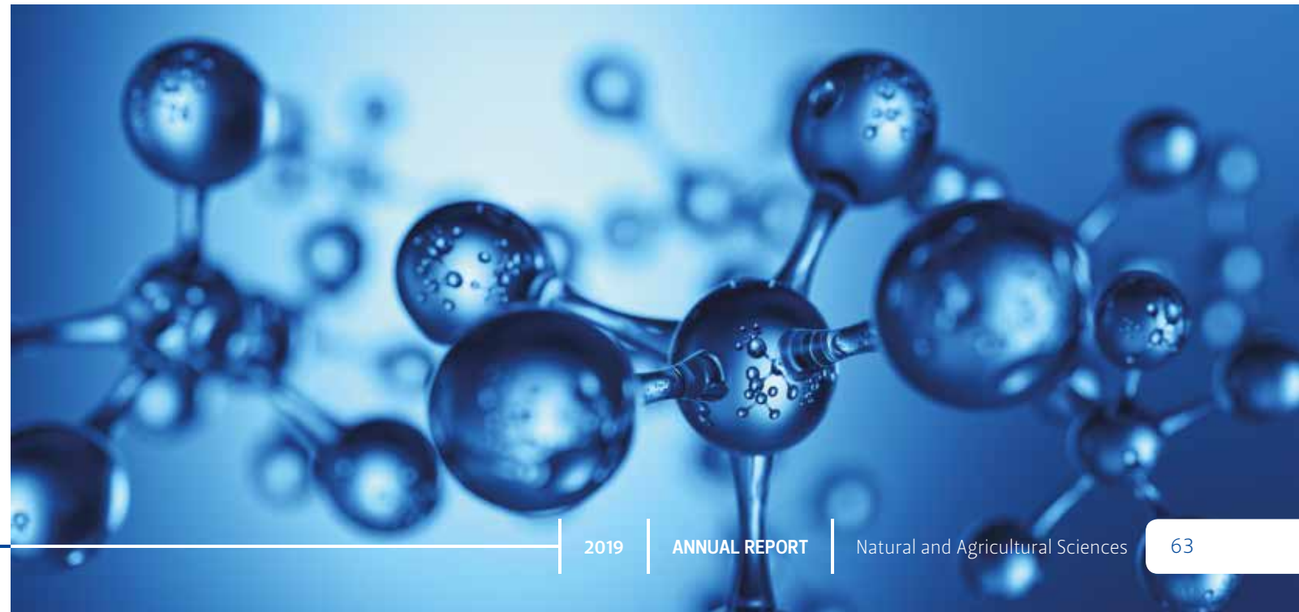
Dr Brink was a Research Visitor to the School of Chemistry, University of Manchester and her research group conducted research experiments at the UK national Synchrotron DIAMOND via remote access. She and Dr Truidie Venter were invited by the Cambridge Crystallographic Data Centre to present at the American Chemical Society (ACS) Annual National Meeting (August 2019, San Diego). Dr Venter and Dr Brink held research discussions with Prof N Gerasimchuk, at Missouri State University, about possible collaboration.

Prof Deon Visser and Dr Marietjie 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, Dr Gilles Gasser from ParisTech, France, Prof Ted Kroon from the UFS Department of Physics.

Prof Conradie collaborated with Prof M Landman, Prof P van Rooyen and Dr F Malan from the University of Pretoria, Dr Gurthwin Bosman from Stellenbosch University and Dr CGCE van Sittert from NWU. Internationally she also collaborated with Prof Abhik Ghosh (Department of Chemistry and Centre for Theoretical and Computational Chemistry, University of Tromsø), Prof Irena Hoskovcová (University of Chemistry and Technology, Prague), Penny Brothers (University of Auckland), Prof JH Potgieter (University of the Witwatersrand and Manchester Metropolitan University), Claude P Gros (Université de Bourgognein Dijon), Karl M Kadish (University of Houston) and Dr Jean Jules Fifen (University of Ngaoundere in Cameroon).

Prof Swarts visited and presented a lecture to the research groups of Prof Henry Lang (Chemnitz Technical University, Germany) to further existing collaboration in the fields of electrochemistry, metallocenes and phthalocyanines. He also visited the Syngaschem BV at Differ, Technical University, Eindhoven (Prof Hans Niemantsverdriet) to further their collaboration in the field of heterogeneous catalysis. Prof Swarts also collaborated with Prof M Landman (University of Pretoria) and with Prof Mike Cook (University of East Anglia).

Prof Moskaleva collaborated with researchers from Germany within the Nanoporous Gold Catalysts (NAGOCAT) Research Group funded by the German Research Foundation (DFG), and Dr Langner collaborated with Dr Kobus van der Walt (CUT) on the development of polypropylene powders for laser sintering, and with Prof Hans Niemantsverdriet of Syngaschem BV at Differ, Technical University, Eindhoven. Prof Erasmus and Dr Müller also collaborated with Prof Niemantsverdriet.



POSTGRADUATE STUDENTS

In 2019, the Bloemfontein Campus hosted 20 Honours, 40 MSc, and 21 PhD candidates.

A total of 17 Honours students graduated, while the following students received their MSc degrees: L Mona and A Ngcephe (Analytical Chemistry); TL Ngake and E Chiyindiko (Physical Chemistry); and Z Morerwa, M Khasemene, M Motente and S Redgard (Inorganic Chemistry).

The following students were awarded their PhD degrees:

Ferreira, H
Thesis: Density functional theory calculations and electrochemistry of octahedral $M(L,L'\text{-}BID)_3$ complexes, L and L' = N and/or O and M = selected transition metals
Promoter: Prof J Conradie

Ramadan, A
Thesis: Silica polymerization kinetics and application of silica-based polymers
Promoter: Prof AS Luyt

A number of our postgraduate students delivered papers and presented posters at various conferences. These included:

- Emmie Chiyindiko, Tankiso Ngake, Nandisiwe Mateyise, Deidré van der Westhuizen (oral presentation and posters at the 70th Annual Meeting of the International Society of Electrochemistry)
- A Davies, J Faber, T Molahloe, MB Mabaleha, G Erasmus, K Ehlers, J van Rooyen (presented posters at the Frank Warren Conference 2019)
- Ms Jeaneme Kuhn (oral presentation at the South African Wildlife Management Association (SAWMA) Conference)
- Ms LE Kapp, Mr C van Staden, Ms L Jansen van Vuuren, Ms U Oosthuizen and Ms J Els (oral presentations at the Student Symposium of the Suid Afrikaanse Akademie vir Wetenskap)
- Ms JBM Smit (poster presentation at the 20th IUPAC International Symposium on Organometallic Chemistry directed towards Organic Synthesis [ISOM23])
- Mr MR Swart (poster presentation at the International Symposium on Olefin Metathesis and Related Chemistry, Barcelona, and the International FreeStatePhyChem-2019 Symposium)

Dr Marietjie Schutte-Smith and Jeaneme Kuhn at the SAWMA Conference

POSTDOCTORAL RESEARCH FELLOWS

The following postdoctoral research fellows were hosted by the Department of Chemistry in 2019:

- Dr Manish Sinha (India)
- Dr Alexander Orbett (South Africa)
- Dr Penny Mokolokolo (South Africa)
- Dr Dumisani Kama (South Africa)
- Dr Adebayo A. Adeniyi (Nigeria)
- Dr Anwar Noreljaleel (Sudan)
- Dr Mohammed Abdelaziz Elkhidir Elmakki (Sudan)

STAFF MATTERS

Prof Ben Bezuidenhoudt was appointed as a Research Fellow in Process Chemistry.

Sarah Matome was appointed as an NRF intern under the mentorship of Dr C Marais, and Mr Benji Nkabiti was appointed as Lecturer in Analytical Chemistry as part of nGAP.

Ms Alet van Rooyen received a service certificate for 30 years' service to the UFS.

Dr Truidie Venter relocated to another company at the end of October 2019.

Staff relaxing during the 'Potjie Competition' held at the Paradys Experimental Farm

RESEARCH OUTPUTS

Research Articles

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Adeniyi, A.A. & Conradie, J. 2019. Electronic effect of β-diketonato ligands on the redox potential of **fac** and **mer** tris (β-diketonato) iron(III) complexes: density functional theory study and molecular electrostatic potential analysis. *International Journal of Quantum Chemistry* 119: e26036.

Adeniyi, A.A. & Conradie, J. 2019. Influence of substituents on the reduction potential and pK_a values of β-diketones tautomers: A theoretical study. *Electrochimica Acta* 297: 947-960.

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Adeniyi, A.A., Ngake, T.L., Potgieter, J.H. & Conradie, J. 2019. Electrochemical behaviour of amino substituted β-amino α,β unsaturated ketones: A computational chemistry and experimental study. ***Electrochimica Acta*** 296:1070-1082. DOI: 10.1016/j.electacta.2018.11.144.

Alexander, O.T., Brink, A. & Visser, H.G. 2019. The crystal structure of bis(μ^2-5,7-dichloroquinolin-8-olato κ^3N,O:O)-tetrakis(5,7-dichloroquinolin-8-olato κ^2N,O)bis(methanol-κ^1O) di-europium(III)-toluene (1/1),$C_{63}H_{39}Cl_{12}Eu_2N_6O_8$. *Zeitschrift fur Kristallographie-New Crystal Structures* 235(1): 247-249.

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Brink, A. & Helliwell, J. 2019. Formation of a highly dense tetra-rhenium cluster in a protein crystal and its implications in medical imaging. *IUCrJ* 6(4): 695-702.

Brink, A. & Helliwell, J. 2019. Why is interoperability between the two fields of chemical crystallography and protein crystallography so difficult? *IUCrJ* 6(5): 788-793. [Recommended in *F1000Prime* as being of "*special significance in its field"].*

Brink, A., Kama, D.V., Alberto, R. & Roodt, A. 2019. Crystal structure of hexacarbonyl-(μ^2-methanoato-k^2O:O′)-(μ^2–bis(di-ptolylphosphino) cyclohexylamine-κP:P′) dirhenium(I), $C_{42}H_{45}NO_8P_2Re_2$. *Zeitschrift fur Kristallographie-New Crystal Structures* 235(2): 1-3.

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Conradie, J. 2019. Density functional theory calculated data of different electronic states and bond stretch isomers of tris(trifluoroacetylacetonato)-manganese (III). *Data in Brief* 27: 1-6.

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Venter, J.A. 2019**.** Oksidatiewe addisie van jodometaan aan Rh (I) neokupferraat komplekse as model vir 'n unieke toepassing van Tolman se beginsels. *South African Journal for Science and Technology / Suid-Afrikaanse Tydskrif vir Natuurwetenskap en Tegnologie* 38(1): 1-15.

Zhuang, Z., Li, Y., Huang, J., Li, Z., Zhao, K., Zhao, J., Xu, L., Zhou, L., Moskaleva, L. & Mai, L. 2019. Sisyphus effects in hydrogen electrochemistry on metal silicides enabled by silicene subunit edge. *Science Bulletin* 64: 617-624.

Conference Contributions

Conference Papers/Posters

Abraha, Y.W. & Langner, E.H.G. 2019. *Modification of nano-sized zinc zeolitic 2-methylimidazolate framework 8 (ZIF-8) by solvent assisted ligand exchange (SALE) for enhanced carbon dioxide uptake.* Poster presented at the International FreeStatePhyChem-2019 Symposium, Bloemfontein, South Africa. 12 August 2019.

Adeniyi, A.A & Conradie, J. 2019. *Complementary insight into the experimental reduction potentials of the tris(β-diketonato) iron(III) complexes using the DFT methods*. Paper delivered at the 70th Annual Meeting of the International Society of Electrochemistry, Durban, South Africa. 4-9 August 2019.

Adeniyi, A.A., Conradie, J. & Ngake, T.L. 2019. *The impact of the solvent media and substituents on the energy band-gap and redox potential of hydroxyl benzophenone (HBP) using both experimental and computational methods*. Poster presented at the 13th CHPC National Conference, Kempton Park, South Africa. 1-5 December 2019.

Alexander, O.T., Alberto, R. & Roodt, A. 2019. *Engineering of N-nased ligand cobalt complexes as potential water splitting catalyst.* Paper delivered at ReMec 2: 2nd Symposium on Reaction Mechanisms, Johannesburg, Qwaqwa and Bloemfontein, South Africa. 28 October-1 November 2019.

Azov, V.A. 2019. *Electrochemical behaviour of tetrathiafulvalenes in dynamic molecular systems.* Paper delivered at the, 70th Annual Meeting of the International Society of Electrochemistry, Durban, South Africa. 4-9 August 2019.

Azov, V.A. 2019. *Electrochemical behaviour of tetrathiafulvalenes in functional molecular systems.* Paper delivered at the International FreeStatePhyChem-2019 Symposium, Bloemfontein, South Africa. 12 August 2019.

Azov, **V. A.** 2019. *Tetrathiafulvalene-based molecular receptors for recognition of electron deficient guests.* Paper delivered at the Frank Warren Organic Chemistry Conference, Drakensberg, South Africa. 7-11 July 2019.

Azov, V. A. & Böckmann, M. 2019. *Tetrathiafulvalene-azobenzene macrocycles: controlling electrochemical properties of tetrathiafulvalene by light*. Poster presented at the 70th Annual Meeting of the International Society of Electrochemistry, Durban, South Africa. 4-9 August 2019.

Bezuidenhout, Z. & Roodt, A. 2019. *Activating natural product diolefins by transition metal coordination.* Paper delivered at ReMec 2: 2nd Symposium on Reaction Mechanisms, Johannesburg, Qwaqwa and Bloemfontein, South Africa. 28 October-1 November 2019.

Bonnet, S.L. 2019. *Sixty years of flavonoid chemistry at the University of the Free State: Past and contemporary research*. Keynote lecture delivered at the Frank Warren Organic Chemistry Conference, Drakensberg, South Africa. 7-11 July 2019.

Brink, A. 2019. *Exploring strategies for radiopharmaceuticals with rhenium in chemical and protein crystallography.* Poster presented at the Biophysics and Structural Biology at Synchrotrons Workshop, Cape Town, South Africa. 17-24 January 2019. [Awarded outstanding poster prize].

Brink A. 2019. *Merging the boundaries between chemical and bio-catalysis: Stepping toward the 4th Industrial Revolution*. Paper delivered at ReMec 2: 2nd Symposium on Reaction Mechanisms, Johannesburg, Qwaqwa and Bloemfontein, South Africa. 28 October-1 November 2019.

Brink A 2019. *Traversing interoperability – drug development harnessing the CSD and PDB.* Paper delivered at the American Chemical Society Annual Meeting, San Diego, USA. 25-30 August 2019.

Chiyindiko, E., Conradie, J. & Langner, E.H.G. 2019. *Electrochemical reduction of bis(β-diketonato) copper(II) compounds*. Paper delivered at the 70th Annual Meeting of the International Society of Electrochemistry, Durban, South Africa. 4-9 August 2019.

Chiyindiko, E., Conradie, J. & Langner, E.H.G. 2019. *Electrochemistry of gamma-substituted complexes of bis(β-diketonato) copper (II)*. Poster presented at the 70th Annual Meeting of the International Society of Electrochemistry, Durban, South Africa. 4-9 August 2019. [Awarded best poster prize Symposium 14 Molecular Electrochemistry].

Chiyindiko, E., Langner, E.H.G. & Conradie. J. 2019. *Redox properties of bis(β-diketonato) copper(II) complexes.* Paper delivered at the International FreeStatePhyChem-2019 Symposium, Bloemfontein, South Africa. 12 August 2019.

Conradie J. 2019. *Jahn-Teller effect observed in octahedral copper(II) complexes*. Poster presented at the 13th CHPC National Conference, Kempton Park, South Africa. 1-5 December 2019.

Conradie, J. 2019. *Noncovalent rhodium-rhodium interactions*. Paper delivered at the 1st International Conference on Noncovalent Interactions, Lisbon, Portugal. 2-6 September 2019.

Conradie, J. 2019. *Redox behaviour of [Ru(β-diketonato) $_3$] complexes*. Paper delivered at the 70th Annual Meeting of the International Society of Electrochemistry, Durban, South Africa. 4-9 August 2019.

Conradie, J. 2019. *Trends in ^{103}Rh NMR shifts of Rh-β-diketonato complexes*. Paper delivered at the Bruker NMR User Meering, Bloemfontein, South Africa. 29-31 January 2019.

Conradie, J., Conradie, M.M. & Ferreira, H. 2019. *Redox behaviour of a series of Co(II) complexes, containing substituted phenanthrolines,* Poster presented at the International FreeStatePhyChem-2019 Symposium, Bloemfontein, South Africa. 12 August 2019.

Conradie, J., Conradie, M.M. & Ferreira, H. 2019. *Redox behaviour of substituted tris (1,10-phenanthroline) cobalt(II) complexes.* Poster presented at the 70th Annual Meeting of the International Society of Electrochemistry, Durban, South Africa. 4-9 August 2019.

Conradie, J. & Ghosh, A. 2019. *High performance computing of super heavy elements of the periodic table.* Poster presented at the 13th CHPC National Conference, Kempton Park, South Africa. 1-5 December 2019.

Elmakki, M., Venter, G.J., Venter, J.A. & Roodt, A. 2019. *Homogeneous catalyst models using natural rubber as a ligand*. Paper delivered at ReMec 2: 2nd Symposium on Reaction Mechanisms, Johannesburg, Qwaqwa and Bloemfontein, South Africa. 28 October-1 November 2019.

Erasmus, E. 2019. *Truncated cubicCu-oxide nanocrystals*. Paper delivered at the International FreeStatePhyChem-2019 Symposium, Bloemfontein, South Africa. 12 August 2019.

Faber, J., Marais, C. & Wilhelm, A. 2019. *Investigation into the oxidation reactions of the C-glucosylated xanthone, mangiferin*. Poster presented at the Frank Warren Organic Chemistry Conference, Drakensberg, South Africa. 7-11 July 2019.

Fourie, E. 2019. *Fluorene-containing β-diketonato ligands and their Rh(I) complexes*. Paper delivered at the International FreeStatePhyChem-2019 Symposium, Bloemfontein, South Africa. 12 August 2019.

Jacobs, F.J.F., Venter, G. & Brink, A. 2019. *Asking biological questions for radiopharmaceuticals*. Poster presented at Hot Topics in Contemporary Crystallography 4 (HTTC4) – Structural Biology, Dubrovnik, Croatia. 1-6 October 2019.

Jacobs, F.J.F., Venter, G. & Brink, A. 2019. *Exploring the synergistic world of macromolecular catalysis*. Paper delivered at ReMec 2: 2nd Symposium on Reaction Mechanisms, Johannesburg, Qwaqwa and Bloemfontein, South Africa. 28 October-1 November 2019.

Jacobs, F.J.F., Venter, G.J.S. & Brink, A. 2019. *Rhenium radiopharmaceuticals inspired by biological moieties.* Poster presented at the Biophysics and Structural Biology at Synchrotrons Workshop, Cape Town, South Africa. 17-24 January 2019. [Awarded outstanding poster prize].

Jansen van Vuuren, L., Visser, H.G. & Schutte-Smith, M. 2019. *Renium trikarboniel komplekse van (2-alkielamino) tropone en aminotroponimiene as potensiële chemoterapeutiese middels.* Paper delivered at the Studentesimposium in die Natuurwetenskappe, Bloemfontein, South Africa. 1 November 2019.

Kama, D.V., Brink, A., Alberto, R. & Roodt, A. 2019. *Exploring structural implications of diphosphinoamine ligands on radiopharmaceuticals and catalysis*. Paper delivered at ReMec 2: 2nd Symposium on Reaction Mechanisms, Johannesburg, Qwaqwa and Bloemfontein, South Africa. 28 October-1 November 2019.

Kapp, L., Visser, H.G. & Schutte-Smith, M. 2019. *Kankerbestryding met metale: karaterisering, substitusie kinetika, asook evaluering van renium(I) trikarboniel en dikarboniel komplekse vir fotodinamiese terapie*. Paper delivered at the Studentesimposium in die Natuurwetenskappe, Bloemfontein, South Africa. 1 November 2019.

Khasemene, M.T.W., Brink, A. & Roodt, A. 2019. *Middle and late transition metals as carbon dioxide capture and model water-splitting catalysts.* Paper delivered at ReMec 2: 2nd Symposium on Reaction Mechanisms, Johannesburg, Qwaqwa and Bloemfontein, South Africa. 28 October-1 November 2019.

Kuhn, J., Visser, H.G., Schutte-Smith, M. & Deacon, F. *Analysis of the effect of heavy metal distribution on the browsing patterns of giraffes (Giraffa Camelopardalis).* Paper delivered at the Southern African Wildlife Management Association Conference on Sustainable landscapes for wildlife conservation and management, Wilderness, South Africa. 1-5 September 2019.

Landman, M., Malan, F.P., Singleton, E. & Conradie, J. 2019. *Synthesis of NHC-stabilised heterohalo cyclopentadienyl Cr(III) complexes, electrochemical properties and base-free glucose dehydration.* Paper delivered at the International FreeStatePhyChem-2019 Symposium, Bloemfontein, South Africa. 12 August 2019.

Li, S., Li, Y., Bäumer, M. & **Moskaleva, L.** 2019. *Theoretical study on the structures and thermodynamics of A-type rare earth sesquioxides by HSE and PBE+U methods.* Poster presented at the CECAM Workshop on Correlated electron physics beyond the Hubbard model, Bremen, Germany. 4-8 February 2019.

Malan, F.P., Singleton, E., Van Rooyen, P.H., Conradie, J. & Landman, M. 2019. *Electronic effects of N-heterocyclic carbene ligands on the catalytic activity of half-sandwich Ni(II) complexes*. Paper delivered at the International FreeStatePhyChem-2019 Symposium, Bloemfontein, South Africa. 12 August 2019.

Malloum, A., Fifen, J. & Conradie, J. 2019. *Solvation energies of the proton in ammonia.* Poster presented at the 13th CHPC National Conference, Kempton Park, South Africa. 1-5 December 2019.

Malloum, A., Fifen, J. & Conradie, J. 2019. *Theoretical infrared spectrum of the ethanol hexamer*. Poster presented at the 13th CHPC National Conference, Kempton Park, South Africa. 1-5 December 2019.

Malloum, A., Fifen, J.J. & Conradie, J. 2019. *Structures and hydrogen bond networks of molecular clusters*. Poster presented at the 1st International Conference on Noncovalent Interactions, Lisbon, Portugal. 2-6 September 2019.

Masiu, M.P. & Langner, E.H.G. 2019. *The synthesis and electrochemical study of ZIF-8 and ZIF-67 with ferrocenecarboxylic acid attached to its surface*. Poster presented at the International FreeStatePhyChem-2019 Symposium, Bloemfontein, South Africa. 12 August 2019.

Mateyise, N.G.S., Conradie, M.M. & Conradie, J. 2019. *Electrochemical behaviour 1,3-substituted-propane-1,3-diones*. Poster presented at the International FreeStatePhyChem-2019 Symposium, Bloemfontein, South Africa. 12 August 2019.

Mateyise, N.G.S., Conradie, M.M. & Conradie, J. 2019. *HPC calculations to understand the reduction of 1, 3-substitutedacetylacetone derivatives*. Poster presented at the 13th CHPC National Conference, Kempton Park, South Africa. 1-5 December 2019.

Mateyise, N.G.S., Conradie, M.M. & Conradie, J. 2019. *Redox behaviour [Rh (β-diketonato) (CO) (PPh$_3$)] complexes.* Poster presented at the 70th Annual Meeting of the International Society of Electrochemistry, Durban, South Africa. 4-9 August 2019.

Mateyise, N.G.S., Conradie, M.M. & Conradie, J. 2019. *Redox behaviour 1, 3-substituted-propane-1, 3-diones.* Poster presented at the 70th Annual Meeting of the International Society of Electrochemistry, Durban, South Africa. 4-9 August 2019. [Awarded best poster prize in Symposium 14 Molecular Electrochemistry].

Mokolokolo, P.P., Pretorius, C., Brink, A., Schutte-Smith, M., Alberto, R. & Roodt, A. *Schiff bases, an unending journey.* Paper delivered at ReMec 2: 2nd Symposium on Reaction Mechanisms, Johannesburg, Qwaqwa and Bloemfontein, South Africa. 28 October-1 November 2019.

Morerwa, Z.G., Roodt, A. & Brink, A. 2019. *Environmentally friendly rhodium(I) model catalysts*. Paper delivered at ReMec 2: 2nd Symposium on Reaction Mechanisms, Johannesburg, Qwaqwa and Bloemfontein, South Africa. 28 October-1 November 2019.

Morerwa, Z.G., Roodt, A. & Venter, G.J.S. 2019. *Environmentally friendly rhodium(I) model catalysts*. Paper delivered at the the American Chemical Society Annual Meeting, San Diego, USA. 25-30 August 2019.

Moskaleva, L.V., Dononelli, W., Tomaschun, G. & Klüner, T. 2019. *Understanding dioxygen activation on nanoporous gold. A DFT and microkinetic modeling study*. Paper delivered at the Symposium of the Research Unit NAGOCAT, Luneburg, Germany. 7-12 September 2019.

Moskaleva, L.V., Dononelli, W., Tomaschun, G. & Klüner, T. 2019. *Understanding dioxygen activation on nanoporous gold. A DFT and microkinetic modeling study*. Poster presented at the 3rd International Symposium on Nanoporous Materials by Alloy Corrosion, Philadelphia, USA. 24-28 February 2019.

Moskaleva, L.V., Tomaschun, G., Dononelli, W., & Bäumer, M. 2019. *Theoretical modelling of methanol oxidation on nanoporous gold using stepped and kinked extended gold surfaces*. Paper delivered at CATSA 2019, Langebaan, South Africa. 10-13 November 2019.

Motente, M.A., Venter, J. & Brink, A. 2019. *Rhodium(I) N-heterocyclic carbene complexes as model catalysts*. Paper delivered at ReMec 2: 2nd Symposium on Reaction Mechanisms, Johannesburg, Qwaqwa and Bloemfontein, South Africa. 28 October-1 November 2019.

Muller, K.A., Roodt, A., Schutte-Smith, M. & Steyl, G. 2019. *Theoretical and solid state investigation of copper(II) O, O'-bidentate and copper(I) triphenylphosphine complexes*. Poster presented at ReMec 2: 2nd Symposium on Reaction Mechanisms, Johannesburg, Qwaqwa and Bloemfontein, South Africa. 28 October-1 November 2019.

Ngake, T.L., Potgieter, J.H. & Conradie, J. 2019. *Electrochemical study of β-amino-α,β-unsaturated ketones*. Paper delivered at the International FreeStatePhyChem-2019 Symposium, Bloemfontein, South Africa. 12 August 2019.

Ngake, T.L., Potgieter, J.H., Conradie, J. & Langner, E.H.G. 2019. *Electrochemical behaviour of tris (β-ketoiminato) ruthenium (III) complexes*. Poster presented at the 70th Annual Meeting of the International Society of Electrochemistry, Durban, South Africa. 4-9 August 2019.

Ngake, T.L., Potgieter, J.H., Conradie, J. & Langner, E.H.G. 2019. *Voltammetry of imino-β-diketones.* Paper delivered at the 70th Annual Meeting of the International Society of

Electrochemistry, Durban, South Africa. 4-9 August 2019.

Nkoe, P.I., Brink, A. & Schutte-Smith, M. *A mechanistic study of bipyridine and β-diketone bidentate ligand interactions on the rhenium(I) tricarbonyl core.* Paper delivered at ReMec 2: 2nd Symposium on Reaction Mechanisms, Johannesburg, Qwaqwa and Bloemfontein, South Africa. 28 October-1 November 2019.

Oosthuizen, U., Schutte-Smith, M. & Visser, H.G. 2019. *Studie van bimetaalverbindings vir die behandeling van verskillende kankersoorte*. Paper delivered at the Studentesimposium in die Natuurwetenskappe, Bloemfontein, South Africa. 1 November 2019.

Parrott, L.K. & Erasmus, E. 2019. *Graphene oxide based supports, with chitosan and magnitite, for pallaium catalysed reduction of nitrophenol*. Poster presented at the International FreeStatePhyChem-2019 Symposium, Bloemfontein, South Africa. 12 August 2019.

Redgard, S. & Roodt, A. 2019. *Nucleophile assisted carbon dioxide fixation for a cleaner environment*. Paper delivered at ReMec 2: 2nd Symposium on Reaction Mechanisms, Johannesburg, Qwaqwa and Bloemfontein, South Africa. 28 October-1 November 2019.

Roodt, A. 2019. *Designing horses for courses: Fundamental aspects of 'Applied' Chemical Processes' (Know Mechanisms)*. Invited Keynote Lecture delivered at ReMec 2: 2nd Symposium on Reaction Mechanisms, Johannesburg, Qwaqwa and Bloemfontein, South Africa. 28 October-1 November 2019.

Schutte-Smith, M., Roodt, A. & Visser, H.G. *Methanol substitution in fac-[Re(Trop)(CO)$_3$(CH$_3$OH)] – an ambient and high-pressure kinetic investigation.* Paper delivered at ReMec 2: 2nd Symposium on Reaction Mechanisms, Johannesburg, Qwaqwa and Bloemfontein, South Africa. 28 October-1 November 2019.

Smit, J.B.M., Marais, C. & Bezuidenhoudt, B.C.B. 2019. *Hydroformylation of oxygenated 1, 2-diphenylethenes and -ethynes en Route to Isoflavonoids*. Poster presented at the 20th IUPAC International Symposium on Organometallic Chemistry (ISOM23), directed towards organic synthesis, Heidelberg, Germany, 21-25 Jul-2019.

Swart, M.R., Erasmus, E., Marais, C. & Bezuidenhoudt, B.C.B. 2019. *A study towards improving cross-metathesis reactions between styrene- and acrylate derivatives*. Poster presented at the International FreeStatePhyChem-2019 Symposium, Bloemfontein, South Africa. 12 August 2019.

Swart, R.M., Erasmus, E., Marais, C. & Bezuidenhoudt, B.C.B. 2019. *An investigation of the influence of p-cresol on Grubbs second-generation catalyzed cross-metathesis*. Poster presented at the 23rd International Symposium on Olefin Metathesis and Related Chemistry (ISOM23), Barcelona, Spain. 30 June-03 July 2019.

Swarts, J.C., Buitendach, B.E. & Niemantsverdriet, J.W. 2019. *Electrochemical generation of oxygen on iridium/ruthenium modified electrodes.* Paper delivered delivered at the 27th International Conference on Coordination and Bioinorganic Chemistry (ICCBIC), Smolenice, Slovakia. 2-7 June 2019.

Swarts, J.C. & Joubert, C.C. 2019. *Reaction between CO and H_2 catalyzed by Fe-Cu particles supported on silicon wafers including electrochemical and spectroscopic aspects.* Keynote Paper delivered at the International FreeStatePhyChem-2019 Symposium, Bloemfontein, South Africa. 12 August 2019

Swarts, P.J. & Conradie, J. 2019. *Electrochemical studies on novel subphthalocyanines*. Paper delivered at the International FreeStatePhyChem-2019 Symposium, Bloemfontein, South Africa. 12 August 2019.

Tsai, C-W., Niemantsverdriet, J. & Langner, E.H.G. 2019. *Ligand exchanged nano-ZIF-8 with enhanced CO_2 adsorption.* Paper delivered at the 6th International Conference on Multifunctional, Hybrid and Nanomaterials, Sitges, Spain. 11-15 March 2019.

Van der Westhuizen, D., Von Eschwege, K. & Conradie, J. 2019. *Determination of electrochemical, spectral and computational properties of substituted $[Ru(phen)_3]^{2+}$ and $[Ru(bpy)_3]^{2+}$ complexes.* Paper delivered at the 70th Annual Meeting of the International Society of Electrochemistry, Durban, South Africa. 4-9 August 2019.

Van der Westhuizen, D., Von Eschwege, K.G. & Conradie, J. 2019. *Ru(II) complex electrochemical and spectral properties*. Paper delivered at the International FreeStatePhyChem-2019 Symposium, Bloemfontein, South Africa. 12 August 2019.

Von Eschwege, K.G. & Conradie, J. 2019. *Theoretical prediction of redox potentials*. Paper delivered at the International FreeStatePhyChem-2019 Symposium, Bloemfontein, South Africa. 12 August 2019.

Wilhelm, A. 2019. *HPLC-based activity profiling for GABAA receptor modulators in Murraya exotica.* Paper delivered at the Frank Warren Organic Chemistry Conference, Drakensberg, South Africa. 7-11 July 2019.

Xantini, Z, & Erasmus, E. 2019. *Preparation, characterisation and comparing three different catalytic supports for hydrogenation of unsaturated carbonyl compounds*. Poster presented at the International FreeStatePhyChem-2019 Symposium, Bloemfontein, South Africa. 12 August 2019.

Patents

Roodt, A., Alberto, R.A., Frei, A., Mokolokolo, P.P., Bolliger, R.K., Brink, A. & Kama, D.V. 2019. *Multinuclear complexes and their preparation*. PCT Patent Application No. *PCT/IB2018/060506* | VS Ref: P3490pc00-TM6JA/LD, *WO2019/123409 A1*, 27 June 2019.

STAFF (2019)

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 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

Secretaries: Ms E Andrews and Ms A Pieters

Senior Officers - Professional Services: Mr MP Coetzee, Ms T Swarts and Ms R Wales (Finances)

Officers - Professional Services: Dr MM Conradie-Bekker, Ms WC du Plessis (Marketing), Ms M Meyburgh, Mr R Swart and Dr T Venter

Technical Aid Assistants: Mr ID Fish, Mr J Mafahle, Mr J Masedi, Ms J Mmope, Mr J Mokhesi and Mr GI Nkotshana

Qwaqwa Campus

Senior Lecturer: Dr JP Mofokeng

Lecturers: Dr MA Malimabe, Dr NF Molefe, Mr K Mpitso (Subject Head) and Mr TA Tsotetsi

Junior Lecturer: Mr R Moji

Officers - Professional Services: Ms CE Clarke-Konig, Ms P Leche and Mr MFT Mosoabisane

South Campus

Lecturer: Mrs R Meintjes

Facilitators: Ms J Botha, Ms C de Klerk, Dr M du Plessis, Ms B van Tonder, Dr R Siegert and Ms Z Venter

DEPARTMENT OF

COMPUTER SCIENCE AND INFORMATICS

CONTACT DETAILS

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OVERVIEW OF 2019

The Department of Computer Science and Informatics (CSI) participated in the review process implemented by the Directorate for Institutional Research and Academic Planning (DIRAP) and received positive feedback. The Department is engaged in establishing an Industry Advisory Board, which was recommended by the external review panel.

We endeavour to expose our students to the latest trends in information technology (IT) and expand our industry engagement in various ways. This included a workshop in collaboration with BBD Software Development at the beginning of 2019. The Department also entered into a memorandum of agreement with IoT.nxt, which promises to bring many opportunities for our students and expose them to the latest development in the 'internet of things' (IoT). A memorandum of agreement was also entered into with Xineoh, and internships will follow. A marketing video was produced in collaboration with IoT.nxt, BBD and Xineoh and is available on the new departmental website.

Members of the Editorial Board of the JEMR, from the left: Marina Groner, Walter Bischof, Pieter Blignaut and Rudolf Groner

ACHIEVEMENTS

Staff Achievements

Prof Pieter Blignaut was appointed as Associate Editor of the *Journal of Eye Movement Research* (JEMR).

Prof Liezel Nel and Mr Pakiso Khomokhoana (PhD student) received the Best Paper award at the 48th Annual Conference of the Southern African Computer Lecturers' Association (SACLA) for their paper, titled 'Decoding Source Code Comprehension: Bottlenecks experienced by senior Computer Science students'.

Prof Liezel Nel (left) and Mr Pakiso Khomokhoana (right) with the Best Paper award at SACLA 2019

A nursing student exploring the Virtual Reality Ward at the usability test of the VE created for nursing practical training

Student Achievements

As part of his master's studies, Mr Bennie Botha (supervised by Dr Lizette de Wet), who is also a staff member at the UFS School of Nursing, created a Virtual Environment (VE) that will assist in the training of nursing students. This VE was subjected to rigorous usability testing involving panels from both the Department of Computer Science and Informatics and the School of Nursing, as well as prospective nursing student users. The Vice-Chancellor, Prof Francis Peterson, also tested the VE. This research was featured on the UFS website and was also included as an article in the 'Cape Times' of 26 November 2019. This research stimulated collaboration between faculties and departments, encouraging flexibility, teamwork and making compromises to the advantage of the student and research. The VE has also been demonstrated to the UFS Medical School to investigate similar options for the training of medical doctors and other related medical practitioners. Although a Virtual Reality (VR) option could also save costs as it is a much more affordable option than simulation training, it should be seen as an additional training method and not as a replacement for the current simulation training.

Miss Mapule Madzena, a second-year student, qualified to be a reserve for the winning teams of the Centre for High Performance Computing (CHPC) Student Cluster Competition. During January 2019 they went to Texas, USA for training.

Miss Tebello Lebesa, an Honours student in Computer Science and Informatics, was invited to make a presentation on Artificial Intelligence (AI) and Machine Learning at the first TechCon in Lesotho, a technological conference held on 25 September 2019, with the theme 'The Fourth Industrial Revolution'.

Mr Kenneth Wright, a third-year student, was given the tremendous opportunity of working at Xineoh as a data science intern. Various staff members of the company, from the CEO to the accountants, spent time helping him in his endeavour to forge a path in the career of data science. He also worked alongside Dr Adriaan van Brakel, who has a PhD in fibre optics, on a research project. The project concentrated on hyperparameter optimisation of machine learning models using genetic algorithms.

The IT Students' Association (ITSA) hosted an opening event on 9 March 2019 to welcome back returning members and to welcome all CSI first-years. The week leading up to the event, a problem-solving competition, was held for the first-year students, with the finals taking place at the event itself. Each member from the winning team received a departmental branded USB drive, and a voucher for an ITSA-designed hoodie.

Mr Johandré Bothma, an ITSA member, was elected Chairperson of the Faculty of Natural and Agricultural Sciences Student Council.

TEACHING

The Electronic Computer Literacy Assessment (ECLA) programme has been in operation for the last five years, and is used by all three UFS campuses to assess the first-year computer literacy modules. The assessments are done in a live environment, allowing students to test and develop their skills in a real-world environment. Nearly 4 000 students completed various assessments during 2019.

Continuous expansions and updates were applied to improve and expand functionality. Major updates planned for 2020 include biometric authentication and scheduling of assessments.

RESEARCH

Research on the Bloemfontein Campus focuses on six themes:

Blockchain Technology

Dr Wynand Nel continued his research in the area of the Fourth Industrial Revolution (4IR), specifically focusing on Blockchain technology. Various aspects of Blockchains are being investigated, ranging from the different consensus algorithms, including Proof-of-Work (PoW), to the frameworks identifying suitable applications versus unsuitable Blockchain applications. With the collaboration of Dr Andries Burger and a postgraduate student, Mr Riaan Bezuidenhout, a paper was presented at the Free State Fourth Industrial Revolution Summit, held in November 2019.

Dr Wynand Nel at the 3rd International Conference on Computer-Human Interaction Research and Applications (CHIRA)

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 focuses on the identification and evaluation of unique, discipline-specific strategies that could be utilised by instructors to improve the teaching and learning of various fundamental Computer Science concepts. Three PhD students are currently working on decoding related projects.

Data Science / Natural Language Processing

The Data Science / Natural Language Processing (NLP) research group, under the guidance of Dr Eduan Kotzé, continued work on the linguistic aspects of online hate speech. Two new research projects commenced in 2019. The first research project's aim is to classify conflict and security events in South Africa. This study is making use of text classification, word and document embeddings, as well as topic modelling techniques and relies on real-time data streams from several social media data sources to monitor protests and crime in South Africa. The other research project focuses on the feasibility of using machine and deep learning methods for the prospecting of palaeontological resources within South Africa. One postdoctoral research fellow, three PhD and two master's students are involved in this research group.

Eye-Tracking

Prof Tanya Stott continued the collaborative eye-tracking research aimed at identifying and categorising the eye movements of school learners who experience difficulty in reading and understanding 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 under development on the topic.

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, with her current focus being the use of Brain-Computer Interfaces (BCIs) as an evaluation tool.

In 2019 research projects included the evaluation of a game-based assessment in comparison with traditional paper-based assessments in students' understanding of assessment questions, the determinants of continuance use of mobile applications (specifically concentrating on emotional valence and expectation confirmation), as well as evaluating the influence of technostress trifecta aspects on student academic performance.

The Department has acquired a variety of tools and technologies in terms of BCIs over the past few years to assist in this research area, including the Emotiv EPOC, SmartBCI, and Emotiv Insight.

Internet of Things

Prof Paul Kogeda is working on a number of projects on the Internet of Things (IoT) addressing various challenges facing society, such as water resource management, sewerage and waste management and health issues. He is currently the principal investigator in a Kenya/South Africa collaborative research project on water pipeline leakage detection and prediction.

On the Qwaqwa Campus, the following research endeavours continued during 2019:

- Mr Gavin Dollman is working on machine and deep learning predictive models for prospecting new fossil sites in South Africa.
- Mr Adebola Musa is doing research on Information and Communications Technology (ICT) intervention in the transport sector. His other research interests include Machine Language, Artificial Neural Networks, Data Mining and Electronic Election.
- Mr Fani Radebe's research area is in Information Systems, focusing on mobile bullying, a subset of cyberbullying where aggression is carried out through mobile phones. Currently, he is investigating mobile bully-victim behaviour, with the main aim to develop a mobile app (artefact) to aid law enforcement in diagnosing and curbing mobile bullying in schools, by providing a platform to safely identify mobile bully-victims. The use of the app will thus enable police to resolve mobile bully-victim incidents, which may instil learners' trust in law enforcement, and the use of the app may also help raise awareness about mobile bullying.
- 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, which will assist the deaf in communicating with the hearing through a sign language interpretation system.

ENGAGED SCHOLARSHIP

Tswellang Special School

The Department has a long-standing relationship with the Tswellang Special School for disabled learners. The Department donated a number of computers to the school in 2019 and has helped with the setup and installation of desktop computers, as well as the roll-out of software provided by the Department of Education.

Monyetla Saturday School Project

The Monyetla Saturday School project has been running on the South Campus for the past few years, and aims to assist Grade 12 learners from schools in Bloemfontein, Botshabelo and Thaba 'Nchu to improve their results and afford them opportunities to qualify for bursaries and tertiary education. The CSI computer labs are made available free of charge to assist in this regard.

Computer Literacy Training

In the Information Technology Service Learning module (CSIS2642), presented by Mr Rouxan Fouche, the students from the Department of Computer Science and Informatics presented computer literacy training sessions for members of the Mangaung and Botshabelo community. This was done every Friday over a period of 11 weeks in the second semester in one of the UFS computer laboratories. The Department also provided transport for community members.

Currently, the Department is involved with two community partners. The partnership with the Mangaung Concerned Residents (MCR) has been in place for seven years, and the MCR assists the Department in identifying individuals from the surrounding community that will benefit most from the training that is offered. The Department also assists the South African Red Cross Society (a new partner identified in 2018) by providing computer literacy training to a number of their volunteers from Bloemfontein. In 2019 a total of 160 community members attended the community training sessions. After the completion of the training programme and accompanying examination, the participants receive an accredited certificate from the Department that they can include in their CV. The MCR reported back that a number of the attendees were able to acquire employment as administrative personnel with their newly acquired computer literacy skills. The skills they have acquired have also enabled some of the community members to start their own small businesses, and they can now electronically keep track of all their information and make use of electronic marketing.

The importance of computer literacy and the impact it has on the successful application for work by many individuals from the community, is often overlooked. It is interesting to note that interested members from the community range in age from individuals who have just left school to those who are well on their way to retirement.

Science Minds

Mrs Masabata Thakaso, from the South Campus, embarked on a community service project that aims to assist learners from disadvantaged backgrounds with computer skills, mathematics, physical science and social skills. An auxiliary social worker and a social worker are part of the team. The lectures take place during school terms and holidays, and the project has led to improved self-confidence and physical appearance, and excellent performance in computer literacy. The fun activities the project hosted were mathematics competition, prize-giving (for good attendance, ethical behaviour and excellent leadership skills) and an end-of-year function.

Makerspace and IDEAS Lab

In August 2019 the Department was approached by Ms Lianda Coetzer, Chief Officer of Library and Information Services on the South Campus, to collaborate on the Makerspace Initiative. This initiative is an Institutional Transformation Plan (ITP)-funded project aimed at providing recipients with a space to work across a range of disciplines, IT, robotics and crafts. The Makerspace

set up on the South Campus is intended to provide students with the infrastructure and resources to find new ways and places to use IT, and to encourage the development of creativity and innovation.

Prof Liezel Nel and several ITSA students are working on a curriculum to jumpstart the initiative. The curriculum currently includes various IT initiatives, such as computer literacy, web development, Raspberry Pi robotics and Python programming, video editing, 3D-modelling (using a state-of-the-art, ITP-funded Morgan 3D printer), graphic design, mobile app development, and scrapbooking. The curriculum will be presented on Fridays and Saturdays by final-year and postgraduate students from the Department.

UFS Python Project

The UFS Python Project, under the guidance of Mr Daniël Wium, offered three courses during 2019 – LEGO Robotics, Introductory Python and Advanced Python. Learners participated in LEGO Robotics challenges, the National Talent Search and the national Programming Olympiad. Students also participated in the Standard Bank Technology Impact Challenge. We won two Gold, three Silver, and four Bronze awards for the National Talent Search, while for the Programming Olympiad we received three Bronze awards, and one participant made it to the second round, to which only the top 20% nationally are invited.

UFS Python Project

NATIONAL AND INTERNATIONAL COLLABORATION

Mr Tobias Loke and Mr Matthias Rodemeier, both from the Ostwestfale-Lippe University of Applied Sciences, visited the Department in 2019 as part of a student exchange programme facilitated by the UFS Office for International Affairs. They worked on the Agri-Decision Support Systems (DSS) project, which is a joint IT-Agriculture research project on the meaning of applied Informatics as part of studies in Environmental Informatics. The principal investigators of this joint research project were Dr Eduan Kotzé and Dr Antonie Geyer.

The Department continued its informal collaboration agreement with the Computational Linguistics Research Centre (CLiPS) associated with the Department of Linguistics in the Faculty of Arts at the University of Antwerp. One of the joint research projects investigated the automatic classification of security events in South Africa Open Source Intelligence (OSINT). Two papers were submitted and accepted in accredited journals.

Dr Eduan Kotzé, Prof Paul Kogeda, Mr Gavin Dollman and Mr Adebola Musa visited the Appalachian State University in Boone, North Carolina, in September/October 2019. The visit was part of the University Capacity Development Programme's US-SA Higher Education Network and the University Staff Doctorate Programme (USDP).

Prof Paul Kogeda visited the Strathmore University in Kenya, from 19 to 25 September 2019, to attend a meeting on a collaborative project between the South African and Kenyan project teams.

POSTGRADUATE STUDENTS

Twenty-one (21) students were enrolled as Honours students in 2019, with six master's and 12 doctoral students making up the postgraduate student cohort.

Six Honours students graduated on the Bloemfontein Campus in 2019.

POSTDOCTORAL RESEARCH FELLOWS

Dr Andronicus Akinyelu, from Nigeria, continued his postdoctoral research 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, also from Nigeria, was appointed as a postdoctoral research fellow in the Department in 2019. He works with Dr Eduan Kotzé on NLP research projects. Dr Oriola co-authored three research papers in 2019, with one paper being published by an International Scientific Indexing (ISI) journal and two papers accepted in international, peer-reviewed conference proceedings.

Dr Silas Verkijika, from Cameroon, completed his postdoctoral research fellowship, under the supervision of Dr Lizette de Wet, in July 2019.

On the Qwaqwa Campus, Dr George Musumba, from Kenya, continued as a postdoctoral research fellow, under the supervision of Dr Ruth Wario. He worked on the application of ICT ranging from health and education under the banner 'ICT4D'. They published four articles together in 2019, including two in peer-reviewed conference proceedings.

STAFF MATTERS

Prof Paul Kogeda was appointed as Associate Professor.

Dr Burgert Senekal, an NRF C2-rated researcher, was appointed as Research Fellow and is working on Natural Language Processing research projects with Dr Eduan Kotzé.

Dr Burgert Senekal (left) and Dr Eduan Kotzé (right)

Mr Arnold Thompson was appointed as Technical Assistant on the South Campus.

Prof Pieter Blignaut embarked on early retirement at the end of 2019.

Dr Andries Burger resigned and the vacancy will be filled in 2020.

Dr Lizette de Wet received a 25-year long service award.

RESEARCH OUTPUTS

Research Articles

Akinyelu, A.A. 2019. Machine learning and nature inspired based phishing detection: A literature survey. *International Journal on Artificial Intelligence* 28(5): 1-35. DOI: 10.1142/S021821301999001X.

Akinyelu, A.A & Ezugwu, A.E. 2019. Nature inspired instance selection techniques for support vector machine speed optimization. *IEEE Access* 7(1): 154581-154599.

Akinyelu, A.A., Ezugwu, A.E. & Adewumi, A.O. 2019. Ant colony optimization edge selection for support vector machine speed optimization. *Neural Computing & Applications* (2019): 1-35. DOI: 10.1007/s00521-019-04633-8.

Blignaut, P. 2019. A cost function to determine the optimum filter and parameters for stabilizing gaze data. *Journal of Eye Movement Research* 12(2): 1-11. DOI: 10.16910/jemr.12.2.3.

Blignaut, P.J., Janse van Rensburg, E. & Oberholzer, M. 2019. Visualization and quantification of eye tracking data for the evaluation of oculomotor function. *Heliyon* 5(1): e01127-1-e01127-25. DOI: 10.1016/j.heliyon.2019.e01127.

De Wet, L. 2019. Model for the continuance use intention of mobile learning games. *Journal for New Generation Sciences* 17(1): 73-89.

Ezugwu, A.E., Adeleke, O.J., Akinyelu, A.A. & Viriri, S. 2019. A conceptual comparison of several metaheuristic algorithms on continuous problems. *Neural Computing and Applications* (2019): 1-45. DOI: 10.1007/s00521-019-04132-w.

Kogeda, O.P. 2019. A model for evaluating digital forensic tools. *Journal of Engineering and Applied Science* 14(19): 7048-7058.

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Musumba, G.W. & Wario, R.D. 2019. A hybrid technique for partner selection in virtual enterprises. *African Journal of Science, Technology, Innovation and Development Online*: 1-19. DOI: 10.1080/20421338.2019.1655212.

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Senekal, B. 2019. #doomsdayprepper: Analysing the online prepper community on Instagram. *Ensovoort* 40(11): 1-21.

Senekal, B. & Kotzé, E. 2019. Oopbronintelligensie (OSINT) vir veiligheidsdoeleindes: Die ontwikkeling van 'n dataontledingspyplyn om relevante WhatsApp-boodskappe te ontleed. *Suid-Afrikaanse Tydskrif vir Natuurwetenskap en Tegnologie* 38(1): 1-10. DOI: 10520/EJC-1710e4963d.

Senekal, B. & Kotzé, E. 2019. Open source intelligence (OSINT) for conflict monitoring in contemporary South Africa: Challenges and opportunities in a big data context. *African Security Review* 28(1): 19-37. DOI: 10.1080/10246029.2019.1644357.

Stott, A. & Beelders, T.R. 2019. The influence of science reading comprehension on South African township learners' learning of science. *South African Journal of Science* 115(1/2): 1-9. DOI: 10.17159/sajs.2019/5146.

Verkijika, S.F. 2019. Digital textbooks are useful, but not everyone wants them: The role of technostress. *Computers & Education* 140: 1-16. DOI: 10.1016/j.compedu.2019.05.017.

Verkijika, S.F. 2019. If you know what to do, will you take action to avoid mobile phishing attacks: self-efficacy, anticipated regret and gender. *Computers in Human Behavior* 101: 286-296. DOI: 10.1016/j.chb.2019.07.034.

Verkijika, S. F. 2019. Understanding the acceptance and use of M-Learning Apps by entrepreneurs: An application of the social-cognitive and motivational theories. *Information Resources Management Journal (IRMJ)* 32(4): 42-55. DOI: 10.4018/IRMJ.2019100103.

Verkijika, S.F. & De Wet, L. 2019. Understanding word-of-mouth (WOM) intentions of mobile app users: The role of simplicity and emotions during first interaction. *Telematics & Informatics* 41: 218-228. DOI: 10.1016/j.tele.2019.05.003.

Zemblys, R., Niehorster, D.C. & Holmqvist, K. 2019. gazeNet: End-to-end eye-movement event detection with deep neural networks. *Behavioral Research* 51: 840-864. DOI: 10.3758/s13428-018-1133-5.

Books

Brokensha, S., Kotzé, E. & Senekal, B.A. 2019. *Reinventing the Social Scientist and Humanist in the Era of Big Data: A perspective from South African Scholars.* SUN MeDIA: Bloemfontein.

Conference Contributions

Conference Papers/Posters

Akinyelu, A.A. 2019. *Improved bio-inspired technique for big data analytics and machine learning speed optimization.* Poster presented at the South African Forum for Artificial Intelligence Research (FAIR) 2019. Cape Town, South Africa. 4-6 December 2019.

Bezuidenhout, R., Nel, W. & Burger, A. 2019. *Improving the energy efficiency of bitcoin mining.* Paper delivered at the 1st Free State Joint Provincial Summit on the 4IR (Industrial Revolution), Bloemfontein, South Africa. 28-29 November 2019.

Holmqvist, K. & Blignaut, P.J. 2019. *Small eye movements cannot be reliably measured by video-based P-CR eye trackers.* Poster presented at the European Conference on Eye Movement, Alicante, Spain. 18-22 August 2019.

Khomokhoana, P.J. & Nel, L. 2019. Decoding source code comprehension: Bottlenecks experienced by senior Computer Science students. Paper delivered at the 48th Annual Conference of the Southern African Computer Lecturers' Association (SACLA), Drakensberg, South Africa. 15-17 July 2019. [Best Paper award].

Lombard, W., Van Zyl, J. & Beelders, T.R. 2019. *Red meat consumer's preferences: A case study of the Mangaung Metropolitan Municipality.* Paper delivered at the 22nd International Farm Management Association Congress, Tasmania, Australia. 3-8 March 2019.

Conference Proceedings

Kau, F.M. & Kogeda, O.P. 2019. Impact of subscription fraud in mobile telecommunication companies. In: *Proceedings of the IEEE 2019 Open Innovations Conference*. Cape Town, South Africa. 2-4 October. O. Nixon & J. Odhiambo (Eds). IEEE. pp. 42-47.

Kogeda, P. 2019. A data-driven decision support system for augmenting safety fishing in South Africa. In: *Proceedings of the South African Telecommunication Networks and Applications Conference* (SATNAC). Ballito, South Africa. 1-4 September. J. Lewis & T. Balmahoon (Eds). SATNAC. pp. 93-118.

Kogeda, P. 2019. A prediction model for mitigating Tuberculosis infection for HIV patients at Greater Tubatse Local Municipality in South Africa. In: *Proceedings of the South African Telecommunication Networks and Applications Conference* (SATNAC). Ballito, South Africa. 1-4 September. J. Lewis & T. Balmahoon (Eds). SATNAC. pp. 234-239.

Musumba, G.W. & Wario, R.D. 2019. A decision-making approach to evaluation of learning components in adaptive educational systems. In: *Proceedings of the 48th Annual Conference of the South African Computer Lecturers' Association (SACLA)*. Northern Drakensberg, South Africa. 15-17 July 2019. B. Tait & J. Kroeze (Eds). pp. 55-72.

Musumba, G.W. & Wario, R.D. 2019. Towards a context-aware adaptive e-learning architecture. In: *ICT Education. SACLA 2018. Communications in Computer and Information Science* (Vol 963). S. Kabanda, H. Suleman & S. Gruner (Eds). Cham: Springer. pp. 191-206. DOI: 10.1007/978-3-030-05813-5_13.

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Musumba, G.W. & Wario, R.D. 2019. Towards fuzzy analytical hierarchy process model for performance evaluation of healthcare sector services. In: *Information and Communication Technology for Development for Africa. ICT4DA 2019. Communications in Computer and Information Science* (Vol 1026). F. Mekuria, E. Nigussie & T. Tegegne (Eds). Springer, Cham. pp. 113-118.

Nel, G. & Nel, L. 2019. Motivational value of Code.org's Code Studio Tutorials in an undergraduate programming course. In: *ICT Education. SACLA 2018. Communications in Computer and Information Science* (Vol 963). S. Kabanda, H. Suleman & S. Gruner (Eds). Cham: Springer. DOI: 10.1007/978-3-030-05813-5_12.

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Oriola, O. & Kotzé, E. 2019. Automatic detection of abusive South African tweets using a semi-supervised learning approach. In: *Proceedings of the 1st South African Forum for Artificial Intelligence Research (FAIR 2019)*. Cape Town, South Africa. 3-6 December 2019.

Oriola, O. & Kotzé, E. 2019. Automatic detection of toxic South African tweets using support vector machines with n-gram features. In: *Proceedings of the 6th International Conference on Soft Computing & Machine Intelligence (ISCMI 2019)*. Johannesburg, South Africa. 19-20 November 2019. pp. 126-130.

Verkijika, S.F. 2019. An evaluation of the password practices on leading e-commerce websites in South Africa. International Information Security Conference 2018. H. Venter, M. Loock, M. Eloff & J. Eloff (Eds). In: *Communications in Computer and Information Science*. Springer Nature Switzerland. pp. 973: 104-114. DOI: 10.1007/978-3-030-11407-7_8.

Wario R.D. & Nyaga, C. 2019. A survey of the constraints encountered in dynamic vision-based sign language hand gesture recognition. *Universal Access in Human-Computer Interaction. Multimodality and Assistive Environments. HCII 2019. Lecture Notes in Computer Science (*Vol 11573*).* M. Antona & C. Stephanidis (Eds). Cham: Springer. pp: 373-382. DOI: 10.1007/978-3-030-23563-5_30.

STAFF (2019)

Head of Department: Dr JE Kotzé

Bloemfontein Campus

Professor: Prof P Blignaut

Associate Professors: Prof P Kogeda and Prof T Stott

Adjunct Professor: Prof L Nel

Senior Lecturer: Dr L de Wet

Lecturers: Dr AJ Burger, Mr R Fouché, Mr WSJ Marais, Dr W Nel, Mrs TS Nkalai and Mr DJ Wium

Junior Lecturer: Mr C Cilliers

Programme Director: Mr WSJ Marais

Senior Assistant Officers: Mr S Radebe and Mr V van der Bank

Officer: Mrs S Opperman

Assistant Officers: Mrs S Mocwana and Mrs R Smith

Messenger: Mr W Baranye

Qwaqwa Campus

Senior Lecturer: Dr R Wario

Lecturers: Mr G Dollman, Mr M Mase, Mr A Musa and Mr F Radebe (Subject Head)

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
CONSUMER SCIENCE

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OVERVIEW OF 2019

The Department of Consumer Science seeks to equip its undergraduate students with the knowledge to identify and understand the needs of individuals and families with regard to food, clothing and housing, and with the skills to help them fulfil these needs with available resources.

The Department also strives to motivate and lead postgraduate students to undertake research to strengthen the scientific basis from which the consumer can benefit.

We focus on consumer behaviour related to sustainability issues, such as recycling of waste and apparel, food security and food waste. Innovative products are developed from underdeveloped resources to aid in food security. We strive to get more involved with the staff and students on campus to encourage healthier lifestyles and sustainable behaviour.

The Department also offers the students the opportunity to go on an educational tour to Cape Town, which is always a highlight.

ACHIEVEMENTS

Staff Achievements

Prof Hester Steyn was appointed to chair the Programme Committee on 'Consumer and sustainable development' for the International Federation for Home Economics (IFHE) Annual Meeting in Trinidad and Tobago from 17 to 22 March 2019. She also presented the Keynote address at the 9th IFHE Africa Region Conference and 46th Home Economics Association of Zambia National Conferences at the National Science Centre, Lusaka, Zambia (26-30 August 2019).

Student Achievements

Ms Charné Britz won the Free State Women's Agricultural Union Award for the best performance through all the years of study, while Ms Minette van Heerden won the Beth Erlank prize for the best student in Clothing.

The departmental Flash Fact competition was won by Smangele Dladla, on the topic 'Eye tracking and brain mapping of consumers' reactions on insect based protein products'.

TEACHING

The Department of Consumer Science offers undergraduate programmes in Bachelor of Consumer Science (BConsumer Science) and BSc in Consumer Science. In addition, the following courses are presented for other faculties:

- Skills for Occupational Therapy students in their second year of study, designed to assist them with tasks to improve physical skills (CNOT2604).
- Technology for Education students, to develop skills for practical application in a classroom (TEGN2624).

The students had the opportunity to participate in a week-long tour to Cape Town, filled with fun educational activities. Factory tours to K-way, Imaterial, Skinny LaMinx, Crown National, Esthe (leather shoes), Newlands breweries and Ina Paarman's Test Kitchen formed part of the itinerary. Ina Paarman also gave a presentation to the students. In the beautiful gardens of Babylonstoren, Heilie Pienaar, food stylist and recipe developer, shared her experiences with the students and gave some career advice. Lena-lisa, the designer, also welcomed the students into her studio and provided some insights.

Students on Cape Town tour

RESEARCH

Research in the Department of Consumer Science was focused primarily on the following areas:

Food Security

One focus in this area is on ensuring sustainable food security through the reduction of food waste. This research is directly related to Sustainable Development Goal (SDG) 12.3 – 'By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses'.

South Africa is considered a food secure nation and has enough food for every one of its 53 million people, yet 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, food waste prevention research is essential. Approximately R21.7 billion per annum is lost as a result of household food waste. 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. There is limited research on the drivers of household food waste in relation to consumers' perceptions, attitudes and behaviour in South Africa. Ample literature is available for nations on other continents, but South Africa needs location and culture-specific solutions and interventions as a result of our diversity. With this as background, four studies attempted to fully comprehend and contextualise consumers' household food waste behaviour in Mangaung and Parys, as well as rural and urban Lesotho.

Two studies were undertaken on evaluating coping strategies and government support to developing intervention programmes to improve food insecurity and vulnerabilities. These studies are in line with SDG 2.3 – 'By 2030, double the agricultural productivity and incomes of small-scale food producers, in particular women, indigenous peoples, family farmers, pastoralists and fishers, including through secure and equal access to land, other productive resources and inputs, knowledge, financial services, markets and opportunities for value addition and non-farm employment' – and SDG 12.3 (see above). The studies aimed to identify possible 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. Neighbouring countries were also part of the initiatives.

One project focused on the Oyster mushroom cultivation initiative supported by an external donor in cooperation with the Lesotho Government. The researchers aimed to determine the influence of the initiative on access and availability of the involved households. The information obtained will be used to develop consumer acceptability profiles, followed by product development in order to create markets for the cultivators, thereby increasing incomes.

Another collaboration resulted in a project that focused on intervention solutions to increase food security amongst rural households in the Lubombo region of Eswatini, with the assistance and participation of local government extension workers. 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 these households.

Research was also undertaken on determining the link between food insecurity and malnutrition and identifying possible areas of concern to policy makers. Urbanisation is occurring at a rapid pace particularly in developing countries. Although migration to urban areas happens in anticipation of access to better employment opportunities and healthcare, it results in high levels of food insecurity and poor nutrition, especially among children where malnourishment (i.e. stunting, wasting, underweight) is prominent. Moreover, nutrient inadequacy may compromise the structural development of the brain and the child's ability to excel at school. Although studies have been conducted on the food (in) security in rural areas, few studies investigated the relationship between food (in)security and malnutrition of children, especially in urban informal settlements. It is for this reason that 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, Eastern Cape.

Consumers have to become more aware of the negative environmental impact of the meat industry, and the need to find other alternatives in order not to exploit all the natural resources. The focus of this research project is on the use of edible insects as an alternative source of protein and to gain an understanding of consumer expectations regarding the consumption of edible insects. The aim of another research project is thus 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 insects' protein and also test the taste to see 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.

Natasha Cronjé, Petro Swart and Carien Denner attended World Wildlife Fund for Nature (WWF) Living Planet Conference: Nourish the Nation, 25 July 2019, Pretoria, South Africa.

From the left, Carien Denner, Natasha Cronjé and Petro Swart at the WWF Living Planet Conference

Recycling

A further cluster of research projects focuses on recycling. One such project investigates various aspects of recycling of clothing articles. It has been found that very few consumers recycle items of unused clothing and they also do not have adequate knowledge about the process or how it can make a difference. However, many of those interviewed indicated a willingness to donate items if they knew of opportunities. Further research will investigate donation needs and the possibility of creating collaboration between those in need and consumer donations.

Other recycling-related projects include buying behaviour and barriers preventing consumers from purchasing so-called 'green' products, and textile recycling (reclaiming the fibres from e.g. school uniforms and creating new items). A further project will investigate how wool from Dorper sheep (which is considered 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.

Petro Swart attended the Dutch Design Week in October 2019, Eindhoven, the Netherlands. It is the largest design event in Northern Europe and presents work and concepts from more than 2 600 designers to more than 335 000 visitors from all over the world. The theme was 'Waste: how to reduce, use and let it work for you'.

Clothing and Culture

Dress is an important aspect of all societies, and is embedded in the history, culture and societal values of a people. In many African cultures the traditional dress has been influenced by assimilation and acculturation. The current study seeks to investigate this and to attempt to interpret information carried in either the original traditional dress or the modern traditional dress.

Product Development

According to the Food and Agriculture Organization (FAO) of the United Nations, the notion of creating a world where all people have physical and economic access to sufficient, safe and nutritious food at all times has been faced with tremendous challenges. The rising rate of undernourishment in developing and underdeveloped countries, the effects of climate change and declining crop yields, are just a few of the challenges facing most countries, and South Africa is no exception. It is necessary to find and develop more resilient, productive and sustainable agricultural practices. The most viable adaptation option to increase food production and profits in the vulnerable hot and dry regions, is to include crops which are indigenous, edible and are less impacted by climate change.

With this in mind, wild edible indigenous plants from semi-arid and arid African areas are being 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,* are 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 contents. A research group including Honours and master's students will be involved in this study.

As part of the Cactus Pear project, the cactus pear fruit and nopalito recipes, which were developed by students over a number of years, were tested, edited and photographed in 2019. The UFS Cactus Pear website, containing the final approved recipes and general information concerning the cactus pear, will be available from February 2020. The website, under the banner of the UFS, Faculty of Agricultural and Natural Science and the Agricultural Research Council (ARC), aims to educate and inform the South African consumer.

ENGAGED SCHOLARSHIP

Outreach

The service learning module (CNSB 3732) requires final-year students to participate in one of the community projects as their practical for the semester. The projects for 2019 were located at the Free State Residential Care Centre from the 14 February to 17 May 2019. The projects involved various activities such as baking, redecorating the tuckshop, making aprons for the bakery department, woodwork, packaging orders, compiling a recipe booklet for the high care centre, and needlework. The students were required to teach and develop appropriate practical skills, knowledge, values and attitude. A total of 16 students and 160 people with disabilities at the Care Centre benefited from this project. The students acquired experience on how to solve problems in the real world, how to be patient, how adults learn and how to transfer knowledge to other people, as well as to gain first-hand insight in terms of the plight of disadvantaged people. The semester ended by hosting a function themed 'circus'. In concluding the module, the students were required to make a presentation of their experience.

Project participants at the Free State Residential Care Centre

Raising awareness

The final year students presented workshops to the residents of Wag-'n-Bietjie Residence on the Bloemfontein Campus, with members of the Residence Committee, corridor primes, and mentors participating. The aim was to teach residents how to cook healthy and affordable meals in 30 minutes or less. Student consumption patterns and facilities available to students in the residence were taken into consideration. Each student received a recipe booklet and learnt the skills necessary to prepare these recipes. Equipping the students and creating awareness is a positive step towards combating food insecurity among students.

Consumer Science students teaching easy nutritious recipes to residents of Wag-'n-Bietjie Residence

Review of articles

As part of our service to the scientific community, a number of academics reviewed articles for academic journals, *inter alia*, Dr Ismari van der Merwe for the *Journal of Applied Science and Technology*, Prof Hester Steyn for the *Journal of Consumer Sciences*, Dr Jana Vermaas for the *International Journal of Home Economics*, Dr Natasha Cronjé for the *Journal of Cleaner Production*, and Dr Albie Du Toit for *Industrial Crops and Products* and *4Open*.

POSTGRADUATE STUDENTS

Sixteen students graduated with the BScHons (Consumer Science) in 2019 and four students attained their MSc Consumer Science degrees – Carien Denner, Stephani Du Plessis, Lucil Hiscock and Petro Swart.

Ms Nokhuthula Tinta attained her PhD with the thesis titled 'Empowerment model for people with disabilities participating in income generating activities: A case of a protective workshop in Bloemfontein'. Her promoter was Prof Hester Steyn.

STAFF MATTERS

Carien Denner completed the MSc (Consumer Science) and Nokuthula Tinta completed the PhD (Consumer Science). Dr Tinta was promoted from Junior Lecturer to Lecturer.

All staff members in the Department attended a course on 'Sustainable value chains' and writing winning proposals, at the Centre for Sustainable Agriculture, Rural Development and Extension (CENSARDE), presented by the International Centre for Development Oriented Research in Agriculture (ICRA).

Staff members and presenter attending ICRA course

Prof Hester Steyn retired at the end of 2019, as Head of the Department of Consumer Science after many years of managing the Department, teaching and mentoring.

RESEARCH OUTPUTS

Research Articles

Cronjé, N., Steyn, H.J.H. & Schall, R. 2019. Catholyte as an environmentally friendly detergent: effect on the colourfastness of black dyed textiles. *The Journal of The Textile Institute*. Published online. DOI: 10.1080/00405000.2019.1703489.

De Wit, M., Du Toit, A., Fouche, H.J., Hugo, A. & Venter, S. 2019. Screening of cladodes from 42 South African spineless cactus pear cultivars for morphology, mucilage yield and mucilage viscosity. *Acta Horticulturae* 1247(7): 47-55.

De Wit, M., Du Toit, A., Ostoff, G. & Hugo, A. 2019. Cactus pear antioxidants: A Comparison between fruit pulp, fruit peel, fruit seeds and cladodes of eight different *cactus pear cultivars (Opuntia ficus-indica and Opuntia robusta). Journal of Food Measurement and Characterization*, 2019: 1-10. DOI 10.1007/s11694-019-00154-z.

Denner, C. & Vermaas, J.F. 2019. Assessment of barriers preventing recycling practices among bars and eateries in Central South Africa. *Transactions on Ecology and the Environment* 231: 183-192.

Du Toit, A., De Wit, M., Fouche, H., Taljaart, M., Venter, S. & Hugo, A. 2019. Mucilage powder from cactus pears as functional ingredient: Influence of cultivar and harvest month on the physicochemical and technological properties. *Journal of Science and Technology* 56(5): 2404-2416.

Du Toit, A., De Wit, M., Naude, S., Taljaard, M., Fouche, H.J., Hugo, A. & Venter, S.L. 2019. Functional properties and sensory evaluation of mucilage from South African cactus pear cladodes. *ISHS Acta Horticulturae 1247: IX International Congress of Cactus and Cochineal: CAM Crops for a Hotter and Drier World: 251-260.* DOI: 10.17660/ActaHortic.2019.1277.34.

Du Toit, A., De Wit, M., Seroto, K.D., Fouche, H., Hugo, A. & Venter, S. 2019. Rheological characterization of cactus pear mucilage for application in nutraceutical food products. *Acta Horticulturae* 1247(9): 63-72.

Conference Contributions

Conference Papers/Posters

Cronjé, N. & Buku, Z. 2019. *Attitudes and perceptions of consumers as contributing factors towards generating household food waste in Manguang, South Africa*. Paper delivered at the #reducefoodwaste: Conference on Food Waste Prevention and Management, Vienna, Austria. 26 April 2019.

Cronjé, N., Van der Merwe, I., Geyer, A. & Van Niekerk, J. 2019. *The role of culture in nutrition and sustainable diets.* Poster presented at the 4th International Congress Hidden Hunger: Hidden hunger and the transformation of food systems: How to combat the double burden of malnutrition. Stuttgart, Germany. 27 February-1 March 2019.

Steyn, HJH. 2019. *Multi-disciplinary strategies for achieving sustainable development across Africa.* Keynote address at the 9th IFHE Africa Region Conference and 46th HEAZ National Conferences at the National Science Centre, Lusaka, Zambia. 26-30 August 2019.

STAFF (2019)

Head of Department: Prof HJH Steyn

Associate Professor: Prof HJH Steyn
Lecturers: Dr N Cronjé, Ms N Tinta, Dr I van der Merwe and Dr JF Vermaas
Junior Lecturers: Ms PZ Swart
Part-time Contract Lecturers: Dr A du Toit and Mrs F van Tonder
Programme Director: Dr I van der Merwe
Senior Officer - Professional Services: Mrs D Jacobs
Officer - Professional Services: Ms C Denner
Senior Assistant Officer: Mrs W van der Walt
NRF Intern: Ms Ketshepileone Matlhoko

DEPARTMENT OF
ENGINEERING SCIENCES

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OVERVIEW OF 2019

In 2019 Engineering Sciences added one additional module on Geo-techniques to their syllabus, and increased their graduates from five to eleven. The U-Teach outreach project to 600 teachers was completed six months ahead of schedule.

In terms of research, we completed the development of the Green Building Index (GBI) research project and developed training material to present courses on the GBI. The research and development of a Green Manufacturing Index as well as research on new energy efficient materials started in 2019.

As part of the Solar Thermal Energy Research Group (STERG) at Stellenbosch University, two staff members participated in a technical visit to concentrated solar power (CSP) and photovoltaic (PV) plants in the Northern Cape. These included Xina Solar One (Parabolic trough CSP – 100 MW), Khi Solar One, Scatec PV Plant (85 MW under construction) and Bokpoort CSP (Parabolic trough – 50 MW).

The Department of Engineering Sciences hosted the annual South African Academy of Engineering (SAAE) event where the president of the International Commission on Irrigation and Drainage (ICID), Mr Felix Reinders, presented on the theme 'Sustainable development of agricultural and forestry systems'. The Department also hosted an evening on digital energy management and presented the topic 'A new era in digital resource management: a UFS perspective' to the South African Institute of Electrical Engineers (SAIEE).

ACHIEVEMENTS

Staff Achievements

Mr Louis Lagrange received the Energy Efficiency Educator of the year in Sub-Sahara Africa award from the South African Energy Efficiency Confederation (SAEEC) at its conference in November 2019.

Mr Louis Lagrange receiving the SAEEC award

TEACHING

The Department of Engineering Sciences equips students with a fundamental three-year BSc, 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, mechanical, mechatronic, electrical and electronic engineering. During 2019 this range of possible disciplines was expanded to also include industrial and aeronautical engineering, both offered at the University of the Witwatersrand.

From the total 46 different modules, departments in the Faculty of Natural and Agricultural Sciences present the fundamental modules on physics, chemistry, computer science, mathematics and applied mathematics. The Department of 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 and thermodynamics for mechanical engineering. A new module, Geo-techniques, was added in 2019 for the civil engineering component of the degree.

In 2019, Engineering Sciences had 81 registered students – 28 in their first year, 31 in their second year and 22 in their third year of study.

Engineering Sciences expanded their equipment for student practicals substantially in 2019, with the addition of ten customised electrical wiring boards and cut-through sections of vehicle engines and differentials.

RESEARCH

Academics in the Department of Engineering Sciences conduct their research activities under the broad theme of energy. The following specific focus areas are currently being pursued:

Green Building Index (GBI)

The use of resources in existing buildings that are currently either not measured at all, or measured inappropriately mainly due to the complexities and cost of accurate measurement, result in the inefficient use of resources. The 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

This research is an expansion of the current UFS-merSETA (Manufacturing, Engineering and Related Services Sector Education and Training Authority) GBI 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. This proposed system will be based on the design of an index that will involve both the modelling and measurement of several manufacturing processes. This will ultimately culminate into a Decision Support System (DSS) which will be made available to operational managers and process engineers to benchmark, and thus manage, the manufacturing processes from the perspective of 'green sustainability'.

High Performance Materials

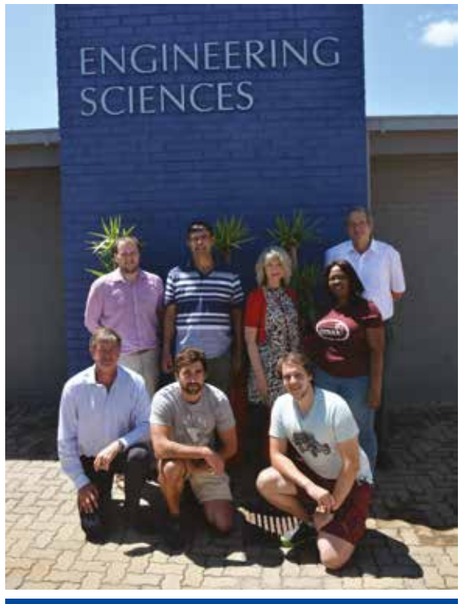
The results from the GBI project are providing information that will allow us to develop new energy-efficient materials to minimise energy consumption in existing buildings. The project investigates the need for high performance materials as part of the particular building sector GBI case studies.

NATIONAL AND INTERNATIONAL COLLABORATION

Valuable international collaboration on renewable hydrogen integration studies has been established with the University of KU Leuven in Belgium.

STAFF MATTERS

Mr JF Lubbe attained 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'.



Department of Engineering staff members
Back from the left: Dr JM Maritz, Mr HJD Lubbe, Ms C du Toit, Ms Z Mngomezulu and Prof HJ Marx
Front from the left: Mr LF Lagrange (HoD), Mr NC Bernstein and Mr GD le Roux

RESEARCH OUTPUTS

Research Articles

Lubbe, F., Harms, T. & Maritz, J. 2019. A statistical analysis of wind data. *Journal of Energy in Southern Africa*. 30(4).

Maritz, J. 2019. Optimized energy management strategies for campus hybrid PV-Diesel systems during utility load shedding events. ***Processes*** 7(**7**): 430.

Conference Contributions

Conference Papers/Posters

Lagrange, LF. 2019**.** *Metrics of tuneable LED lighting and their effect on human centric circadian rhythms*. Paper delivered at the Annual Conference of the South African Energy Efficiency Confederation (SAEEC), Pretoria, South Africa. 14-15 November 2019.

Lubbe, JF. 2019**.** *A new era of digital resource management: A UFS perspective*. Paper delivered at the annual student symposium as part of the Centre for Renewable and Sustainable Studies (CRSES), Cape Town, South Africa. 17-18 July 2019.

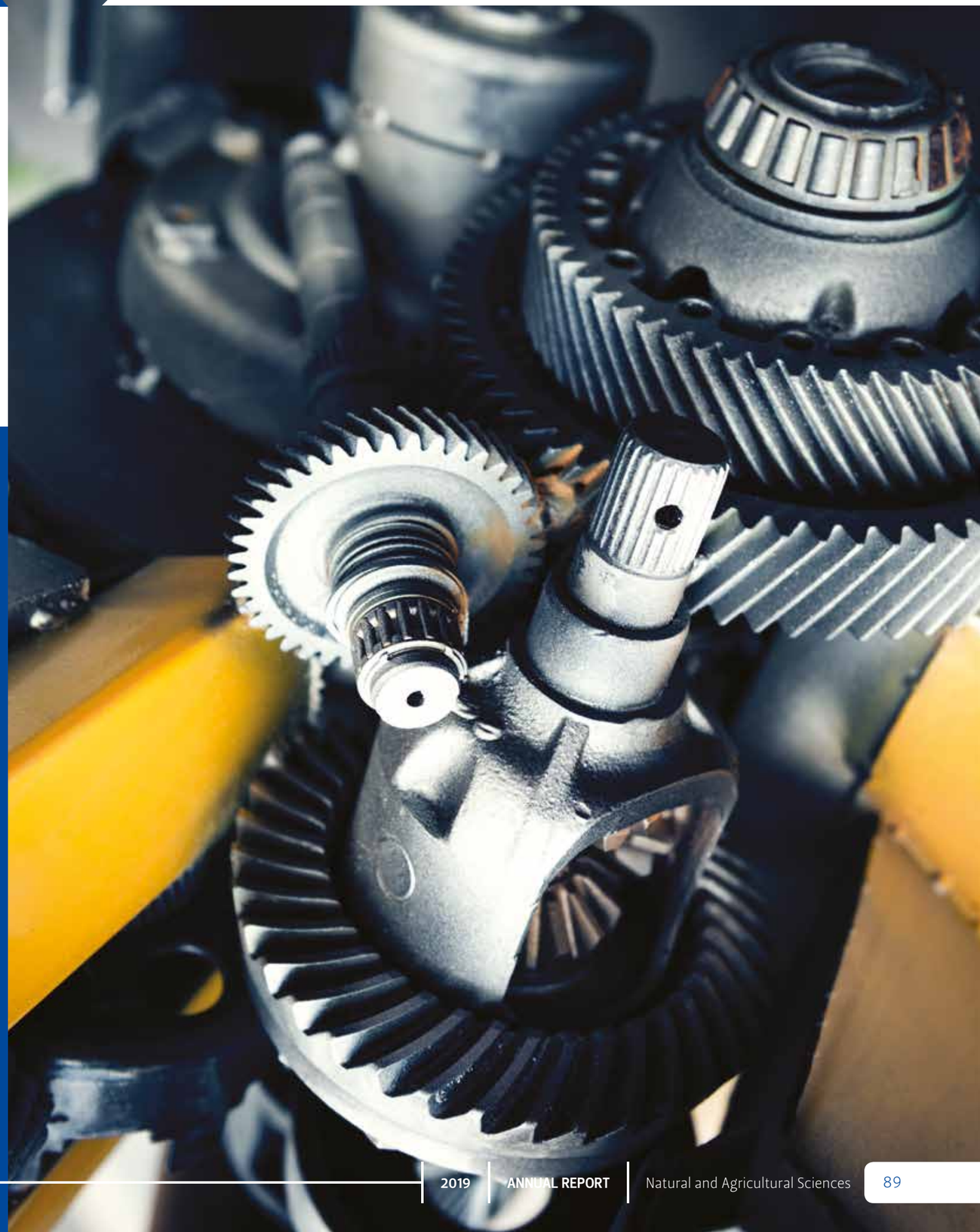
Maritz, J. 2019**.** *A new era of digital resource management: A UFS perspective*. Paper delivered at the Higher Education Facilities Management Association of SA (HEFMA), Johannesburg, South Africa. 14-17 October 2019.

Maritz, J. 2019**.** *Machine learning techniques for energy management and M&V*. Paper delivered at the Annual Conference of the South African Energy Efficiency Confederation (SAEEC), Pretoria, South Africa. 14-15 November 2019.

STAFF (2019)

Head of Department: Mr LF Lagrange

Associate Professor: Prof HJ Marx
Senior Lecturer: Mr LF Lagrange
Lecturers: Mr NB Bernstein, Mr CJB Bezuidenhout, Ms EP Boje, Mr JA Deacon, Mr JJ Haefele and Mr RJ Homann
Junior Lecturers: Ms HC Oosthuizen and Mr IP Scott
Researchers: Mr JF Lubbe and Dr JM Maritz
Senior Assistant Officer: Ms C du Toit
Assistant Officer: Ms ZV Mngomezulu
Senior Technician: Mr HJdW Lubbe



DEPARTMENT OF GENETICS

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OVERVIEW OF 2019

Teaching and research activities in the Department of Genetics are focused on the broad areas of Genetics (that cover the traditional activities relating to heredity and molecular genetics), and Forensics (including both Forensic Genetics and Forensic Science). Activities in specific areas are detailed in the relevant sections that follow.

In the past year, there was particularly strong growth in both undergraduate student numbers and the number of applications for study in undergraduate and Honours programmes. This created new challenges, but the Department is also excited about continued growth. Innovation and renewal in teaching were introduced in several modules, which is a challenge considering the dramatic increases in numbers, but, in some instances, this also helps to manage larger classes.

Research and postgraduate training were conducted in the fields of Behavioural Genetics, Conservation Genetics, Forensic Genetics, Forensic Science, Human Genetics, Plant Molecular Biology, Fungal Biosystematics, Biodiversity and Conservation. To add to these fields, the first PhD student enrolled for the Department's new qualification in Conservation Biology. A total of 43 Honours students, three MSc students and two PhD candidates were awarded degrees in 2019.

Continued collaboration contributed to the success of our research endeavours. National collaboration involved various organisations and institutions, including universities, law enforcement agencies and nature conservation departments. At international level, there was collaboration with researchers in the USA and Austria. At local level, the Department engaged in community service through a school extension programme and job-shadowing.

Staff and students produced eighteen journal papers, two books and nine conference contributions. In recognition of their expertise, several staff members served on discipline-specific boards or journal editorial boards.

Finally, two new staff members and a postdoctoral research fellow joined the Department of Genetics in 2019. One of our staff members and a student received Faculty awards.

ACHIEVEMENTS

Staff Achievements

Shortly after taking up a position at the UFS, Prof Renate Rebello won second prize in the Faculty of Natural and Agricultural Sciences Flash Fact competition.

Dr Marieka Gryzenhout, together with Mr Gary Goldman from Cape Town, published a nature guide titled *Field-guide to mushrooms & other fungi from South Africa*. The book contains descriptions of 200 species (the largest, to date), as well as extensive background information and tips on fungi. The book has already sold more than 1 500 copies since its publication and is a culmination of a boom in citizen scientists who are serious and enthusiastic about fungi. This is the second book that Dr Gryzenhout has published on South African mushrooms.

Student Achievements

Ms Ilke Meintjes, a BSc Honours student in Behavioural Genetics, was awarded the Dean's medal for best final-year student in respect of a first Bachelor's degree in the Faculty of Natural and Agricultural Sciences, for her BSc majoring in Behavioural Genetics.

TEACHING

The year 2019 was a period of strong growth for the Department of Genetics in terms of undergraduate numbers. Class sizes in Genetics modules reached new heights, with ~388 second-year and ~170 third-year students. The number of applications for undergraduate studies in Forensic Sciences increased to 2 000 for 80 available spaces. At Honours level, the Department received 125 applications for 21 positions in the Forensic Science / Forensic Genetics programmes, and 73 applications for 23 places in the Genetics / Behavioural Genetics programmes.

There were highlights in innovation in teaching in several modules. In the Introduction to Genetics module, students were exposed to paternity testing using synthetic blood, and were able to karyotype 15 case studies in order to diagnose genetic diseases. This was implemented despite a class size of 524 first-year students. In our first semester second-year genetics module (GENE2616), students again made use of the clicker system, which facilitated enhanced engagement with the class. At third-year level, in our Population Genetics module (GENE3744), there was a significant shift to expand population genetic data analysis to also include newer molecular markers. The second- and third-year Forensic Science students were exposed to mock crime scenes to test their abilities in identifying evidence-of-value and proper evidence collecting.

RESEARCH

Human Genetics

The focus in Human Genetics is on understanding human diseases. This includes not only their distribution, causes and progression, but also their most effective treatment regimes. Consequently, the training and research in the Department of Genetics has a clinical flavour. Research is conducted by Dr Gerda Marx, Mrs Sue-Rica Schneider and Prof Renate Rebello, together with staff members from other faculties and an expanding group of national collaborators. Research projects include, *inter alia*, genetic aspects of HIV, diabetes, psychiatric disorders and pre-eclampsia.

Behavioural Genetics

The research focus in Behavioural Genetics at the UFS is on the functioning of the serotonergic neurotransmitter system. Current projects in this field are investigating juvenile delinquent males in humans and normal vs. abnormal functioning in animals (horses). Machine learning is also investigated as a means to analyse genotypic differences and functioning of an isolated system. A strong focus for 2019 was on establishing an Equine Behaviour research group. This will involve the quantification of abnormal behaviour, underlying vulnerability genotypes and rehabilitation strategies.

Conservation Genetics

The Conservation Genetics group studies patterns of genetic diversity and differentiation within and between animal populations, together with the processes that sustain these patterns. Current projects are focused on patterns of genetic diversity in vervet monkeys, giraffe, kudu, springbok, freshwater mussels, rhinos, mopane worms and mopane trees; the adaptive significance of variation in springbok and mice; and the genetic characterisation of farm animal genetic resources, focused on the Boerperd and Nguni cattle.

Highlights for 2019 were published papers on aspects of the work on giraffe, mice and springbok. Furthermore, genotypes of different horse breeds were added to our existing database. This information is being used to effectively screen for genotypes associated with performance traits, in order to provide breeders with genetic information which will aid in future breeding strategies.

An emerging growth area is zebrafish, which are used as a model to study the effects of genetic bottlenecks on fitness traits, with the focus currently on tolerance to temperature changes. A highlight for 2019 was receiving and commissioning an automated system for the breeding and keeping of zebrafish.

Conservation Biology

As a spin-off of the Conservation Genetics research activities, new qualifications in Conservation Biology – at MSc and PhD levels – were launched in 2019 to accommodate students who wish to pursue projects with a strong conservation focus, but who do not have a formal genetics background. The programme is also intended to accommodate established conservation professionals. Mr Heath Cronje, reserve manager at the Doornkloof Nature Reserve in the Northern Cape, became the first student to register for a PhD in Conservation Biology at the UFS.

Plant Molecular Biology

This research programme is focused on deciphering the genetics of flower pigmentation in *Clivia* species. Analysis of Next Generation Sequencing (NGS) data corresponding to the flower

transcriptome in *Clivia miniata* has led to the identification of several (flower) pigmentation-linked sequence variants, as well as polymorphic microsatellite loci. This data is currently being validated with the ultimate purpose of providing a diagnostic service to *Clivia* breeders and enthusiasts across South Africa.

Forensic Genetics and Forensic Entomology (in combination)

The Forensic Genetics and Forensic Entomology working group undertook various research projects of value during the course of 2019. The research aims to improve the accuracy of post-mortem interval (PMI) estimations. These calculations are of significance in criminal investigations and the combined use of Forensic Genetics and Forensic Entomology will serve this purpose.

A core component of the research is based on DNA barcoding of forensically-important insect species in South Africa. This will assist in building a DNA barcoding database which will contribute to baseline knowledge in the field of forensic entomology. Concurrent with this, is a study examining gene expression/ profiling in forensically-important insects for age determination. DNA analysis of soil samples to investigate possible changes in the microbiome will also contribute to this specific research field.

The Department of Genetics has allocated dedicated laboratory space and equipment for a Forensic Entomology laboratory where insects can be reared for research purposes.

Forensic Genetics

Research activities include the investigation into the genetic diversity of 27 Y-STR loci in different population groups in South Africa and Zimbabwe. Valuable equipment, including a Veriti PCR cycler from Thermo Fisher © was obtained to facilitate this research. Research into human touch-DNA is still ongoing with several of the 2019 Honours research projects were assigned to this field. The research into the statistical interpretation of DNA profiles relating to crime scenes and parentage testing is also still ongoing.

2019 Forensic Genetics group, under guidance of Ms Letecia Wessels (3rd from the left) and Dr Karen Ehlers (4th from the left)

Forensic Sciences

Research in Forensic Sciences is performed in close collaboration with the forensic division of the South African Police Service (SAPS) in the fields of ballistics and fingerprint development. Miss Mary Gordon, an Honours student, successfully developed novel techniques that can be utilised in forensic laboratories to develop latent fingerprints on different types of thermal paper – such as payment slips.

A latent fingerprint on paper, detected and visualised during Mary Gordon's Honours project

In the field of ballistics, Honours students investigated the deposition of gunshot residue at various distances with different handguns, which provided valuable data for crime scene reconstruction investigators.

In terms of postgraduate training, there is close collaboration between the South African Doping Control Laboratory (SADoCoL) and the Department of Genetics. A SADoCoL staff member, Prof Marthinus van der Merwe, presents a sports doping module for the Honours course. In addition, some Forensic Science students (Honours and MSc) conducted their research projects in SADoCoL's World Anti-Doping Agency (WADA) accredited laboratory, and thus gained practical experience in a fully functional and accredited sports doping laboratory. Research projects include the analysis of insulin analogs in human urine for doping control in sport, in order to develop chromatography methods with mass-spectrometric detection to analyse insulins. Most of SADoCoL's current validated methods are based on this technology, and therefore the instrumentation and expertise exists in SADoCoL to further develop this into the detection of insulins in human urine.

Fungal Biosystematics, Biodiversity and Conservation

This research group conducts a number of studies on the biodiversity and conservation of fungi from various groups and ecological niches, and addresses biosystematical problems where needed. The first checklist for South African macrofungi, with an accompanying field guide, has recently been published. Such outputs fuel growing checklists through projects focusing on invasion biology, conservation, citizen science, termite mound ecology, psychedelic mushrooms, and by making use of environmental sequencing. This work also stimulates fungal taxonomy when fungi are identified and new species are marked for description.

Bioinformatics Course

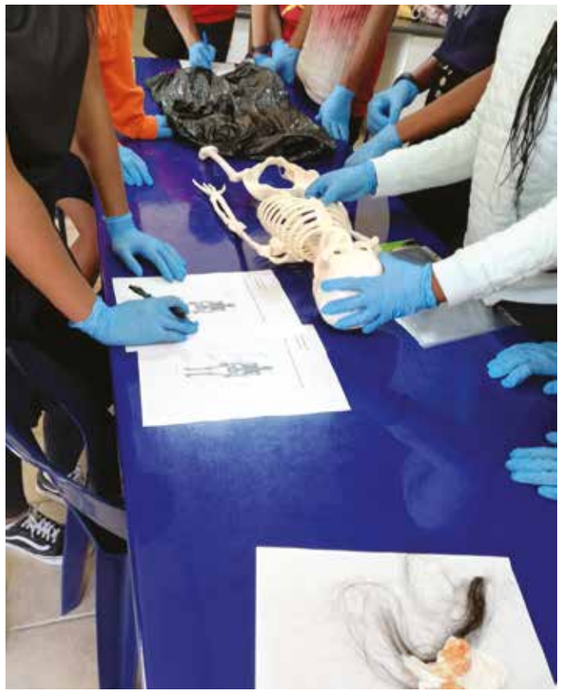
In addition to the discipline-specific research activities, Prof Rebello initiated and coordinated an H3ABioNet-sponsored Introduction to Bioinformatics course for staff and postgraduate students. Twenty-six participants from across the Bloemfontein Campus committed eight hours each week (from mid-August to mid-November) to attend on-line sessions, under the guidance of System Administrator, Dr Errol Cason, and specially-trained Teaching Assistants, Dr Willem Coetzer and Mr Thabang Madisha.

ENGAGED SCHOLARSHIP

Dr Karen Ehlers continued to serve as a member of the National Forensic Oversight and Ethics Board (NFOEB) and attended Parliament, with Judge Yvonne Mokgoro and Mrs Vanessa Lynch, to discuss the current functioning of the DNA Board with the Portfolio Committee on Police.

Prof Paul Grobler served on the Council of the Southern African Wildlife Management Association (SAWMA) as immediate past-president. He also continued to serve as Genetics sub-editor for the Springer-Nature journal, *Mammalian Biology*.

An interactive and specialised school 'extension programme' was piloted by Prof Renate Rebello at Curro, Bloemfontein, aimed at enriching the teaching and learning of high school learners and making them aware of study options and careers. Sessions covered aspects of crime scene management, anthropology, proteins and their synthesis, patterns of inheritance, and the scope and challenges of Biotechnology.



Learners at Curro School being introduced to aspects of genetics and crime scene management

Miss Bruwer, a pupil from Sentraal High School, was accommodated by the Department of Genetics to job-shadow under the supervision of Dr Karen Ehlers and Mrs Letecia Wessels.

Prof Renate Rebello was one of two presenters on the LLM Forensic Law course, which is in its fourth year at Stellenbosch University. She focused on the 'Science behind Forensics', while Ms Vanessa Lynch (Founder and Executive Head of The DNA Project) presented on DNA Law and aspects around it. It is a popular and interesting course, which features prominent invited guests and visits to the High Court, a forensic pathology unit, and the Forensic Science Laboratory (FSL).

NATIONAL AND INTERNATIONAL COLLABORATION

Nationally, strong collaboration in the field of Conservation Genetics continued with the National Zoological Garden (NZG), in particular with Prof Antoinette Kotzé, a long-standing affiliated Associate Professor in the Department of Genetics. Several UFS-registered PhD students are conducting the practical work towards their degrees at the NZG.

In Forensic Science, there is collaboration with SAPS as well as SADoCoL.

Prof Frank Zachos, from the Natural History Museum in Vienna, visited the Department in September. Prof Zachos is the Curator of Mammals at the Museum and is also Editor of the Springer-Nature journal, *Mammalian Biology*. During this visit, Prof Zachos presented a public lecture in the Department before visiting Doornkloof Nature Reserve in the Northern Cape with Prof Grobler, to interact with Mr Heath Cronje, PhD student in the Department.

In December, the Department hosted Prof Jess Jones from the Department of Fish and Wildlife Conservation at Virginia Polytechnic Institute and State University (Virginia Tech). Prof Jones presented a public lecture on the freshwater mussel conservation programme at Virginia Tech, and accompanied Prof Grobler and Mr Gerhard van Bosch (MSc student) on a field excursion to the Okavango in Botswana, to study freshwater mussels. Prof Jones serves as co-supervisor to Mr Van Bosch.

Conservation Genetics group at the Okavango panhandle to study freshwater mussels (from the left) Prof Paul Grobler, Mr Gerhard van Bosch and Prof Jess Jones (Virginia Tech)

Prof Everton Miranda, from the Mato Grosso State University in Brazil, visited the campus on 20 March 2019 and delivered a paper on 'Human conflicts with apex predators in the arch of deforestation (Amazon forest)', focusing mainly on jaguars, anacondas and harpy eagles – presenting their problems and possible conflict solutions in Earth's most biodiverse landscape.

POSTGRADUATE STUDENTS

In 2019, a total of 43 students were enrolled for their Honours degrees – 8 in Forensic Sciences, 11 in Forensic Genetics and 24 in Genetics.

At MSc level, three students were enrolled for Forensic Sciences, seven for Forensic Genetics, three for Forensic Interdisciplinary, fifteen for Genetics and eight for Genetics Interdisciplinary – totalling 36 master's students.

At PhD level, 17 candidates were registered – one in Forensic Sciences, three in Forensic Genetics, one in Forensic Entomology, nine in Genetics and three in Genetics Interdisciplinary.

In terms of students graduating in 2019, 43 graduated at Honours level (8 in Forensic Sciences, 11 in Forensic Genetics and 24 in Genetics), while three students graduated at MSc level – Marika van Niekerk and Kgothatso Mokgakala specialising in Genetics, and Chantay Susmak specialising in Human Genetics.

At PhD level the following candidates graduated in 2019:

Van Wyk, Anri
Thesis: Hybridization and the effect on conservation: Investigating introgression in three antelope genera *Hippotragus*, *Connochaetes* and *Damaliscus*
Promoter: Prof JP Grobler

Smith, Rae
Thesis: Monitoring the impact of translocation on the genetic diversity and fitness of the Cape mountain zebra (*Equus zebra zebra*)
Promoter: Prof A Kotzé

POSTDOCTORAL RESEARCH FELLOWS

Dr Soumya Ghosh, from India, joined the Department in 2019, as a postdoctoral research fellow with Dr Marieka Gryzenhout. Dr Ghosh is studying the microbiomes and plant pathogens of target novel crops and associated soils in South Africa, as well as the ectomychorizal (mushrooms) diversity of South Africa. Previously, Dr Ghosh completed terms as a postdoctoral researcher / research fellow at Kuchaman College (India), Stellenbosch University, Thompson Rivers University (Canada), Technical University of Munich (Germany), Eberhard Karls University of Tübingen (Germany), University of Groningen (the Netherlands), Institute of Microbial Technology (India), Post Graduate Institute of Medical Education (India) and University of Pune (India).

STAFF MATTERS

In 2019 we welcomed two new staff members to the Department of Genetics.

Prof Renate Rebello is a Human Geneticist, with a background in diagnostic and research Medical Genetics. She was awarded her PhD in London and worked at Stellenbosch University as a senior lecturer for several years. Besides Maternal and Foetal Health, her other passion is Forensic Genetics, which has led to her involvement in many academic activities linked to The DNA Project. She joined the Department of Genetics in April 2019.

Ms Boipelo Segoje joined the team in June 2019 as Secretary in the Department.

RESEARCH OUTPUTS

Research Articles

Bairu, M.W., Coetzer, W.G. & Amelework, A.B. 2019. Tracing the genetic origin of two *Acacia mearnsii* seed orchards in South Africa. *South African Journal of Botany* 126:70-77.

Coetzer, W.G. & Grobler, J.P. 2019. Genetic variation among different springbok (*Antidorcas marsupialis*) colour variants. *Mammalian Biology* 99:42-53.

Gosse, J.T., Ghosh, S., Sproule, A., Overy. D., Cheeptham, N. & Boddy, C.N. 2019. Whole genome sequencing and metabolomic study of cave *Streptomyces* isolates ICC1 and ICC4. *Frontiers in Microbiology* 10:1020.

Hoang, M.T.V., Irinyi, L., Chen, S.C.A., Sorrell, T.C., ISHAM Barcoding of Medical Fungi Working Group* & Meyer, W. 2019. Dual DNA barcoding for the molecular identification of the agents of invasive fungal infections. *Frontiers in Microbiology* 10:1647 (*Gryzenhout, M. is part of the Working Group).

Holderegger, R., Balkenhol, N., Bolliger, J., Engler, J.O., Gugerli, F., Hochkirch, A., Nowak, C., Segelbacher, G., Widmer, A. & Zachos, F.E. 2019. Conservation genetics: Linking science with practice. *Molecular Ecology* 28:3848-3856.

Kinge, T.R., Cason, E.D., Valverde, A., Nyaga, M. & Gryzenhout, M. 2019. Endophytic seed mycobiome of six sorghum (*Sorghum bicolor*) cultivars from commercial seedlots using an Illumina sequencing approach. *Mycosphere* 10(1): 739-756.

Kloppers, J.F., Marx, G.M. & Janse van Rensburg, W.J. 2019. Intron 22 inversion real-time polymerase chain reaction detection in haemophilia A families from central South Africa. *South African Medical Journal* 109(11):876-879.

Kotzé, A., Ralph, T.M.C., Barrow, L.N., Tarrant, J., Du Preez, L., Madisha, M.T. & Dalton, D.L. 2019: Lack of phylogeographic structure in the endangered Pickersgill's Reed Frog; *Hyperolius pickersgilli* (Raw, 1982). *African Journal of Herpetology* 68:1-17.

Kotzé A., Smith, R.M., Moodley, Y., Luikart, G., Birss, C., Van Wyk, A.M., Grobler, J.P. & Dalton, D.L. 2019. Lessons for conservation management: Monitoring temporal changes in genetic diversity of Cape mountain zebra (*Equus zebra zebra*). *PLoS ONE* 14(7): e0220331.

Madisha, M.T., Du Plessis, M., Kotzé, A. & Dalton, D.L. 2019. Complete mitochondrial genomes of the African clawless (*Aonyx capensis*) and spotted necked (*Hydrictis maculicollis*) otter: Structure, annotation, and interspecies variation. *Mitochondrial DNA Part B* 4(1):1556-1557.

Mollentze, W.F., Joubert, G., Prins, A., Van der Linde, S., Marx, G.M. & Tsie, K.G. 2019. The safety and efficacy of a low-energy diet to induce weight loss, improve metabolic health, and induce diabetes remission in insulin-treated obese men with type 2 diabetes: A pilot RCT. *International Journal of Diabetes in Developing Countries* 39(4):618-625.

Nebel, C., Gamauf, A., Haring, E., Segelbacher, G., Väli, Ü., Villers, A. & Zachos, F.E. 2019. New insights into population structure of the European golden eagle (*Aquila chrysaetos*) revealed by microsatellite analysis. *Biological Journal of the Linnean Society* 128:611-631.

Ponsonby, D.W., Madisha, M.T., Schwaibold, U. & Dalton, D.L. 2019. Genetic diversity of African clawless otters (*Aonyx capensis*) occurring in urbanised areas of Gauteng, South Africa. *South African Journal of Science* 115(7/8):4889.

Smith, R.M., Bhoora, R.V., Kotzé, A., Grobler, J.P. & Dalton, D.L. 2019. Translocation a potential corridor for equine piroplasms in Cape mountain zebra (*Equus zebra zebra*). *International Journal for Parasitology: Parasites and Wildlife* 9:130-133.

Van der Westhuizen, L., Magwaba, T., Grobler, J.P., Bindeman, H., Du Plessis, C., Van Marle-Köster, E. & Neser, F.W.C. 2019. Genetic variability in a population of Letelle sheep in South Africa. *South African Journal of Animal Science* 49(2):281-289.

Van Niekerk, M.E., Deacon, F. & Grobler, J.P. 2019. The genetic status of the introduced giraffe population in Central South Africa. *Koedoe* 61(1): a1570.

Van Wyk, A.M., Dalton, D.L., Kotzé, A., Grobler, J.P., Mokgokong, P.S., Kropff, A.S. & Jansen van Vuuren, B. 2019. Assessing introgressive hybridization in roan antelope (*Hippotragus equinus*): Lessons from South Africa. *PLoS ONE* 14(10): e0213961.

Van Wyk, A.M., Labuschagne, C., Kropff, A.S., Kotzé, A., Grobler, J.P., Jansen van Vuuren, B. & Dalton, D.L. 2019. A targeted gene approach to SNP discovery in the blue (*Connochaetes taurinus*) and black wildebeest (*C. gnou*). *Conservation Genetics Resources* 11:35-38.

Books

Goldman, G.B. & Gryzenhout, M. 2019. *Field guide to mushrooms & other fungi of South Africa*. Cape Town, Struik Nature.

Turner, T.R., Schmitt, C.A. & Cramer, J.D. 2019. *Savanna monkeys: The genus Chlorocebus*. Cambridge, Cambridge University Press.

Chapters in Books

Coetzer, W.G., Lorenz, J.G., Freimer, N.B. & Grobler, J.P. 2019. Population genetic structure of vervet monkeys in South Africa. In: *Savanna monkeys: The genus Chlorocebus*. T.R. Turner, C.A. Schmitt & J.D. Cramer (Eds). Cambridge, Cambridge University Press. pp. 101-108.

Hailer, F., Kutschera, V.E. & Zachos, F.E. 2019. A summary of brown bear genetic studies: Phylogeny, phylogeography and evolutionary relationships with polar bears. In: *Of bears and Men – Conclusions of the 1st international bear meeting IBEAR*. P. Schlup & S.T. Hertwig (Eds). Bern, Haupt Verlag. pp. 10-31.

Rodríguez, R.L., Gaetano, T.J., Grobler, J.P. & Freimer, N.B. 2019. Causes of variation in the static allometry of morphological structures: A case study with vervet monkeys. In: *Savanna monkeys: The genus Chlorocebus*. T.R. Turner, C.A. Schmitt & J.D. Cramer (Eds). Cambridge, Cambridge University Press. pp. 224-234.

Sponheimer, M., Loudon, J.E., Grobler, J.P., Moyer, K. & Lorenz, J.G. 2019. Vervet monkeys (*Chlorocebus pygerthrus*), chimpanzees (*Pan troglodytes*), and humans (*Homo sapiens*): Studying interactions using stable isotope analysis. In: *Savanna monkeys: The genus Chlorocebus*. T.R. Turner, C.A. Schmitt & J.D. Cramer (Eds). Cambridge, Cambridge University Press. pp. 255-262.

Conference Contributions

Conference Papers/Posters

Coetzer, W.G., Turner, T.R., Schmitt, C.A. & Grobler, J.P. 2019. *Adaptive genetic variation at three loci in South African vervet monkeys (Chlorocebus pygerythrus)*. Paper delivered at the biennial conference of the Zoological Society of Southern Africa (ZSSA), Skukuza, South Africa. 7-10 July 2019.

De la Rey, J. & Marx, G.M. 2019. *An epigenetic Type 2 Diabetes Mellitus case control study of the TCF7L2 promotor region*. Paper delivered at the South African Society for Human Genetics (SASHG) Conference, Cape Town, South Africa. 3-9 August 2019.

Ehlers K & Wessels L. 2019. *Tertiary training in Forensic Sciences*. Paper delivered at the 3rd QIAGEN Regional Investigator Forum Africa, Stellenbosch, South Africa. 6-7 November 2019.

Grobler, J.P., Coetzer, W.G., Schmitt, C.A & Turner, T.R. *Patterns of neutral and adaptive genetic diversity in South African vervet monkey populations.* Paper presented at the Annual Meeting of the Primate Ecology and Genetics Group, Pretoria, South Africa. 13 July 2019.

Grobler, J.P., Van Niekerk, E.M. & Deacon, F. 2019. *The genetic status of the introduced giraffe population in the Free State Province, South Africa.* Paper delivered at the annual symposium of the Southern African Wildlife Management Association (SAWMA), Wilderness, South Africa. 1-5 September 2019.

Gryzenhout, M., Ghosh, S., Magagula, N., Jacobs-Venter, R., Dames, J., Mueller, G. & Wilson, J. 2019. *The hidden invasion: A proposed framework to assess fungal invasions*. Paper delivered at the AICB Conference, Stellenbosch, South Africa. 11-13 November 2019.

Magagula, N., Ghosh, S., Wilson, J. & Gryzenhout, M. 2019. *Establishing a checklist of probable non-native ectomycorrhizal fungi for the greater Cape Town and Stellenbosch areas of South Africa, for use in possible NEM: BA Alien and Invasive Species assessments*. Paper delivered at the AICB Conference, Stellenbosch, South Africa. 11-13 November 2019.

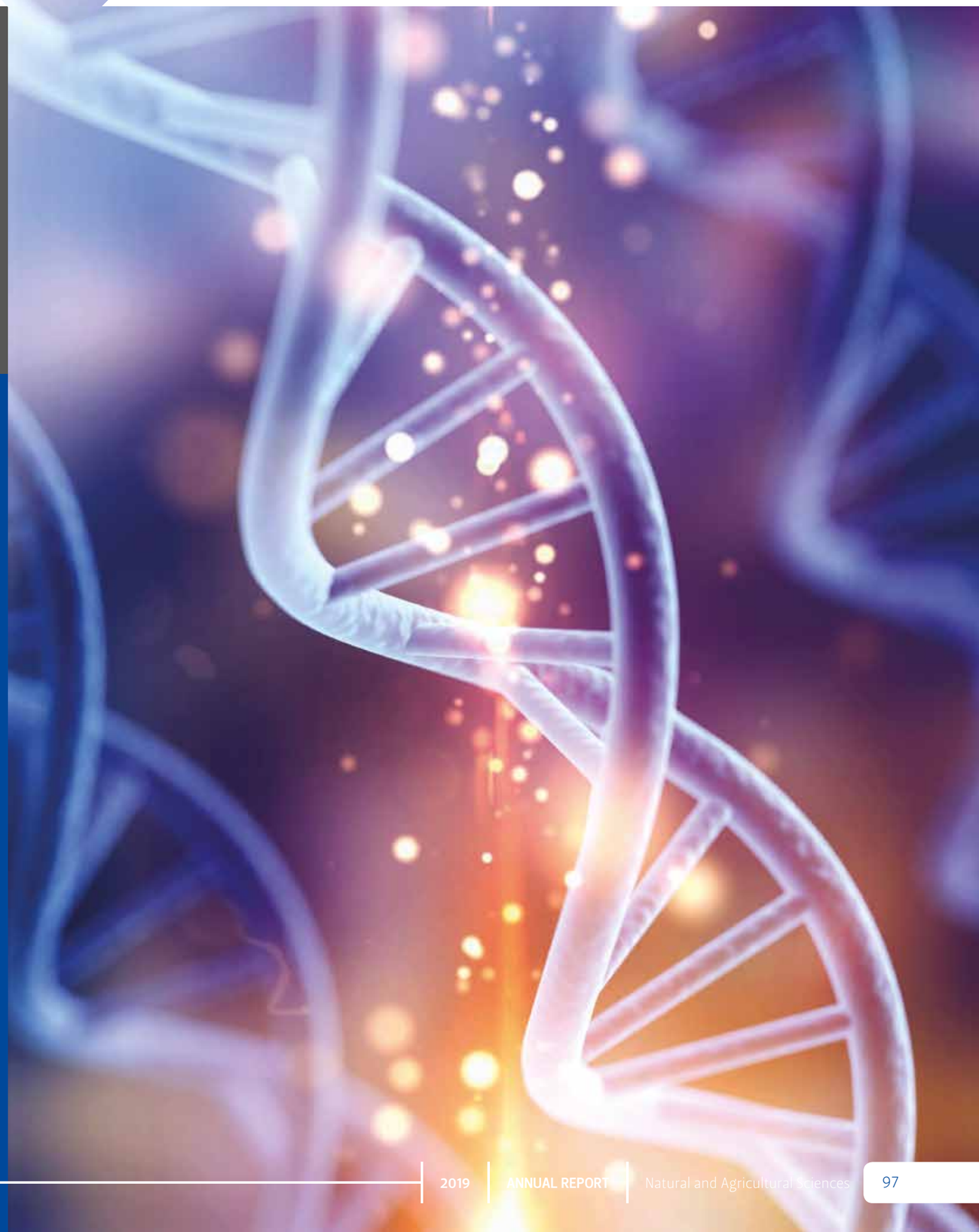
Van Bosch, G., Van der Merwe, J., Barkhuizen, L., Jones, J., Hallerman, E.M. & Grobler, J.P. 2019. *The genetic status of freshwater mussels in central South Africa.* Poster presented at the annual symposium of the Southern African Wildlife Management Association (SAWMA), Wilderness, South Africa. 1-5 September 2019.

Viljoen, T. 2019. *A kinetic investigation of the formation of hanium(IV) complexes*. Paper delivered at ReMec 2: 2nd Symposium on Reaction Mechanisms, Johannesburg, Qwaqwa and Bloemfontein, South Africa. 28 October-1 November 2019.

STAFF (2019)

Head of Department: Prof JP Grobler

Professor: Prof JP Grobler
Associate Professor: Prof R Rebello
Senior Lecturers: Dr S Brink, Dr K Ehlers, Dr M Gryzenhout and Dr G Marx
Lecturers: Ms H Bindeman, Mr FM Maleka, Ms Z Murray, Ms SR Schneider, Mr T Viljoen and Ms L Wessels
Junior Lecturer: Ms Z Raffie
Affiliated Professors: Prof T Turner and Prof FE Zhachos
Affiliated Associate Professors: Prof A Kotzé and Prof BK Reily
Research Associate: Prof JJ Spies
Affiliated Lecturers: Lt Col A Lucassen and Dr M van der Merwe
Programme Directors: Dr K Ehlers (Forensics) and Ms Z Murray (Genetics)
Senior Officers - Professional Services: Dr WG Coetzer and Mr T Madisha
Senior Assistant Officer: Ms B Henn
Assistant Officer (Lab Technician): Ms B Radise
Secretary: Ms B Segoje



DEPARTMENT OF GEOGRAPHY

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OVERVIEW OF 2019

Postgraduate students from the Department of Geography attended the annual Society of South African Geographer's (SSAG) Student Conference at the University of the Witwatersrand (Wits) in July 2019.

We held a postgraduate seminar for students from both Qwaqwa and Bloemfontein on the Bloemfontein Campus in October 2019.

Postgraduate seminar participants

ACHIEVEMENTS

Staff Achievements

Ms Elizabeth Rudolph was elected chair of the Association of Polar Early Career Scientists of South Africa (APECSSA).

Dr Samuel Adelabu achieved an NRF Y-rating, and Pululu Mahasa attained his PhD from North-West University (NWU).

Student Achievements

Tsholofelo Kohitlhetse, an Honours student, won the prize for the best presentation in Physical Geography at the SSAG Student Conference. Her presentation was titled 'The effect of land use on water quality of the Modder River between the Rustfontein and Krugersdrift dams, central Free State'.

Another Honours student, Nombulelo Sikhosana, won the Jubilee bursary from the SSAG Council.

TEACHING

Undergraduate students in the Department were involved in a number of excursions and field trips during 2019.

On 30 March 2019, Dr Jay Le Roux took his Geomorphology third-year students to two geomorphic sites in and around Bloemfontein – the Soetdoring Nature Reserve for soil erosion assessment/research activities and the Florisbad Quaternary Research Station, where they received a talk by Dr Lloyd Rossouw from the National Museum.

Geomorphology third-year students visiting Soetdoring Nature Reserve for soil erosion assessment and research activities

Students learning about the fossils at Florisbad Quaternary Research Station

Mrs Tobeka Mehlomakhulu took her third-year Rural Geography students on an excursion to rural settlements in Bloemfontein.

Mrs Tobeka Mehlomakhulu and the third-year Rural Geography students

Dr Tom Okello and Dr Pululu Mahasa took the second- and third-year Geography and Tourism students from the Qwaqwa Campus for an annual field trip to Durban from 8 to 11 October 2019. The excursion involved field lectures at strategic locations along the N3 Route and in Durban.

RESEARCH

Dr Samuel Adelabu continued his research on fire risk analysis in a mountainous protected area which started in 2016. This research has been supported by the Afromontane Research Unit (ARU) since 2016, and by the NRF-Thuthuka Programme since 2017.

Dr Jay le Roux and Mrs Marike Stander visited the Northwest Agricultural and Forestry University in Xianyang, China in July 2019, for meetings and experiments at the State Key Laboratory of Soil Erosion and Dryland Farming on the Loess Plateau. Their research visit was part of an ongoing research project between China and South Africa on 'Sediment sources identification and erosion control measures in Chinese and South African watersheds', supported by the National Natural Science Foundation of China (NSFC) and the NRF. They were joined by Mohamed Ahmed from the Agricultural Research Council - Institute for Soil, Climate and Water (ARC-ISCW), Alen Manyevere from the University of Fort Hare (UFH), and Flora Makgale, a PhD student from Wits. An important aim of this large collaborative research project is to use the largest (in-house) rainfall simulator in the world, where soil erosion experiments are conducted on Loess soils under different crops and management

practices. Soils in the Loess Plateau are highly erodible, with deep gullies dominating large parts of the landscape; however, Chinese researchers are doing exceptional work to monitor soil erosion and with restoration efforts (e.g. by means of planting 'countless' trees across China).

Soils in the Loess Plateau are highly erodible with deep gullies dominating large parts of the landscape

Mrs Stander's PhD project, which forms part of the overall project, is on 'The evaluation and application of composite fingerprinting technology to identify sediment sources associated with erodible duplex soils in South Africa'.

ENGAGED SCHOLARSHIP

The Qwaqwa Department of Geography collaborated with the United Nations University Institute for the Advanced Study of Sustainability (UNU-IAS) to produce a short video on sustainability, focusing on the everyday experiences of three students from Japan, Vietnam and South Africa. The film was produced for the Education for Sustainable Development in Africa (ESDA) project, an inter-university educational and research programme that aims to train future leaders for sustainable development in Africa, by promoting knowledge creation and exchange between Africa and Asia. Intended as an educational tool, this 13-minute video aims to prompt reflection on sustainability and what the concept means to each viewer. The video was filmed in Japan, South Africa and Vietnam with the support of local communities. It contains no interviews and does not attempt to define sustainability, but rather aims to encourage personal interpretation (https://www.youtube.com/watch?v=UW3n29t87Sc).

Ms Elizabeth Rudolph was invited to share with the Mountain Club of South Africa's Magaliesberg Branch on current Earth Science research on Marion Island.

Dr Tom Okello continued as the Faculty advisor for the UFS Enactus Qwaqwa, and he led the Qwaqwa team to the 2019 Enactus South Africa National Competition at Sandton Convention Centre, on 8 and 9 July 2019. As part of his service to the scientific community, he reviewed and examined more than 10 articles and 15 master's theses. He also served on the steering committee of the Qwaqwa Staff Sports welfare team, which hosted the University of Lesotho and participated in Staff Sports welfare competitions in Eswatini and Botswana in March and November.

Dr Samuel Adelabu reviewed and examined more than 10 articles and 10 master's dissertations and PhD theses.

In August, the Department of Geography assisted Joleen Hamilton with the Creative Clubs initiative on the South Campus, during which Grade 9 learners from various schools were given talks and fun learning activities related to Geography.

NATIONAL AND INTERNATIONAL COLLABORATION

Mr Adriaan van der Walt is involved in a joint climate research project in collaboration with the School of Geography, Archaeology and Environmental Studies at the University of the Witwatersrand.

The Department of Geography at the Qwaqwa Campus is a core driving institution in the Core-to-Core project, an international research collaboration funded by the Japan Society for the Promotion of Science (JSPS), titled 'Formation of Social Design Research Hub for Tackling Sustainability Issues' (2018-2021). This is a partnership with the University of Tokyo's Graduate Program in Sustainability Science Global Leadership Initiative (GPSS-GLI), UNU-IAS, University of Cape Town, University of Ibadan, Nigeria, Chulalongkorn University, Thailand and Akita International University, Japan, along with other institutions in both Africa and Asia. The Core-to-Core project is an important initiative for the Qwaqwa Campus, and feeds directly into the ARU strategic goals for developing inter- and trans-disciplinary research through the Sustainability Sciences. The collaboration with the primary partners, the GPSS-GLI and UNU-IAS, has been nurtured at the request of Vice-Chancellor Prof Francis Petersen.

The same group of academics has also been increasingly involved with the Education for Sustainable Development in Africa – Next Generation Researchers (ESDA-NGR) consortium, again at the request of Prof Petersen. ESDA is an inter-university collaboration programme of graduate training and research among eight African partner universities, aimed at promoting sustainable development in Africa. It is a valuable network, both for research and teaching, for the ARU, and the Qwaqwa Campus.

A new German-South African collaboration aims to implement novel tools for assessing land degradation. The three-year project – known as the South African Land Degradation Monitor, or simply SALDi – will build upon earlier research by the ARC-ISCW. A kick-off meeting for the project was held at ARC-ISCW in March, attended by collaborating scientists including Dr Jussi Baade and Dr Chris Schmullius from Germany's Friedrich Schiller University of Jena, as well as Dr Le Roux and Mrs Stander from the UFS Department of Geography. The research team visited the Welbedacht Dam, which was built in the early 1970s as part of Bloemfontein's water supply but has silted up to such a degree that it now has only a fraction of its original storage capacity.

Sedimentation in the Caledon River and Welbedacht Dam

A portable rainfall simulator used to measure runoff and soil erosion rates on different landuse/soil combinations near Ladybrand

Dr Samuel Adelabu was actively involved in collaborations with colleagues from, *inter alia*, the University of KwaZulu-Natal (UKZN), South African National Space Agency (SANSA), University of Limpopo, University of Witwatersrand, Agricultural Research Council (ARC), University of Johannesburg, Walter Sisulu University, North-West University, University of Cape Town, University of Ibadan and the University of Tokyo.

Dr Tom Okello was actively involved in collaborations with colleagues from, *inter alia*, UKZN (also co-promoting a doctoral student), University of Zululand, Walter Sisulu University, and the South African Monitoring and Evaluation Association (SAMEA).

POSTGRADUATE STUDENTS

Five Honours students from the Qwaqwa Geography Department collaborated on a global field exercise from 11 to 16 February, partnering with five master's and doctoral students from the University of Tokyo GPSS-GLI. The excursion was in the Eastern Free State, mainly in Qwaqwa. The field exercise, led by Dr Melissa Hansen, provided training in qualitative research methods in a real-world context and focused on the role of young social entrepreneurs in Qwaqwa.

Two students (BA Honours and third-year BA) were also chosen to travel to Akita, Japan from 20 to 26 August, to participate in a second global field exercise with GPSS-GLI. The exercise focused on the degree of collaboration between local residents and in-migrant entrepreneurs by analysing community interactions occurring in third spaces.

Four students from the Department graduated with their MSc in 2019: TI Mhlomi (specialisation in Geography), NM Sekhele (specialisation in Environmental Geography), S Gcayi (specialisation in Environmental Geography), and RT Pohlo (specialisation in Environmental Geography).

POSTDOCTORAL RESEARCH FELLOWS

Dr Samuel Adelabu hosted Dr Kayode Adepoju, from Nigeria, as a postdoctoral research fellow in the Department of Geography at the Qwaqwa Campus from 2017 to 2019. During that time Dr Adepoju published a number of journal articles and five papers in peer-reviewed conference proceedings, with a further two papers currently under review.

STAFF MATTERS

Dr Samuel Adelabu completed his term as Subject Head at the Qwaqwa Campus and will move to the Bloemfontein Campus in January 2020.

Mrs Marike Stander was appointed to lecture second-year Environmental Geography on the Bloemfontein Campus. She is currently also busy with her doctoral studies.

Ms Ntebohiseng Sekhele (Qwaqwa Campus) was promoted to Lecturer. She is also busy with her doctoral studies, linked to the University Staff Doctorate Programme (USDP).

Prof Geoffrey Mukwada and Dr Tom Okello, both from the Qwaqwa Campus, are involved in the USDP. Prof Mukwada is the project leader of the Programme as well as a promoter of two USDP doctoral candidates (Ms Ntobohiseng Sekhele and Mr Grey Magaiza), while Dr Okello is promoter of a further two doctoral candidates (Ms Nomcebo Dlamini and Ms Mukondeleli

Manuga). Prof Mukwada, Dr Okello and Ms Sekhele visited the Appalachian State University in North Carolina as part of the annual USDP activities.

RESEARCH OUTPUTS

Research Articles

Adagbasa, E.G., Adelabu, S.A. & Okello, T.W. 2019. Application of deep learning with stratified K-fold for vegetation species discrimination in a protected mountainous region using Sentinel-2 image. *Geocarto International*: 1-21. DOI: 10.1080/10106049.2019.1704070.

Adepoju, K.A., Adelabu, S.A. & Fashae, O. 2019. Vegetation response to recent trends in Climate and landuse dynamics in a typical humid and dry tropical region under global change. *Advances in Meteorology* 2019 (Article ID 4946127). DOI: 10.1155/2019/4946127.

Gcayi, S.R., Chirima, G.J., Adelabu. S.A., Adam, E. & Abutaleb, K. 2019 Evaluating the potential of narrow-band indices to predict soybean Glycine Max L. Merr grain yield in the Free State and Mpumalanga of South Africa. *Open Access Journal of Environmental & Soil Science* 3(1): 265-278.

Kudo, S., Allasiw, D., Matsuyama, K. & M. Hansen, M. 2019. Translocal learning approach: Facilitating knowledge exchanges across communities with different localities. *Africa Educational Research Journal* 10: 50-62.

Malherbe, H., Le Maitre, D., Le Roux, J.J., Pauleit, S. & Lorz C. 2019. A simplified method to assess the impact of sediment and nutrient inputs on river water quality in two regions of the southern coast of South Africa. Environmental Management 63: 658-672. DOI: 10.1007/s00267-019-01147-w.

Pretorius, A. & Rudolph, E. M. 2019. Reflections on the SSAG 2018 conference: Focus, formats, and impacts. *South African Geographical Journal*: (Online). DOI: 10.1080/03736245.2019.1670235.

Conference Contributions

Conference Papers/Posters

Adepoju, K. & Adelabu, S.A. 2019 *Assessing the effect of land use transition, climate and vegetation anomalies on fire and encroaching species distribution in mountainous grassland.* Paper delivered at Institute of Australian Geographers conference 2019, West Point, Tasmania. 9-13 July 2019.

Hansen, M. 2019. *Translocal learning approach: Facilitating knowledge exchanges across communities with different localities*. Paper delivered at the South Africa-Japan Universities (SAJU) Forum, Pretoria, South Africa. 23-24 May 2019.

Le Roux, J.J. 2019. Soil erosion prevention is better than cure in South Africa's only large river network without a dam. Paper delivered at the Combined Congress, Bloemfontein, South Africa. 21-25 January 2019.

Mukwevho, R., Van der Walt, A.J. & Deacon, F. 2019. *Exploring how extreme temperatures influence movement patterns of giraffes at Rooipoort Nature Reserve, Northern Cape Province*. Paper delivered at the Southern African Wildlife Management Association, Wilderness, South Africa. 1-5 September 2019.

Okello, T.W. 2019. *Community opinions on land use practices and activities in relation to natural resource conservation at the Amboseli ecosystem, Kenya*. Paper delivered at the IGU Commission on Africa Studies Annual Conference, University of Zululand, South Africa. 17-19 June 2019.

Van der Walt, A.J. & Fitchett, J.M. 2019. *Statistical classification of South African Seasonal Divisions on the Basis of Daily Temperature Data.* Paper delivered at the Society of South African Geographers Conference, Bloemfontein, South Africa. 8-10 July 2019.

Conference Proceedings

Adepoju, K. & Adelabu, S. 2019. Assessment of fuel and wind drivers of fire risk in protected mountainous grassland of South Africa. In: *IEEE Xplore IGARSS 2019 - 2019 IEEE International Geoscience and Remote Sensing Symposium*. Yokohama, Japan, 28 July-2 August 2019. pp. 86-870. DOI: 10.1109/IGARSS.2019.8900100.

Adepoju, K., Adelabu, S. & Mokubung, C. 2019 Mapping Seriphium Plumosum encroachment in mountainous grassland using species distribution modelling. In: *Proceedings of the 2nd World Environmental Conservation Conference: Transition Pathways to Sustainable Development Goals: Integrated landscape approach, Economic wellbeing and Inclusive climate resilience*. S.A. Agele & S.O Oladeji (Eds). Akure, Nigeria, 5-18 June 2019. pp. 60-69.

Mofokeng, D.O., Adelabu, A.S., Adepoju, K. & Adam, E. 2019 Spatio-temporal analysis of lightning distribution in Golden Gate Highlands National Park (GGHNP) using geospatial technology. In: *IEEE Xplore IGARSS 2019 - 2019 IEEE International Geoscience and Remote Sensing Symposium*, Yokohama, Japan. 28 July-2 August 2019. pp. 9898-9901. DOI: 10.1109/IGARSS.2019.8897912.

Mureriwa, N.F., Adam, E. & Adelabu, S. 2019. Cost effective approach for mapping prosopis invasion in arid South Africa using SPOT-6 imagery and two machine learning classifiers. In: *IGARSS 2019 - 2019 IEEE International Geoscience and Remote Sensing Symposium*, Yokohama, Japan. 28 July-2 August 2019. pp. 3724-3727. DOI: 10.1109/IGARSS.2019.8900609.

STAFF (2019)

Head of Department: Dr Charles Barker

Bloemfontein Campus

Senior Lecturers: Dr C Barker and Dr J le Roux

Lecturers: Mrs M Dunn, Ms E Kruger, Mrs T Mehlomakhulu, Ms EM Rudolph, Mrs M Stander and Mr AJ van der Walt

Course Coordinator: Ms E Kruger

Senior Officer - Professional Services: Mrs S Brits

Senior Assistant Officer: Ms N van Dyk

Qwaqwa Campus

Associate Professor: Prof G Mukwada

Senior Lecturers: Dr SA Adelabu (Subject Head) and Dr TW Okello

Lecturers: Dr M Hansen, Dr P Mahasa and Ms N Sekhele

Course Coordinator: Dr TW Okello

Senior Assistant Officer: Ms M Lebeko

DEPARTMENT OF GEOLOGY

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OVERVIEW OF 2019

The Department of Geology is responsible for teaching and research in the geological sciences at the University of the Free State (UFS). The Department offers six undergraduate, three Honours, and four MSc programmes (Geology, Geochemistry, Environmental Geology, and Mineral Resource Management [MRM]), as well as the PhD by research.

In 2019 the Department awarded a total of 75 degrees which includes 23 Honours, 10 MSc and one PhD. The Department enrolled 50 undergraduate students, 25 Honours students, 53 MSc students (36 in MRM, 17 in Geology, Geochemistry and Environmental Geology), and 7 PhD candidates in 2019.

ACHIEVEMENTS

Staff Achievements

Dr Matthew Huber was allocated a Y2-rating from the National Research Foundation (NRF). He also received a certificate of completion from the Planetary Science Engagement Institute after attending a workshop on 22 and 23 March. *Rosestad Radio* interviewed Dr Huber regarding the work that the Geophysical Research and Analysis of the Vredefort Impact with Timely Anthropological Studies (GRAVITAS) research group has undertaken. During the interview, Dr Huber responded to questions concerning the nature of the Vredefort Impact Structure, including how the impact itself formed, as well as how humankind utilised the structure through time, in particular the San people who engraved the Daskop Granophyre Dyke.

Ms Rinae Makhadi was awarded her MSc degree with a project titled 'Assessment of groundwater quality near two municipal solid waste landfill sites in Bloemfontein, South Africa'.

Ms Makhadi was also recognised for the inspirational work she is doing in the classroom as part of the Khotatsa project, which aims to appreciate the good work of UFS lecturers. Her recognition followed the nomination by one of her second-year Environmental Geology students for her extra effort in her lectures.

TEACHING

The Geology Department offered six undergraduate programmes for the BSc majoring in Geology, Environmental Geology, Geochemistry, Geology and Geography, Geology and Chemistry, and Geology and Physics. The Department offered 17 undergraduate and 13 Honours modules, including a new module introduced in 2019 on 'Skills development and ethics for geoscience professionals' to equip our graduates with an industry-relevant practical edge. The Department's Honours programmes offer specialisation degrees in Geology, Geochemistry and Mineralogy, and Environmental Geology.

The modules presented by the Department attempt to integrate theory, laboratory and geological field investigations, and most include visits to mines and mineral processing plants, geoscientific laboratories or research centres. At the undergraduate level, the first-, second- and third-year students visited various geological sites to study the different geological aspects pertinent to the respective modules.

In the first semester, first-year undertook field excursions to Austin's Post (Edenburg district) as part of the Introduction to Geology module, and to Bankfonten (Jagersfontein District) in the second semester as part of General Geology and South African Stratigraphy module. The field school provided students with first-hand exposure to a variety of sedimentary structures as well as an introduction to stratigraphic relationships.

Second-year students attended the field school under the supervision of Adriaan Odendaal and Wayne Nel, during which they were involved in practical lessons in stratigraphic relationships, occurrences and origin of rocks, and the development of fieldwork skills such as the use of the geological compass, the mapping of rocks in the field and the construction of geological profiles and traverses.

Adriaan Odendaal explaining sedimentary aspects associated with channel deposits on the farm Bankfontein to second-year students

As part of their Environmental Geology module, second-year students undertook a field excursion in the second semester to the two municipal waste disposal sites in Bloemfontein. The field excursion provided students with practical lessons on some of the aspects that have to be considered when selecting solid waste disposal sites as well as some of the waste management issues that the city is currently facing.

Second-year students investigating the stratified nature of cross-bedded units associated with the Musgrave Member, south of Bloemfontein

Third-year students in the Economic Geology and Exploration Geology modules took part in a field trip to the Vredefort Dome and Tshepong Gold Mine. The students, supervised by Matthew Huber, Jarlen Beukes and Martin Clark, practiced field mapping, performed mining geology exercises in an open-pit mine, and went underground to observe the process of the mining of gold.

Economic and Exploration Geology students on a field trip in the Vredefort Dome

Third-year students in the Igneous Petrology module, under the supervision of Prof Frederick Roelofse, visited the Big Hole Museum in Kimberley to learn more about the geology of diamonds, diamond mining and diamond processing.

RESEARCH

A US$1.5-million grant was secured from the International Continental Scientific Drilling Programme (ICDP) for scientific drilling on the Bushveld Complex. The proposal was submitted by a group of international scientists coordinated by researchers from the GFZ German Research Centre for Geosciences, the University of the Witwatersrand, the UFS (Prof Frederick Roelofse), and the Friedrich-Alexander University in Germany.

An Interdisciplinary Grant was awarded for the research project titled 'GRAVITAS', which is run by the Impact Research Group that was formed by Dr Matthew Huber, Dr Elizaveta Kovaleva and Dr Martin Clark of the Department of Geology, together with Dr Francois Fourie from the Institute for Groundwater Studies (IGS) and Ms Liezel Blomerus from the Department of Anthropology. The GRAVITAS research team visited the Vredefort Impact Structure twice in 2019 as part of the group's intensive field investigation of the structure. From these two field trips, the research group have generated a number of manuscripts,

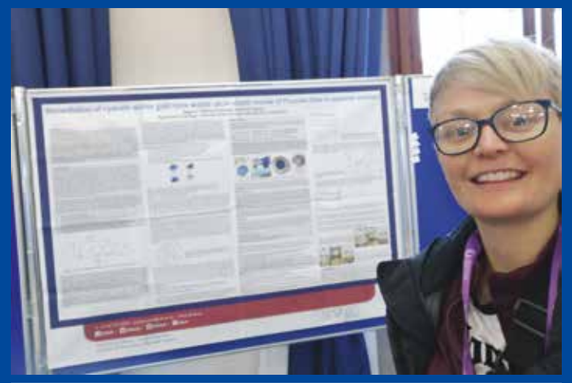
publishing two papers in 2019. They also created a webpage https://www.ufs.ac.za/giving/donate-here-to-ufs/ia-projects/gravitas-(grv). Research related to GRAVITAS was publicised on numerous international forums, including *Fox News*, *Newsweek*, and *Sputnik France*, as well as in national news agencies such as *The Citizen* and *Rapport*.

Dr Robert Hansen researched the nucleation and precipitation of secondary minerals in sulfidic tailings facilities. The purpose of this research was to determine the required super saturation of these mineral salts, which are not in most cases taken into account in environmental risk assessments, but which can have a significant influence on the mobility of hazardous substances from the tailings into the surrounding environment. Dr Hansen submitted a paper to the *South African Journal of Geology*.

A project was initiated to determine the effect of climate cycles and weathering bedrock influences on the hydrogeochemistry of the natural streams in the Drakensberg. Samples were collected from the area and analysed. Environmental geology and geochemistry research projects were mostly focused on the determination of the geochemical processes responsible for environmental risks in sulfidic tailings facilities. Kinetic geochemical and process network (systems) modelling formed the cornerstone of this research.

A collaborative project with SAENSE (a biochemistry platform funded by the Technology Innovation Agency [TIA] and located at UFS) to roll out water treatment technologies, has been ongoing.

As part of her PhD study, Ms Megan Welman-Purchase undertook research on 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.



Megan Welman-Purchase at the 15th Biennial Society for Geology Applied to Mineral Deposits (SGA) meeting in Glasgow, Scotland

Following negotiations between the UFS and the University of Johannesburg (UJ) in 2018, the Department of Geology 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 the University of the Witwatersrand. In 2019 three projects involving Prof Frederick Roelofse, Dr Elizaveta Kovaleva and Ms Justine Magson secured funds from DSI-NRF CIMERA. This partnership will allow access to postgraduate student-funding opportunities in years to come.

Dr Hendrik Minnaar conducted research on the magmatic and crust formation processes in the Paleoproterozoic Richtersveld Magmatic Arc. Dr Minnaar also started an NRF-funded research project along with Mr Pelele Lehloenya on the composition and evolution of the Paleoproterozoic Gladkop Suite, Namaqua Metamorphic Province. From July 8 to 19, Mr Lehloenya attended training on mineral separation (specifically zircon) at the Central Analytical Facilities (CAF) at Stellenbosch University. He was trained in heavy liquid separation, as well as picking and mounting of zircons and also received training on cathodoluminescence (CL) imagery acquisition.

Pelele Lehloenya during training on mineral separation at CAF, Stellenbosch University

As part of his PhD research project on the fluvial-lacustrinal Beaufort Group of the Karoo Supergroup, Mr Adriaan Odendaal is investigating the Ecca-Beaufort contact, west of Bloemfontein, and the occurrence of large-scale mass movements in the Thaba 'Nchu area, which will lead to two possible articles for publications in addition to his PhD thesis.

Ms Justine Magson is undertaking research for her PhD 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'.

Ms Jarlen Beukes continued with research towards 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. From August 19 to 23, Ms Beukes performed Sr isotope analyses using the laser ablation multi-collector inductively coupled plasma source mass spectrometer (LA-MC-ICPMS) housed at the UJ Geology Department. The *in situ* isotope analyses were done on plagioclase from the Flatreef stratigraphic units.

As part of his PhD, Mr Ernest Moitsi continued work on the mineralogical characterisation and metallurgical response of various Upper Group 2 chromitite facies-types from Sibanye Still-Water in Marikana, Bushveld Complex in the Northwest Province.

The MSc projects of Ms Thendo Mapholi and Mr Justin Nel on Nkombwa Phosphate Mineralogy and on the structural geology of the Namaqualand Mobile Belt are also in advanced stages of completion.

The Department's research infrastructure was significantly improved through the acquisition of a new Rigaku ZSX Primus IV X-Ray Fluorescence Spectrometer with elemental mapping capabilities.

In an attempt to increase the research outputs of the academic staff, the Department organised a three-day Writing Retreat at the Golden Gate Highlands National Park in November 2019 with financial support from the UFS Postgraduate School. Seven academic staff, two scientific technical staff, one postdoctoral research fellow and one postgraduate student attended the workshop.

Prof Bisrat Yibas (second from the right) at the International Mine Water Association Conference in Perm, Russia (15-19 July 2019)

ENGAGED SCHOLARSHIP

Dr Huber presented two lectures at the University for the Third Age, on 'The Development of Life through Earth's History' (7 February) and 'The Catastrophe that made South Africa Rich' (7 November). Dr Huber was also the invited speaker at the Student Affairs Research Colloquium: Moonshot Thinking Session, held on 2 August 2019.

Mr Moitsi served on the Mineralogical Association of South Africa (MINSA) committee for the term 2019/2020.

NATIONAL AND INTERNATIONAL COLLABORATION

The Department has excellent relationships with the industry, as exemplified by Minerals Education Trust Fund (METF) subventions to all our full-time academic staff members to date, and the increasing levels of collaboration. The feedback the Department received from mining companies on the quality of our graduates was very encouraging. As a result, student bursaries, research support such as provision of access to mine facilities and research materials such as drill cores and samples, are improving. A number of Honours, MSc and PhD research projects are supported by the industry. Staff research and interaction with the industry have also improved significantly.

Dr Huber's collaboration agreement with De Beers, which started in 2018, continued into 2019, resulting in four Honours students generating projects related to the analysis of mantle xenoliths from kimberlite pipes. These projects included 200 electron microprobe analyser (EMPA) and LA-ICP-MS points generated by De Beers.

As reported above, collaboration with the GFZ German Research Centre for Geosciences, the University of the Witwatersrand and the Friedrich-Alexander University, led to a grant from the ICDP.

The collaboration between the Department and DSI-NRF CIMERA is continuing with three projects and will continue to allow access to postgraduate student-funding opportunities in years to come.

The staff of the Geology Department also 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
- Freidrich-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

POSTGRADUATE STUDENTS

The Geology Department offers a variety of postgraduate programmes including Honours, four different MSc programmes (Geology, Geochemistry, Environmental Geology, and Mineral Resource Management (MRM), and the PhD degree by research. In 2019, the Department enrolled 85 postgraduate students – 25 Honours, 46 MSc and 7 PhD candidates.

Thirty-four (34) postgraduate degrees, which includes 23 Honours, 10 MSc and one PhD, were awarded in 2019.

Mr Marvin Peter Nicholas completed his MSc specialising in geology with the project titled 'Assessment of the applicability of the South African waste classification legislation on geological mine waste with special reference to gold mine tailings in the Witwatersrand – a geochemical perspective'. Mr Louis Naude attained his MSc after successfully completing a project titled 'Geochemical model of adsorption behavior of uranium on mine soil impacted by Witwatersrand gold tailings facilities'. Dr Robert Hansen supervised both Mr Nicholas and Mr Naude. Mr George du Plessis completed his MSc with a dissertation titled 'The parageneses of sulphide minerals in transgressive carbonatite of the Palabora Complex, South Africa' under the supervision of Prof Roelofse, Prof Gauert, Mr Giebel and Mr Rentel.

Seven MRM MSc degrees were awarded to George B Kabaso, Bittah Gorgozcynski, Ndinelao N Kashidinge, Barend F Steenkamp, Simon L Riekert, Annelizle Botha and Venkile Cindrella Mkasi, who successfully completed the two-year intensive modules and mini-dissertations required for the fulfillment of MRM MSc qualification.

The doctoral awardee was Dr Robert Johannes Giebel, with a thesis titled 'Petrogenesis of carbonatites: Mineral variations and effects on the REE mineralization'. His main promoter was Prof Chris Gauert.

As part of the Department's intensive Honours programme, the 2019 Honours students undertook a number of field investigations and site visits. Applied and Advanced Mineralogy students visited the Sibanye-Stillwater Platinum Processing Plant (formerly known as Lonmin) and the Gold One Processing Plant located in Springs, as well as Mintek and SGS laboratories.

Mineralogy Honours students visiting the Gold One Mine Processing Plant

The Honours students also undertook field excursions to gain advanced structural geological mapping skills, as part of the Advanced Structural Geology module under the supervision of Dr Hendrik Minnaar.

Dr Hendrik Minnaar explaining structural features in the field to the Honours class

The Honours Advanced Economic and Exploration Geology students, accompanied by Dr Matthew Huber, Dr Martin Clark, Ms Jarlen Beukes, and Ms Motlatji Molabe, attended a field course that mainly took place in Mpumalanga. The students visited an exploration site of Harmony Gold Mine where active drilling was going on, Sheba Gold Mine, Dorstfontein East Coal Mine, and Nkomati Nickel Mine, as well as the Barberton Geo-trail, the Kaapsehoop Escarpment, and Lone Creek Falls to see historical mining areas and the regional geology. The Golden Gate Highlands National Park was visited on the return trip to Bloemfontein.

The third annual Honours Debate was held on 15 October 2019. The event featured all 25 of the Honours students, who were divided into two teams to propose and oppose the motion, 'Resolved that the value of mining polymetallic seafloor nodules is greater than the environmental cost of mining activities'. Prof Bisrat Yibas, Dr Robert Hansen, and Dr Matthew Huber formed the judging committee. After intense debate with valid and interesting points raised by both teams, the judges agreed that the outcome should be a draw.

POSTDOCTORAL RESEARCH FELLOWS

The Department hosted two postdoctoral research fellows – Dr Elizaveta Kovaleva (Russia) and Dr Martin Clark (Canada), until the employment Dr Kovaleva as Senior Lecturer in the Department in August 2019.

Dr Clark competed in the Entrepreneurship Development in Higher Education (EDHE) competition, presenting a business concept outlining that by initiating a business arm of a project, students who develop unique skillsets can be placed in the business arm to begin their career delivering drone-analysis services to industry. He was selected as one of the four UFS student entrepreneurs to proceed to the regional competition hosted at the Central University of Technology (CUT).

STAFF MATTERS

Three academic appointments were made in 2019. Mr Ernest Matome Moitsi was appointed as a Lecturer in January 2019 and Dr Elizaveta Kovaleva was appointed as a Senior Lecturer in August 2019, respectively. Prof Bisrat Yibas was appointed as a Professor and Head of the Department and assumed duties on July 2019. This brings the academic staff complement of the Department to 13.

Mrs Rina Immelman, who served the Department for 39 years as the financial and administrative officer, retired in October 2019.

Department of Geology staff (2019)
Front from the left: Ms J Beukes, Ms R Immelman, Ms P Swart, Ms T Mapholi, Mr E Moitsi and Ms M Purchase
Middle from the left: Mr D Radikgomo, Mr P Lehloenya, Mr A Odendaal, Dr H Minnaar, Mr A Felix, Dr M Huber and Dr E Kovaleva
Back from the left: Mr W Nel, Ms C van der Vyver, Ms J Magson (Programme Director), Prof F Roelofse (HoD to June 2019), Dr R Hansen and Dr M Clark (postdoctoral research fellow)
Absent: Ms R Makhadi and Prof B Yibas (HoD from July 2019)

RESEARCH OUTPUTS

Research Articles

Fourie, F., Huber, M.S. & Kovaleva, E. 2019. Geophysical characterization of the Daskop Granophyre Dyke and surrounding host rocks, Vredefort Impact Structure, South Africa. *Meteoritics and Planetary Science* 54:1579-1593.

Goderis, S., Soens, B., Huber, M.S., McKibbin, S., Van Ginneken, M., Debaille, V., Greenwood, R., Franchi, I., Cnudde, V., Van Malderen, S., Vanhaecke, F., Koeberl C., Topa, D. & Claeys, P. 2019. Cosmic spherules from Widerøefjellet, Sør Rondane Mountains (East Antarctica). *Geochimica et Cosmochimica Acta*. DOI: 10.1016/j.gca.2019.11.016.

Göllner, P.L., Wüstemann, T., Bendschneider, L, Reimers, S., Clark, M.D., Gibson, L., Lightfoot, P.C. & Riller, U. 2019. Thermo-mechanical interaction of a large impact melt sheet with adjacent target rock, Sudbury impact structure, Canada. *Meteoritics & Planetary Science* 1-18.

Huber, M.S., Koeberl, C., Smith, F.C., Glass, B.P., Mundil, R. & McDonald, I. 2019. Geochemistry of a confirmed Precambrian impact ejecta deposit: The Grænsesø spherule layer, South Greenland. *Meteoritics & Planetary Science* 54:2254-2272.

Huber, M.S. & Kovaleva, E. 2019. Microstructural dynamics of central uplifts: Reidite offset by zircon twins at the Woodleigh impact structure, Australia: COMMENT. *Geology* 47: e465.

Kovaleva E. & Habler, G. 2019. Spatial distribution of zircon with shock microtwins in pseudotachylite-bearing granite gneisses, Vredefort impact structure, South Africa. *Journal of Structural Geology* 129: 103890.

Kovaleva, E., Huber, M.S., Roelofse, F., Tredoux, M. & Praekelt, H. 2019. Reply to the comment made by W.U. Reimold on "Pseudotachylite vein hosted by a clast in the Vredefort granophyre: characterization, origin and relevance" by E. Kovaleva *et al*., South African Journal of Geology, 2018, 121, 51-68.doi:10.25131/sajg.121.0002. *South African Journal of Geology* 122(1): 109-115.

Kovaleva, E., Zamyatin, D. & Habler, G. 2019. Granular zircon from Vredefort granophyre (South Africa) confirms the deep injection model for impact melt in large impact structures. *Geology* 47: 691-694.

Kusiak, M.A., Kovaleva, E., Wirth, R., Klötzli, U., Dunkley, D.J., Yi, K. & Lee, S. 2019. Lead oxide nanospheres in seismically deformed zircon grains. *Geochimica et Cosmochimica Acta* 262: 20-30.

Miller, D. & Killick, D. 2019. Non-Ferrous metal artefacts from the northern Lowveld, South Africa, ca. 1000 CE to ca. 1880 CE. *Journal of Archaeological Science: Reports* 24: 913-923.

Ololade, O.O., Mavimbela, S., Oke, S.A. & Makhadi, R. 2019. Impact of leachate from Northern Landfill Site in Bloemfontein on water and soil quality: Implications for water and food security. *Sustainability* 11: 4238. DOI: 10.3390/su11154238.

Conference Contributions

Conference Papers/Posters

Fourie, F., Kovaleva, E. & Huber, M. 2019. *Geophysical surveys across the Daskop Granophyre Dyke.*Paper delivered at the 16th SAGA Biennial Conference and Exhibition, Durban, South Africa. 6-9 October 2019.

Gomez-Arias, A., Yesares, L., Castillo, J., Welman-Purchase, M.D. & Vermeulen, D. 2019. *Limitations of current protocols to predict groundwater contamination from alkaline mine waste*. Paper delivered at the 46th Annual Congress of the Internal Association of Hydrologists (IAH2019), Malaga, Spain. 22-27 September 2019.

Huber, M.S. & Kovaleva, E. 2019. *Was the Vredefort melt sheet similar composition to the Sudbury melt sheet?* Paper delivered at the 50th Lunar and Planetary Science Conference, The Woodlands, Texas, USA. 18-22 March 2019.

Huber, M.S., Kovaleva, E., Clark, M. & Fourie, F. 2019. *Geophysical analysis of Granophyre dykes at the Vredefort impact structure.* Paper delivered at the 11th Igneous and Metamorphic Studies Group Meeting, Johannesburg, South Africa. 14-15 January 2019.

Kovaleva, E., Huber, M.S., Clark, M. & Fourie, F. 2019. *Timing of emplacement of Vredefort granophyre dykes.* Paper delivered at the Large Meteorite Impacts and Planetary Evolution VI Conference (LPI Contrib. No. 2136, 5080), Brasilia, Brazil. 20 September-3 October 2013.

Kovaleva, E., Zamyatin, D. & Habler, G. 2019. *The oldest evidence of reidite presence on Earth: Vredefort impact structure,* Abstract Volume, 21. Paper delivered at the 11th Igneous and Metamorphic Studies Group Meeting, Johannesburg, South Africa. 14-15 January 2019.

Kovaleva, E., Zamyatin, D. & Leroux, H. 2019. *Twisted kink bands: New shock deformation microstructure in zircon from the Vredefort impact structure.* Paper delivered at the Large Meteorite Impacts and Planetary Evolution VI Conference (LPI Contrib. No. 2136, 5056), Brasilia, Brazil. 30 September-3 October 2019.

Conference Proceedings

Oke, S.A., Purchase, M.D. & Mokitlane, L. 2019. Laboratory remediation of iron-sulphate contaminant in acid mine waters using waste rocks. In: *Proceedings of the 5th World Congress on New Technologies (NewTech'19)*. Paper No: ICEPR'19 162. Lisbon, Portugal. 18-20 August 2019.

Welman-Purchase, M.D. & Hansen, R.N. 2019. Remediation of cyanide with in gold mine waste: an in-depth review of Prussian blue in aqueous solutions. In: *15th Biennial SGA Meeting Proceedings 4*. pp. 1555-1557.

STAFF (2019)

Head of Department: Prof Bisrat Yibas

Associate Professor: Prof F Roelofse
Senior Lecturers: Dr R Hansen, Dr M Huber, Dr E Kovaleva and Dr H Minnaar
Lecturers: Ms J Beukes, Ms J Magson, Mr ME Moitsi and Mr A Odendaal
Junior Lecturers: MS R Makhadi, Ms T Mapholi and Mr J Nel
Affiliated Professors: Prof DE Miller, Prof R Schemers andProf Ayla Scooch
Affiliated Associate Professors: Prof CD Geert, Prof GJB Germs, Prof L Jacobson and Prof RP Schouwstra
Affiliated Senior Lecturer: Dr A Bisnath
Affiliated Lecturers: Mr AC Dunne, Mr PJ Grobler, Mr I Hunt, Mr PG Laurens, Dr H Prinsloo, Mr PJ Viljoen, and Mr MJAR Vrijens
Research Fellows: Prof WP Colliston, Dr PG Meintjes, Dr L Nel, Dr HE Praekelt and Prof WA van der Westhuizen
Affiliated Researchers: Dr JO Claassen, Ms HCF Pretorius and Dr MJ van der Merwe
Research Associate: Dr Johan Loock
Programme Director: Ms J Magson
Senior Assistant Officers: Mr A Felix, Ms R Immelman, Ms P Swart and Ms C van der Vyver
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 2019

Our Department continued producing high quality statistical and actuarial graduates and the numbers of Honours and master's students increased. The Statistical Consultation Unit completed more than 60 projects in the course of the year.

ACHIEVEMENTS

Staff Achievements

Prof Max Finkelstein, an NRF A-rated researcher, produced a number of notable publications in the course of the year.

TEACHING

Our Department presents degrees in Actuarial Science, Mathematical Statistics, Applied Statistics and Econometrics.

Dr Michael von Maltitz has been taking the lead in the Department, and indeed the Faculty, in terms of new approaches to the decolonisation of the undergraduate curriculum. He has worked very closely with the Centre for Teaching and Learning (CTL) on these issues, and is in the process of publishing papers outlining his novel approaches.

RESEARCH

In terms of research, our Department specialises in:

- Extreme Value Theory (Dr A Verster, Prof De Waal, Dr D Chikobvu)
- Bayesian Statistics (Dr S van der Merwe, Prof A van der Merwe, Dr M Sjolander)
- Multiple Imputation (Dr M von Maltitz)
- Statistics in Education (Liza da Silva, Dr L van der Merwe, Dries Naude)
- Various financial types of research within Actuarial Science (Frans Koning, Louwtjie Voges, Jan Blomerus, Zani Ludick),
- Mortality analysis and improvements

NATIONAL AND INTERNATIONAL COLLABORATION

Prof Jan Beirlant, from KULeuven, has a long-standing collaboration with the Department, and visits on an annual basis, presenting lectures in the Extreme Value Theory (EVT) course. He also actively engages in research with other researchers in the Department on this topic.

Prof Max Finkelstein has maintained ongoing collaboration with researchers from Israel, South Korea, India, China and Russia.

POSTDOCTORAL RESEARCH FELLOWS

The Department of Mathematical Statistics and Actuarial Science hosted one postdoctoral research fellow in 2019 – Dr Nilen Hazra, from India, who worked with Prof Finkelstein.

STAFF MATTERS

Our Department lost one actuary, Jan-Paul Venter who emigrated to Canada, and employed a new actuary, Mr Louwtjie Voges.

Prof Martin van Zyl retired early. His replacement, Dr Chakraborty, will only commence duties in 2020 due to delays in obtaining the necessary work permit.

Prof Robert Schall moved to a half-day post from the start of 2019, and Dr Sean van der Merwe took over responsibility for the Statistical Consultation Unit.

RESEARCH OUTPUTS

Research Articles

Beirlant, J., Kijko, A., Reynkens, T. & Einmahl, J. 2019. Estimating the maximum possible earthquake magnitude using extreme value methodology: The Groningen case. *Natural Hazards* 2018: 1-23.

Beirlant, J., Maribe, G. & Verster, A. 2019. Using shrinkage estimators to reduce bias and MSE in estimation of heavy tails. *Revstat-Statistical Journal* 17(1): 91-108.

Burger, D., Schall, R., Jacobs, R. & Chen, D. 2019. A generalized Bayesian nonlinear mixed-effects regression model for zero-inflated longitudinal count data in tuberculosis trials. *Pharmaceutical Statistics* 18: 420-432.

Cha, J. & Finkelstein, M. 2019. New failure and minimal repair processes for repairable systems in a random environment. *Applied Stochastic Models in Business and Industry* 35: 522-536.

Cha, J. & Finkelstein, M. 2019. On some characteristics of quality for systems operating in a random environment. *Proceedings of The Institution of Mechanical Engineers, Part O: Journal of Risk and Reliability* 233(2): 257-267.

Cha, J. & Finkelstein, M. 2019. Optimal preventive maintenance for systems having a continuous output and operating in a random environment. *TOP* 27: 327-350.

Cha, J. & Finkelstein, M. 2019. Some results on discrete mixture failure rates. *Communications in Statistics - Theory and Methods* 48(15): 3884-3898.

Cha, J. & Finkelstein, M. 2019. Stochastic modeling for systems with delayed failures. *Reliability Engineering and System Safety* 188(C): 118-124.

Cha, J. & Finkelstein, M. 2019. Stochastic modeling of quality of systems operating in a heterogeneous environment. *Applied Stochastic Models in Business and Industry* 35: 1344-1365.

Chikobvu, D. & Makoni, T. 2019. Statistical modelling of Zimbabwe's international tourist arrivals using both symmetric and asymmetric volatility models. *Journal of Economic and Financial Sciences* 12: a426-1-a426-10.

Chikobvu, D., Shoko, C. & Bessong, P. 2019. A comparison of the time homogeneous and time non-homogeneous Markov models for monitoring HIV/AIDS disease progression: Results from patients on ART. *Biomedical Research* 30(5): 786-795.

Finkelstein, M. & Levitin, G. 2019. Preventive maintenance for homogeneous and heterogeneous systems. *Applied Stochastic Models in Business and Industry* 35: 908-920.

Finkelstein, M., Levitin, G. & Stepanov, O. 2019. On operation termination for degrading systems with two types of failures. *Proceedings of the Institution of Mechanical Engineers,*

Part O: Journal of Risk and Reliability 233(3): 419-426.

Hazra, N. & Finkelstein, M. 2019. Comparing lifetimes of coherent systems with dependent components operating in random environments. *Journal of Applied Probability* 56: 937-957.

Jakata, O. & Chikobvu, D. 2019. Modelling extreme risk of the South African Financial Index (J580) using the generalised Pareto distribution. *Journal of Economic and Financial Sciences* 12: a407-1-a407-7.

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Shoko, C. & Chikobvu, D. 2019. A superiority of viral load over CD4 cell count when predicting mortality in HIV patients on therapy. *BMC Infectious Diseases* 19(1): 169-1-169-10.

Van der Merwe, A.J., Sjolander, M.R. & Van Zyl, R. 2019. Bayesian testing for process capability indices. *South African Statistical Journal* 53(2): 87-113.

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STAFF (2019)

Head of Department: Mr F Koning

Professors: Prof M Finkelstein (contract) and 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, Ms E Girmay, Mr Z Ludick, Mr M Moletsane, Mr D Naude, Ms W Oosthuizen, Dr M Sjölander, Dr S van der Merwe and Mr L Voges

Programme Director: Dr M von Maltitz

Secretary: Ms ME Mathee

Messenger: Mr W Baranye

DEPARTMENT OF

MATHEMATICS AND APPLIED MATHEMATICS

CONTACT DETAILS

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OVERVIEW OF 2019

On the teaching side, the Department of Mathematics and Applied Mathematics offers a variety of modules – some with the emphasis on the more abstract (or pure) side of mathematics, and others more on its applicable side. Students who finish their studies in our Department typically attain the degrees BSc, BCom, and sometimes even BA. We also offer service modules to many students who study in other scientific directions, such as physical sciences, biology, agriculture, engineering, and the building sciences.

Research activities have picked up considerably over the past few years. Several publications have appeared, mainly in the areas of graph theory, combinatorics, algebra, and numerical analysis.

The Department is also concerned with what is happening on school level. Some of the staff members (Christiaan Venter, Renier Jansen and Jon Smit) were closely involved with the training of learners who are interested in Mathematics Olympiads. One of these projects is the popular Nautilus Mathematics project, designed to train talented learners from all over the Free State and Northern Cape to enhance their skills in problem solving. We find that students in our Department who have been involved in Mathematical Olympiads during their school years, generally excel faster than those who have not.

ACHIEVEMENTS

Staff Achievements

Prof Tomas Vetrik attained a C2-rating from the NRF during 2019.

Prof Jeandrew Brink was involved in the compilation of a video of geodesic orbits around a Manko-Novikov singularity, which was selected to be part of a Stamus 3 concert whose proceeds will go towards promoting the Stephen Hawking Medal for Science Communication, and to the Stephen Hawking Foundation to support its charitable activities. It may also be part of a subsequent documentary.

Student Achievements

The following students received the coveted CB van Wyk prizes in 2019:

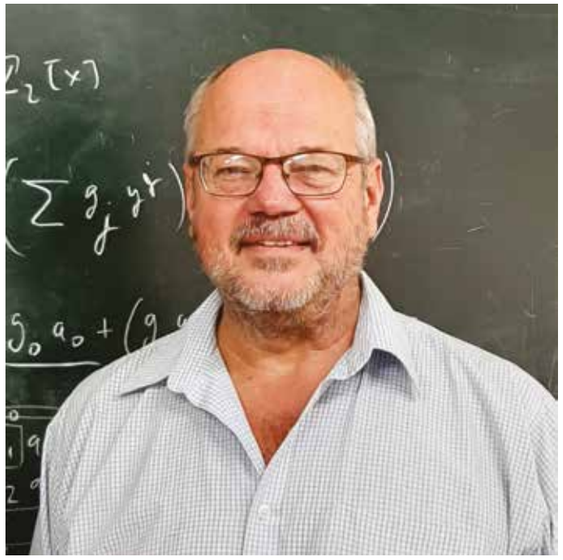
- Miss M van Schalkwyk – best first-year student during 2018
- Mr P Schall – best second-year student during 2018
- Miss E Ferreira – best third-year student during 2018

TEACHING

The structure of first-year teaching has changed. Only one first semester module (Calculus Techniques) is now available. In the second semester, we offer two possible modules for mainstream mathematics, both of which are essential for further study in mathematics. This format introduces university level mathematics at a slower pace, an issue that many students had a problem with in the past.

RESEARCH

Prof Johan Meyer, an algebraist, continued his research in collaboration with international colleagues, Prof W-F Ke, (National Cheng Kung University, Tainan, Taiwan) and Prof CJ Maxson (Texas A&M University, Texas, USA). A paper (jointly with Prof Ke and Dr Boykett from Linz, Austria) on bijective matrix maps was published during 2019, and a joint paper with Dr B-E de Klerk on the structure of automorphisms of certain abelian groups, was also published.



Prof Johan Meyer on a research visit to Tainan, Taiwan

Prof Tomas Vetrik's research involves mainly graph theory and combinatorics. He visited the following collaborators during 2019: Dr M Imran (United Arab Emirates University), Prof M Alfuraidan (King Fahd University of Petroleum and Minerals, Saudi Arabia), Dr M Abas (Slovak University of Technology), and Dr P Ali (Yeungnam University, South Korea). He also received a visit from Dr S Fufa, Addis Ababa University in Ethiopia at the beginning of the year.

Dr Albert Kriel continued his research in numerical methods for hyperbolic problems, and a paper in this regard was accepted for publication.

Prof Jeandrew Brink

Prof Jeandrew Brink's research is on various theoretical aspects of testing general relativity. She is a member of the MeerTime collaboration, which looks at using data from the MeerKAT telescope to time and detect pulsars. She is also working with members of the Laser Interferometric Gravitational-Wave Observatory (LIGO) on finding ways of using gravitational waves to test Einstein's theory.

Dr Ur Koumba, of the Qwaqwa Campus, collaborated with Dr Calvin Mudzingiri (from the Department of Economics and Finance on the same campus) and Dr JC Mba, from the University of Johannesburg, in the area of financial mathematics. He has been invited to write a chapter for the book *The Bridge between Microeconomics and Macroeconomics – Perspectives and Application*, an open access book edited by Dr O Ozcelebi.

Dr Narcisse Loufouma Makala, from the Qwaqwa Campus, collaborated with Dr Koumba on a project on 'Quasi inessential elements on ultrapowers of Banach algebras'. A publication is forthcoming.

Dr Edgard Ngounda, our specialist in financial mathematics

ENGAGED SCHOLARSHIP

Prof Johan Meyer, together with Christiaan Venter, Renier Jansen, Jon Smit and Dr Ben-Eben de Klerk, continued to be involved with Olympiad training and setting of papers. Many school learners from all over the Free State and Northern Cape benefitted from this.

Prof Meyer also reviewed several papers for *Zentralblatt Math* (published by Springer), as well as for *Math Reviews*.

Dr Samantha Dorfling was the main organiser of the annual Open Day held at the UFS in September 2019 for the prize winners of the *Wiskunde en Wetenskap-in-Aksie* programme, organised by the *SA Akademie vir Wetenskap en Kuns*.

Prof Jeandrew Brink is 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

Members of the Department maintained their international collaboration with researchers from, *inter alia*, Slovakia, Saudi Arabia, United Arab Emirates, Ethiopia, Indonesia, Taiwan, and the USA, as indicated in the section on Research, above.

POSTGRADUATE STUDENTS

In 2019, five students were enrolled for BScHons – of whom three attained their degrees, and E Ferreira with distinction. At MSc level, three students were enrolled, and L Makau and H Magau completed their degrees. Three students were enrolled for the PhD – JB Smit in graph theory, RS Jansen in category theory and H Magau in fractional calculus.

POSTDOCTORAL RESEARCH FELLOWS

The Department hosted two postdoctoral research fellows in 2019 – Dr S Balachandran from India and Prof P Cara from Belgium.

STAFF MATTERS

Dr Ur Koumba was appointed as Senior Lecturer at our Qwaqwa Campus, as from 1 April 2019.

Dr Ben-Eben de Klerk left the Department at the end of June 2019, and Prof Jeandrew Brink, a cosmologist and applied mathematician, joined the Department in July 2019.

Ms Julia van Niekerk, an excellent teacher in the Department for more than 40 years

RESEARCH OUTPUTS

Research Articles

Bataineh, M.S., Jaradat, M.M.M. & Vetrik, T. 2019. Edge-maximal graphs without disjoint odd cycles. *Ars Combinatoria* 143: 247-253.

Boykett, T., Ke, W-F. & Meyer, J.H. 2019. On invertible matrices over a near-field. *Journal of Algebra* 526: 345-355.

Du Toit, L. & Vetrik, T. 2019. On the metric dimension of circulant graphs with 2 generators. *Kragujevac Journal of Mathematics* 43(1): 49-58.

Koumba, U., Mudzingiri, C. & Mba, J.C. 2019. Does uncertainty predict cryptocurrency returns? A copula-based approach. *Macroeconomics and Finance in Emerging Market Economies* 13(1): 1-22.

Mengesha, D.A. & Vetrik, T. 2019. Resolving sets of directed Cayley graphs for the direct product of cyclic groups. *Czechoslovak Mathematical Journal* 69(3): 621-636.

Vetrik, T. 2019. Degree-based topological indices of TU4C8(S) nanotubes. *U.P.B. Scientific Bulletin, Series B* 81(4): 187-196.

Vetrik, T. 2019. Polynomials of degree-based topological indices for hexagonal nanotubes. *U.P.B. Scientific Bulletin, Series B* 81(1): 109-120.

Vetrik, T. & Balachandran, S. 2019. Degree-based topological indices of hexagonal nanotubes. *Journal of Applied Mathematics and Computing* 58(1): 111-124.

Conference Contributions

Conference Papers/Posters

Jansen, R.S. *Constant subcategories via dual closure operators.* Paper delivered at the Annual Conference of the South African Mathematical Society, Cape Town, South Africa. 2-4 December 2019.

Meyer, J.H. & Maxson, C.J. *Congruence preserving functions on special p-groups.* Paper delivered at the Arbeitstagung Allgemeine Algebra No 98, Dresden, Germany. 21-23 June 2019.

STAFF (2019)

Head of Department: Prof JH Meyer

Bloemfontein Campus

Senior Professor: Prof JH Meyer

Associate Professors: Prof J Brink and Prof T Vetrik

Senior Lecturers: Dr S Dorfling

Lecturers: Dr B-E de Klerk, Dr A Kriel, Dr E Ngounda and Mr C Venter

Junior Lecturers: Ms MJF Botha and Ms AE Swart

Temporary Lecturers: Mr RS Jansen, Ms H Oosthuizen, Mr JB Smit and Ms JS van Niekerk

Programme Director: Mr C Venter

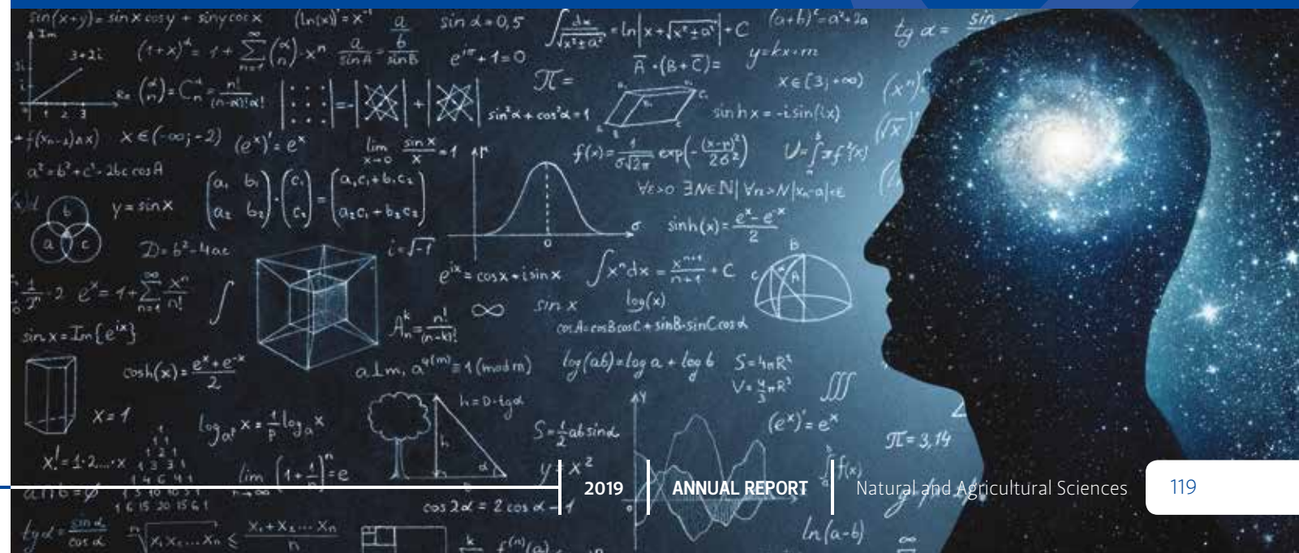
Administrative Officer: Ms SM Venter

Qwaqwa Campus

Senior Lecturer: Dr UA Koumba

Lecturers: Dr N Loufouma Makala and Mr SP Mbambo (Subject Head)

Junior Lecturer: Ms C Faber



DEPARTMENT OF

MICROBIAL, BIOCHEMICAL AND FOOD BIOTECHNOLOGY

CONTACT DETAILS

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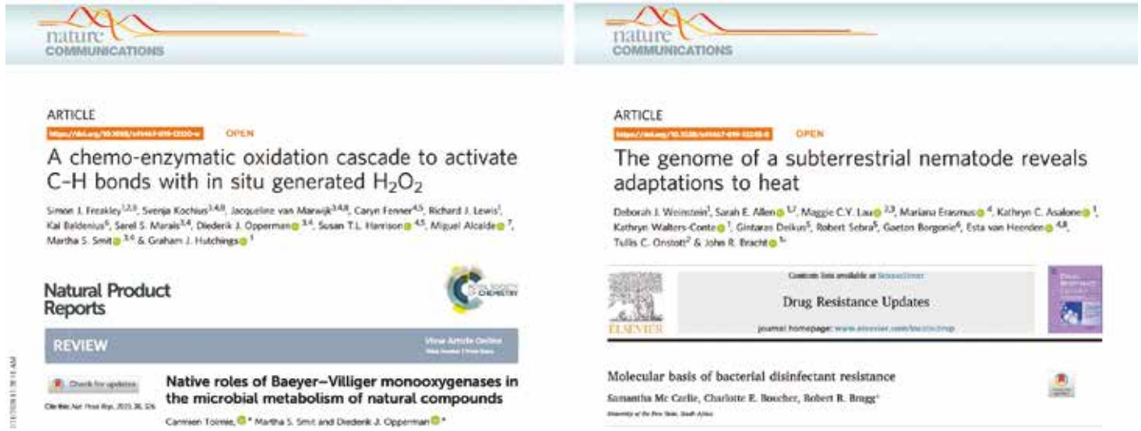
OVERVIEW OF 2019

The Department of Microbial, Biochemical and Food Biotechnology performed well in all deliverables set out for the year, including teaching, research, and creating commercial opportunities to contribute to the third-stream income of the UFS.

The Department is 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: (i) production of safe and novel food products, (ii) biocatalytic production of chemicals or bioremediation of chemical pollution, and (iii) improvement of human and animal health.

In 2019, ten members of the Department, including postdoctoral research fellows and students, were co-authors of four papers which appeared in journals with an impact factor higher than 11. It is significant that members of the Department were the corresponding authors of three of the four articles. The first, which appeared in *Natural Products Reports*, comprised the PhD literature review of Dr Carmien Tolmie who completed her PhD under the supervision of Prof Dirk Opperman. The second paper appeared in *Nature Communications* and involved a large team of Biochemists and Chemists from the UFS, University of Cape Town (UCT) and Cardiff University and required Dr Svenja Kochius and Dr Jacqui van Marwijk (both postdoctoral research fellows) to visit UCT and Cardiff University, while Cardiff University postdoctoral fellow, Simon Freakley, visited UCT and UFS on separate occasions. The third paper, also in *Nature Communications,* involved a large team of international scientists, including Dr Mariana Erasmus, Manager of the UFS Screening Applications and Exploring Novelty in Specialised Environments (SAENSE) Platform, and former staff member, Prof Esta van Heerden. The fourth paper, titled 'Molecular basis of bacterial disinfectant resistance', is a literature review in *Drug Resistance Updates* by first-year master's student, Samantha Mc Carlie, supervised by Prof Rob Bragg and Dr Charlotte Boucher.

Prof Celia Hugo is first author of a chapter about the genus *Chryseobacterium* in the online version of *Bergey's Manual of Systematics of Archae and Bacteria*, written in collaboration with Dr Jean-Francois Bernardet of the Institut National de la Recherche Agronomique (INRA – the French National Institute for Agricultural Research), Dr Ainsley Nicholson of the Centers for Disease Control and Prevention (CDC-Atlanta, USA) and Prof Peter Kämpfer of the University of Giessen (Germany).



The Department is very proud of four co-authored papers in journals with impact factors higher than 11

ACHIEVEMENTS

Staff Achievements

Prof Rob Bragg was an invited speaker at the International Symposium on Mycoplasma and Infectious Coryza, held in Amersfoort in the Netherlands in November 2019. This meeting was arranged to celebrate the 100th anniversary of the GD Diergezondheid, a government-funded veterinary diagnostic facility (www.gddiergezondheid.nl). The symposium brought together the world-leaders on both these important poultry diseases.

Prof Bragg was also a keynote speaker at the 21st World Veterinary Poultry Association Congress held in Bangkok, Thailand in September 2019. This congress is the largest event for those involved in poultry health and was attended by about 3 000 delegates. His presentation was on disease control options in a post antibiotic era.

Four members of the Veterinary Biotechnology group, from the left, Prof Rob Bragg, Samantha Mc Carlie, Lise Kilian and Dr Charlotte Boucher, at the 21st World Veterinary Poultry Association Congress

Prof Celia Hugo was elected as Secretary of the Subcommittee on the Taxonomy of Aerobic Bacteroidetes at the FEMS2019 Conference for European Microbiologists held in Glasgow, Scotland in July 2019. This subcommittee forms part of the International Committee on Systematics of Prokaryotes (ICSP).

Prof Arno Hugo received an Exemplary Award from the Pig Breeders' Society of South Africa during their centenary-year celebrations at a gala dinner in Johannesburg on 22 May 2019. This was awarded in appreciation for his contribution to science and research on pig meat.

Prof Koos Albertyn, in his capacity as South African Yeast Commissioner, attended the annual Yeast Commissioner Meeting held during the 35th International Specialised Symposium on Yeasts, in Antalya, Turkey, in October 2019. During this meeting South Africa was awarded the rights to host the 15th International Congress on Yeasts, which will be held in Cape Town in 2024.

Prof Koos Albertyn (centre) and two PhD students, Ruan Fourie (left) and Eduvan Bisschoff (right) at the 35th International Specialised Symposium on Yeasts in Antalya, Turkey

Student Achievements

Master's student Soveij van der Schyff was first runner-up in the regional Free State FameLab heat, held in November 2019. FameLab is a science communication competition, with more than 30 participating countries globally. Mrs Van der Schyff's presentation focused on her MSc topic – rotavirus reassortment.

PhD student Christopher Rothmann was awarded the joint runner-up award for his company, LiquidCulture, in the Existing Tech Business category of the 2019 National Entrepreneurship Intervarsity competition, supported by Entrepreneurship Development in Higher Education (EDHE) and the Allan Gray Orbis Foundation. All 26 South African public universities were represented, with 1 155 initial entries. Twenty-seven finalists from 16 universities participated in the national finals held on 19 September 2019 in Johannesburg. LiquidCulture was started in the Department by Rothman and postdoctoral research fellow Dr Errol Cason, with support from the UFS Directorate of Research Development (DRD) and funding from the Technology Innovation Agency (TIA). LiquidCulture supplies liquid yeast to breweries and bakeries and will operate out of the Department until mid-2020.

Christopher Rothmann, PhD student and co-founder of the company LiquidCulture, preparing yeast cultures that will be shipped to various breweries in South Africa

TEACHING

The Department is 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 around 80 in Biochemistry.

RESEARCH

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

Prof Celia Hugo and her research group continued their research on psychrotolerant bacteria in food, with an emphasis on the genus *Chryseobacterium*. One novel *Chryseobacterium* species, *C. pennipullorum*, was described in 2019.

During 2019 Prof Arno Hugo and his research group worked 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 access to refrigeration facilities. Prof Hugo and his team also started 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.

In the Sensory and Product Development Laboratory, Dr Carina Bothma investigated the sensory profiling and nutritional values of novel food plants such as *Agave americana* and lucerne.

Prof Maryna de Wit's research focused on the functional uses of cactus pears (*Opuntia ficus-indica* and *Opuntia robusta*) in food applications. Seed oil content, composition, quality and shelf-life of 42 available cultivars were determined, while the extraction and application of the yellow and red colourants (betalains) from the fruit were investigated. The young cladodes (called nopalitos when used as vegetables) from 20 cultivars were compared in terms of morphological, nutritional and sensory quality attributes. Research is ongoing on the slimy hydrocolloid mucilage as functional ingredient in food.

Prof Garry Osthoff continued to investigate the composition of milk from 25 African non-dairy animals. The question he and his students aim to answer is whether there is a phylogenetic difference in the milk composition of the three subclades of the placental mammals (Eutheria), namely the elephants and close relatives from Africa and Asia (Afrotheria), the sloths and close relatives from South America (Xenarthra) and all other placental mammals (Boreoeutheria). From the little data on milk of the sloths and close relatives (Xenarthra) and the elephants and close relatives (Afrotheria), it seems as if the evolutionary developments in the milk of all placental mammals (Eutherians) were final before the placental mammals from the South American and African continents (Atlantogenata) split from those from the other continents (Boreoeutherians). All differences in the milk nutrient composition between species of these clades may therefore be considered unique to the species. The simultaneous extreme differences regarding the absence of α-casein, high content of oligosaccharides, high content of medium chain fatty acids and drastic changes in fatty acid composition over lactation, is unique to the elephants, i.e. species specific. Prof Osthoff and his students also ventured into a little-studied field of milk – the metabolites. The aim is to obtain a correlation between the metabolites of blood, milk and milk nutrients and to make a comparison between species of selected taxa. Prof Osthoff presented his results on a poster at the International Dairy Federation (IDF) Summit, Istanbul, Turkey.

Dr Koos Myburgh and his students are working on the activation of plasminogen to plasmin. This process plays a detrimental role during flocculation/gelation in milk.

Prof Bennie Viljoen continued his research on the medicinal and animal feed potential of edible mushrooms.

Biocatalysis and Bioremediation

The TIA-funded SAENSE Platform, led by Prof Angel Valverde, continued to apply the knowledge gained from their work in extreme environments to develop remediation strategies for the treatment of polluted water for several different industries. Research was also conducted on the feasibility of biogas production from various substrates and wastes, and the use of metal-mineral-microbe interactions for metal biorecovery.

Dr Julio Castillo received funding from NRF-FBIP (Foundational Biodiversity Information Programme) to investigate unexplored bacterial diversity and their metabolic potential within South African scalding springs.

Dr Castillo, Prof Valverde and Dr Olihile Sebolai, in collaboration with Prof Motlalepula Matsabisa from the Department of Pharmacology, received funding from UFS for their interdisciplinary research project to study extreme environments as sources of antimicrobial compounds.

The aim of the Biocatalysis and Structural Biology Group of Prof Dirk Opperman and Prof Martie Smit is to develop novel biocatalytic systems for the introduction of oxygen into molecules and the further conversion of these hydroxylated products. The group focuses on the oxyfunctionalisation of various natural and petrochemical hydrocarbons, including monoterpenes, alkanes, and alkenes by cytochrome P450 monooxygenases, and the synthesis of esters and lactones from the corresponding ketones.

Prof Opperman received funding from SASOL for the biocatalytic production of diols and from the Global Challenges Research Fund (GCRF) through the START (Synchrotron Techniques for African Research and Technology) programme to undertake X-ray crystallography of proteins of interest to biocatalysis or drug discovery. Group members Jasmin Aschenbrenner, Dr Ana Ebrecht and Dr Rodolpho do Aido-Machado attended the 14th International Symposium on Biocatalysis and Biotransformations (BioTrans2019) in Groningen, the Netherlands from 7 to 11 July. Prof Frances Arnold, Nobel Prize winner in Chemistry in 2018, was one of the keynote speakers at the Symposium.

A second important event for the Biocatalysis group was the Catalysis Society of South Africa Conference (CATSA 2019) which took place in Langebaan, South Africa from 10 to 13 November. Prof Opperman was a keynote speaker while Prof Smit and Jasmin Aschenbrenner delivered oral presentations and Songezo Gidaga, Lynette Nel, Tarsisius Tiyani and Amanda Vorster presented posters.

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.

Members of the Molecular Virology group at the 12th African Rotavirus Symposium (30 July to 1 August 2019) during which a decade of rotavirus vaccination in Africa was celebrated

The work of the Clinical Biochemistry Group, led by Dr Frans O'Neill, focused on human cellular detoxification and sterol metabolism, as well as the purification and heterologous expression of reproductive hormones.

The Pathogenic Yeast Research Group of Prof Koos Albertyn, Prof Carlien Pohl-Albertyn and Dr Olihile Sebolai, forms part of the SARChI Chair in Pathogenic Yeasts (headed by Prof Pohl-Albertyn), awarded in 2018. It focuses on molecular mechanisms of virulence and the role of bioactive lipids in pathogenic yeasts, specifically *Cryptococcus neoformans* and several *Candida* species. In order to study the molecular mechanisms behind the virulence of these yeasts they were successful in constructing several CRISPR-Cas9 gene deletion systems to efficiently delete and modify genes in order to study their effects. One of their aims is to develop microbial growth control strategies by identifying novel drug targets. This includes the re-purposing or re-positioning of medicines that are typically used to treat non-infectious conditions, as anti-*Cryptococcus* drugs. The researchers are also interested in the virulence of polymicrobial infections consisting of *C. albicans* and the bacterium *Pseudomonas aeruginosa* and they have developed an invertebrate infection model to study this interaction.

Prof Koos Albertyn and Prof Carlien Pohl-Albertyn attended the FEBS Advanced Lecture Course on Molecular Mechanisms of Host-Pathogen Interactions and Virulence in Human Fungal Pathogens from 18 to 25 May 2019 in La Colle sur Loup, France. They presented their work on gene editing tools in *Candida albicans* as well as results on the effect of antifungal fatty acids on this yeast. This course provided excellent opportunities to network with leaders in the field of human fungal pathogens.

The Veterinary Biotechnology Research Group of Prof Rob Bragg and Dr Charlotte Boucher continued their work on the development of sub-unit vaccines against *Avibacterium paragallinarum* and Infectious bronchitis virus (a coronavirus of birds). Full genome sequencing of the four important strains of *A. paragallinarum* was successfully completed and the data used to identify potential antigens for the development of subunit vaccines. A new project in 2020 will investigate if some of these antigens can be expressed as possible subunit vaccines.

Work continued on the phage display libraries for the development of antibody fragments and antiviral peptides. Antibody fragments were found, which neutralise Infectious bronchitis virus and Newcastle disease virus. This project is entering a possible commercialisation phase. Antivirus peptides against Newcastle disease virus have also been found and these might be developed further, depending on funding and collaboration with UCT.

In exciting research on resistance to disinfectants, a highly resistant bacterial strain isolated from dairy cows was sequenced and revealed around 600 novel genes, many of which can be found in clusters. There are many known efflux pump genes which have been found, and also a number of hypothetical proteins which cluster with the known resistance genes. There are some exciting possibilities of gaining important insight into resistance to disinfectants. It is hoped that novel, as yet unknown, mechanisms of resistance to disinfectants will be discovered. Currently, there is some indication that the highly resistant strain has the capability of growing in the presence of the disinfectants.

ENGAGED SCHOLARSHIP

The SAENSE Platform hosted two Open Days for high school learners during 2019. The participating schools included a home school group from Bloemfontein and district (May 2019) and Calculus School (July 2019). The SAENSE Platform also presented the Open Day to the third-year Animal Breeding Students of the UFS (October 2019). In addition, St Michael's School invited the Platform to present the Open Day to their learners during the school's Science Week (September 2019). The aim of the open days is to introduce the learners to some of the basics of the science that the SAENSE Platform is doing, focusing on microorganisms and how they can be used to make a difference in real life situations the world is currently facing, specifically in the fields of water bioremediation and waste to energy. The SAENSE Platform also made a promotional video about their Open Days.

In November the Department donated ten fully functional microscopes to the Life Sciences class of the Luckhoff Combined School. Anzell Spelding, a teacher at the school – with a newly built science laboratory but little equipment – enquired whether the Department had any microscopes available to donate. As the Department had recently acquired a new set of state-of-the-art microscopes for undergraduate teaching in the field of Microbiology, ten older but fully functional microscopes and two additional microscopes (for parts) were donated to motivate the learners to choose science as a career.

Prof Koos Albertyn handing over a donation of ten microscopes to Anzell Spelding, of Luckhoff Combined School

NATIONAL AND INTERNATIONAL COLLABORATION

The Veterinary Biotechnology Group has several international collaborations. In a long-standing collaboration with Dr Patrick Blackall from the University of Queensland, Brisbane, Australia, who is widely regarded as the world expert on infectious coryza in chickens, the long-term storage of the very fastidious bacterium, *Avibacterium paragallinarum,* the causative agent of infectious coryza, is being investigated.

They also have 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 collaboration with Dr Gavakar of Ventri Biologicals, the largest poultry vaccine manufacturer in India, on the development of effective vaccines against infectious coryza and also possible subunit vaccine development.

Prof Arno Hugo collaborated with the Agricultural Research Council (ARC), Sernick Group, North-West University (NWU), University of Fort Hare (UFH) 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 Hollmann, who was appointed as an affiliated professor in 2018, visited the Department in November 2019. He delivered a public lecture titled 'Are Peroxygenases the new P450 monoogygenases? Scope and limitations of Peroxygenases for Organic Synthesis' and attended CATSA 2019, where he was a plenary speaker.

Prof Trudi O'Neill has active collaborations with several national and international groups. During 2019 she continued the collaboration with Dr Nilsa de Deus from the Mozambique National Institute of Health, on rotavirus diversity in Mozambique. Two master's students, Ms Benilde Munlela and Mr Simone Boene, visited UFS from July to mid-September. 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 in 2019. The project utilises the rotavirus reverse genetics system and aims to generate chimeric viruses that can be used in next-generation rotavirus vaccine development. Dr Amy Strydom, a postdoctoral research fellow in Molecular Virology, visited the Federal Institute for Risk Assessment (BfR) in Berlin, Germany during May 2019, receiving training in the generation and characterisation of rotavirus reassortants. The Molecular Virology Group hosted the second annual partners meeting for this DFG-funded project from 9 to 11 September 2019. Attending partners included Prof Reimar Johne (BfR, Germany), Prof Albie van Dijk (NWU) and Dr Nilsa de Deus (National Institute of Health, Mozambique) and their teams. Project associates Dr Martin Nyaga (NGS Unit) and Prof Christiaan Potgieter (Deltamune, Pretoria), also participated.

Dr Amy Strydom, pictured with Dr Alex Falkenhagen, at the BfR in Berlin, Germany in May 2019

As part of the South Africa / Argentina Joint Science and Technology Research Collaboration, Dr Danilo Legisa, a postdoctoral research fellow affiliated to Dr Martin Blasco at the Centre for Biotechnology of the Argentinean National Institute of Industrial Technology (INTI) in Buenos Aires, visited Prof O'Neill's laboratory for a second time during September 2019. In a reciprocal visit, master's student Mercy Ogunyinka visited INTI for four weeks in August to perform deep-well plate screens.

Researchers in the SAENSE Platform collaborated with several national and international researchers. Their collaboration with researchers from the German Research Centre for Geoscience (Prof M Zimmer), Ritsumeikan University (Prof H Ogasawara) and Princeton University (TC Onstott) continued. The collaboration is funded by the International Continental Scientific Drilling Program (ICDP), the National Science Foundation (NSF) and the NRF. The multidisciplinary research project, titled 'KASMS: Kinetically Activated Subsurface Microbial Sampler', aims to investigate the processes of hydrogen genesis during seismic cycles in active fault zones in order to better understand the correlation between seismicity and gas release and to geochemically characterise the extreme environment of life in the deep subsurface.

In the transnational project titled 'Mine tailing revalorization' awarded by UNESCO and led by Prof Manuel Caraballo from the University of Chile, Dr Julio Castillo contributed as an environmental microbiologist in the analysis of the microbial diversity of some tailings located in Chile. Other members of this project included Dr Lola Yesares (iCRAG Ireland), Dr Anita Parbhakar-Fox (University of Tasmania), Dr Guillermo Javier Copello (University of Buenos Aires), Dr Mercedes Becerra (University of Chile), Dr Roberto Fernández de Luis (BC Materials, Spain) and Dr Annika Parviainen (University of Granada).

The Platform continued with the joint project with the Central University of Technology (CUT) on 'Unravelling the microbiome of Sesotho (sorghum beer) through targeted metagenomics'. The objective of this project, led by Prof Angel Valverde (UFS) and Dr Olga de Smidt (CUT), is to better understand the microbial communities involved in the fermentation process of Sesotho. Understanding this diversity is vital if we aim to translate this knowledge into practical application, for example, to improve Sesotho fermentation, aroma and style. Other participating researchers are Dr Errol Cason (UFS), Dr Jan-G Vermeulen (UFS), Dr Marcele Vermeulen (UFS), Prof Bennie Viljoen (UFS), Ms Laurinda Steyn (UFS) and Ms Mpho Malefane (CUT).

Dr Frans O'Neill continued his collaboration with Prof Albie van Dijk (NWU) on the role of GLYAT in cellular detoxification, Prof David Marais (UCT) on phytosterols in selected South African fauna and Dr Dee Blackhurst (UCT) on reactive oxygen species in rotavirus infected cells. He also collaborated with AniPharm Pty Ltd on the production of equine chorionic gonadotropin as well as Dr Martin Blasco at the Centre for Biotechnology of INTI in Argentina on receptor-based assays.

Dr Gabré Kemp collaborated with Dr Tim Downing of the Department of Biochemistry and Microbiology at Nelson Mandela University (NMU) on the toxicity and metabolism of environmental bacterial compounds. The collaboration focuses on mass spectrometric analysis of protein amino acid compositions, amino acid extracts, and amino acid isotopologue distribution in cell extracts.

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 2019 the Department had twenty-two students registered for BScHons – seven for Microbiology, eleven for Biochemistry and four for Food Science. At the April 2019 graduation, twelve students graduated with BScHons majoring in Biochemistry, one student majoring in Food Science, and eight majoring in Microbiology.

Thirty-eight students were registered in the Department for master's degrees – 18 in Microbiology, 12 in Biochemistry and 8 in Food Science. Twenty-two students graduated at the April 2019 graduation ceremony with master's degrees:

- Annè Calitz with MSc (Agriculture) in Food Science – with distinction
- Rita Myburgh with MSc (Agriculture) in Food Science
- Schae-Lee Olckers with MSc (Agriculture) in Food Science – with distinction
- Daphney Rasebotsa with MSc (Agriculture) in Food Science
- Anmeri Rautenbach with MSc (Agriculture) in Food Science – with distinction
- Poojah Jawallapersand with MSc in Biochemistry
- Nkhasi Lekena with MSc in Biochemistry
- Larise Oberholster with MSc in Biochemistry
- Amanda Vorster with MSc in Biochemistry – with distinction
- Eduvan Bisschoff with MSc in Microbiology
- Janetta Magrieta Coetzee with MSc in Microbiology
- Lukas Marthinus du Plooy with MSc in Microbiology – with distinction
- Julius Eduard Hellmoth with MSc in Microbiology
- Milton Tshidiso Mogotsi with MSc in Microbiology – with distinction
- Lize Oosthuizen with MSc in Microbiology – with distinction
- Bianca Pieterse with MSc in Microbiology
- Willem Jacobus Sander with MSc in Microbiology – with distinction
- Christina Maria van der Berg with MSc in Microbiology
- Jeanette van Niekerk with MSc in Microbiology
- Sanele Dube with MSc in Food Science
- Sibusiso Kobeni with MSc in Food Science
- Thembakazi Noguda with MSc in Food Science

A further two students graduated at the December 2019 graduation ceremony with master's degrees:

- Corinne Fourie with MSc in Biochemistry – with distinction
- Gerhardus Petrus Potgieter with MSc in Biochemistry – with distinction

In 2019 a total of 22 students were registered in the Department for doctoral degrees – 12 in Microbiology, 7 in Biochemistry and 3 in Food Science. Five doctoral degrees were awarded at the April 2019 graduation ceremony:

Folorunso, Olufemi Samuel
Thesis: Identification of engineering yeast strains for the production of rotavirus VP6-based vaccine candidates
Promoter: Prof HG O'Neill

Maleke, Maleke Mathews
Thesis: Insights into rare earth metal microbe interactions using a known metal resistant bacterium and a site-specific isolate
Promoter: Dr J Castillo

Tolmie, Carmien
Thesis: Natural roles and biocatalytic applications of Baeyer-Villiger monooxygenases from *Aspergillus flavus*
Promoter: Prof DJ Opperman

Dithebe, Khumisho
Thesis: Characterization of intracellular gas bubbles in saccharomyces
Promoter: Prof CH Pohl-Albertyn

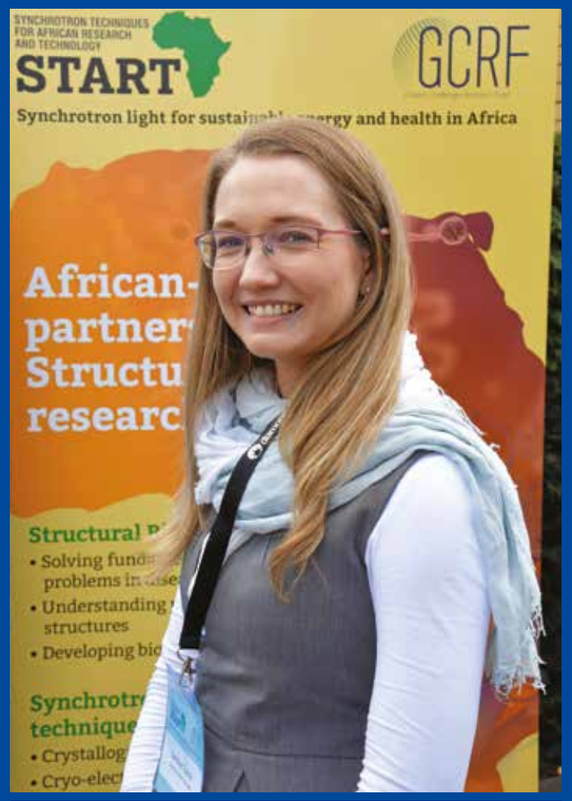
Van Wyngaard, Barbara Elizabeth
Thesis: The effect of dietary omega-3 fatty acids with specific reference to echium seed oil on pork quality
Promoter: Prof A Hugo

POSTDOCTORAL RESEARCH FELLOWS

The Department of Microbial, Biochemical and Food Biotechnology was privileged to host 16 postdoctoral research fellows during 2019. These were:

- Dr Rodolpho do Aido-Machado (Brazil)
- Dr Errol Cason (South Africa)
- Dr Moses Madende (Zimbabwe)
- Dr Adepemi Ogundeji (South Africa)
- Dr Saheed Sablu (Nigeria)
- Dr Amy Strydom (South Africa)
- Dr Wouter van der Westhuizen (South Africa)
- Dr Jacqueline van Marwijk (South Africa)
- Dr Marcele Vermeulen (South Africa)
- Dr Carmien Tolmie (South Africa)
- Dr Ana Ebrecht (Argentina)
- Dr Jan-G Vermeulen (South Africa)
- Dr Angelique Lewies (South Africa)
- Dr Ana-Luiza Silva (Brazil)
- Dr Shayanki Lahiri (India)
- Dr Olufemi Folorunso (Nigeria)

In 2019, Dr Carmien Tolmie was a UFS-based postdoctoral researcher within the GCRF-START (Global Challenges Research Fund – Synchrotron Techniques for African Research and Technology) programme, which funds collaboration between the Diamond Light Source, UK, and several research groups at South African universities. Dr Tolmie was given the opportunity to spend a two-month research visit between May and June 2019 with the Structural Genomics Consortium (SGC) at University of Oxford. The SGC is a not-for-profit, public-private partnership with the directive to carry out basic science of relevance to drug discovery. Dr Tolmie was hosted in the Biotechnology research group, headed by Dr Nicola Burgess-Brown, and the Protein Crystallography (Px) group, headed by Dr Frank von Delft, where she performed high-throughput protein purification and crystallisation trials of fungal proteins. Dr Von Delft is an alumnus of the UFS, having attained his BSc Honours in Biochemistry in 1996.



Dr Carmien Tolmie representing the UFS Biocatalysis and Structural Biology research group at the United Kingdom's START launch event, held at St Catherine's College, Oxford, from 27 to 28 March 2019

STAFF MATTERS

Dr Onele Gcilitshana joined the Department in January 2019 as Lecturer in Microbiology. Her position is linked to the Research Chair of Prof Carlien Pohl-Albertyn.

Dr Olihile Sebolai was promoted to Associate Professor in June 2019. At the end of 2019 Prof Trudi O'Neill and Prof Celia Hugo were promoted to Professors, and Dr Maryna de Wit to Associate Professor – with effect from 1 January 2020.

Prof Angel Valverde and Dr Charlotte Boucher resigned at the end of 2019. Prof Valverde left the UFS for a position with the Spanish National Research Council, while Dr Boucher left to study medicine at the UFS.

RESEARCH OUTPUTS

Research Articles

Agunbiade, M.O., Pohl, C., Van Heerden, E., Oyekola, O. & Ashafa, A. 2019. Evaluation of fresh water Actinomycete bioflocculant and its biotechnological applications in wastewaters treatment and removal of heavy metals. *International Journals of Environmental Research and Public Health* 16: art 3337.

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De Wit, M., Du Toit, A., Fouché, H.J., Hugo, A. & Venter, S.L. 2019. Screening of cladodes from 42 South African spineless cactus pear cultivars for morphology, mucilage yield and mucilage viscosity. *Acta Horticulturae* 1247: 47-55.

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De Wit, M., Fouché, H.J., De Waal. H.O., Coetzer, G.M. & Venter, S.L. 2019. Promoting the potential of spineless cactus pear (*Opuntia ficus-indica*) as a multi-use crop at the Oppermansgronde community in the Free State province of South Africa. *Acta Horticulturae* 1247: 57-62.

Disetlhe, A.R.P., Marume, U., Mlambo, V. & Hugo A. 2019. Effects of dietary humic acid and enzymes on meat quality and fatty acid profiles of broiler chickens fed canola-based diets. *Asian-Autralasian Journal of Animal Sciences* 32: 711-720.

Dithugoe, C.D., Van Marwijk, J., Smit, M.S. & Opperman, D.J. 2019. An alcohol dehydrogenase from the short-chain dehydrogenase/reductase family of enzymes for the lactonization of hexane-1,6-diol. *ChemBioChem* 20: 96-102.

Downing, S., Van Onselen, R., Kemp, G. & Downing, T.G. 2019. Metabolism of the neurotoxic amino acid β-N-methylamino-L-alanine in human cell culture models. *Toxicon* 168: 131-139.

Dube, J.P., Valverde, A., Steyn, J.M., Cowan, D.A. & Van der Waals, J.E. 2019. Differences in bacterial diversity, composition and function due to long-term agriculture in soils in the eastern Free State of South Africa. *Diversity* 11: art 61.

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Josa-Culleré, L., Lahdenperä, A.S.K., Ribaucourt, A., Höfler, G.T., Gargiulo, S., Liu, Y.-Y., Xu, J.-H., Cassidy, J., Paradisi, F., Opperman, D.J., Hollmann, F. & Paul, C.E. 2019. Synthetic biomimetic coenzymes and alcohol dehydrogenases for asymmetric catalysis. *Catalysts* 9:207.

Josling, G.C., Hugo, A., Fair, M.D. & De Witt, F.H. 2019. Long term effect of dietary lipid saturation on eggshell quality and bone characteristics of laying hens. *Poultry Science* 98:3593-3601.

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Raliat, A.A., Saheed, S. & Abdulhakeem, S.O. 2019. *Pteleopsis suberosa* Engl. and Diels (Combretaceae) aqueous stem bark extract extenuates oxidative damage in streptozotocin-induced diabetic Wistar rats. *Pharmacognosy Journal* 11: 183-190.

Sabiu, S., Madende, M., Ajao, A.A., Ogundeji, O.A., Lekena, N. & Alayande, K.A. 2019. The scope of phytotherapy in southern African antidiabetic healthcare. *Transactions of the Royal Society of South Africa* 74: 1-18.

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Chapters in Books

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Conferences Contributions

Conference Papers/Posters

Albertyn, J., Bisschoff, E., Du Plooy, M., Klinck, J., Fourie, R. & Pohl, C. 2019. *CRISPR-Cas9 gene editing tools in pathogenic and non-pathogenic yeasts*. Poster presented at the FEBS Advanced Lecture Course on Molecular Mechanisms of Host-Pathogen Interactions and Virulence in Human Fungal Pathogens, La Colle sur Loup, France. 18-24 May 2019.

Aschenbrenner, J.C., Ebrecht, A.C., Smit, M.S. & Opperman, D.J. 2019. *Substrate promiscuity of the self-sufficient CYP505A30*. Poster presented at the 14th International Symposium on Biocatalysis and Biotransformations, Groningen, the Netherlands. 7-11 July 2019.

Bekker, A. & Myburgh J. 2019. *Plasminogen activation by components within mastitis and colostrum milk*. Poster presented at the South African Large Herds Conference, Port Elizabeth, South Africa. 5-7 June 2019.

Binneman, R., Lemmer, J.D., Hugo, A. & De Witt, F.H. 2019. *The effect of dietary ascorbic acid on colour and oxidative stability of broiler breast meat.* Poster presented at the 51st Congress of the South African Society for Animal Science, Bloemfontein, South Africa. 10-12 June 2019.

Bisschoff, E., Albertyn, J. & Pohl, C.H. 2019. *The development of a wide range CRISPR-Cas9 gene editing system for yeast.* Paper delivered at the 35th International Specialised Symposium on Yeasts, Antalya, Turkey. 21-25 October 2019.

Bisschoff, E., Du Plooy, M., Klinck, J., Fourie, R., Pohl C. & Albertyn, J. 2019. *CRISPR-Cas9 gene editing tools in pathogenic and non-pathogenic yeasts.* Paper delivered at the 35th International Specialised Symposium on Yeasts, Antalya, Turkey. 21-25 October 2019.

Boucher, C.E., Jawallapersand, P. & Bragg, R.R. 2019. *Post-mortem evaluation of chicken lymphatic tissues after infection with Avibacterium serovar C-3 (SA-3 strain)*. Poster presented at the International Symposium on Avian Mycoplasmosis and Infectious Coryza, Amersfoort, the Netherlands. 13-15 November 2019.

Boucher, C.E., Van der Westhuizen, W.A., Le Roux, G. & Jawallapersand, P. 2019. *A macabre tale of infectious coryza: Post-mortem insights of chicken lymphatic tissues after infection with Avibacterium serovar C-3 (SA-3 strain)*. Poster presented at the World Veterinary Poultry Association Congress, Bangkok, Thailand. 16-18 September 2019.

Bragg, R.R. 2019. *Disease control options in a post antibiotic era.* Keynote address delivered at the World Veterinary Poultry Association Congress, Bangkok, Thailand. 16-18 September 2019.

Bragg R.R. 2019. *The difficulties in controlling Serogroup C strains of Avibacterium paragallinarum.* Paper delivered at the International Symposium on Avian Mycoplasmosis and Infectious Coryza, Amersfoort, the Netherlands. 13-15 November 2019.

Bragg, R.R. & Mc Carlie, S.J. 2019. *Biosecurity – Our last hope and the problem of disinfectant resistance.* Paper delivered at the International Symposium on Avian Mycoplasmosis and Infectious Coryza, Amersfoort, the Netherlands. 13-15 November 2019.

Cason, E.D., Gómez, A. & Valverde, A. 2019. *Riverine microbial communities respond to chronic contamination*. Poster presented at 8th FEMS Congress of European Microbiologist, Glasgow, United Kingdom. 7-11 July 2019.

Castillo, J., Maleke, M., Rankoroane, T., Cason, E., Gomez-Arias, A. & Valverde, A. 2019. *Remediation catalyses of AMD by indigenous microorganisms during chemical treatment*. Paper delivered at the Goldschmidt Conference, Barcelona, Spain. 18-23 August 2019.

De Klerk, I., Einkamerer, O.B., Hugo, A., Ferreira, A.V. & Fair, M.D. 2019. *The effect of diet neutral-detergent fibre content on the meat quality of finishing lambs.* Poster presented at 51st South African Association of Animal Science and Technology Congress, Bloemfontein, South Africa. 10-12 June 2019.

De Wit, M., Du Toit, A., Bothma, C., Hugo, A., Naudé, S. & Bouwer, K. 2019. *Application of liquid native and powdered freeze-dried mucilage in functional food product development – A sensory perspective*. Poster presented at the 23rd South African Association for Food Science and Technology Biennial Congress and Exhibition, Johannesburg, South Africa. 1-4 September 2019.

De Wit, M., Du Toit, A., Fouché, H.J. & Hugo, A. 2019. *Cactus pears in human food: Conventional and unconventional applications.* Paper delivered at the 51st Congress of the South African Society for Animal Science, Bloemfontein, South Africa. 10-12 June 2019.

Díaz, J., Yesares, L., Gómez-Arias, A., Castillo, J. & Sáez, R. 2019. *REE-mineralogical mine waste characterization and revalorization of Palabora Igneous Complex.* Paper delivered at the Goldschmidt Conference, Barcelona, Spain. 18-23 August 2019.

Do Aido-Machado, R., Jacobs, C.L., Tiyani, T.T., Smit, M.S. & Opperman, D.J. 2019. *Specificity and selectivity of different CYP153 alkane hydroxylases.* Poster presented at the 14th International Symposium on Biocatalysis and Biotransformations, Groningen, the Netherlands. 7-11 July 2019.

Du Plessis, S., Hope-Jones, M., Hugo, A. & Strydom, P.E. 2019. F*atty acid composition of South African lamb from three production systems.* Poster presented at the 65th International Congress of Meat Science and Technology, Potsdam, Germany. 4-9 August 2019.

Du Toit, A., De Wit, M., Fouché, H.J. & Hugo, A. 2019. *Young cladodes from cactus pears (Opuntia ficus-indica) as a viable food source.* Paper delivered at the 51st Congress of the South African Society for Animal Science, Bloemfontein, South Africa. 10-12 June 2019.

Du Toit, A., De Wit, M., Mpemba, O., Makhalemele, B., Huang, Y-C., Colbert, T., Venter, S. & Hugo, A. 2019. *Young cladodes from cactus pear (Opuntia ficus-indica) as a viable food source.* Poster presented at the 23rd South African Association for Food Science and Technology Biennial Congress and Exhibition, Johannesburg, South Africa. 1-4 September 2019.

Ebrecht, A.C., Sewell, B.T., Smit, M.S. & Opperman, D.J. 2019. *Function and structure of yeast cytochrome P450 reductase.* Poster presented at the 14th International Symposium on Biocatalysis and Biotransformations, Groningen, the Netherlands. 7-11 July 2019.

Einkamerer, O.B., Hugo, A., Ferreira, A.V. & Fair, M.D. 2019. *The effect of diet acid-detergent fibre content on the production performance of finishing lambs.* Poster presented at 51st Congress of the South African Society for Animal Science, Bloemfontein, South Africa. 10-12 June 2019.

Engel, J., Mthethwa, K., Opperman, D. & Kara, S. 2019. *Optimization of the convergent cascade for synthesis of epsilon-caprolactone.* Poster presented at the 14th International Symposium on Biocatalysis and Biotransformations, Groningen, the Netherlands. 7-11 July 2019.

Fourie, R., Albertyn, J. & Pohl, C.H. 2019. *Drilling beyond the tip of the iceberg: A deeper look at the polymicrobial interaction between Candida albicans and Pseudomonas aeruginosa using RNAseq*. Poster presented at the 35th International Specialised Symposium on Yeasts, Antalya, Turkey. 21-25 October 2019.

Freitag, A., Cluff, M., Hitzeroth, A.C., Hugo, A. & Hugo, C.J. 2019. *Growth and survival of Staphylococcus aureus and Escherichia coli in Boerewors formulated with reduced or partially replaced NaCl.* Poster presented at the 23rd South African Association for Food Science and Technology Biennial Congress and Exhibition, Johannesburg, South Africa. 1-4 September 2019.

Gómez-Arias, A., Yesares, L., Maleke, M., Vermeulen, D., Nieto, J.M. & Castillo, J. 2019. *Geochemical mine waste characterization and revalorization of Palabora Igneous Complex*. Paper delivered at the Goldschmidt Conference, Barcelona, Spain. 18-23 August 2019.

Jamiu, A.T., Kuloyo, O., Mokoena, N., Albertyn, J. & Pohl, C.H. 2019. *Influence of polyunsaturated fatty acids on fluconazole susceptibility of Candida krusei*. Poster presented at the One Health: A focus on Infectious Diseases in Africa Symposium, Durban, South Africa. 27-28 May 2019.

Killian, L., Van der Westhuizen, W.A., Boucher, C.E. & Bragg, R.R. 2019. *Diversify or perish: exploring new ways to prevent infectious bronchitis in poultry.* Poster presented at the World Veterinary Poultry Association Congress, Bangkok, Thailand. 16-18 September 2019.

Kgotle, E.Y., Pilenyane, N., Pohl, C.H. & Sebolai, O.M. 2019. *The biological function of 3-hydroxy fatty acids in specific opportunistic pathogens.* Poster presented at the 3rd EMBO Workshop on AIDS-Associated Mycoses, Cape Town, South Africa. 10-12 July 2019.

Kgotle, E.Y., Pohl, C.H., Albertyn, J. & Sebolai, O.M. 2019. *Elucidating the role of 3-hydroxy fatty acids in the pathogenicity of Pseudomonas aeruginosa.* Paper delivered at the Southeastern Regional Lipid Conference, Asheville, USA. 6-8 November 2019.

Kobeni, S., Osthoff, G., Madende, M., Hugo, A. & Marabini L. 2019. *African elephant milk: unique composition and changes over lactation*. Poster presented at the International Dairy Federation World Dairy Summit, Istanbul, Turkey. 16-21 October 2019.

Kuloyo, O., Fourie, R., Albertyn, J. & Pohl, C.H. 2019. *Arachidonic acid increases expression of CDR1 in C. albicans, but inhibits efflux activity.* Poster presented at the FEBS Advanced Lecture Course on Molecular Mechanisms of Host-Pathogen Interactions and Virulence in Human Fungal Pathogens, La Colle sur Loup, France. 27-28 May 2019.

Kuloyo, O., Fourie, R., Albertyn, J. & Pohl, C.H. 2019. *Arachidonic acid increases expression of CDR1 in C. albicans, but inhibits efflux activity.* Paper delivered at the 35th International Specialised Symposium on Yeasts, Antalya, Turkey. 21-25 October 2019.

Lemmer, J.D., Hugo, A., Fair, M.D. & De Witt, F.H. 2019. *Evaluating the use of dietary supplemental ascorbic acid on broiler performance and litter quality under South African summer conditions.* Poster presented at 51st Congress of the South African Society for Animal Science, Bloemfontein, South Africa. 10-12 June 2019.

Lum Nde, A., Charimba, G., Hitzeroth, A., Oosthuizen, L., Steyn, L., Newman, J. D. & Hugo, C. 2019. *Whole-genome sequencing of a novel Chryseobacterium strain isolated from poultry feather waste*. Poster presented at the 8th FEMS Congress of European Microbiologist, Glasgow, United Kingdom. 7-11 July 2019.

Lum Nde, A., Charimba, G., Hitzeroth, A., Steyn, L., Newman, J. D. & Hugo, C. 2019. *Polyphasic taxonomy of a novel Chryseobacterium strain isolated from poultry feather waste.* Poster presented at the 23rd South African Association for Food Science and Technology Biennial Congress and Exhibition, Johannesburg, South Africa. 1-4 September 2019.

Macdonald, J.F., Einkamerer, O.B., Lepori, A., Hugo, A., Josling, G.C. & Fair, M.D. 2019. *The effect of fibre source on the digestibility and production performance of finishing lambs.* Poster presented at 51st Congress of the South African Society for Animal Science, Bloemfontein, South Africa. 10-12 June 2019.

Madu, L.U., Pohl, C.H. & Sebolai, O.M. 2019. *Chloroquine and primaquine diphosphate as possible alternative drugs for the treatment of cryptococcal infection.* Paper delivered at the 3rd EMBO Workshop on AIDS-Associated Mycoses, Cape Town, South Africa. 10-12 July 2019.

Makhalemele, B., De Wit, M., Truter, M., Du Toit, A., Amoo, S. & Hugo, A. 2019. 1. *The morphological and physic-chemical evaluation of nopalitos from twenty South African cactus pear cultivars.* Poster presented at 23rd South African Association for Food Science and Technology Biennial Congress and Exhibition, Johannesburg, South Africa. 1-4 September 2019

Matu, A., Cason, E.D., Vermeulen, M., Valverde, A. & Castillo, J. 2019. *Untapped bacterial diversity in South African hot springs*. Paper delivered at the Joint Biodiversity Information Management and Foundational Biodiversity Information Programme Forum, Pretoria, South Africa. 20-22 August 2019.

Mc Carlie, S.J., Boucher, C.E. & Bragg, R.R. 2019. *Evaluation of disinfectant resistance in Serracia marcsence VKR: Disease control options in a post antibiotic era*. Poster presented at the World Veterinary Poultry Association Congress, Bangkok, Thailand. 16-18 September 2019.

Mendes dos Ramos, S., Albertyn, J. & O'Neill, H.G. 2019. *The recombinant production of truncated rotavirus VP4 and VP4-NSP4 as non-replicating vaccine candidates.* Poster presented at the 12th African Rotavirus Symposium, Johannesburg, South Africa. 30 July-1 August 2019.

Miya, S., De Wit, M., Van Biljon, A., Amonsou, E. & S. Venter. 2019. *Mucilage: Characterization of proteins and carbohydrates responsible for capacity and stability of foam food systems.* Poster presented at the 23rd South African Association for Food Science and Technology Biennial Congress and Exhibition, Johannesburg, South Africa. 1-4 September 2019.

Moholisa, E., Strydom, P., Kealeboga, M., Magoro, M. & Hugo, A. 2019. *Physico-chemical stability of bovine blood sausages*. Poster presented at the 65th International Congress of Meat Science and Technology, Potsdam, Germany. 4-9 August 2019.

Moholisa, E., Strydom, P., Magoro, M., Mosimanyana, K. & Hugo, A. 2019. *The microbial stability of overwrapped and vacuum packaged bovine blood sausage.* Poster presented at the 23rd South African Association for Food Science and Technology Biennial Congress and Exhibition, Johannesburg, South Africa. 1-4 September 2019.

Mpemba, O., Du Toit, A., De Wit, M. & Hugo, A. 2019. *Nopalitos a new food source: Comparison of two cultivars to known vegetables.* Poster presented at the 23rd South African Association for Food Science and Technology Biennial Congress and Exhibition, Johannesburg, South Africa. 1-4 September 2019.

Mushanganyisi, D., De Wit, M., Bothma, C., Hugo, A., Venter, S., Du Toit, A. & Du Toit, L. 2019. *Functional properties of cactus pear mucilage: gelling, emulsification edible coatings and spherification.* Poster presented at the 23rd South African Association for Food Science and Technology Biennial Congress and Exhibition, Johannesburg, South Africa. 1-4 September 2019.

Myburg, R. & Hugo, A. 2019. *Verification of the South African pork classification system.* Poster presented at the 23rd South African Association for Food Science and Technology Biennial Congress and Exhibition, Johannesburg, South Africa. 1-4 September 2019.

Naidoo, Y., Pierneef, R., Cason, E.D., Valverde, A. & Cowan, D. 2019. *The soil resistome of a natural xeric gradient in the Namib Desert*. Poster presented at 8th FEMS Congress of European Microbiologist, Glasgow, United Kingdom. 7-11 July 2019.

Nisson, D., Kieft, T.L., Warr, O., Walters, C.C., Van Heerden, E., Cason, E.D., Castillo, J., Vermeulen, J.G., Freifeld, B.M., Ogasawara, H., Durrheim, R.J., Lollar, B.S., Onstott, T. C. & Leibenberg, B. 2019. *Abiotic (Prebiotic?) organic chemistry in a potential ancient hypersaline brine: New insights on the limits of microbial life inhabiting 3.1 km deep fracture fluid in South Africa.* Paper delivered at the American Geophysical Union Conference, San Francisco, USA. 9-13 December 2019**.**

Ntoi, M.A., Madu, L.U., Pohl, C.H., Albertyn, J. & Sebolai, O.M. 2019. *Interactions between amoeba and Cryptococcus neoformans: a possible explanation for the acquisition of virulence factors.* Poster presented at the 3rd EMBO Workshop on AIDS-Associated Mycoses, Cape Town, South Africa. 10-12 July 2019.

Ogundeji, A.O., Pohl, C.H. & Sebolai, O.M. 2019. *Acetylsalicylic acid (Aspirin) as a photosensitiser in photodynamic treatment against Cryptococcus neoformans and Cryptococcus gattii.* Poster presented at the 3rd EMBO Workshop on AIDS-Associated Mycoses, Cape Town, South Africa. 10-12 July 2019.

Ogundeji, A.O., Pohl, C.H. & Sebolai, O.M. 2019. *The antifungal activity of photodynamic treatment with methylene blue against Cryptococcus neoformans and Cryptococcus gattii.* Poster presented at the 3rd EMBO Workshop on AIDS-Associated Mycoses, Cape Town, South Africa. 10-12 July 2019.

Ogunyinka, M.I., Folorunso, O.S., Legisa, D., Blasco, M., Albertyn, J. & O'Neill, H.G. 2019. *Rotavirus VP6 extracellular secretion by Kluyveromyces lactis*. Poster presented at the 12th African Rotavirus Symposium, Johannesburg, South Africa. 30 July-1 August 2019.

Onstott, T. C., Kieft, T.L., Nisson, D., Warr, O., Lollar, B.S., Freifeld, B.M., Lau, Y.M., Ogasawara, H., Webb, S.J., Garvin, Z.K., Harris R. L., Cason, E.D., Castillo, J., Vermeulen, J.G., Van Heerden, E., Leibenberg, B., Harrison, W., Durrheim, R.J., Manzi, M.S. & Walters C.C. 2019. *Deep subsurface, precambrian hypersaline environments as training sites for exploration of the Martian subsurface*. Paper delivered at the American Geophysical Union Conference, San Francisco, USA. 9-13 December 2019.

Oosthuizen, L., Charimba, G., Hitzeroth, A., Lum Nde, A., Steyn, L., Newman, J. D. & Hugo, C. 2019. *Chryseobacterium pennipullorum sp. nov., isolated from poultry feather waste.* Poster presented at the 8th FEMS Congress of European Microbiologist, Glasgow, United Kingdom. 7-11 July 2019.

Porotloane, B.F., Ogundeji, A.O., Pohl, C.H., Albertyn, J. & Sebolai, O.M. 2019. *The re-purposing of copper acyl salicylate as an purposing of copper acyl salicylate*. Poster presented at the 3rd EMBO Workshop on AIDS-Associated Mycoses, Cape Town, South Africa. 10-12 July 2019.

Pilenyane, N., Kgotle E.Y., Madu, L.U., Ogundeji, O.A., Pohl, C.H., Albertyn, J. & Sebolai O.M. 2019. *The biological function of Cryptococcus 3-OH fatty acids.* Poster presented at the 3rd EMBO Workshop on AIDS-Associated Mycoses, Cape Town, South Africa. 10-12 July 2019.

Sander, W.J., Pohl, C.H. & O'Neill, H.G. 2019. *Rotavirus infection increases PGE_2 production, leading to increased rotavirus yield and replication.* Poster presented at the 12th African Rotavirus Symposium, Johannesburg, South Africa. 30 July-1 August 2019.

Segone, N., Strydom, A., Strydom, M. & O'Neill, H.G. 2019. *Surveillance and characterization of porcine rotavirus in the Western Cape Province, South Africa*. Poster presented at the 12th African Rotavirus Symposium, Johannesburg, South Africa. 30 July-1 August 2019.

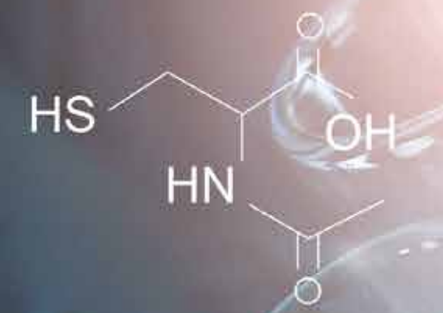
Van der Schyff, S.S., Du Preez, L.L. & O'Neill, H.G. 2019. *An in silico investigation into possible structural constraints during reassortment of rotavirus segment 9, encoding VP7*. Poster presented at the 12th African Rotavirus Symposium, Johannesburg, South Africa. 30 July-1 August 2019.

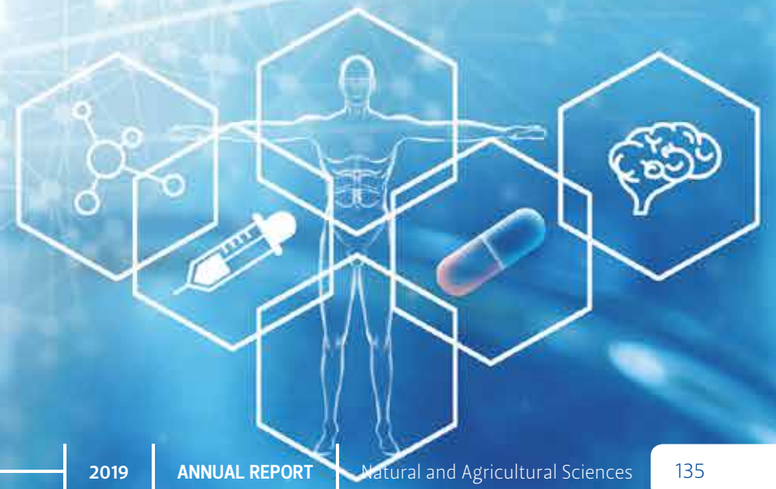
Vermeulen, J., Cason, E., Valverde, A., Castillo, J. & Vermeulen, M. 2019. *Microbial diversity and metabolic potential in South African hot Springs*. Paper delivered at the 8th FEMS Congress of European Microbiologist, Glasgow, United Kingdom. 7-11 July 2019.

STAFF (2019)

Head of Department: Prof M Smit

Professors: Prof J Albertyn, Prof R Bragg, Prof A Hugo, Prof G Osthoff, Prof C Pohl-Albertyn, Prof M Smit and Prof B Viljoen
Associate Professors: Prof C Hugo, Prof T O'Neill, Prof D Opperman, Prof O Sebolai and Prof A Valverde Portal
Affiliate Professor: Prof F Hollmann
Affiliate Associate Professor: Prof B Lodolo
Senior Lecturers: Dr C Boucher, Dr M de Wit, Dr K Myburgh and Dr F O'Neill
Affiliate Senior Lecturer: Dr S Bareetseng
Lecturers: Dr C Bothma, Dr O Gcilitshana and Ms L Steyn
Senior Researchers: Dr J Castillo-Hernandez and Dr G Kemp
Research Associates: Dr R Ells and Prof D Litthauer
Programme Directors: Prof J Albertyn (Microbiology) and Dr F O'Neill (Biochemistry)
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
Senior Assistant Officer: Ms E van den Heever
Storeman: Ms M Mogopodi
Technical Help: Ms A de Bruin, Mr VJ Lamle, Mr K Mashuga, Ms L Mazwi, Mr P Mereko and Mr J Mvula





DEPARTMENT OF PHYSICS

CONTACT DETAILS

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OVERVIEW OF 2019

The Department of Physics 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 1.5m 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.

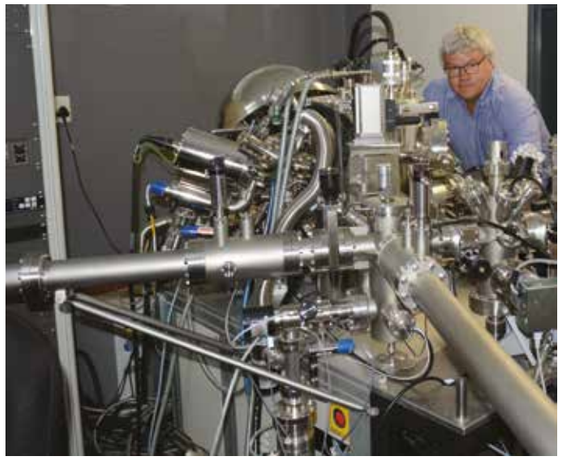
RESEARCH

2019 was another successful year for the Department and the researchers continued to produce a high number of ISI accredited journal papers.

In particular, the research group of the SARChI Chair in Solid-state Luminescent and Advanced Materials continued to produce high quality outputs. An important delegation of promoters and students from the Department participated in the symposium on 'Luminescence research across the equator' at Ghent University in October 2019. This symposium was organised in the framework of a bilateral project between South Africa and Belgium, jointly funded by the NRF and the Fonds Wetenschappelijk Onderzoek – Vlaanderen (FWO [Research Foundation – Flanders]). The symposium served as a closing session for the project, summarising achievements and discussing possible future collaborations. During this two-day event, seven oral presentations were delivered by researchers from Ghent University and eleven oral presentations by UFS researchers.

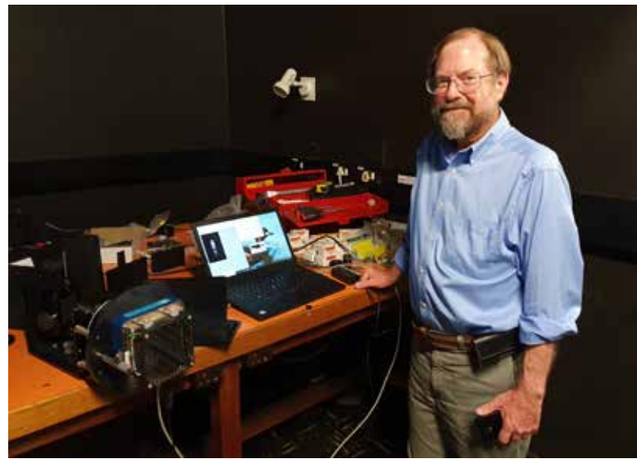
Participants in the 'Luminescence research across the equator' symposium in Ghent, Belgium

Prof Hendrik Swart (SARChI Chairholder) was once again very involved in presenting invited lectures internationally during 2019. These included presentations at, *inter alia*, the SPIE Photonics West Conference, held in San Francisco from 2 to 7 February, the International Conference on Excited States of Transitions Elements (ESTE 2019), held in Kudowa Zdrój, Poland from 8 to 13 September, the E-MRS Fall Meeting, held at the Warsaw University of Technology from 16 to 19 September, the 5th International Conference on Sensors Engineering and Electronics Instrumentation Advances (SEIA' 2019), which took place in the Canary Islands from 25 to 27 September, and the Materials Research Meeting 2019 on Materials Innovation for Sustainable Development Goals, held in Yokohoma, Japan from 10 to 14 December.



Prof Hendrik Swart with the X-ray Photoelectron Spectroscopy (XPS) system

The Astrophysics Research Group continued to make excellent progress. In August 2019, Prof Richard Gray from the Appalachian State University (ASU) joined the Department of Physics on a Fulbright Scholarship. Prof Gray, in collaboration with personnel from the Department and the UFS Instrumentation and Electronics Divisions, completed the design and construction of a very sophisticated Spectro-Polarimeter system for the UFS-Boyden 1.5 m telescope. Prof Gray is also actively involved in teaching some of the Astrophysics undergraduate and postgraduate courses in the Department of Physics.



Prof Richard Gray, Appalachian State University

Participants in the 7th Annual Conference on High Energy Astrophysics in Southern Africa (HEASA 2019), Swakopmund, Namibia

ENGAGED SCHOLARSHIP

The Two Observatories Project includes the Boyden Observatory and Science Centre, situated approximately 25 km from Bloemfontein), and the old Lamont-Hussey Observatory on Naval Hill in the centre of Bloemfontein, which has been converted into a digital planetarium.

There is a great synergy between the two facilities. The planetarium is often the first point of contact for learners and the public, whereas the Boyden Observatory is used for intensive learning experiences. Boyden also hosts an astronomy museum

depth to what people experience at the planetarium. Together, the observatories foster education, science communication and the development of eco- and astro-tourism in central South Africa.

The historic Lamont-Hussey Telescope was restored and reassembled as an exhibit at the planetarium in February 2019. The exhibit is a wonderful testimony to the scientists who worked tirelessly to observe the night sky from the Lamont Hussey Observatory, now converted to a digital planetarium.

The restored and reassembled Lamont-Hussey exhibit

POSTGRADUATE STUDENTS

In terms of postgraduate students, 2019 was a most successful year for the Department – delivering 11 PhD and 7 MSc graduates.

On the Bloemfontein Campus, MI Nemufulwi graduated with an MSc in Physics, and R Makole, BC Tladi, S Nqayi and TM Modungwe graduated with an MSc in Nano Physics. On the Qwaqwa Campus, DK Muthee graduated with an MSc in Physics.

At PhD level four students graduated from the Bloemfontein Campus and seven from the Qwaqwa Campus – all with the PhD in Physics. They were:

Shingane, K
Thesis: Magnetic, luminescence and gas sensing properties of various zinc oxide nanostructures: The influence of surface modification by gold on the gas sensing properties
Promoter: Prof OM Ntwaeaborwa

Tshabalala, ZP
Thesis: Preparation, surface characterization and luminescent properties of lanthanides-doped mixed silicates powder and thin film phosphors for application in light emitting diodes
Promoter: Prof OM Ntwaeaborwa

Hasebeldaim, EHH
Thesis: Luminescence properties of ZnO and ZnO:Eu^{3+} nanostructures and thin films
Promoter: Prof HC Swart

Saeed, NAM
Thesis: Luminescent properties of YOF phosphor for solar cell application
Promoter: Prof E Coetsee-Hugo

Kiprotich, S
Thesis: Growth and characterisation of tunable CdTe and CdSe nanoparticles by facile synthetic route for use in biological applications
Promoter: Prof FB Dejene

Korir, PS
Thesis: Structural and luminescence properties of RE-doped yttrium aluminate and silicate thin film phosphors for LEDs applications
Promoter: Prof FB Dejene

Hile, DD
Thesis: Synthesis, growth and characterization of ZnSe nanostructure thin films for application in Light Emitting Materials
Promoter: Dr LF Koao

Hussen, MK
Thesis: Synthesis and characterization of undoped and Cr^{3+} doped ZnM_2O_4(M=Ga, Al) spinels nano structures by sol-gel method for bio imaging applications
Promoter: Prof FB Dejene

Habte, AG
Thesis: Characterization of doped tin dioxide nanostructure and chemically deposited cadmium selenide thin film
Promoter: Prof FB Dejene

Seid, ET
Thesis: Generation of novel un-doped and doped ZnO nanomaterials using controlled sol-gel method for applications as a transparent conducting oxide
Promoter: Prof FB Dejene

Werta, SZ
Thesis: Synthesis and characterization of electrodeposited CdS, CdS:Mg, CdS:Zn and ZnS thin films for solar cell applications
Promoter: Prof FB Dejene

POSTDOCTORAL RESEARCH FELLOWS

In 2019, the Department of Physics hosted eleven postdoctoral research fellows – nine involved in Solid-state Physics, and two in Astrophysics. They were:

- 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)

STAFF MATTERS

Prof RE Kroon was promoted to full Professor and Dr KG Tshabalala was promoted to Senior Lecturer.

A number of new appointments were made in the Department – Mr LJB Erasmus as Junior Researcher and Mr AJ Fourie as Professional Officer at the Bloemfontein Campus and Mr V Adoons and Mrs S Bogacwi were appointed at the Qwaqwa Campus as Senior Assistant - Professional Officer and Assistant Officer, respectively.

RESEARCH OUTPUTS

Research Articles

Abdalla, H., Meintjes, P.J., Van Soelen, B. *et al.* 2019. A very high energy component deep in the γ-ray burst afterglow. *Nature* 575: 464-467.

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STAFF (2019)

Head of Department: Prof JJ Terblans

Bloemfontein Campus

Senior Professors: Prof PJ Meintjes and Prof HC Swart
Professors: Prof RE Kroon, Prof WD Roos and Prof JJ Terblans
Associate Professors: Prof E Coetzee-Hugo and Prof MJH Hoffman
Senior Lecturers: Dr RA Harris and Dr B van Soelen
Lecturers: Dr S Cronje and Mr DP van Jaarsveldt
Junior Lecturer: Miss H Szegedi
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
Senior Officer - Professional Services: Dr HJ van Heerden
Officer - Professional Services: Mr AJ Fourie
Officer: Miss K Cronje
Assistant Officers: Mrs Y Loots and Miss D Mangope

Qwaqwa Campus

Professor: Prof BF Dejene
Senior Lecturers: Dr LF Koao and Dr KG Tshabalala (Subject Head)
Lecturers: Dr SJ Motloung and Dr RO Ocaya
Senior Assistant Officer - Professional Services: Mr V Adoons
Assistant Officer: Mrs S Bogacwi

DEPARTMENT OF
PLANT SCIENCES

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OVERVIEW OF 2019

The Department of Plant Sciences has three divisions – Botany (both Bloemfontein and Qwaqwa Campuses), Plant Breeding and Plant Pathology. Our staff teach and perform research within the individual divisions, but also in a variety of projects that combine different aspects of the three divisions. Collaboration with various national and international institutions, local councils and associations is indicative of the relevance and applicability of plant science to industry.

Highlights of 2019 include a number of high profile scientific publications in collaboration with both national and international co-workers, postgraduate students who walked away with a number of prizes at various conferences, staff members serving on editorial boards, an increasing number of postdoctoral research fellows, excellent practical experience gained by undergraduate students after participating in excursions and the number of postgraduate students who graduated during 2019 (6 Honours, 14 master's and 10 doctoral students).

ACHIEVEMENTS

Staff Achievements

Prof Maryke Labuschagne was appointed to the editorial board of the *Journal of Cereal Science*, a leading British journal on cereal chemistry. She was also appointed as Specialty Chief Editor for *Frontiers in Sustainable Food Systems*, a journal that is part of the Frontiers group of journals published in Switzerland.

Dr Angeline van Biljon and Prof Maryke Labuschagne, both executive committee members of Cereal Science and Technology-Southern Africa (CST-SA), served on the scientific committee that organised the 3rd New Voices symposium, which was held on 11 September at the Grain Building in Pretoria. This association has established itself as a link between students and their future employers in the grain and oilseed industry.

Prof Wijnand Swart, was elected as President of the Southern African Society of Plant Pathology (SASPP).

Dr Lize Joubert was awarded first place at the Department of Plant Sciences' Flash Fact Competition for staff, for her presentation on the three-dimensional elaboration of petal structures in *Nemesia* (Scrophulariaceae).

Dr Sandy-Lynn Steenhuisen was appointed as a subject editor for the *South African Journal of Botany*, South Africa's leading botanical journal. She is also currently the Treasurer of the South Association of Botanists (SAAB) and Chairperson of the Local Organising Committee hosting the 46th annual conference of SAAB in January 2020. Dr Steenhuisen was also the recipient of an Afromontane Research Unit (ARU) certificate of recognition for Research Excellence in 2019.

Lisa Rothmann was invited to join the international multi-disciplinary organisation, Open Plant Pathology, in a Junior Leadership position to encourage Open Science practices in Plant Pathology.

Student Achievements

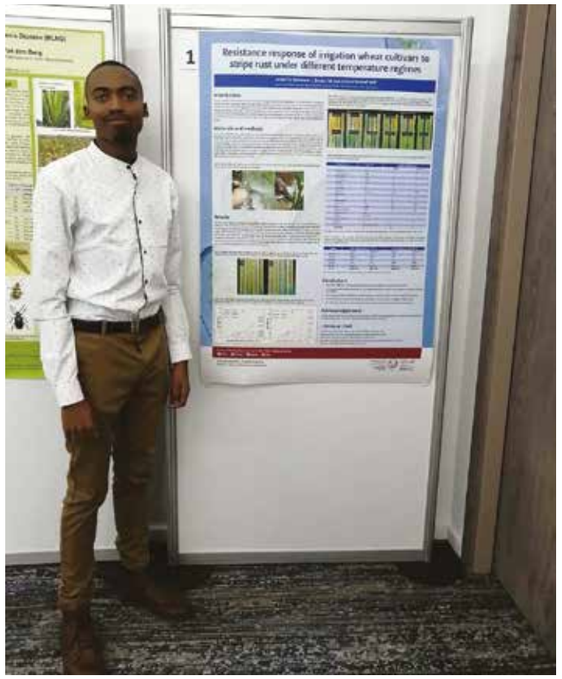
Mr Alex de Gouveia received the junior Captain Scott medal for the best master's study in Botany from the South African Academy of Science and Arts (SAASA), during a prestigious award ceremony held in Stellenbosch on 10 July 2019. His study leaders were Dr Lize Joubert and Dr Mariëtte Jackson.

Mr Alex de Gouveia, winner of the SAASA junior Captain Scott medal, with his study leaders Dr Lize Joubert (left) and Dr Mariëtte Jackson (right)

Postgraduate students from the Department of Plant Sciences attended the University of Johannesburg (UJ) Plant Sciences' Annual Student Symposium from 4 to 5 November 2019. The Department walked away with the following prizes: Best PhD presentation – Dr Ntombokulunga Mbuma, Best MSc presentation – Mr Alec Edwards, 2nd best Honours presenter – Mr Paul Myburgh and 3rd best Honours presenter – Mr Xander Schmidt

Prize winners with staff at the annual UJ Symposium
Front from the left: Dr Nthomokulunga Mbuma, Dr Ansori Maré and Dr Andri van Aardt
Back from the left: Paul Myburgh, Xander Scmidt, Mawethu Ndiki and Alec Edwards

Thabiso V Masisi, an MSc (Agriculture) student from Plant Pathology, won first prize for his poster presentation at the South African National Seed Organisation (SANSOR) Annual Conference. His Honours research was titled, 'Resistance response of irrigation wheat cultivars to Stripe Rust under different temperature regimes', supervised by Dr Willem Boshoff.



Mr Thabiso Masisi at the SANSOR Conference

Cereal Science and Technology-South Africa hosted their annual New Voices Symposium, at which postgraduate students are given the opportunity to deliver oral presentations of their scientific findings to a group of their peers and industry members. Lisa Rothmann won the John Taylor Floating Trophy for the first prize for PhD research. Her presentation was titled 'A quantitative summary of a ten-year survey of white mold prevalence in South Africa'. Marlese Meiring was placed in the top three with her presentation titled, 'Screening for tolerance to *Sclerotinia sclerotiorum* in soybean cultivars'.

Laetitia Voua Otomo and Thumeka Tiwani, both PhD students in Botany on the Qwaqwa Campus, attended and presented their research at the 6th World Congress on Medicinal and Aromatic Plants for Human and Animal Welfare (WOCMAP VI), held in Northern Cyprus in November 2019. Both students were supervised by Dr Lisa Komoreng.

Thumeka Tiwani and Laetitia Voua Otomo at WOCMAP VI

Howard Castelyn won the EM van Zinderen Bakker prize for outstanding PhD study in Botany titled 'Molecular and cellular analysis of adult plant resistance in wheat to *Puccinia graminis* f.sp. *tritici*' (supervisor Prof ZA Pretorius, co-supervisors Prof B Visser and Dr LA Boyd).

Stephanie McDonald won the Botanical Society of South Africa (Free State Branch) prize for best Honours student in Botany (supervisor Dr M Cawood).

Palesa Mmereki won the South African Plant Breeders' Association (SAPBA) prize for the best MSc student in Plant Breeding (supervisor Prof L Herselman, co-supervisor Dr A Minnaar-Ontong).

Chrissie Miles won the Plant Breeding prize for the best PhD student in Plant Breeding (promoter Prof M Labuschagne, co-promoter Dr A van Biljon).

Lehlohonolo Donald Adams received the award for the top master's ARU candidate from the Afromontane Research Unit (supervisor Dr S Steenhuisen, co-supervisors Dr VR Clark and Dr G Martin).

TEACHING

The third-year Botany students went on a field excursion to Hogsback in the Eastern Cape in February as part of their Field Excursion module. Students worked on projects including pollination biology, vegetation surveys in forest, grassland, wetland, fynbos and exotic plantations, identification and management of alien invasive plants, and identification of important plant families of South Africa.

Students and staff during the 2019 Hogsback excursion

Mr Anton Swanepoel, a field scientist in product development at Bayer Crop Sciences, gave a lecture on recent developments and advances in agricultural research that have an impact at farm level, to the third-year Plant Pathology class in October.

Botany Eco-physiology second-year students attended a successful field excursion in October to the Amanzi Game Lodge. They were introduced to adaptations in different plants to grow and survive in the Free State environment. They mastered techniques to measure chlorophyll content and photosynthetic rate in plants under different environmental conditions.

Together with Prof Aliza Le Roux from the Department of Zoology and Entomologyy, Dr Sandy-Lynn Steenhuisen organised a joint three-night field excursion into the Golden Gate Highlands National Park for third-year students in the biological sciences at the Qwaqwa Campus, Students were exposed to several practical methods of conducting ecological surveys of vegetation and animal behaviour, including transect and plot surveys of plant diversity in different vegetation types, small mammal trapping, light-trapping of insects, camera trapping, and collecting, analysing and reporting on field data.

Dr Willem Boshoff presented an invited lecture on 'Stem rust in wheat – the Southern African perspective' as part of an on-line seminar to MSc students taking the course Plant Breeding and Protection for Sustainable Production at the Department of Plant Protection Biology in the Swedish University of Agricultural Sciences. Prof Botma Visser presented an invited lecture titled 'Out of Africa to Down Under: A study on the proposed inter-continental movement of wheat stem rust' as part of the same on-line seminar.

RESEARCH

SARChI Chair in Disease Resistance and Quality of Field Crops

This research chair continued with research on quality in field crops, delivering two MSc dissertations on quality protein maize and how it is affected by abiotic stress conditions. In collaboration with the International Institute for Tropical Agriculture (IITA), and a PhD study was completed on biofortification of the banana family with provitamin A. Another PhD study was completed on the inheritance and expression of iron and zinc in South African maize hybrids. Eight papers in accredited journals (three with an impact factor higher than four) and three book chapters were published from the crop quality research in 2019. Five papers on this research were presented at international conferences. In terms of disease resistance, two MSc students completed their dissertations on research related to rust resistance breeding, and 15 accredited papers were published on disease resistance in field crops, with a focus on wheat.

Recent successes of the cereal rust programme include the characterisation and report of the 5th variant of the Ug99 stem rust race in South Africa, of which the data was made available to local wheat producers and breeders. The first report of stripe rust in Zimbabwe was also recently documented. The impact of this race on Zimbabwean wheat cultivars, as well as its potential risk to South African wheat cultivars, was assessed and illustrated the relevance of UFS rust programme in the region.

Recent international and local collaboration led to the following achievements:

- The research of Dr Jianping Zhang at Commonwealth Scientific and Industrial Research Organisation (CSIRO), 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.
- A collaborative and landmark study between the UFS, the Plant Breeding Institute of the University of Sydney, University of Cambridge and others, addressed the movement of stem rust urediniospores from southern Africa to Australia on high-altitude winds.
- Rust researchers at the UFS contributed to a publication in *Communications Biology* by Dr Diane Saunders from the John Innes Centre in Norwich, describing the first stem rust incursion into the United Kingdom in many years.
- In collaboration with co-workers from the Centre for Rapid Prototyping and Manufacturing at the Central University of Technology (CUT), devices commonly used during collection and application of rust spores to plants, but which are not commercially available, were redesigned and 3D-printed through an innovative additive manufacturing process. This work was awarded the best-on-show poster prize at an earlier international conference and subsequently published in *Frontiers in Plant Science*.
- In collaboration with Dr Jim Kolmer at the Department of Plant Pathology, University of Minnesota, UFS personnel contributed to a publication describing the potential of leaf rust to migrate over long distances.
- Prof Visser collaborated with Dr Terefe and Dr Prinsloo of the Agricultural Research Council-Small Grain (ARC-SG), Bethlehem, to describe the first detection of wheat stripe mosaic virus and *Polymyxa graminis* as its associated vector, in South Africa.
- Given the international emphasis on durable resistance in wheat cultivars to rust diseases, UFS pathologists and co-workers published an article in *Plant Disease* describing a new, repeatable and easy to use method to assess different types of stripe rust resistance in adult plants.
- In a collaborative project with the UFS that was accepted for publication in *Nature Communications*, Dr Melania Figueroa of CSIRO provided the first genomic evidence for somatic hybridisation in rust pathogens. Using next-generation sequencing technology, they confirmed that somatic hybridisation of two different stem rust races that exchanged complete nuclei, gave rise to the Ug99 stem rust race described by Prof Pretorius 20 years ago. Confirmation of one of the races involved in this somatic hybridisation event as Pgt21, found in South Africa nearly 100 years ago before migrating to Australia in the 1950s, is a remarkable discovery.
- Research outputs were popularised through articles in *Wheat Focus*. Topics covered were a paper on the importance of wheat rust monitoring as new rust races made their appearance, and a first report of wheat stripe mosaic virus in South Africa.

Botany: Plant physiology/biochemistry and molecular biology

Dr Marieta Cawood's research focused on extraction, identification, and utilisation of plant secondary metabolites in agricultural and medicinal fields. Under abiotic stress conditions, the chemical composition and allelopathic influence of the underutilised crop, *Amaranthus cruentus*, were explored by a PhD student. Another PhD study examined control strategies for silverleaf nightshade (*Solanum elaeagnifolium* Cav.) with emphasis on the impact of biological control. An MSc project focused on the chemical composition and resistance of pecan nut cultivars in South Africa.

Dr Lintlè Mohase and her research team continued their research on plant-defence mechanisms in wheat during aphid infestations under changing environmental conditions. She collaborated with plant breeder Dr Ntjapa Lebaka from South African Breweries (SAB) Hop Farms in George, Dr Willem Boshoff, a UFS pathologist, and an entomologist from ARC-SG, Bethlehem, Dr A Jankielsohn. Her research concentrated 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, as well as the effect of commercial plant activators on crop protection against the aphid, *Diuraphis noxia*.

Dr Gerhard Potgieter was involved in the evaluation of the bio-stimulant properties of certain secondary molecules isolated from various plant and animal sources. Use of these bio-stimulants in addition to traditional agricultural practices is to improve yield and quality of crops in existing cultivation areas. 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 to obtain a colour and form signature for plants to enable them to identify alien invasion in a given vegetation type.

Dr Makoena Moloi's research focused on the influence of aspects of climate change, such as drought and temperature stress, on the biochemical responses of crops with agricultural importance. The purpose was to find any biochemical mechanisms that are linked with crop production under stress conditions, and how such information can be used for crop selection in breeding programmes. Furthermore, they focused on the use of biostimulants, phytohormones or nutrients in improving tolerance of crop plants under stress conditions.

Prof Botma Visser collaborated with plant pathologist Dr Willem Boshoff to genotype cereal rust species. During 2019, stem and leaf rust of oat, leaf rust of barley and leaf rust of sunflower were genotyped. He was also involved in the identification of wheat viruses from diseased plants, and he investigated a new potential fungicide that could control stripe rust of wheat.

Dr Rudo Ngara continued with research on adaptive mechanisms of plants to a range of abiotic stresses. In 2019, Dr Ngara recruited one new doctoral and three master's students to work on the project in collaboration with Dr Stephen Chivasa, from Durham University in the UK, and Dr Nemera Shargie, from ARC-Grain Crops (ARC-GC) in Potchefstroom. Dr Ngara's projects are funded by the NRF and the Royal Society of London.

Botany: Phytomedicine and ethnobotany

Dr Lisa Komoreng continued with her research on traditional medicinal plants used in the treatment of tuberculosis and elephantiasis and its secondary infections in South Africa. Her research also focused on bioprospecting of indigenous medicinal plants that are used in the Eastern Free State for the treatment of various ailments. Dr Komoreng's research group screened medicinal plants for *in vitro* antimicrobial, antimycobacterial, anti-inflammatory, anti-oxidant, anthelmintic and cytotoxic properties. The active compounds were isolated from plants showing good pharmacological activities without any toxic properties. The project runs in collaboration with Prof Oriel Thekisoe and Prof Rialet Pieters from North-West University.

Botany: Plant taxonomy and molecular systematics

Dr Lize Joubert's research focused on combining taxonomic approaches with pollination biology, flower evolution and development research to investigate various aspects of the diversity of South African flowering plants. Her research included topics such as floral adaptation to pollinator shifts because of climate change and optimisation of floral characters in crops for higher pollination efficiency and improved yield. In 2019 she conducted field work in the Northern and Western Cape to collect specimens and data for the *Nemesia* floral evolution project. She also collaborated with Dr Jackson on taxonomic revisions and molecular systematic analysis of key South African flowering plant groups.

Field work at Goegap Nature Reserve in the Northern Cape for the Nemesia floral evolution project

Dr Mariëtte Jackson is heading 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 is being investigated, analysing fossil soil sediment from Prof Louis Scott's fossil pollen collection, to obtain ancient DNA that can be used within phylogenetic studies. Ancient DNA was sequenced with Next Generation Sequencing (NGS) technologies.

Botany: Palaeo-botany and ecology

Dr Andri van Aardt and Prof Louis Scott are currently investigating the long-term change patterns in vegetation by studying both fossil and present-day plant material. Dr Van Aardt is in the process of investigating the relationship between vegetation and soil in the Drakensberg Mountains using drone technology for the identification of alien invasive plants. In terms of palaeoecology, her research included pollen analysis with the aim of getting a better understanding of vegetation changes around certain sites in the Free State (Florisbad) and Gauteng (Colbyn) during the Quaternary. She also investigated the potential use of leaf epidermis as to contribute to previous palaeo-environmental reconstructions from the Pretoria Saltpan (Tswaing Crater). Prof Scott continued research on various projects with international collaborators on palaeoclimatic reconstruction of different biomes in southern Africa, including modelling of the last glacial maximum in South Africa, reviewing pollen studies in the Southern Kalahari (Wonderwerk and Equus Caves) and the Western Cape (Princess Vlei and Uniondale). Dr Joubert collaborated with Dr Van Aardt in developing species circumscriptions to link lineages of extant species to microfossils used in palaeo-vegetation reconstruction.

Research into the behavioural cues used by lizard pollinators of the 'Hidden flower', *Guthriea capensis*, continued in 2019 with a collaboration between Dr Sandy-Lynn Steenhuisen and researchers from the Pollination Ecology Research Group at the University of KwaZulu-Natal (UKZN) in Pietermaritzburg. The novelty of this pollination system discovered in the Drakensberg Mountains gained much public interest in 2019, resulting in numerous radio and newspaper press releases. Research avenues into plant invasion ecology grew substantially on the Qwaqwa Campus during 2019, with collaborations on high altitude plant invasions continuing between Dr Steenhuisen's research laboratory, the ARU, the Centre for Biological Control (Rhodes University), and a newly formed partnership with the Centre for Invasion Biology at Stellenbosch University.

An interesting project also gained momentum during the year involving the Qwaqwa Departments of Plant Sciences, and Zoology and Entomology, the ARU and BirdLife South Africa. In this project, Dr Steenhuisen and her postdoctoral research fellow, Dr Nicholas Le Maitre, collaboratively investigated the use of sound recorders to determine the diversity of primarily wetland bird species in the Golden Gate Highlands National Park. This project will be expanded to look at seasonal changes and recolonisation of animals in wetland vegetation after fire, with plans to investigate other animal groups such as frogs and insects in future. The project aims to compare plant and animal diversity in various wetlands in protected and disturbed wetlands using methods with minimal disturbance.

Plant Breeding: Molecular plant breeding

Dr Adré Minnaar-Ontong's research focused on the genetic variation of *Sclerotinia sclerotiorum* populations on different hosts in South Africa – a project funded by the NRF-Thuthuka. The outcome of this project contributed towards her most recent research that includes the development of a breeding programme for resistance to Sclerotinia diseases in economically important oil crops and other hosts. South African sunflower and soybean cultivars were evaluated for resistance to sclerotinia diseases to promote the improvement of disease control strategies. The research was funded by the NRF-Thuthuka as well as Grain SA. Further research also included the genetic analysis of soybean resistance to *Fusarium virguliforme*, a pathogen responsible for Fusarium Sudden Death Syndrome. This project aims to evaluate commercial soybean cultivars for resistance and the outcomes of these projects is of significant importance to soybean production of South Africa.

Prof Liezel Herselman's research continued to make progress towards the introgression of different rust resistance (stem, stripe, and leaf rust), as well as Fusarium head-blight (FHB) resistance genes in South African wheat cultivars. New developments in her research were presented at the First International Wheat Conference in Canada. In 2019 her research focused on the genetic analysis of rust resistance in winter wheat. A PhD student identified a new source of adult plant stem rust resistance in a South African wheat cultivar on a chromosome not previously associated with adult plant resistance. It is postulated that this resistance is governed by a single major quantitative trait locus. An MSc student characterised a potential new source of stem rust resistance in lines received from an international collaborator. Results indicated that the identified single dominant gene could be *Sr13* or a closely linked gene in its region.

Dr Ansori Maré made progress with crosses to transfer one

From the left, Dr Willem Boshoff, Prof Liezel Herselman, Prof Maryke Labuschagne and Dr Brigitta Töth at the 1st International Wheat Congress in Saskatoon, Canada

stem rust and three stripe rust resistance genes into lines that already contain eight other rust and FHB-resistance genes. Breeding for resistance against wheat diseases has in the recent past resulted in the release of several lines by the UFS to South African breeding companies for use in their breeding programmes. The double haploid technique was standardised as part of this project at the UFS for routine use on all breeding material developed under the SARChI Chair. This project was recently strengthened by the relocation of the KASP™ SNPline equipment to the Bloemfontein Campus, which will substantially benefit current and future breeding programmes.

Prof Liezel Herselman and Alexander Jones (LGC Genomics) with the KASPar SNPLine equipment relocated from the CenGen Laboratory

Plant Breeding: Conventional breeding

Dr Rouxlène van der Merwe's research focused on the stability analysis of Edamame (*Glycine max* L.) introductions in South African production conditions. This research project, undertaken in collaboration with the Edamame Development Program (EDP), funded by the Durban City Council and KwaZulu-Natal Government, was concluded in 2019.

Other research (in collaboration with the Northeast Institute of Geography and Agroecology of Chinese Academy of Sciences), focused on breeding for resistance to pod dehiscence in vegetable-type soybean. This research continued to make progress towards the development of an improved South African vegetable-type soybean cultivar that shows resistance to pod shattering. Dr Minnaar-Ontong collaborated on this project and was responsible for marker-assisted selection. Green pod yield and nutritional content of large-seeded (vegetable-type) soybean were also investigated, in collaboration with the EDP, and funded by the NRF-Thuthuka. This research made progress towards the development of an improved South African vegetable-type soybean cultivar that shows high yield potential and with improved nutritional value. In addition, promising cultivars are being evaluated on agronomic performance and consumer acceptability in order to be promoted for production by small-scale farmers. The projects run in collaboration with Dr Angeline van Biljon, who assisted with amino acid and sugar analysis, Prof Arno Hugo and Dr Carina Bothma (both from the Department of Microbial, Biochemical and Food Biotechnology), who assisted with fatty acid analysis and sensory tests. This research continued to make progress towards the characterisation of vegetable-type soybean cultivars in terms of drought stress tolerance in collaboration with Dr Makoena Moloi and Dr Angeline van Biljon.

Plant Breeding: Wheat-quality and crop-nutritional value research

Dr Angeline van Biljon's research focuses mainly on the influence of abiotic stress on nutritional quality of various staple crops and vegetables. Both size exclusion- and reverse phase-high performance liquid chromatograph (HPLC) techniques were applied to determined storage protein fractions of various wheat cultivars. The carotenoid content of maize and butternuts was determined using HPLC. The genetic enhancement of minerals, such as iron and zinc, in maize and the bioavailability thereof, and zein protein determination remains an important research focus as well. Total starch, amylose and tryptophan determinations also contribute to the quality profile of maize lines that are incorporated into various breeding programmes. These results supported projects in collaboration with the International Maize and Wheat Improvement Centre (CIMMYT) in Zimbabwe, ARC-SG and Starke Ayres.

Within Prof Maryke Labuschagne's research, two PhD projects commenced in collaboration with CIMMYT in Mexico on the influence of heat and drought stress on the expression of gluten proteins in bread and durum wheat. Other projects are underway on the effect of the *wbm* (wheat bread making) gene in South African wheat cultivars, and one on waxy wheat, in collaboration with CIMMYT in Mexico and the University of Cordoba in Spain.

Maize projects included a PhD study on iron and zinc biofortification of quality protein maize and provitamin A maize. In addition, a PhD project on genetic linkage drag for yield in quality protein maize was initiated. Two more PhD projects with CIMMYT included genetic gain in quality protein maize (QPM) and abiotic stress effects on QPM in Ethiopia.

Plant Pathology: Cereal rust diseases

Dr Willem Boshoff and Prof Zakkie Pretorius have collaborative projects with researchers from the USA, which include barley stem rust resistance mapping (University of Minnesota) and stem rust race nomenclature (Agricultural Research Service - United States Department of Agriculture [ARS-USDA]). Satisfactory field results were obtained in a project funded by King Abdullah University of Science and Technology (KAUST) that will contribute to our understanding of durable stripe rust resistance in wheat. Greenhouse and field trials were conducted to screen UK wheat cultivars against stem rust race PTKST, in collaboration with scientists at the John Innes Centre. Research in collaboration with Dr Hongwei Li, Institute of Genetics and Developmental Biology, Chinese Academy of Sciences, on the establishment of wheat-*Thinopyrum ponticum* translocation lines carrying new sources of resistance to stem rust was published in the Journal of Genetics and Genomics.

Dr Boshoff was also 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 involved greenhouse and field screening with selected races of the three rust pathogens of wheat. Data from these trials is annually included in the national wheat production guidelines of ARC-SG. Significant progress was made with projects studying pathogenic variability in stem rust of oats and rust resistance of forage crops with two scientific papers published.

Prof Maryke Labuschagne, Dr Willem Boshoff and Prof Zakkie Pretorius participated in the ARC-SG planning committee meeting on 11 and 12 July

Plant Pathology: Soil microbial ecology

The Soil and 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 genetic and functional diversity of the rhizosphere microbiome of diseased plants is compared with that of healthy plants using various advanced biochemical and molecular tools. In 2019, SMEG was joined by two new MSc students, Mr Bongani Mahlangu and Miss Danette Strauss. Apart from being funded by Nulandis and the ARC, the group was contracted by Medigrow in Lesotho to look at the cultivation of cannabis in tunnels.

Plant Pathology: Mycology

During 2019 the Pecan Health Research Group of Dr Gert Marais conducted six field trips, including the Orange River from Luckhof to Upington, Vaalharts, Schweizer-Reneke, Jacobsdal, as well as various areas in the Limpopo Province, Mpumalanga, Gauteng, KwaZulu-Natal, Eastern Cape and North West. During these trips, nine farmers' days were held where information regarding the newest findings on student projects was shared with pecan producers and other interested parties. This research is part of a five-year project between the South African Pecan Nut Producers Association (SAPPA) and the UFS. A booklet, describing the more important pecan diseases in South Africa was prepared and handed to the industry during the Annual General Meeting of SAPPA in November 2019. This is the first version to serve as a guide for producers in the field, and it is expected that it will be further expanded as research is continued on pecan diseases. Two MSc projects were concluded, confirming that the fungus causing scab on pecans in the USA, namely *Venturia effusa*, is not the same causative agent of scab in South Africa, which is *Cladosporium cladosporioides*. In addition, it was also confirmed that the fungus, *Neofusicoccum parvum*, is the causative agent of die-back in pecans.

Plant Pathology: Epidemiology

The epidemiology programme was led by Lisa Rothmann and supported by Prof Neal McLaren and Marlese Meiring. The focus of the group is Sclerotinia stem and head rot of soybean and sunflower, as well as sorghum pathology. Prof McLaren retired at the end of 2018 and was appointed as a Research Fellow, operating from the Western Cape. His activities included data science workshops at Stellenbosch University and the University of Pretoria and research collaboration with ARC-GC, Western Cape Department of Agriculture and Sorghum Trust.

Sorghum leaf blight symptoms caused by Exserohilum turcicum

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 applied 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 ARC-GC (Potchefstroom and Cedara). Research support from the Sorghum Trust continued during 2019.

Sclerotinia research focused on soybean and sunflower cultivar evaluations, in field trials in the Eastern Free State and Mpumalanga. These trials aimed at identifying cultivars that can be included into pre-breeding programmes as a result of a higher tolerance to Sclerotinia disease potentials. This research was supported by the Sasol Trust, Oil and Protein Seeds Development Trust (OPDT) and Protein Research Foundation (PRF), under the initiative of Grain SA. 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. Another study under the mentorship of Prof Emerson del Ponte from the Plant Pathology Department at the Universidade Federal de Viçosa (Minas Gerais, Brazil, was initiated in 2019. This study is 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, which is new to their research group.

Marlese Meiring, PhD student, with Mr Koos Strydom of Clocolan, on whose farms her research on Sclerotinia sclerotiorum is being conducted

Other research activities

The Geo Potts Herbarium acquired a light box, which is used to digitise all specimens in the main collection. Specimen images are made available online on the Herbarium website (https://herbaria.plants.ox.ac.uk/bol/blfu).

Ms Magdil Pienaar using the new light box in the Geo Potts Herbarium

The Geo Potts Herbarium was acknowledged for its contribution to research papers published by international researchers – Stinka, A. & Mei, G. 2019. *Ehrharta erecta* Lam. (Poaceae, Ehrhartoideae): distribution in Italy and taxonomy of one of the most invasive plant species in the world. *Bioinvasions Records* 8(4): 742-752.

ENGAGED SCHOLARSHIP

Dr Boshoff and Prof Herselman acted as evaluators for new projects submitted to the Winter Cereal Trust for funding and Dr Boshoff also acted as convenor of the wheat rust consortium. Dr Boshoff represented the UFS at the National Small Grain Cultivar Advisory Committee and as a member of the ARC-SG annual planning committee meeting. Dr Boshoff handled several disease-related enquiries from producers and representatives from agricultural companies during the 2019 wheat season.

Dr Van Aardt gave a talk at the Botanical Society of South Africa's Free State branch in March titled 'Know your shrubs', and Dr Joubert presented a talk to the Free State Branch of Birdlife South Africa in May on the transition from bee to bird pollination.

Dr Mohase presented a guest lecture titled 'Prospects and challenges in wheat production' at the Glen College of Agriculture, Bloemfontein in August, and Dr Marais presented a guest lecture on 'The polyphagous shot hole borer (PSHB) in agriculture' to the Fichardt Park community in October.

During the 2018/2019 growing season, Lisa Rothmann and Marlese Meiring led 12 information sessions on Sclerotinia diseases. These were supported by industry partners under the auspices of the South African Sclerotinia Research Network, supported by Grain SA. They were held primarily in the Free State and Mpumalanga, and were aimed at connecting the producers with the current research being conducted, as well as to hear what the needs of the producers in terms of academia and industry. Through this type of interaction, practical management strategies for diseases caused by Sclerotinia can be developed for and communicated to local producers. Data from surveys among the producers was added to a disease database for the creation of a risk area map for Sclerotinia diseases of oilseed crops.

Scientific communication and popular articles are produced and distributed through the *Dry Bean Organisation Magazine*, *SAGrain Magazine* and the *Oilseed Focus Magazine*. Contributions were made by Lisa Rothmann, Marlese Meiring, Prof Neal McLaren, Alec Edwards, Dr Chrisna Steyn and Dr Adré Minnaar-Ontong, from the Plant Pathology and Plant Breeding divisions of the Department. Topics included sorghum disease management, understanding Sclerotinia diseases and potential interventions as well as interest articles on the importance of soil health, climate and biodiversity.

NATIONAL AND INTERNATIONAL COLLABORATION

Many of our collaborative research initiatives are reported on in detail in the above sections. In summary:

Prof Labuschagne at Plant Breeding is actively collaborating with CIMMYT in Zimbabwe and Kenya on maize breeding, and with CIMMYT, Mexico and the University of Cordoba in Spain on wheat quality. Further collaboration is with IITA in Nigeria on cassava and cowpea biofortification. Nationally, she collaborates with the ARC-Bethlehem, Pretoria and Potchefstroom on wheat, maize and legume projects.

Dr Mohase collaborated with Dr A Jankielsohn of ARC-SG on aphid diversity in South Africa and Lesotho, who provided guidance on biotype evaluation of aphids collected from field trials and volunteer wheat in Lesotho, and analysis of soil samples from the various study sites in Lesotho. She also co-supervised a PhD student. Together with Dr N Lebaka, a plant breeder from SAB Hop Farms, Dr Mohase guided the design and analysis of data collected from field trials in Lesotho. Dr Lebaka co-supervised a master's student. Dr Mohase also collaborates with Lesotho Agricultural Research on a project on wheat germplasm in Lesotho. The unit provided germplasm that was used in the field trials as well as the agronomic traits of some of the cultivars. They also coordinated their extension officers who provided some land at the study sites.

Lisa Rothmann and Marlese Meiring are collaborating with Dr Derick van Staden from AgriSeed/DMS Genetics in Delmas in terms of soybean and sunflower field trials on the experimental farm, which are aimed at cultivar and fungicide evaluations. The soybean and sunflower national cultivar trial seed are provided by Dr Safiah Maali and Annelie de Beer from the ARC-GC in Potchefstroom.

Healthy soybean plants

During 2019, Lisa Rothmann visited the Universidade Federal de Viçosa (Minas Gerais, Brazil) to be mentored by Prof Emerson Del Ponte, in the Epidemiology division of the Fitopatologia Departamento (Plant Pathology Department). This paved the way for the official MoU between the UFS and the Universidade Federal de Viçosa, which facilitates research collaboration and potential future exchange opportunities between the Plant Pathology departments of each institution.

Dr Moloi and Dr B Tóth, Institute of Nutrition, University of Debrecen, Hungary collaborated on a project which led to a book chapter being published.

Dr Rouxléne van der Merwe collaborated with the Northeast Institute of Geography and Agroecology (Chinese Academy of Sciences), on the breeding for resistance to pod dehiscence in vegetable-type soybean breeding companies. She also collaborated with researchers from the University of Manitoba in Canada and the University of Nebraska in the USA. Dr Van der Merwe continued her collaboration with the EDP, on germplasm maintenance of introduced varieties, base seed multiplication, research and training of students, pre-breeding and new cultivar development for South African growing conditions. Collaboration was also established between Dr Van der Merwe and Dr Potgieter with Stoller Africa with the aim of evaluating their growth enhancement products in statistically designed field trials.

Dr Joubert collaborated with Dr P Bester from the South African National Biodiversity Institute (SANBI) on systematics and evolutionary research of *Nemesia*, a genus endemic to Southern Africa and of significant horticultural and conservational importance. She also collaborated with Prof B Glover from the University of Cambridge on floral evolution and development research.

Prof P Crous, Director of the Westerdijk Fungal Biodiversity Institute in the Netherlands and Secretary-General of the International Mycological Association continued his collaboration with Prof Swart, as an Affiliated Professor in the Department. He was closely involved in research collaboration with Prof Swart and two postdoctoral fellows, Dr Marcelo P Sandoval Denis and Dr Alejandra Lopez.

Dr Boshoff and Prof Pretorius conducted international research projects in collaboration with researchers at the Chinese Academy of Sciences, Beijing (on wheat stem rust), KAUST, Kingdom of Saudi Arabia (on wheat stripe rust), John Innes Centre, UK (on wheat stripe and stem rust), the University of Minnesota (on barley stem rust and oat leaf rust), ARS-USDA (on wheat stem rust), the University of Sydney, Australia (on wheat stem rust), and the Norwegian University of Life Sciences (on wheat stripe rust). Nationally they conducted rust projects in collaboration with CenGen, ARC-SG, Sensako, Corteva Agriscience, Link Seed and Seed Co.

Dr Willem Boshoff and collaborators visiting a wheat rust nursery at the Corteva Research Farm outside Greytown, KwaZulu Natal

Prof Visser was involved in research projects with researchers from the Department Plant Pathology, University of Minnesota (on wheat stem rust) and the John Innes Centre, United Kingdom (on wheat stripe rust). At national level, he collaborated with researchers at the ARC-SG.

Dr Ngara continued with her international collaboration with Dr Stephen Chivasa from Durham University on the Newton Advanced Fellowship-Royal Society grant, and also spent five weeks on a research visit to Dr Chivasa's laboratory. Nationally, Dr Ngara collaborated with Dr Nemera Shargie, and Dr Toi Tsilo, from ARC-SG on project funded by the NRF-Thuthuka.

Dr Rudo Ngara at Durham University, UK

Dr Jackson collaborated with Mrs Elmarie van Rensburg from the National Museum in Bloemfontein on the use of molecular systematics to investigate the phylogenetic relationships of genera in the family Aizoaceae.

Prof Scott and Dr Van Aardt collaborated with Dr Piet-Louis Grundling from Working for Wetlands at the Department of Environmental Affairs in order to obtain palaeo-reconstructions of the environments in the Grassland-Savanna transition. Prof Scott and Dr Van Aardt are also involved in a number of ongoing research projects with international collaborators on, including:

- Florisbad (Dr Michael Toffolo, Bordeaux Montaigne University)
- Namib Desert (Prof George Brook, University of Georgia)
- The search for cryptotephra in a fossil pollen sequences in Africa (Prof Cutis Marean, State University, Phoenix, Arizona)
- Dr Magdalena Sobol (University of Toronto) on *Acacia*-type (*Vachellia* and *Senegalia*)] pollen morphology
- Pollen analyses of Western Cape Province (Prof Carlos Cordova [University of Oklahoma] and Dr Andy Carr [Leicester University])

Dr Komoreng collaborated with Dr Nomampondomise Mofokeng (UFS Department of Chemistry, Qwaqwa Campus) and Dr Saheed Sabiu (UFS Department of Microbial, Biochemical and Food Technology), Prof Oriel Thekisoe and Prof Rialet Pieters (North-West University), Prof Philisiwe Nomngongo (University of Johannesburg), Prof Roger Coopoosamy (Mangosuthu University of Technology), Dr Buyisile Mayekiso (University of Fort Hare) and Mr Meshack Mofokeng (ARC-Vegetable and Ornamental Plants [ARC-VOP])

During the course of 2019, a number of collaborative agreements were signed and became operational. These included:

- An agreement on research collaboration was reached between Dr Potgieter and Introlab (SA) to evaluate the bio-stimulant properties of Xcell Boost on different crops under certain stress conditions.
- The official Memorandum of Understanding (MoU) between Grain SA and the UFS (Plant Sciences) was signed for administrating the South African Sclerotinia Research Network (SASRN). Lisa Rothmann is the chairperson driving the Network, which is composed of a community of practice and a research consortium. Academia, industry members and producers are the cornerstone of this Network. The SASRN had its official launch and website release (www.sclerotinia.co.za) in September 2019. The three key issues on which the SASRN will focus are: (i) generating a centre of excellence and expertise, (ii) the role South Africa can play in the Sclerotinia research arena internationally, and (iii) developing and communicating practical management strategies for diseases caused by Sclerotinia for our local producers. The latter focus point is reliant on driving parallel, comprehensive and cohesive research to benefit multiple investigators and the public to which the SASRN is committed. The principle investigators of the research consortium, situated at the UFS, include Dr Adré Minnaar-Ontong (Plant Breeding) and Lisa Rothmann (Plant Pathology).
- Lisa Rothmann and Dr Edson Ncube, from the ARC-GC, signed the official MoU for sorghum research focusing on grain mold and foliar diseases. Prof Neal McLaren is the mentor for the project, providing supervision to Lisa Rothmann on administrative, postgraduate and research related matters. Field trials are conducted in KwaZulu-Natal where bi-weekly screenings for foliar diseases are observed. Future research aims to provide risk forecasting models for potential disease risk periods. Lindy Rose from Stellenbosch University will also be involved in this study and will provide valuable mentorship and practical guidance on mycotoxin extractions and analyses of the sorghum grain. Thabiso Masisi is the master's student who is working with these collaborators.
- A collaboration agreement was signed between UFS and the Western Cape Department of Agriculture in 2019.

During July 2019, the Department of Plant Sciences hosted Prof Britt Bousman (Texas State University), Dr Kristen Wroth (University of Tuebingen) and Dr Michael Toffolo (Bordeaux Montaingne University), who focused on different aspects of archaeology at Lovedale in the Free State as part of ongoing collaboration between the UFS, the National Museum and the three universities abroad. Individuals from this collaboration study different environmental proxies (plant and faunal fossils) and archaeological finds.

The group of Quaternary scientists
Front from the left: Dr Brigette Cohen (National Museum), Dr Andri van Aardt (UFS), Prof Britt Bousman (Texas State University)
Middle from the left: Dr Kristen Wroth (University of Tuebingen) and Dr Lloyd Rossouw (National Museum)
Back from the left: Prof Louis Scott (UFS), Prof Maitland Seaman (UFS) and Dr Michael Toffolo (Bordeaux Montaingne University)

Prof Simon Krattinger and Dr Jan Bettgenhaeusar from Kaust University visited the UFS in September 2019. They toured greenhouse and rust laboratory facilities followed by a field trip to trials planted outside Greytown, KwaZulu-Natal.

Prof Robert Park, Head of Cereal Rust Research at the Plant Breeding Institute of the University of Sydney, visited the Department in October 2019 to discuss collaborative research opportunities.

Prof Robert Park (centre) with Prof Botma Visser (left) and Dr Willem Boshoff (right)

POSTGRADUATE STUDENTS

During 2019, a total of 11 Honours, 49 master's and 53 doctoral students were enrolled for postgraduate studies in Plant Sciences.

At the 2019 graduations, five students graduated with the BScHons majoring in Botany (three on the Bloemfontein Campus and two on the Qwaqwa Campus) and one student graduated with the BScHons in Agriculture majoring in Plant Pathology.

Three students graduated with the MSc (Agriculture):

- Roeléne Marx (Plant Breeding)
- Tondani Mishasha (Plant Breeding – with distinction)
- Whelma Mphela (Plant Breeding – with distinction)

A further 11 students graduated with the MSc:

- Harlod Kaondo (Plant Breeding – with distinction)
- Hilda Shawa (Plant Breeding)
- Sifiso Nzama (Plant Breeding)
- Marlese Bester (Plant Health Ecology)
- Mamosa Ngcala (Botany [Qwaqwa Campus] – with distinction)
- Nhlakanipho N Mdletshe (Botany [Qwaqwa Campus])
- Rinette Labuschagne (Botany [Bloemfontein campus])
- Selloane Lehasa (Botany [Qwaqwa Campus])
- Sellwane Moloi (Botany [Qwaqwa Campus])
- Thulani Mthombeni (Botany [Bloemfontein Campus])
- WC Heppell (Botany [Bloemfontein Campus])

Ten candidates from the Department of Plant Sciences graduated with the PhD in 2019 – six in Plant Breeding, three in Plant Pathology, and one in Botany. They were:

Akhtar, Sajjad
Thesis: Heritability and expression of iron and zinc concentration in maize under abiotic stress conditions in South Africa (PhD in Plant Breeding)
Promoter: Prof MT Labuschagne

Allemann, Anette
Thesis: The effect of herbicide formulations and soybean genotype on the relationship between beneficial organisms and root pathogens (PhD in Plant Pathology)
Promoter: Prof WJ Swart

Amah, Delphine Mutanga
Thesis: Genetic variability of carotenoids and polyploidy induction towards vitamin A biofortification in plantain (*Musa* spp.) (PhD in Plant Breeding)
Promoter: Prof MT Labuschagne

Chung, Hung-Yu
Thesis: The influence of sorghum physiology on rhizosphere interactions and their effect on root disease (PhD in Plant Pathology)
Promoter: Prof WJ Swart

Goche, Tatenda
Thesis: Characterisation of the physiological, biochemical and molecular responses of sorghum to drought stress (PhD in Botany – Qwaqwa campus)
Promoter: Dr R Ngara

Mbuma, Ntombokulunga Wedy
Thesis: Evaluating families and breeding values of parental populations in sugarcane (PhD in Plant Breeding)
Promoter: Prof MM Zhou

Müller, Olaf
Thesis: Integration of diverse maize germplasm pools base on genomic and henotypic analyses (PhD in Plant Breeding)
Promoter: Prof MT Labuschagne

Ndoro, Oswell Farayi
Thesis: Use of exotic germplasm to enhance the performance of local maize (PhD in Plant Breeding)
Promoter: Prof MT Labuschagne

Smit, Armand
Thesis: Yield stability of edamame (*Glycine max* L.) introductions under South African production conditions (PhD in Plant Breeding)
Promoter: Dr R van der Merwe

Van Rooyen, Danelle
Thesis: Relationship between sorghum plant and grain characteristics, colonisation by mycotoxigenic *Fusarium* spp. and mycotoxin levels (PhD in Plant Pathology)
Promoter: Prof NW McLaren

POSTDOCTORAL RESEARCH FELLOWS

Dr Howard Castelyn (from South Africa) was appointed as a postdoctoral research fellow in the laboratory of Prof Visser to continue with the bio-informatic analysis of the adult wheat-stem rust interaction.

Three postdoctoral research fellows were affiliated to the SMEG in 2019, namely Dr Makomborero Nyoni from Zimbabwe, Dr Alejandra Lopez from Colombia and Dr Marcelo Sandoval-Denis.

Dr Neila Abdi, from Tunisia, completed her first year as postdoctoral research fellow as part of the SARChI Chair on Disease Resistance and Quality of Field Crops, working on the influence of abiotic stress on gluten protein in wheat.

Under the supervision of Dr Steenhuisen on the Qwaqwa Campus, Dr Nicholas Le Maitre (from South Africa) focused on the introgression between native and exotic *Celtis* species, the use of acoustics to assess bird diversity of wetlands in Golden Gate Highlands National Park, and the population genetics of rare *Protea* species, in collaboration with the Department of Zoology and Entomology and the ARU.

STAFF MATTERS

Dr Adré Minnaar-Ontong, Lintle Mohase and Dr Rouxléne van der Merwe were promoted to Senior Lecturer positions in the Department and Dr Tom Ashafa (Qwaqwa Campus) was promoted to Associate Professor.

Dr Ansori Maré was appointed as Junior Lecturer in Plant Breeding and Dr Ntombokulunga (Ntombi) Mbuma was appointed as Lecturer in Plant Breeding (as part of the SARChI Chair). Dr Pheello Mojau was appointed as Lecturer in Plant Sciences on the Qwaqwa Campus. He was previously a Professional Officer in the Department.

Ms Lumka Mbingeleli was appointed as Senior Assistant Officer. Ms Nelmari Janse van Rensburg, Senior Assistant Officer, and Dr Lisa Komoreng, Senior Lecturer on Qwaqwa Campus, resigned during 2019 and Dr Marieta Cawood (Lecturer, Botany) and Ms Sadie Geldenhuys (Officer, Plant Breeding) both retired in December 2019.

Dr Gerhard Potgieter received a 35-year service award from the UFS, while both Prof Maryke Labuschagne and Prof Botma Visser received 30-year service awards.

RESEARCH OUTPUTS

Research Articles

Ahmad, T., Cawood, M.E., Iqbal, Q., Ariño, A., Batool, A., Tariq, R.M.S., Azam, M. & Akhtar, S. 2019. Phytochemicals in *Daucus carota* and their health benefits - Review Article. *Foods* 8: 424.

Akinnuoye-Adelabu, D.B., Steenhuisen, S. & Bredenhand, E. 2019. Improving pea quality with vermicompost tea and aqueous biochar: Prospects for sustainable farming in Southern Africa. *South African Journal of Botany* 123: 278-285.

Amah, D., Alamu, E., Adesokan, M., Van Biljon, A., Maziya-Dixon, B., Swennen, R. & Labuschagne, M. 2019. Variability of carotenoids in a *Musa* germplasm collection and implications for provitamin A biofortification. *Food Chemistry X* 2: 100024.

Amah, D., Van Biljon, A., Brown, A., Perkins-Veazie, P., Swennen, R. & Labuschagne, M. 2019. Recent advances in banana (*Musa* spp.) biofortification to alleviate vitamin A deficiency. *Critical Reviews in Food Science and Nutrition* 59: 3498-3510.

Amah, D., Van Biljon, A., Maziya-Dixon, B., Labuschagne, M. & Swennen, R. 2019. Effects of *in vitro* polyploidization on agronomic characteristics and fruit carotenoid content; Implications for banana genetic improvement. *Frontiers in Plant Science* 10: 1450.

Birkenfeld, M., Horwitz, L.K., Bar-Yosef Mayer, D.E., Bond, J., Guttmann-Bond, E., Cummings, L.S., Goldgeier, H., Krakovsky, M., Natalio, F., Nebenhaus, K., Neumann, F.H., Porat, N., Scott, L., Simmons, T., Yashuv, T. & Avner, U. 2019. Investigations at Naḥal Roded 110: A Late Neolithic ritual site in the southern Negev. *Antiquity* 93(367): e4. DOI10.15184/aqy.2019.6.

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Boshoff, W.H.P., Bender, C.M. & Pretorius, Z.A. 2019. Reaction of South African rye, triticale and barley forage cultivars to stem and leaf rust. *South African Journal of Plant and Soil* 36(2): 77-82.

Boshoff, W.H.P., Bender, C.M. & Pretorius, Z.A. 2019. The value of field ratings of differential lines for pathotyping *Puccinia graminis* f. sp. *tritici*. *European Journal of Plant Pathology* 155(1): 349-352.

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Conference Contributions

Conference Papers/Posters

Achilonu, C., Gryzenhout, M. & Marais, G.J. 2019. *Alternaria spp. associated with anthracnose and leafspot on pecans in South Africa.* Paper delivered at the 51st Congress of the Southern African Society for Plant Pathology, Langebaan, South Africa. 20-24 January 2019.

Adams, L.D., Martin, G., Clark, V.R. & S. Steenhuisen. 2019. *Following the fate of seeds to investigate the spread of invasive Pyracantha angustifolia (Firethorn) in the eastern Free State, South Africa.* Paper delivered at the Annual Conference of the The National Symposium on Biological Invasions, Tulbagh, South Africa. 15-17 May 2019.

Adams, L.D., Martin, G., Clark, V.R. & S. Steenhuisen. 2019. *Reproductive ecology of the invasive firethorn species, Pyracantha angustifolia (Rosaceae), in the eastern Free State Province.* Poster presented at the 45th Annual Conference of the South African Association of Botanists, Johannesburg, South Africa. 8-11 January 2019.

Adams, Z., Thekisoe, M.M.O. & Komoreng, L.V. 2019. *An ethnobotanical survey of traditional medicinal plants used against elephantiasis in the OR Tambo District, Eastern Cape.* Poster presented at the 45th Annual Conference of the South African Association of Botanists, Johannesburg, South Africa. 8-11 January 2019.

Bender, C.M., Boshoff, W.H.P. & Pretorius, Z.A. 2019. *The impact of new races of Puccinia graminis f. sp. tritici on South African wheat cultivars.* Paper delivered at the 51st Congress of the Southern African Society for Plant Pathology, Langebaan, South Africa. 20-24 January 2019.

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Cawood, M.E. & Saba, L. 2019. *Bioactivity of Artemisia afra essential oil and extracts and their ability to reduce disease symptoms in wheat caused by the Russian wheat aphid.* Paper delivered at the 12th International Congress of Plant Biotechnology and Agriculture, Caya Guillermo, Cuba. 27-31 May 2019.

Cawood, M.E. & Saba, L. 2019. *The impact of Agave attenuata extracts on biotic resistance responses of wheat and their ability to act as repellents/insecticides against the Russian wheat aphid.* Paper delivered at the 4th International Conference on Plant Science & Physiology, Sydney, Australia. 25-26 March 2019.

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Coertzen, J., Gryzenhout, M., Slippers, B. & Marais, G.J. 2019. *Botryosphaeriaceae fungal pathogens associated with pecans, with special reference to Neofusicoccum parvum*. Poster presented at the 51st Congress of the Southern African Society for Plant Pathology, Langebaan, South Africa. 20-24 January 2019.

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Labuschagne, M.T., Töth, B. & Van Biljon, A. 2019. *Proteomic analysis of wheat seed in response to low nitrogen and phosphorous stress.* Paper delivered at the 1st International Wheat Congress, Saskatoon, Canada. 21-26 July 2019.

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Liu, Y., Minnaar-Ontong, A. & Labuschagne, M.T. 2019. *Wbm: a gene link to bread making quality in South Africa wheat?* Poster presented at the 1st International Wheat Congress, Saskatoon, Canada. 21-26 July 2019.

MacDonald, S., Oosthuizen, G., Marais, G. & Cawood, M.E. 2019. *A comparative study of the chemical composition and bioactivity of extracts from leaves of two Pecan nut cultivars grown in South Africa.* Paper delivered at the 12th International Congress of Plant Biotechnology and Agriculture, Caya Guillermo, Cuba. 27-31 May 2019.

Maré, A., Herselman, L. & Boshoff, W.H.P. 2019. *Development of wheat lines with complex resistance to rusts and Fusarium head blight.* Poster presented at the 1st International Wheat Congress, Saskatoon, Canada. 21-26 July 2019.

Masisi, T.V., Rothmann, L., Bender, C.M., Maree, G.J. & Boshoff, W.H.P. 2019. *Comparative virulence of stripe rust pathotype 6E22A+ and field isolate GWK2015_56.* Paper delivered at the Cereal Science and Technology SA 3rd New Voices Symposium, Pretoria, South Africa. 11 September 2019.

Masisi, T.V., Rothmann, L., Bender, C.M., Maree, G.J. & Boshoff, W.H.P. 2019. *Resistance response of irrigation wheat cultivars to stripe rust under different temperature regimes.* Poster presented at the South African National Seed Organisation Annual Conference, Umlazi, South Africa. 21-24 May 2019. [First prize poster presentation].

Mbuma, N.W., Zhou, M.M. & Van der Merwe, R. 2019. *Family by environment interactions for sugarcane yield in South Africa*. Paper delivered at the 92nd South African Sugar Technologists' Association Congress, Durban, South Africa. 20-22 August 2019.

Mdletshe, N.W., Thekisoe, M.M.O. & Komoreng, L.V. 2019. *Comparison on pharmacological activity of Rhoicissus tomentosa and Rhoicissus tridentata for the treatment of elephantiasis in South Africa.* Paper delivered at the 45th Annual Conference of the South African Association of Botanists, Johannesburg, South Africa. 8-11 January 2019.

Meiring, M.C. & McLaren, N.W. 2019. *Screening for tolerance to Sclerotinia sclerotiorum in soybean cultivars.* Paper delivered at the Third Annual New Voices Symposium, Pretoria, South Africa. 11 September 2019.

Meyer, W.B., Boshoff, W.H.P., Minnaar-Ontong, A. & Visser, B. 2019. *Phenotypic and genotypic variation of Puccinia helianthi in South Africa.* Paper delivered at the 51st Congress of the Southern African Society for Plant Pathology, Langebaan, South Africa. 20-24 January 2019.

Minnaar, H., Prins, R., Bender, C.M., Maree, G.J. & Boshoff, W.H.P. 2019. *Phenotypic expression of stripe rust resistance using spray and point inoculation.* Poster presented at the 51st Congress of the Southern African Society for Plant Pathology, Langebaan, South Africa. 20-24 January 2019.

Mishasha, T., Zhou, M.M. & Van der Merwe, R. 2019. *Using quantitative genetic parameters to determine sample size for sucrose content in sugarcane breeding.* Paper delivered at the 92nd South African Sugar Technologists' Association Congress, Durban, South Africa. 20-22 August 2019.

Mohase, L., Adendorff, J. & Jankielsohn, A. 2019. *Foliar application of Alexin™ selectively enhances defence responses to Russian wheat aphid, Diuraphis noxia.* Paper delivered at the Joint Conference of the South African Association of Botanists,

Southern African Society for Systematic Biology and African Mycological Association, Johannesburg, South Africa. 8-11 January 2019.

Myburgh, P.P., Maré, A. & Boshoff, W.H.P. 2019. *Phenotypic and genotypic characterisation of South African winter wheat cultivars for stem rust resistance*. Paper delivered at the Annual Postgraduate Symposium of the Department of Botany and Plant Biotechnology, University of Johannesburg, Johannesburg, South Africa. 3-4 November 2019.

Ngara, R., Goche, T. & Chivasa, S. 2019. *Comparative physiological, biochemical and proteomic analysis of two sorghum varieties in response to drought stress*. Poster presented at the Plant Cell and Environment 40th Anniversary Symposium, University of Glasgow, Scotland. 4-6 September 2019.

Ngara, R., Goche, T. & Chivasa, S. 2019. *Sorghum as a model system in plant stress biology: lessons learnt from drought response studies*. Paper delivered at the Connecting Minds Africa Conference, Nairobi, Kenya. 25-27 September 2019.

Ngara, R., Ngcala, M.G., Moloi, S.J., Goche, T., Shargie, N.G. & Chivasa, S. 2019. *Comparative molecular analysis of sorghum in response to abiotic stresses*. Paper delivered at the 45th Annual Conference of the South African Association of Botanists, Johannesburg, South Africa. 8-11 January 2019.

Ngcala, M.G., Chivasa, S. & Ngara, R. 2019. *High temperature stress triggers molecular responses in sorghum cell suspension cultures.* Paper delivered at the 45th Annual Conference of the South African Association of Botanists, Johannesburg, South Africa. 8-11 January 2019.

Pretorius, Z.A. 2019. *Are cereal rusts still important?* Invited keynote delivered at the 51st Congress of the Southern African Society for Plant Pathology, Langebaan, South Africa. 20-24 January 2019.

Prins, R., De Klerk, C., Boshoff, W.H.P., Abbrouk, M., Bettgenhaeuser, J., Minnaar, H., Pretorius, Z.A., Doležel, J., Šimková, H., Wessels, E., Horn, M. & Krattinger, S.G. 2019. *Pursuing the partial stripe rust resistance QYr.sgi-4A.1 gene of the wheat cultivar Kariega*. Poster presented at the Plant and Animal Genome Conference XXVII, San Diego, USA. 12-16 January 2019.

Rothmann, L.A., Bester, M.C., Steyn, C. & McLaren, N.W. 2019. *A community of practice: modelled on Sclerotinia stem rot of soybean.* Paper delivered at the 51st Congress of the Southern African Society for Plant Pathology, Langebaan, South Africa. 20-24 January 2019.

Rothmann, L.A., McLaren, N.W., Dos Santos Alves, K. & Del Ponte, E.M. 2019. *A quantitative summary of a 10-year survey of white mold prevalence in South Africa.* Paper delivered at the Third Annual New Voices Symposium, Pretoria, South Africa. 11 September 2019.

Ruiz-Hernández, V., Joubert, L., Rodríguez-Gómez, A., Terry, P.M.J., Weiss, J., Bielza, G.B.J. & Egea-Cortines, M. 2019. *Visual traits override scent cues in Bombus terrestris floral selection.* Poster presented at the New Phytologist Next Generation Scientists Symposium, Dublin, Ireland. 22-25 July 2019.

Scott, L., Gil-Romera, G., Neumann, F.H., Sobol, M., Horwitz, L.K., Van Aardt, A. & Fernandez-Jalvo, Y. 2019. *Diverse modes of pollen taphonomy and late Quaternary palaeo-environments in the Kalahari.* Paper delivered at Session: Wonderwerk Cave and Related Research Projects in the Northern Cape Province, Association of Southern African Professional Archaeologists, Kimberley, South Africa. 2-4 July 2019.

Semu, E., Gryzenhout, M. & Marais, G.J. 2019. *Chaetomium species associated with pecans in South Africa.* Poster presented at the 51st Congress of the Southern African Society for Plant Pathology, Langebaan, South Africa. 20-24 January 2019.

Siwale, J., Gerrano, A., Labuschagne, M.T., Van Biljon, A. & Lebaka, N. 2019. *Variation in Fe, Zn, protein and anti-nutritional contents in Bambara groundnut (V. subterranea) accessions*. Paper delivered at the First African Plant Breeders Conference, Accra, Ghana. 23-25 October 2019.

Theron, N., Gryzenhout, M., Swart, W.J. & Marais, G.J. 2019. *Cladosporium cladosporioides, causative agent of pecan scab in South Africa.* Poster presented at the 51st Congress of the Southern African Society for Plant Pathology, Langebaan, South Africa. 20-24 January 2019.

Tiwani, T., Pieters, R., Horn, S., Thekisoe, O.M.M. & Komoreng, L.V. 2019. *Phytochemical screening, antimicrobial activity aand cytotoxicity of Platycarpha glomerata and Tulbaghia alliacea used in the treatment of lymphatic filariasis in the Eastern Cape, South Africa*. Paper delivered at the 6th World Congress on Medicinal and Aromatic Plants, Famagusta, Northern Cyprus. 13-17 November 2019.

Töth, B., Van Biljon, A., Ammar, K., Sipos, P., Győri, Z., Guzmán, C. & Labuschagne, M.T. 2019. *Variability in mono- and polymeric proteins in a worldwide collection of commercial durum wheat cultivars and correlations with alveograph W and P/L.* Paper delivered at the 1st International Wheat Congress, Saskatoon, Canada. 21-26 July 2019.

Van Aardt, A.C., Du Preez, P.J. & Scott, L. 2019. *Major plant communities and physical environment in the catchments of the putative palaeo-Kimberley and palaeo-Modder Rivers, Free State South Africa*. Paper delivered at the 16th Biodiversity Research Symposium, Kimberley, South Africa. 18 September 2019.

Van Aardt, A.C., Scott, L., Theron, E.J., & Rossouw, L. 2019. *Charred cuticles in Tswaing crater lake deposits: A palaeoenvironmental indicator?* Paper delivered at the XXII Biennial Congress of the South African Society for Quaternary Research, Mossel Bay, South Africa. 28-31 January 2019.

Van Biljon, A., Miles, C.W., Booyse, M. & Labuschagne, M.T. 2019. *Mixsmart parameters as possible indicators of bread making quality in wheat cultivars adapted to the South African dryland summer rainfall areas*. Paper delivered at the 1st International Wheat Congress, Saskatoon, Canada. 21-26 July 2019.

Visser, B., Meyer, M., Park, R.F., Gilligan, C.A., Burgin, L.E., Hort, M.C., Hodson, D.P. & Pretorius, Z.A. 2019. *Out of Africa to Down-Under: a study on the proposed inter-continental movement of wheat stem rust*. Paper delivered at the 51st Congress of the Southern African Society for Plant Pathology, Langebaan, South Africa. 20-24 January 2019.

Voua Otomo, L., Sabiu, S., Thekisoe, M.M.O. & Komoreng, L.V. 2019. *Investigation of antimicrobial properties from plants used in the treatment of non-filarial elephantiasis in KwaZulu-Natal, South Africa.* Paper delivered at the 45th Annual Conference of the South African Association of Botanists, Johannesburg, South Africa. 8-11 January 2019.

Voua Otomo, L., Sabiu, S., Thekisoe, M.M.O. & Komoreng, L.V. 2019. *Phytochemical analysis and anti-oxidant properties from plants used in the treatment of non-filarial elephantiasis in KwaZulu-Natal, South Africa.* Paper delivered at the 6th World Congress on Medicinal and Aromatic Plants, Famagusta, Northern Cyprus. 13-17 November 2019.

Conference Proceedings

Labuschagne, M.T. 2019. Proteomics in wheat gluten research: where are we standing and where are we going? In: *Proceedings of the 13th International Gluten Workshop*. Mexico City, Mexico, 14-17 March 2018. C.Guzman (Ed). University of Cordoba Press. pp. 11-13.

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STAFF (2019)

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 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 ME Cawood, Dr M Jackson, Dr L Joubert, Dr NW Mbuma and Dr AC van Aardt

Lecturer (units): Ms LA Rothmann

Junior Lecturer: Dr A Maré

Affiliated Professors: Prof PW Crous and Prof PKW Ng

Affiliated Associate Professor: Prof M Zhou

Research Associates: Prof PJ du Preez, Prof NW McLaren, Prof ZA Pretorius, Dr R Prins, Dr L Rossouw, Dr A Venter and Prof JHT Venter

Mentor: Prof L Scott

Programme Director: Prof B Visser

Chief Officer - Professional Services: Ms CM Bender

Officers - Professional Services: Ms M Pienaar and Mr HP Pretorius

Senior Assistant Officers: MP Ms Mbingeleli and Dr C Steyn

Officer: Ms S Geldenhuys

Assistant Officer: Ms Z van der Linde

Messenger: Mrs D Jansen

Cleaners: Mrs NH Dlamini, Mrs NS Macwili and Mrs LHA Molale

Qwaqwa Campus

Associate Professor: Prof AOT Ashafa

Senior Lecturers: Dr LV Komoreng (Subject Head – resigned) and Dr S Steenhuisen

Lecturers: Dr PJ Mojau, Dr R Ngara and Mr RT Pitso

Academic Facilitator: Ms D Mosea

Research Associate: Prof RO Moffett

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DEPARTMENT OF

ZOOLOGY AND ENTOMOLOGY

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OVERVIEW OF 2019

During 2019, numerous fieldtrips were conducted by the different research groups – to the outskirts of Bloemfontein, eastern and western Free State, Mpumalanga, KwaZulu-Natal and even to Antarctica. Colleagues from abroad also joined us on some of these scientific adventures. We collaborated with the Department of Environment, Forestry and Fisheries (DEFF), Free State Department of Economic, Small Business Development, Tourism and Environmental Affairs (DESTEA), South African Institute of Aquatic Biodiversity (SAIAB), as well as a number of South African universities.

Hennie Butler was part of a multidisciplinary research project involving researchers from Zoology and Entomology, Animal, Wildlife and Grassland Sciences, Division of Virology, Department of Genetics, Biochemistry Division, Food Science Division, Microbiology Division and the SAENSE Platform, which focused on various aspects of rhino conservation. The aim of this collaboration is to create a model for conservation via research and education to be used as an example for other countries. This model includes students, academics, professionals, sponsors and stakeholders and covers various topics relating to rhino management, conservation and education.

Div Fourie conducted fieldwork and bio-assays in the Nelspruit region on macadamia nuts, investigating synthetic pyrethroid resistance development in the stinkbug complex, which is severely damaging sub-tropical fruits and nuts in that region. The main aim is to help growers to manage the increasing pesticide resistance. Two new projects will be launched early in 2020 on walnut orchards in the Free State, where two invasive and highly damaging scale species have been identified. The primary aim will be to use modern integrated and biological methods in line with Integrated Pest Management (IPM) practices, to investigate management options.

During December, Prof Charles Haddad and Dr Vaughn Swart hosted a team of four international researchers to conduct fieldwork in northern KwaZulu-Natal and in the Free State, sampling jumping spiders for research on the evolution of colour vision in this group, and its ecological and behavioural implications, particularly with regard to red colouration.

At the Qwaqwa Campus, the Department had a shared ecology field-trip for third-year students from Qwaqwa Plant Sciences. The field trip, in the Golden Gate Highlands National Park (GGHNP), provided opportunities for learning and encounters with the local wildlife.

The Vertebrate Blood Parasitology research group, based on the Qwaqwa Campus, has started to expand their research so that it became increasingly multidisciplinary. Michelle van As and Dr Johann van As conducted research together with several colleagues from North-West University (NWU) – Potchefstroom Campus. Michelle's work focused on the biological conservation of leopards, their blood parasites and associated vectors and life cycles, as well as organochlorine contamination. She presented the work at two international conferences during 2019 and her research has caused quite a stir in both the ecotoxicology and blood parasite audiences.

Prof Aliza le Roux's Mammal Cognition research team spent time in the field, concentrating on the GGHNP, where they deployed a camera trap grid as part of a regional collaboration with Snapshot Safari. Unfortunately, almost half of the camera traps were stolen and they are working on schemes to circumvent this problem in future. The team also collected data on acoustically active species in a high-altitude wetland, along a rolling grid in the fire-prone grassland. This forms the basis of an exciting new collaboration with the Okinawa Institute of Science and Technology in Japan. Many students in Prof Le Roux's team were busy with their final year of postgraduate studies in 2019, and 2020 should be a significant graduation year on the Qwaqwa Campus!

ACHIEVEMENTS

Staff Achievements

Dr Frank Chidawanyika, a Carnegie Research Fellow, received the Carnegie Cooperation of New York Scholar award at the African Studies Association meeting held in November 2019 in Boston, Massachusetts, where he also served as a panellist on the theme of Climate Change. Dr Chidawanyika received his NRF Y2-rating in June 2019.

Dr Emile Bredenhand (from our Qwaqwa Campus) won a number of awards for his research under the auspices of the Afromontane Research Unit (ARU), including publication with highest impact factor (shared with Dr Patricks Voua Otomo), most publications and the director's achievement award.

Student Achievements

Gerhard de Jager, a PhD student based on the Bloemfontein Campus and supervised by Prof Linda Basson, was invited to participate in the South African National Antarctic Expedition (SANAE) voyage to Antarctica from December 2019 until February 2020. He will form part of the University of Cape Town (UCT) Oceanography team, as Chief Scientist. Gerhard also received the prize for the Best Poster Presentation in Life Sciences at the 56th Meeting of the Microscopy Society of Southern Africa held in Langebaan in December 2019.

Keafon Jumbam, a final-year PhD student supervised by Prof Aliza le Roux on the Qwaqwa Campus, not only won the departmental Flash Fact competition in Qwaqwa, but went on to win the Faculty's competition, the UFS competition, and received third prize in the regional contest. She also won the prize for the best PhD presenter at the Annual Conference of the Zoological Society of Southern Africa (ZSSA), and has already published an article from her PhD.

Alex Botha, another PhD student of Prof Le Roux, took part in a field trip to Botswana with the University of Pretoria's Mammal Research Institute, tracking predators and investigating human-wildlife conflict.

Hendri Stander, an MSc student supervised by Dr Patricks Voua-Otomo, was awarded both the ARU top publication and ARU highest impact factor publication by an MSc student. The paper was also presented at the Society of Environmental Toxicology and Contamination Conference in Toronto, Canada.

Jason Botham, a PhD student jointly supervised by Dr Vaughn Swart and Prof Charles Haddad from the Bloemfontein Campus and Dr Emile Bredenhand from the Qwaqwa Campus, won the ARU award for best PhD student.

Serero Modise won a book prize at a macro-photography workshop which was held at the University of Pretoria.

Christoffel de Lange, a third-year student in the module on Life History Strategies in Arid Environments, won the prize in the Best Assignment Competition among third-year students from our Faculty. The competition was initiated this year by the Library to promote scientific writing among third-year students.

TEACHING

The Department of Zoology and Entomology focuses on a variety of research areas. All of these topics (animal behaviour and etho-ecology, mammal cognition, nematology, aquatic parasitology, wetland ecology, vertebrate hemoparasite biology, conservation ecology, herpetology, tick resistance, arachnology, pest-control and management, insects found in new crops, forensic entomology, dipterology, insect-plant associations, applied agricultural entomology and soil ecology) are incorporated in the undergraduate courses and also serve as baseline for postgraduate projects.

At the Bloemfontein Campus, the Introductory Zoology and Entomology course is taught to an average of 490 first-year students. In the second year, about 100 students are taught on animals of medical and veterinary importance, with a focus on Invertebrates, which is followed by Vertebrate Life and Evolution. The third-year studies consist of Marine and Wetland Ecology, Conservation Ecology, Life strategies of animals in Arid Environments as well as Animal behaviour.

In Entomology, the second-year programme for the 30 to 40 students includes Functional Morphology and Evolution Biology

of insects and Ecophysiology. The third-year programme focuses on Advanced Insect Ecology, Agricultural Entomology with an emphasis on Pest Management, Medical and Veterinary Entomology as well as Applied Insect Biochemistry and Pharmacology. Annually, the student numbers in the third year usually never exceed 10.

On the Qwaqwa Campus, a course in Introductory Zoology and Entomology is taught to an average of 204 first-year students. In the second year, about 50 Zoology students are taught subjects on African vertebrates, Parasitology, Molecular parasitology and Evolution. The second-year Entomology students are lectured in Insect Phyiology, Insect Biodiversity, and in the third year Applied Entomology and Insect Ecology are taught. The third-year Zoology subjects are Ecology and Conservation, Immunology, Evolution, Ecotoxicology as well as Animal Behaviour. All the courses are designed and presented in an African context.

As part of the annual undergraduate student activities, the third-year Zoology students went on their ecology excursion to the Eastern Free State and stayed at Wilgenhof Environmental Education Centre in the GGHNP, whilst the Entomology student excursion took place at the research facility at Bankfontein Farm, Vanderkloof Dam. As part of their module on Evolution, the third-year students went on an excursion to the Sterkfontein Caves and the Maropeng Museum.

The first combined field excursion of the Qwaqwa Botany and Zoology third-year students took place in 2019. Led by Dr Sandy Steenhuisen and Prof Aliza le Roux, the students visited the GGHNP.

Combined Qwaqwa field trip to GGHNP

As part of the Faculty equipment plan, the first-year Biology laboratory received a number of new Zeiss microscopes. Sixty of the compound microscopes have built-in cameras and are attached to iPads. This laboratory is not only used by the first-year Biology students, but also for selected Zoology and Entomology modules, as well as by Plant Sciences.

RESEARCH

Applied Agricultural Entomology

Fieldwork and bio-assays were conducted in the Nelspruit region by Div Fourie, from the Bloemfontein Campus, focusing on macadamia nuts, and continuing with the investigation into pyrethroid resistance developing in the stinkbug complex which is damaging sub-tropical fruit and nuts in the region. This ongoing project is done in collaboration with the Agricultural Research Commission Institute for Tropical and Subtropical Crops (ARC-ITSC) in Nelspruit. A scouting trip was also conducted to Green Valley Nuts at Prieska, with the aim of collecting additional specimens to supplement data collected in previous years. This study was completed, but additional data is needed for publication purposes.

Dr Emile Bredenhand from the Qwaqwa Campus, working in partnership with the Seotlong Agricultural School and the ARC Small Grain (ARC-SG) in Bethlehem, successfully completed various trial experiments to prove ways to enhance agricultural practices using vermicompost, vermitea, earthworm extracts and biochar on variety of crops including soybeans, maize, wheat and sunflowers. Additionally, some Honours projects involved sampling on Elandsrivier Farm, situated between Qwaqwa and Harrismith, focusing on enhancing and analysing insect sampling methods.

Arachnology

During December 2019, Prof Charles Haddad (NRF Y2-rating) hosted a team of international researchers to conduct fieldwork in northern KwaZulu-Natal and the Free State to sample jumping spiders for research on the evolution of colour vision in this group, and its ecological and behavioural implications with regard to red colouration, in particular. Included in this group were Prof Nathan Morehouse and Dr David Outomuro-Priede (University of Cincinnati), Dr Galina Azarkina (Siberian Academy of Sciences) and Mr Kiran Marathe (University of British Columbia). Dr Vaughn Swart (UFS) joined the group for the first part of the trip to collect flies for his research. Part of the fly research was recorded by film crews from Days Edge Productions in the USA (Neil Losin) and Rooted Media in Johannesburg (Barend van der Watt), and will be used in the production of a nature documentary.

The group who visited Ndumo Game Reserve for spider research were David Outomuro-Priede (University of Cincinnati), Mondli Khumalo (filmmaking trainee), Musa Mkhize (Ezemvelo KZN Wildlife), Nathan Morehouse (University of Cincinnati), Vaughn Swart (UFS), Neil Losin (Days Edge Productions), Kiran Marathe (University of British Columbia), Galina Azarkina (Siberian Academy of Sciences) and Barend van der Watt (Rooted Media).

Research team at Ndumo Game Reserve
Standing from the left: David Outomuro-Priede, Mondi Khumalo, Musa Mkhize, Nathan Morehouse, Vaughn Swart, Neil Losin, Kiran Marathe and Galina Azarkina
Front: Barend van der Watt

Aquatic Parasitology

SEAMester is an annual cruise during which 50 postgraduate students selected from all over southern Africa participate in an intensive ten-day ocean sciences experience. During this period, students are involved in daily lectures and practical deck work in marine biology and/or oceanography. Each student also has a research project which is presented at the end of the cruise. SEAmester runs conjointly with the annual Agulhas System Climate Array (ASCA) expedition which collects oceanographic data to better understand the Agulhas Current and its inhabitants.

Three members from the Department of Zoology and Entomology were invited to be part of the SEAmester IV / ASCA cruise on the research vessel *SA Agulhas II*, during July 2019. Prof Linda Basson, as researcher focusing on symbionts of marine organisms, and Gerhard de Jager, lecturing Marine Parasitology, were part of the SEAmester academic staff, while Aneke Kruger (Honours student) was the only student from the UFS to join the other top 50 postgraduate students selected for SEAmester 2019.

Gerhard de Jager and Prof Linda Basson on SEAmester
(Photo credit: Dr Morgan Trimble, MIT/UP)

Prof Linda Basson and Gerhard de Jager were also invited to join the science teams on *SA Agulhas II*, for the annual summer voyage (December 2019 to February 2020) to take the new team to the SANAE base at Antarctica and retrieve the team that had stayed there for the past 14 months.

Prof Linda Basson and Gerhard de Jager on board SA Agulhas II

Repacking gill nets at Xariep Dam, in front from the left, Dr Josi Pegg and Dr Mandla Magoro (from SAIAB) with Luthando Bopheka (UFS), Dr Leon Barkhuizen (DESTEA), and Pieter Swanepoel (Free State Department of Agriculture and Rural Development)

Prof Liesl van As and Luthando Bopheka (PhD student) joined Dr Leon Barkhuizen (DESTEA) and Prof Olaf Weyl (SAIAB) and his students for fieldwork at Xariep.

Dr Johann van As from our Qwaqwa Campus and Dr Courtney Cook (NWU) undertook a week-long survey conducting fieldwork at Sterkfontein Dam. They also joined Dr Leon Barkhuizen and his team during surveys conducted at the Koppies and Bloemhof Dams. The main purpose of these fieldtrips was to collect a diversity of parasites as data for research projects of various postgraduate students. These fieldtrips were a collaborative effort using fishing gear, boats as well as doing microscopy analysis.

Luthando Bopheka (left) and Dr Courtney Cook (NWU) doing fieldwork at Sterkfontein Dam

Conservation Ecology

The GGHNP was the focus of various studies led by Dr Bredenhand, investigating the possibility of using insects and other macroinvertebrates as bioindicators to evaluate the state of the environment, as well as monitoring the success of various conservation practices.

Ecotoxicology Research Group

Dr Patricks Voua Otomo and Michel Kamdem (PhD student), undertook an extended research visit to Bremen University, Germany, sponsored by the Alexander von Humboldt Foundation.

Mbuyiselo Moloi (MSc student) was part of an ARU delegation to Lesotho, led by Dr Ralph Clark, the ARU Director, to scout for industry partners.

Etho-ecology

Various aspects of animal behaviour and ecology related to enzootic geophagy of elephants in Addo Elephant National Park, the taste preference of game species, as well as the effect of dehorning on the behaviour of the southern white rhino, were investigated by the research group led by Mr Hennie Butler.

Environmental Entomology and Dipterology

Dr Vaughn Swart's research focused on the investigation of interspersed arboreal biotopes along different topographical conditions within afromontane grasslands, and their potential as conservation hotspots. Another project concentrated on soil biota as bioindicators of fire disturbances in montane grassland areas within the GGHNP. Phylogenetic analysis of South African *Aedes* Meigen, *Anopheles* Meigen and *Culex* L. (Culicidae) mosquitoes based on *COI*, *ITS2* and *ND4* sequences were undertaken, thus, optimising DNA profiling techniques for the identification of mosquito species in the Free State. In addition, the ecological aspects of fruit flies (Diptera: Tephritidae) on table grapes along the lower Orange River in the Northern Cape, were investigated.

Herpetology

Together with his research team, Prof Neil Heideman (NRF C3-rating), continued to focus on tortoise phylogeny, phylogeography, population genetics, comparative morphology and ecology, with some aspects already published or at an advanced stage of manuscript preparation. Fieldwork was carried out in the Trompsburg area to collect measurement data and blood samples for DNA analyses. The Iziko Museum in Cape Town and Bayworld Museum in Port Elizabeth were visited to obtain morphological data from specimens in their extensive holdings.

Tamson Foster processing museum specimens

In the case of lizards, ecological data was obtained from the Ditsong Museum of Natural History in Pretoria, and some of the data analyses have been completed. This project aims to strengthen our baseline knowledge of the general ecology of these species. Projects dealing with more comprehensive and collective analyses of published DNA sequence data on the acontines (legless lizards) and testudines (tortoises), were initiated. These are aimed at identifying weaknesses and flaws in the data utilised and verifying findings with stronger and reliable datasets, using more robust analyses.

Insect Physiological Ecology

Basal and evolutionary responses to thermal variability were assayed in various pests by Dr Frank Chidawanyika (NRF Y2-rating) and his team. As part of a project seeking to understand their activity at various temporal and spatial scales, field populations of the tomato leafminer were sampled in Tzaneen and Mpumalanga, using pheromone traps. Baseline work to evaluate the impact of *Robinia* on native flora and fauna was undertaken in Clarens (Eastern Free State) in collaboration with the Rhodes University Centre for Biological Control.

Mammal Cognition

Members of the research group, based at the Qwaqwa Campus and led by Prof Aliza le Roux (NRF C2-rating), were very active in the ARU in 2019, with one postdoctoral research fellow (Dr Mpho Ramoejane), one PhD student (Alex Botha), an MSc student (Agnes Mkotywa) and an Honours student (Toka Mosikidi) doing active research on mountain-related topics.

Alex Botha conducted research on jackal behavioural ecology in GGHNP, collecting scat and hair samples and data from radio-collars transmitting movement data to detect responses to changes in light levels. Dr Ramoejane and Toka Mosikidi collected extensive camera-trap data for the Snapshot Serengeti collaboration, and attended an intensive training session on occupancy modelling in R statistics. Agnes Mkotywa's research on the effectiveness of the Golden Gate vulture restaurant will be submitted for publication in 2020, and has already had an impact on the GGHNP management in terms of their conservation planning.

The research group has also commenced a new project on the acoustic diversity of high-altitude wetlands, based on a grant to Prof Le Roux of four song meters (Wildlife Acoustics) and a bat detector. This acoustics project is a novel, non-invasive way of describing the biodiversity of wetlands, and is a collaboration with Dr Sandy Steenhuisen (Plant Sciences, Qwaqwa) which also falls within the ARU's ambit. Prof Le Roux undertook a research visit to Japan in December to start the process of analysing the extensive data already collected. Not content to leave the learning to students alone, she gained some critical skills in GIS data analysis and animal-movement analysis at ESRI (a geographic information system company) in October.

Some of the ARU research undertaken by the Mammal Cognition research group featured on the UFS website: https://www.ufs.ac.za/templates/news-archive/campus-news/2020/january/ufs-scientists-contribute-to-effectiveness-of-vulture-restaurants and https://www.ufs.ac.za/templates/news-archive/campus-news/2020/january/ufs-searches-for-rare-bird-species-white-winged-flufftail

Keafon Jumbam's PhD thesis was based on bat-eared fox research conducted in the Kalahari Desert, and some of her thesis chapters have already been published. Prof Le Roux is also supervising two external students – a master's student at the University of the Witwatersrand started a project on bat-eared fox responses to temperature changes in Tswalu, while her PhD student at the Nelson Mandela University (NMU) is investigating baboon cognitive development in relation to inter-tidal foraging.

Nematology

Dr Candice Jansen van Rensburg and Anke de Smidt attended the 22nd Bi-annual Symposium of the Nematological Society of Southern Africa (NSSA) in Mpumulanga, both presenting on their research related to plant-parasitic and free-living nematodes occurring in nature reserves in the Free State. Dr Jansen van Rensburg also attend the 56th Southern African Society of Aquatic Scientists Conference in Bela Bela with colleagues and students from the Department, all presenting papers. Anke de Smidt and Aneke Kruger undertook monthly visits to the Soetdoring Nature Reserve, for fieldwork on nematodes, which are important indicators of ecosystem health.

Terrestrial Ecology

This is a new research group, established following the appointment of Prof Daryl Codron (NRF C1-rating) in February 2019. The group realised four Honours research projects, resolving mismatches between adaptive physiological traits and diet niches, impacts of size-specific predation on prey populations, and intra- versus inter-specific effects on density-dependent foraging. The studies were undertaken at Florisbad, northwest of Bloemfontein.

From the left, Zimkhitha Mehlomakhulu, Prof Daryl Codron and Rune van der Merwe marking and releasing rats at Florisbad as part of an ecology study

During 2019, the group published one book chapter and six journal articles, including one in *Current Biology* about the nutritional ecospace of the ever-appealing panda, and Dr Codron presented a paper at the annual Ecological Society of America Congress.

Laboratory equipment for the preparation of biological materials for stable isotope analysis was secured, so that current and future students gain experience in this increasingly-widespread approach to ecology. Projects investigating an 'excess' of niche partitioning in some highly diverse communities (i.e. more than required to maintain species' coexistence), and life history traits that drive the evolution of individual niche specialisation, were initiated, to come to fruition in 2020.

Tick Research Unit

Research undertaken in the Tick Research Unit included evaluation of results from the tick collections, which have been sent in from various parts of South Africa over the past 12 years, to indicate the evolution of tick resistance to three main acaricides. Although two of the acaricide groups indicated high tick resistance, one showed a possible reversion back to susceptibility. A continuation of the monitoring for the presence of tick resistance against these commercially available acaricides, to keep track of the tick resistance development or reversion, has been ongoing.

The invasion of the Asiatic Blue tick *(Rhipicephalus microplus*) on a commercial farm near Makhanda in the Eastern Cape, was investigated. Contrary to reports from communal farming systems, a rapid invasion of this alien tick species was not found on the investigated commercial farm. Investigation for the presence of the pathogen *Babesia bovis*, which is transmitted by this tick species, and which causes Asiatic Red water in cattle, was continued. A system for the testing for blue tick resistance against Macrocyclic lactones, an injectable remedy for blue tick control, was successfully developed and described in the dissertation of Kenny Lesenyeho. Although adequate control was still seen in field conditions, subclinical resistance started to show on some farms investigated in the Eastern Cape province.

Vertebrate Haemoparasite Biology

The research group of Dr Johann van As and Michelle van As, focuses on the blood parasite biology of mostly reptiles and mammals, with a specific focus on malaria-like parasites, their vector interactions, life cycle biology and ecotoxicological effects on parasite burdens.

Dr Johann van As (left) and Luthando Bopheka collecting lizards at the Sterkfontein Dam

Their research also aims to describe new species and investigate other health aspects of the vertebrate hosts involved. Two new blood parasite species infecting leopards have been described, with the publication currently in press. This year a new haemogregarine life cycle between a leopard and a tick was discovered. Successful collaboration between the research group and members of the Qwaqwa Botany Department also resulted in a publication.

Michelle van As (UFS) and Marelize Labuschagne (NWU) attending the World Association for the Advancement of Veterinary Parasitology Conference (Madison, USA)

ENGAGED SCHOLARSHIP

As the assistant project manager of the South African National Survey of Arachnida (SANSA), Prof Charles Haddad was heavily involved in the preparation of the first Red List of South African spiders, which was completed in 2019. As part of this process, approximately 2 253 species of spiders recorded from South Africa were evaluated according to the International Union for Conservation of Nature (IUCN) criteria, and a document prepared for each species, with comprehensive information of its taxonomic history, distribution (map and georeferenced records), biology, photographs, etc. This information will be available on the South African National Biodiversity Institute (SANBI) webpage. A review paper on the conservation status of the South African fauna, based on this work, was recently accepted for publication in *Journal of Arachnology.*

PhD candidate, Hannelene Badenhorst, was invited by the No-Till Club of KwaZulu-Natal to speak at the 2019 No-Till Conference held from 3 to 5 September. The focus of her presentation was to promote arthropod diversity in agriculture and inform farmers on its benefits, i.e. ecosystem services provided.

Hennie Butler presented a talk the Free State Hunter's Organisation about rhino poaching and the way forward.

The Tick Research Unit, under the guidance of Ellie van Dalen, regularly tests Blue tick collections from commercial and communal areas to determine the tick acaricide resistance profiles for a specific farm or area and to make recommendations for resistance management. Testing of dip sample concentrations to assure correct dip treatment of cattle for control of cattle ticks to prevent development of tick resistance is also done by them.

Dr Frank Chidawanyika was invited to present a talk at SANBI, Bloemfontein, on their work on the biological control of *Acacia pseudocacia* (Black locust) in Qwaqwa, which they conduct in collaboration with Centre for Biological Control at Rhodes University.

Dr Patricks Voua Otomo and his students, Ayanda Sithebe, Pregent Matsleleng Semase, Mbuyiselwa Shadrack Moloi and Dr Ozekeke Ogbeide, participated in the week-long German Southern Africa Summer School hosted at the Centre for Environmental Management (CEM), where they presented lectures on water monitoring in the Qwaqwa region.

The Bio-Society, led by Honours students on Qwaqwa Campus, organised the Arbor Day celebrations in 2019, and collected data on students' understanding of conservation and biodiversity on Campus. They started the process of describing the fauna and flora on the Qwaqwa Campus, which will result in several informational plaques and (potentially) posters being created in 2020.

Dr Mpho Ramoejane, a postdoctoral research fellow on the Qwaqwa Campus, conducted several interviews with traditional leaders of the Bakoena traditional house and traditional healers on their relationship with wildlife and the history of wildlife in the area. He also recently made contact with the Batlokwa traditional house through Princess Pinky Mmota. Researchers from the Campus have studied the fauna and flora of the region between the Metsimatsho Dam and Tseseng, and the University has recommended this area be considered as a heritage site due to its unique animal and floral diversity. These renewed relationships will help the Department to fulfil and strengthen its community engagement obligations. Dr Ramoejane was also a guest speaker at Bolata Secondary School's prize giving, a guest Judge for the Biodiversity Beauty contest held in the GGHNP and a VIP guest in the Wetlands Day celebration held in Mabolela traditional council.

Serero Modise, PhD student in the Kokonyana Research lab at Qwaqwa, together with Wilgenhof Environmental Education Centre in the GGHNP, was involved in organising school excursions to facilitate environmental conservation education among school learners from the Free State and Gauteng. Furthermore, Prof Aliza le Roux and Mr Modise are part of the GGHNP Forum, in the Environmental Awareness and Biodiversity Management portfolios respectively.

Researchers in the Department of Zoology and Entomology fulfil a range of services to the scientific community. Prof Le Roux continued to serve as council member for the ZSSA and acted as co-chair for the South African Young Academy of Sciences (SAYAS). She was Recommender/Editor at Peer Community in Ecology (PCI Ecology), a new open access (OA) initiative run by scientists, peer-reviewing pre-prints and proposals for pre-registration projects. She also led Mind the Gap, a novel mentorship programme for early-career women on the Qwaqwa Campus – the only initiative on Qwaqwa Campus funded by the Institutional Transformation Plan (ITP).

Academics from the Department were involved in reviewing articles for various publications, including, *inter alia*:

- Prof Charles Haddad for *Arnoldia Zimbabwe, African Invertebrates, Austral Ecology, Biodiversity and Conservation, Check List, Israel Journal of Entomology* and *Zootaxa*. He also processed articles as journal editor for *ZooKeys* and *Zootaxa*.
- Prof Daryl Codron for *African Journal of Wildlife Research, African Zoology, Global Ecology and Conservation* and *Journal of Archaeological Science*.

- Prof Liesl van As for *Acta Amazonica* and *Water SA*, and processed articles as journal sub-editor of the *African Journal of Aquatic Sciences*.
- Prof Linda Basson for *Acta Amazonica, Acta Protozoologica, European Journal of Protistology, Aquaculture Research* and *Journal of Parasitology*.

NATIONAL AND INTERNATIONAL COLLABORATION

Prof Aliza le Roux visited the Okinawa Institute of Science and Technology in Japan in December to cement the collaboration with Dr Nick Friedman, an acoustic expert. She also continued her collaboration with the Snapshot Safari project, led locally by Dr Jan Venter (NMU) and internationally by Prof Craig Packer (University of Minnesota). She attended a workshop in the first semester of 2019, to discuss data from this project, funded by the NRF. She is also collaborating with Prof Andrea Fuller from the University of the Witwatersrand, with research on bat-eared fox responses to heat stress, and is an Associate Member of the African Centre for Coastal Palaeosciences (NMU) on multi-disciplinary baboon / Palaeoscience research.

Dr Candice Jansen van Rensburg and Gerhard de Jager visited the Nematology Research Group at NWU in Potchefstroom to discuss potential collaboration with Prof Driekie Fourie on projects involving nematode molecular taxonomy.

Prof Charles Haddad has continued his collaboration nationally on research on spider ecology and biodiversity with Prof Ansie Dippenaar-Schoeman and Robin Lyle (ARC - Plant Health and Protection [ARC-PHP]) as well as Prof Stefan Foord (University of Venda). Internationally he collaborated with a number of researchers on different aspects of spider taxonomy, systematics and biology, including Dr Martín Ramírez from the Museo Argentino de Ciencias Naturales (Argentina) Prof Stano Pekár from Masaryk University (Czech Republic) Dr Jiri Kral and Dr Franticek Stahlavsky from Charles University in Prague (Czech Republic), Dr Daniele Polotow from the Universidade Federal de São Carlos (Brazil) and Dr Galina Azarkina from the Siberian Academy of Sciences (Russia).

Prof Haddad also established a Memorandum of Understanding (MoU) with Dr Danilo Harms at the Universität Hamburg, Germany and Prof Stefan Foord from the University of Venda, to investigate the biogeographical relationships of southern African arachnids and the historical factors influencing the past and current distributions. The project is funded by the Deutsche Forschungsgemeinschaft (DFG).

Prof Daryl Codron has a long-standing collaboration with researchers from the University of Zurich (Prof M Clauss) and the University of Colorado at Boulder (Prof M Sponheimer). A more recent collaboration with the Hebrew University of Jerusalem (Dr L Horwitz) has already resulted in a publication. Collaboration on a national level helped to facilitate Honours' students fieldwork at the National Museum in Bloemfontein.

Ellie van Dalen's collaboration with animal health companies has involved tick resistance testing of pharmaceutical products (Bayer Animal Health and Virbac Animal Health), and dip sample concentration testing (Elanco Animal Health and Zoetis Animal Health).

Dr Emile Bredenhand continued his collaboration with Dr Justin Hatting, Dr Tarekegn Terefe and Mrs Cathy de Villiers of ARC-SG in Bethlehem, on methods of using earthworm extracts to boost wheat success rate to resist Fusarium root rot. A new collaboration with Dr Astrid Jankielsohn (ARC-SG) and Dr Hemant Tripahi (Leeds University) has commenced, focusing on ways to enhance small scale agricultural farming within the Qwaqwa region. In addition, collaboration with Dr Moeti Taioe, of the Pretoria Zoological Gardens, on projects involving monitoring or various vectors present within Gardens, has been initiated.

Dr Frank Chidawanyika collaborated with Prof Martin Hill and Dr Grant Martin (Rhodes University Centre for Biological Control), Dr David Simelane, Dr Costas Zachariades, Dr Pride Mudavanhu, Lorraine Strathie (ARC-PHP, Weeds Division), Prof Casper Nyamukondiwa (Botswana International University of Science and Technology), and Dr Sinead English and Prof Richard Hall (University of Bristol).

Dr Johann van As continued his collaboration with with Prof Nico Smit, Dr Ed Netherlands and Dr Courtney Cook of NWU, on blood parasites in squamates. Michelle van As also collaborated with these three researchers, as well as Prof Victor Wepener (from the same university), on organochlorine contamination and blood parasites in African leopards.

Prof Liesl van As has extensive collaboration with researchers and research groups in southern Africa, including Dr Kevin Christison (DAFF) – as part of an MoU; Dr Leon Barkhuizen (DESTEA); Prof Olaf Weyl, (SAIAB) (as part of an MoU); Pierre De Villiers (as part of the MoU with CapeNature); and Prof Keta Mosepele from the Okavango Research Institute at the University of Botswana (with whom an MoU is currently being finalised).

Prof Linda Basson commenced collaboration with a number of researchers as part of the NG-Tax Risa project, which is part of Horizon 2020 Marie Skłodowska-Curie Actions Research and Innovation Staff Exchange 2019 (H2020-MSCA-MSCA-RISE-2019). The other researchers involved are Prof Sergio Martorelli (Centro de Estudios Parasitológicos y de Vectores, Argentina), Dr Christian Sonne (Aarhus University, Denmark), Dr Gavin Snow (University of the Witwatersrand), Prof Bettine van Vuuren (University of Johannesburg), Prof Rogelio Aguilar Aguilar and Alma Islas Ortega (National Autonomous University of Mexico) and Prof Richard Snyder (Virginia Institute of Marine Science, USA).

Prof Neil Heideman continued his collaboration on olive toad morphometrics with Dr Mike Bates, herpetologist at the National Museum in Bloemfontein, and with researchers from the University of the Western Cape – Dr Brian Wilson and Fadli Wagiet – on the ecology and conservation of semi-legless skinks along the Cape west coast, as well as with Dr Martin Hendricks and Prof Retha Hofmeyr, a leading expert on African tortoises.

Dr Patricks Voua Otomo continued his collaboration with Prof Julian Filser, from the University of Bremen, on a project related to the effects of imidacloprid, a neonicotinoid insecticide, on the life cycle of the hoverfly *Eristalis tenax.* He also commenced collaboration with a group of researchers headed by Dirk Jungman at the Technical University of Dresden, investigating resilience to the multiple risks of climate change in southern Africa. Another new collaboration was initiated with Dr Norah Basopo from the National University of Science and Technology, Zimbabwe, on the state of aquatic pollution in Qwaqwa.

(Photo credit: Prof Aliza le Roux, Department of Zoology and Entomology)

POSTGRADUATE STUDENTS

In 2019, the following postgraduate students were enrolled in the Department of Zoology and Entomology:

- Honours: 8 in Zoology, and 1 in Entomology on the Bloemfontein Campus, and 5 in Zoology on the Qwaqwa Campus
- MSc: 5 in Zoology and 5 in Entomology on the Bloemfontein Campus, with a further 2 in Zoology on Qwaqwa Campus
- PhD: 11 in Zoology and 8 in Entomology on the Bloemfontein Campus, and 3 in Zoology on the Qwaqwa Campus

In 2019 a total of six students graduated with the Honours degree on the Bloemfontein Campus (5 in Zoology, and 1 in Entomology). Two students graduated with their Honours in Zoology on the Qwaqwa Campus.

At master's level, seven students graduated with the MSc in Zoology – Adriaan Jordaan (with distinction), Kenny Lesyenyeho, Michelle Pottinger, Katlego Mogorosi (all on the Bloemfontein Campus), and Anna Seeti, Simon Mofokeng and Ngitheni Nyoka on the Qwaqwa Campus.

Tsepeso Motolo (with distinction), Bianca Kay (with distinction) and Tanya Smit graduated with the MSc in Entomology on the Bloemfontein Campus.

The Honours Biodiversity and Evolution excursion took place during the September recess, and included activities at Ganora Fossil Farm, as well as estuary and intertidal projects along the south coast.

At the Qwaqwa Campus, the Honours students took part in the first year of the Science for Society module. As part of this multi-disciplinary module, they re-instated the Bio-Society on the Qwaqwa Campus and did some research on how to improve environmental awareness and education on the Campus. This module will hopefully change not only how students learn, but also what we know about wildlife on the Qwaqwa Campus and surrounding areas.

POSTDOCTORAL RESEARCH FELLOWS

The following postdoctoral research fellows were hosted by the Department of Zoology and Entomology in 2019:

- J Verdu Ricoy, from Spain, supervised by Prof Heideman
- R Mutamiswa, from Zimbabwe, supervised by Dr Chidawanyika
- M Ramoejane, from South Africa, supervised by Prof Le Roux
- D Akinnuoye-Adelabu, from Nigeria, supervised by Dr Bredenhand
- O Ogbeide, from Nigeria, supervised by Dr Voua Otomo

Dr Joachim Verdu Ricoy delivered a paper at the 14th Annual Conference of Herpetological Association of Africa, held at Cape St Francis from 9 to 13 September 2019. He also co-authored four papers.

STAFF MATTERS

Dr Daryl Codron was appointed as Senior Lecturer at the beginning of 2019, after Dr Mdu Ndlovu resigned at the end of 2018. He was subsequently promoted to Associate Professor.

Dr Vaughn Swart and Dr Emile Bredenhand were both promoted to Senior Lecturer.

Prof Aliza le Roux was appointed as the Vice-Dean for the Faculty of Natural Sciences on the Qwaqwa Campus.

Ms Ellie van Dalen, Ms Sylvia Teele, Mr Hennie Butler and Prof Liesl van As all received service awards for having worked at the UFS for many decades.

Dr PM Leeto, Lecturer from the Qwaqwa Campus, and Mr Jacob Mabena (Bloemfontein Campus) resigned during 2019.

RESEARCH OUTPUTS

Research Articles

Akinnuoye-Adelabu, D., Hatting J., De Villiers, C., Terefe, T. & Bredenhand E. 2019. Effect of redworm extracts against Fusarium root rot during wheat seedling emergence. *Agronomy Journal* 111(5): 2610-2618.

Akinnuoye-Adelabu, D., Steenhuisen, S.L. & Bredenhand, E. 2019. Improving pea quality with vermicompost tea and aqueous biochar: prospects for sustainable farming in Southern Africa. *South African Journal of Botany* 123: 278-285.

Barrett, P.M., Chapelle, K.E.J., Staunton, C.K., Botha, J. & Choiniere, J.N. 2019. Postcranial osteology of the neotype specimen of *Massospondylus carinatus* Owen, 1854 (Dinosauria: Sauropodomorpha) from the upper Elliot formation of South Africa. *Palaeontologia Africana* 53: 114-178.

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Chidawanyika, F., Mudavanhu, P. & Nyamukondiwa, C. 2019. Global climate change as a driver of bottom-up and top-down factors in agricultural landscapes and the fate of host-parasitoid interactions. *Frontiers in Ecology and Evolution* 7(80). DOI: 10.3389/fevo.2019.00080.

Chukwuka, A., Ogbeide, O. & Uhunamure G. 2019. Gonad Pathology and Intersex severity in pelagic (*Tilapia zilli)* and benthic (*Neochanna diversus* and *Clarias gariepinus*) species from a pesticide-impacted agrarian catchment, south-south Nigeria. *Chemosphere* 225: 535-547. DOI: 10.1016/j.chemosphere.2019.03.073.

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De Jager, G.P., Van Marwijk, J. & Basson, L. 2019. A new *Trichodina* species (Peritrichia: Mobilida) from anuran tadpole hosts, *Sclerophrys* spp. in the Okavango Panhandle, Botswana, with comments on this taxon. *Acta Protozoologica* 58(3): 141-153.

De Swardt, D.H., Lee, A., Butler, H.J. B. & Oschadleus, H.D. 2019. Biometrics and diet of two closely related birds: Karoo Prinia (*Prinia maculosa*) and Drakensberg Prinia (*Prinia hypoxantha*). *Indago* 34(2): 125-133.

Ermilov, S.G. & Hugo-Coetzee, E.A. 2019. New data on oribatid mites (Acari, Oribatida) of South Africa, with description of two new species of the family Oppiidae. *Systematic and Applied Acarology* 24(2): 287-302.

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Jumbam, K.R., Périquet, S., Dalerum, F. & Le Roux, A. 2019. Spatial and temporal variation in the use of supplementary food in an obligate termite specialist, the bat-eared fox. *African Zoology* 54: 63-71.

Kay, B.J., Swart V.R. & Van Der Watt, E. 2019. Evaluation and comparison of various plant extracts as repellents against *Lucilia* spp. *African Entomology* 27(1): 167-177.

Khaustov, A.A., Hugo-Coetzee, E.A. & Ermilov, S.G. 2019. A new species of Tanytydaeus (Acari: Paratydeidae) from termite nests in South Africa. *Systematic and Applied Acarology* 24(9): 1604-1619.

Khaustov, A.A., Hugo-Coetzee, E.A., Ermilov S.G. & Theron, P.D. 2019. A new genus and species of the family Microdispidae (Acari: Heterostigmata) associated with Trinervitermes trinervoides (Sjostedt) (Isoptera: Termitidae) from South Africa. *Zootaxa* 4647(1): 104-115.

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Le Roux, A., Mathibane, A.N. & Nowak, K. 2019. Wild Samango monkeys, *Cercopithecus mitis*, balance risk and opportunity to interact with novel objects in village gardens. *International Journal of Primatology* 40: 661-670.

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Mutamiswa, R., Machekano, H., Chidawanyika, F. & Nyamukondiwa, C. 2019. Life-stage related responses to combined effects of acclimation temperature and humidity on the thermal tolerance of *Chilo partellus* (Swinhoe) (Lepidoptera: Crambidae). *Journal of Thermal Biology* 79: 85-94.

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Conference Contributions

Conference Papers/Posters

Badenhorst, H., Haddad, C.R. & Janion-Scheepers, C. 2019. *Diversity of springtails and spiders in three biomes in central South Africa*. Paper delivered at the 21st International Congress of Arachnology, Christchurch, New Zealand. 10-15 February 2019.

Badenhorst, H., Haddad, C.R, Janion-Scheepers C. & Louw, SvdM. 2019. *Die invloed van landboupraktyke op grondlewende mesofauna van geselekteerde agro-ekosisteme in die Vrystaat Provinsie, Suid-Afrika.* Paper delivered at the 19th Studentesimposium in Natuurwetenskappe, Suid-Afrikaanse Akademie vir Wetenskap en Kuns, Bloemfontein, South Africa. 1 November 2019.

Barkhuizen L.M. 2019. *Conservation status of the common rock catfish Austroglanis sclateri (Boulenger, 1901) in the Free State Province: least concern or threatened?* Poster presented at the 56th Southern African Society of Aquatic Scientists Conference, Bela Bela, South Africa. 30 June-4 July 2019.

Barkhuizen L.M. 2019. *Red swamp crayfish Procambarus clarkii: Second record of a wild population in South Africa.* Paper delivered at the 56th Southern African Society of Aquatic Scientists Conference, Bela Bela, South Africa. 30 June-4 July 2019.

Basson, L. 2019. *Diversity of sessiline ciliates (Peritricha: Sessilina) from fish in Tasmania, Australia.* Paper delivered at the 56th Microscopy Society of Southern Africa Conference, Langebaan, South Africa. 2-6 December 2019.

Basson, L. & De Jager, G.P. 2019. *Cilia in mobiline ciliates from chitons: anomalies or merely odd deviations?* Poster prsented delivered at the 56th Microscopy Society of Southern Africa Conference, Langebaan, South Africa. 2-6 December 2019.

Booysen, R., Haddad, C.R. & Pekár, S. 2019. *Revision, molecular phylogeny and biology of the spider genus Micaria Westring, 1851 (Araneae: Gnaphosidae) in the Afrotropical Region.* Paper delivered at 21st International Congress of Arachnology, Christchurch, New Zealand. 10-15 February 2019.

Bopheka, L., Van As, J., Cook, C. & Van As L.L. 2019. *Possible life cycle of Trypanosoma mukasai in Free State River Systems.* Paper delivered at the 56th Southern African Society of Aquatic Scientists Conference, Bela Bela, South Africa. 30 June-4 July 2019.

Botham, J.L., Swart, V.R., Bredenhand, E. & Haddad, C.R. 2019. *Influence of altitude and stratification on arthropod biodiversity within interspersed arboreal biotopes in Afromontane grasslands.* Paper delivered at the 21st Entomological Society of Southern Africa Conference, Umhlanga, South Africa. 8-11 July 2019.

Chidawanyika, F., Mudavanhu, P. & Nyamukondiwa, C. 2019. *Global climate change as a driver of bottom-up and top-down factors in agricultural landscapes and the fate of host-parasitoid interactions.* Paper delivered at the 21st Entomological Society of Southern Africa Conference Umhlanga, South Africa. 8-11 July 2019.

Codron, D., **Buschke, F., Malindie, S. & Clauss, M.** 2019. *Intra- versus interspecific niche variations in mammal communities: is niche partitioning a valuable assembly rule*? Paper delivered at Ecological Society of America, USSEE Joint Meeting, Louisville, Kentucky, USA. 11-15 August 2019.

De Jager, G.P. & Basson, L. 2019. *First records of the genus Polycycla (Mobilida: Urceolariidae) from holothurian hosts in Africa.* Paper delivered at the 56th Microscopy Society of Southern Africa Conference, Langebaan, South Africa. 2-6 December 2019.

De Jager, G.P. & Basson, L. 2019. *'n Vindingryke silwernitraatimpregneringstegniek vir varswater trigodina-taksonomie*. Paper presented at the 19th Studentesimposium in Natuurwetenskappe, Suid-Afrikaanse Akademie vir Wetenskap en Kuns, Bloemfontein, South Africa. 1 November 2019.

De Jager, G.P. & Basson, L. 2019. *Three new species from the genus Leiotrocha (Peritrichia: Ciliophora) from south coast intertidal chitons*. Poster presented at the 56th Microscopy Society of Southern Africa Conference, Langebaan, South Africa. 2-6 December 2019. [Best Poster Presentation in the Life Sciences].

De Smidt, A. & Jansen van Rensburg, C. 2019. *Nematodes of the Willem Pretorius Nature Reserve in the Free State province, South Africa.* Paper delivered at the 22nd Bi-annual Symposium of the Nematological Society of Southern Africa, Mpumulanga, South Africa. 12-15 May 2019.

Dippenaar-Schoeman, A.S., Haddad, C.R., Foord, S.H., Lyle, R., Lotz, L.N., Sethusa, T. & Raimundo, D. 2019. *Red List of South African spiders: an end-product of the South African National Survey of Arachnida***.** Poster presented at the 21st International Congress of Arachnology, Christchurch, New Zealand. 10-15 February 2019.

Dlamini, N.P. & Voua Otomo, P. 2019. *Determining the effects of biochar soil amendment on the toxicity of sewage sludge on the earthworm Eisenia fetida (Oligochaeta*). Poster presented at the 5th World Congress on Risk Development and Resilience and 9th African Biennial Conference of the Society of Environmental Toxicology and Contamination, Cape Town, South Africa. 6-8 May 2019.

Haddad, C.R., Foord, S.H. & Dippenaar-Schoeman, A.S. 2019. *Spider assemblages in South African grasslands and the factors that shape them: a review of two decades of recent work*. Paper delivered at **the** 21st International Congress of Arachnology, Christchurch, New Zealand. 10-15 February 2019.

Jansen van Rensburg, C. 2019. *Nematodes as bio-indicators of the Seekoeivlei Wetland, South Africa*. Paper delivered at the 56th Southern African Society of Aquatic Scientists Conference, Bela Bela, South Africa. 30 June-4 July 2019.

Jansen van Rensburg, C., **De Jager, G.P. & Basson, L.** 2019. *Nematodes collected from leaf litter in Jonkershoek Nature Reserve, Stellenbosch.* Paper delivered at the 56th Microscopy Society of southern Africa Conference, Langebaan, South Africa. 2-6 December 2019.

Jansen van Rensburg, C. & De Smidt, A. 2019. *Nematofauna of the Soetdoring Nature Reserve in the Free State province, South Africa.* Paper delivered at the 22nd Bi-annual Symposium of the Nematological Society of Southern Africa, Mpumulanga, South Africa. 12-15 May 2019.

Jumbam, K.R., Le Roux, A. & Petelle, M.M. 2019. *Exploratory behaviours and diet breadth of a wild canid reveal low repeatability.* Paper delivered at the 39th Zoological Society of South Africa (ZSSA) Congress, Skukuza, South Africa. 7-10 July 2019. [Prize for Best PhD Presenter].

Kruger, A.X. & Jansen van Rensburg, C. 2019. *Invertebraatdiversiteit van twee soutpanne in die Soetdoring Natuurreservaat*. Paper delivered at the 19th Studentesimposium in Natuurwetenskappe, Suid-Afrikaanse Akademie vir Wetenskap en Kuns, Bloemfontein, South Africa. 1 November 2019.

Madiope, W., Keeping, M. & Fourie, DeV. 2019. *Estimation of yield loss to yellow sugarcane aphid Sipha flava Forbes in South African sugarcane varieties.* Paper delivered at the 21st Entomological Society of Southern Africa Conference. Umhlanga, South Africa. 8-11 July 2019.

Madzivanzira, T.C., Barkhuizen, L.M., South, J. & Weyl, O.L.F. 2019. *Controlling red swamp crayfish Procambarus clarkii (Crustacea, Decapoda) populations in the Free State Province using various eradication methods.* Poster presented at Annual Conference of the Zoological Society of South Africa. Kruger National Park, South Africa. 7-10 July 2019.

Moloi, M.S., Ogbeide, O., & Voua Otomo, P. 2019. *Determination of Heavy Metal Concentration in Treated and Untreated Wastewater from Two Treatment Plants in Maluti-a-Phofung Municipality.* Paper delivered at the 5th World Congress on Risk Development and Resilience and 9th African Biennial Conference of the Society of Environmental Toxicology and Contamination, Cape Town, South Africa. 6-8 May 2019.

Moloi, M.S., Ogbeide, O. & Voua Otomo, P. 2019. *The assessment of heavy metal contribution to the Vaal River basin by wastewater treatment works in the Afromontane region, Free State province (South Africa)*. Paper delivered at the International Mountain Conference 2019, Innsbruck, Austria. 8-12 September 2019.

Mukwevho, L., Ndlovu, M. & Chidawanyika, F. 2019. *Effects of fire and mammal herbivory management regimes on insect functional diversity in the Kruger National Park*. Paper delivered at 21st Entomological Society of Southern Africa Conference, Umhlanga, South Africa. 8-11 July 2019.

Ogbeide, O., Chukwuka, A.V. & Voua Otomo, P. 2019. *Contaminants in African's Mountain Tops: An Understudied Scenario*. Paper delivered at the 5th World Congress on Risk Development and Resilience and 9th African Biennial Conference of the Society of Environmental Toxicology and Contamination, Cape Town, South Africa. 6-8 May 2019.

Pegg, J., Mabin, C.A., Khosa, D., Barkhuizen, L.M. & Weyl, O.L.F. 2019. *Common carp in South Africa – exploring invasion using formal and informal records.* Paper delivered at the Annual Conference of the Zoological Society of South Africa, Kruger National Park, South Africa. 7-10 July 2019.

Semase, M.P., Ogbeide, O. & Voua Otomo, P. 2019. *Ecotoxicological effects of treated and untreated wastewater on lifecycle of Helix pomatia exposed in artificial soil.* Poster presented at the 5th World Congress on Risk Development and Resilience and 9th African Biennial Conference of the Society of Environmental Toxicology and Contamination, Cape Town, South Africa. 6-8 May 2019.

Stander, A.H., Le Roux., A. & Voua Otomo, P. 2019. *Can local enhancement in earthworms affect the outcome of the standard earthworm avoidance test?* Poster presented at the 40th North American Annual Meeting of the Society of Environmental Toxicology and Contamination, Toronto, Canada. 3-7 November 2019.

Van As, L.L. & Christison, K.W. 2019. *A non-alien, fish louse of the genus Argulus Müller, 1785 found on a fish farm.* Paper delivered at the 56th Southern African Society of Aquatic Scientists Annual Conference, Bela Bela, South Africa. 30 June-4 July 2019.

Van As, M., Van As, J. & Smit N.J. 2019. *Possible life cycle stages of a species of Hepatozoon (Apicomplexa: Adeleorina: Hepatozoidae) in an Ixodes tick (Arthropoda: Ixodida: Ixodidae) and an African leopard, Panthera pardus pardus (Linnaeus, 1758), from South Africa*. Paper delivered at the 27th Conference of the World Association for the Advancement of Veterinary Parasitology (WAAVP 2019), Madison, Wisconsin, USA. 7-11 July 2019.

Van As, M., **Wolmarans N., Wepener V. & Smit N.J.** 2019. *Organochlorine pesticides in blood of wild and captive African leopards, Panthera pardus pardus (Linnaeus, 1758)*. Paper delivered at the 5th World Congress on Risk Development and Resilience and 9th African Biennial Conference of the Society of Environmental Toxicology and Contamination, Cape Town, South Africa. 6-8 May 2019.

Van der Merwe, R. & Codron, D. 2019. *Is digtheidsafhanklike habitatseleksie 'n aanduiding van individuele fiksheid?* Paper presented at the 19th Studentesimposium in Natuurwetenskappe, Suid-Afrikaanse Akademie vir Wetenskap en Kuns, Bloemfontein, South Africa. 1 November 2019.

Van der Merwe, S.S., Swart, V.R., Bredenhand, E. & Haddad, C.R. 2019. *Soil Biota as bioindicators of fire disturbances in montane grassland areas within the Golden Gate Highlands National Park.* Paper delivered at the 21st Entomological Society of Southern Africa Conference, Umhlanga, South Africa. 8-11 July 2019.

Voua Otomo, P., Nyoka, N. & Dlamini, N.P. 2019. *Biochar soil amendment and chemical toxicity in portworms and earthworms.* Poster presented at the 40th North American Annual Meeting of the Society of Environmental Toxicology and Contamination, Toronto, Canada. 3-7 November 2019.

Zhao, Z., Heideman, N., Grobler, P., Jordaan, A., Bester, P. & Hofmeyr. M. 2019. *Unravelling the diversification and systematic puzzle of the highly polymorphic Psammobates tentorius complex.* Paper delivered at the 14th Conference of the Herpetological Association of Africa, Cape St Francis, South Africa. 9 -13 September 2019.

Zhao, Z., Verdu-Ricoy, J., Mohlakoana, T.S.G., Jordaan, A., Conradie, V. & Heideman, N. 2019. *Unexpected phylogenetic relationships within the world's largest limbless skink species (Acontias plumbeus) highlight the need for a review of the taxonomic status of Acontias poecilus*. Paper delivered at the 14th Conference of the Herpetological Association of Africa, Cape St Francis, South Africa. 9 -13 September 2019.

STAFF (2019)

Head of Department: Prof L Basson

Bloemfontein Campus

Distinguished Professor: Prof LJ Fourie

Professors: Prof L Basson and Prof NJL Heideman

Associate Professors: Prof CR Haddad and Prof LL van As

Senior Lecturers: Dr F Chidawanyika and Dr D Codron

Lecturers: Mr HJB Butler, Ms L Heyns, Dr C Jansen van Rensburg, Dr VR Swart and Ms EMP van Dalen

Junior Lecturer: Mr DV Fourie

Research Associates: Dr LM Barkhuizen, Dr M Bates, Dr J Botha, Dr KW Christison, Dr L Coetzee, 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: Patrick Mohasi, Tseko Lesaona William and Andreas Thou (AID4)

Qwaqwa Campus

Associate Professor: Prof A le Roux (Subject Head)

Senior Lecturers: Dr P Voua Otomo

Lecturers: Dr E Bredenhand, Dr PM Leeto, Dr J van As and Ms M van As

Officers - Professional Services: Mr JM Mabena and Ms MP Sithole

ACADEMIC
CENTRES

CENTRE FOR

ENVIRONMENTAL MANAGEMENT

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OVERVIEW OF 2019

The Centre for Environmental Management (CEM) achieved substantial success in 2019, particularly in terms of research output. Research outputs have grown steadily over the past fifteen years – the eight research reports and two accredited articles produced in 2005, increased to 54 articles in accredited journals in 2019 as well as a number of research reports and book chapters. A total of 15 students graduated with the structured Masters of Environmental Management (MEM) at the June 2019 graduation ceremony, and one student was awarded a full MSc in Environmental Management. For the first time, the Postgraduate Diploma in Integrated Water Management (PGDip[IWM]) was awarded to 18 students.

ACHIEVEMENTS

Staff Achievements

Dr Nico Avenant (Research Associate) was invited to be a collaborator on the long-term Kalahari Endangered Ecosystem Project (KEEP). Dr Avenant received a C2-rating from the National Research Foundation (NRF). An article about his work on the damage-causing caracal in South Africa appeared in an Italian journal (Ricci, M., Cambone, A. & Isotti, R. 2019. Simba mangu – un futuro per il caracal (a future for the caracal). *La Rivista della Natura* March 2019: 44-51). He is also part of the Zoological Society of Southern Africa (ZSSA) local organising committee for the 2020 International Congress of Zoology (ICZ) to be held in Cape Town. In addition, Dr Avenant still serves on the Executive Committee of the International Conference on Rodent Biology and Management (2006 to present), on the Editorial Board of *Integrative Zoology* (the journal of the International Society of Zoological Sciences with an impact factor of 2.514) and as Section Editor of *African Zoology* (small mammals).

Dr Piet-Louis Gründling (Research Associate), together with Althea Gründling, co-hosted a workshop session, titled 'Peatlands in the South African landscape: Fact or fiction', at the National Wetlands Indaba 2019, held in Tzaneen from 7 to 11 October. During the Indaba, he received the National Wetlands Award for 2019 in the category Education and Skills Development, while Dr Nacelle Collins (Research Associate) received the award in the Science and Research category.

Dr Shola Ololade was nominated and approved as a full member of Sigma Xi: The Scientific Research Honour Society. The society was founded in 1886 at Cornell University, USA and membership is only by nomination and peer review of research publications in pure and applied science.

Mrs Surina Esterhuyse was placed third in the Faculty of Natural and Agricultural Science's Flash Fact competition, held on 5 June 2019.

Mrs Marthie Kemp was interviewed by Dr Turton on the subject of dendrohydrology. The interview was subsequently published in *African Wildlife & Environment* 73:7-9. Mrs Kemp was one of two researchers from the southern hemisphere who attended the 30th European Dendroecological Fieldweek in the Czech Republic. Twenty participants from five continents attended this hands-on course on tree-ring research from 1-8 September 2019.

Mrs Marthie Kemp at the 30th European Dendroecological Fieldweek in the Czech Republic

Dr Anthony Turton was a founding member of the SA Business Water Chamber, established in 2019, which, along with other major players, became the implementation arm of the Public-Private Growth Initiative (PPGI) Water Initiative. He also delivered the keynote address to the South African Federation of Hospital Engineers (SAFHE), in Cape Town on 6 August, on the topic 'Water as a risk in the medical services sector'.

Dr Danie Toerien served on the Editorial Board of *Cogent Social Sciences*, and Dr Pieter Zietsman served on the Editorial Board of *Flowering Plants of Africa Volume 66*.

Student Achievements

Ms Charissa Worthmann (second-year Masters in Environmental Management) was placed first in the FameLab Free State heat, on 14 November 2019.

Ms Charissa Worthmann winner of the the FameLab Free State heat

RESEARCH

Dr Falko Buschke was awarded a research grant for the bilateral project 'SERIAL: Socioecological Resilience in Agricultural Landscapes', in conjunction with the Vrije Universiteit Brussels, Belgium. The project is funded through a South Initiative bilateral grant by the Flemish Interuniversity Council (VLIR-UOS). Dr Buschke joined Dr Tom Pinceel (from KULeuven, Belgium, and CEM Research Fellow) for a field trip to Karingani Private Nature Reserve in Mozambique during March 2019. The purpose of the visit was to carry out an ecological survey of the wetlands in the reserve and to set up a mesocosm experiment to test for the effects of keystone species on the ecological functioning of these systems.

Dr Falko Buschke and Dr Tom Pinceel at Karingani Private Nature Reserve

Prof Paul Oberholster served as coordinator of the Scientific Advisory Panel and was technical editor for the development of the wastewater atlas for Wastewater Management and Sanitation Provision in Africa – a project involving 54 countries, supported through a partnership between the United Nations Environment Program (UN Environment), GRID-Arendal and the African Development Bank. The collaboration aims to harness the strengths of the partners to support Africa to address the challenges of poor access to sanitation and wastewater management services through evidence-based policy support.

Dr Tascha Vos and Dr Stephanie Cawood (Centre for Gender and Africa Studies in the Faculty of the Humanities) led an interdisciplinary research project which brought together limnology and the cultural and social human dynamics of heritage, pilgrimage and ritual. The research project applied the unique bio-cultural screening model that they had developed, to previously sampled sites in the Mohakare Valley, as well as two new sites – Oetse's Cave (Witsieshoek) and Mantsopa (Ladybrand).

Ms Alina Treffield visited the CEM during October and November 2019 as an intern for part of her master's studies at the TU Dresden, Germany. Dr Dirk Jungmann (TU Dresden) is her supervisor in Germany and Mrs Marinda Avenant her host supervisor at CEM. Her research topic is 'The impact of different river systems to the concentration of herbicides during dry season'.

Ms Alina Treffield sampling the Riet River near Jacobsdal

Ms Nele Moreels, a student of Prof Bram Vanschoenwinkel (CEM Research Fellow) from the Vrije Universiteit Brussel (VUB), Belgium, conducted fieldwork in the Eastern Free State in August and September 2019 for her master's study on 'The role of inselbergs in maximising biodiversity conservation while minimising conflicts with agriculture'.

Ms Nele Moreels, visiting master's student from VUB, doing fieldword in the Eastern Free State

ENGAGED SCHOLARSHIP

Aquatic monitoring of Loch Logan

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 Fulufhelo Mudau taking water samples at Loch Logan

Exhibitions at the National Museum Bloemfontein

The Rendezvous Support Group of the Free State Society for the Blind (18 people) visited the exhibitions at the National Museum in Bloemfontein on 12 June 2019, which were arranged by Dr Nico Avenant. Specimens from Acarology, Arachnology, Mammalogy, Ornithology and Palaeontology were presented for the touch experience, while seven National Museum staff members acted as guides.

NATIONAL AND INTERNATIONAL COLLABORATION

Dr Falko Buschke collaborated on various projects with, *inter alia*, Dr Tom Pinceel (KU Leuven, Belgium), Dr Bram Vanschoenwinkel (VUB), Susie Brownlie (private consultant), Emily Botts (private consultant), Sam Sinclair (Imperial College London and University of Oxford), and Jeff Manuel (South African National Biodiversity Institute [SANBI]).

Mrs Marinda Avenant, in collaboration with Dr Dirk Jungmann from the Technical University of Dresden, coordinated and obtained funding from the Volkswagen Foundation to present a Summer School on Aquatic Biomonitoring at the Bloemfontein Campus in March 2019. The Summer School was attended by 66 participants from various Southern African Development Community (SADC) countries. The funding allowed us to sponsor 28 full-time postgraduate students to attend the week-long programme. The programme covered a range of topics, from Hydrology and Catchment land-use to biomonitoring in arid environments, and included perspectives from presenters from Germany and various institutions in South Africa, Lesotho, Namibia, Zambia and Eswatini. The group also visited Mokala National Park in the Northern Cape for a field excursion.

Participants at the Summer School on Aquatic Biomonitoring

Dr Shola Ololade visited the Texas A&M University in San Antonio, in May and June 2019, to establish collaboration with Prof Burak Güneralp (environmental sustainability) and Dr Anthony Fillipi (application of remote sensing and GIS) from the Department of Geography in the College of Geosciences.

Dr Shola Ololade

POSTGRADUATE STUDENTS

In 2019, a total of 27 students were registered for the Postgraduate Diploma in Integrated Water Management (PGDip[IWM]), while 23 were registered for the Master of Environmental Management (MEM), and 9 for the PhD in Environmental Management. Nineteen (19) students graduated with the PGDip(IWM) in 2019, and 17 with the structured MEM.

The MSc in Environmental Management was awarded to SN Malindie at the December 2019 graduation, and the PhD in Environmental Management was awarded to:

Holt, Sharon
Thesis: An investigation of the palaeoecology and past distribution of tortoises (Chelonians) in the arid interior of South Africa: A tool to aid present day conservation
Promoter: Prof D Codron

POSTDOCTORAL RESEARCH FELLOWS

The Centre for Environmental Management hosted three postdoctoral research fellows during 2019 – Dr Sabelo Mavimbela (from Eswatini), Dr Israel Orimoloye (from Nigeria) and Dr Ernestine Atangana (from Cameroon).

STAFF MATTERS

Prof Paul Oberholster was appointed as Director of the Centre for Environmental Management on 1 September 2019.

Prof Paul Oberholster

Miss Fulufelo Mudau was re-appointed as a Research Assistant.

Dr James Brink (Research Associate) lost his fight against brain cancer on 23 September 2019. He was a world-renowned palaeontologist from the National Museum in Bloemfontein and a Research Fellow of the CEM for many years. One of his major scientific contributions was his research in the 1990's on the age of the Florisbad-skull – estimated to be 259 500 years old.

RESEARCH OUTPUTS

Research Articles

Atangana, E. 2019. Adsorption of Zn (II) and Pb (II) ions from aqueous solution using chitosan cross-linked formaldehyde adsorbent to protect the environment. *Journal of Polymers and the Environment* 27(10): 2281-2291.

Atangana, E. 2019. New insight kinetic modeling: Models above classical chemical mechanic. *Chaos, Solitons & Fractals* 128: 16-24.

Atangana, E. & Chiweshe, T.T. 2019. Metal adsorbance in abattoir wastewater using cross-linked chitosan derivatives. *Journal of Polymers and the Environment* 27(11): 2624-2636.

Bootsma, A., Elshehawi, S., Grootjans, A., Grundling, P-L., Khosa, S., Butler, M., Brown, L. & Schot, P. 2019. Anthropogenic disturbances of natural ecohydrological processes in the Matlabas mountain mire, South Africa. *South African Journal of Science* 115(5/6): 69-77 (Art. # 5571).

Buschke, F.T., Botts, E.A. & Sinclair, S.P. 2019. Post-normal conservation science fills the space between research, policy, and implementation. *Conservation Science and Practice* 1(9): 1-9 (Art. # e73).

Buschke, F.T., Brownlie, S. & Manuel, J. 2019. The conservation costs and economic benefits of using biodiversity offsets to meet international targets for protected area expansion. *Oryx* 53(4): 732-740.

Buschke, F.T. & Sinclair, S.P. 2019. Adding ecological and evolutionary processes to restoration biodiversity offset models using neutral theory. *Diversity and Distributions* 25(9): 1351-1361.

De Cuyper, A. D., Clauss, M., Carbone, C., Codron, D., Cools, A., Hesta, M. & Janssens, G. P. 2019. Predator size and prey size-gut capacity ratios determine kill frequency and carcass production in terrestrial carnivorous mammals. *Oikos* 128(1):13-22.

Dlamini, S., Gyedu-Ababio, T.K. & Slaughter, A. 2019. The loading capacity of the Elands River: A case study of the Waterval Boven Wastewater Treatment Works, Mpumalanga Province, South Africa. *Journal of Water Resource and Protection* 11(8): 1049-1063.

Dube, T., Pinceel, T., De Necker, L., Wepener, V., Lemmens, P. & Brendonck, L. 2019. Lateral hydrological connectivity differentially affects the community characteristics of multiple groups of aquatic invertebrates in tropical wetland pans in South Africa. *Freshwater Biology* 64(12): 2189-2203.

Dufour, C.M., Pillay, N., Avenant, N., Watson, J., Loire, E. & Ganem, G. 2019. Habitat characteristics and species interference influence space use and nest-site occupancy: implications for social variation in two sister species. *Oikos* 128(4):503-516.

Ehrlich, C., Codron, D., Hofmann, R.R., Hummel, J. & Clauss, M. 2019. Comparative omasum anatomy in ruminants: Relationships with natural diet, digestive physiology, and general considerations on allometric investigations. *Journal of Morphology* 280(2): 259-277.

Elshehawi, S., Gabriel, M., Pretorius, L., Bukhosini, S., Butler, M., Van der Plicht, J., Grundling, P. & Grootjans, A.P. 2019. Ecohydrology and causes of peat degradation at the Vasi peatland, South Africa. *Mires and Peat* 24: 1-21 (Art. # 33).

Elshehawi, S., Grundling, P., Gabriel, M., Grootjans, A.P. & Van der Plicht, J. 2019. South African peatlands: review of Late Pleistocene-Holocene developments using radiocarbon dating. *Mires and Peat* 24: 1-14 (Art. # 11).

Esterhuyse, E., Vermeulen, D. & Glazewski, J. 2019. Regulations to protect groundwater resources during unconventional oil and gas extraction using fracking. *Wiley Interdisciplinary Reviews-Water* 6(6):1-19 (Art. # e1382).

Geerts, A.N., Moreau, K., Vanschoenwinkel, B., Vanoverbeke, J., Brendonck, L. & De Meester, L. 2019. The power of numbers: Dynamics of hatching and dormant egg production in two populations of the water flea *Daphnia magna*. *Aquatic Ecology* 53(3): 393-406.

Gommery, D., Kgasi, L., Sénégas, F., Vilakazi, N., Hancox, J. & Brink, J. 2019. Waypoint 160, Bolt's Farm Cave System: First in situ primate remains. *Annals of the Ditsong National Museum of Natural History* 8(8): 1-5.

Grine, F.E., Holt, S., Brink, J.S. & Du Plessis, A. 2019. Enamel pearls: Their occurrence in recent human populations and earliest manifestation in the modern human lineage. *Archives of Oral Biology* 101: 147-155.

Grundling, P.L., Grundling, A., De Villiers, L. & Van Deventer, H. 2019. Extinguishing subsurface fires in peatlands with the sprouting water pressure method. *The Water Wheel* September/ October 18(5): 38-41.

Hendus, B., Medina-González, R., Sélem-Salas, C. & Vanschoenwinkel, B. 2019. Explaining diversity patterns in dark waters – a study of aquatic caves in Yucatán, Mexico. *Journal of Tropical Ecology* 35(5): 237-246.

Henry, A.G., Hutschenreuther, A., Paine, O.C., Leichleiter, J., Codron, D., Codron, J., Loudon, J., Adolph, S. & Sponheimer, M. 2019. Influences on plant nutritional variation and their potential effects on hominin diet selection. *Review of Palaeobotany and Palynology* 261: 18-30.

Henschel, J.R., Wassenaar, T.D., Kanandjembo, A., Louw, M.K., Neef, G., Shuuya, T. & Soderberg, K. 2019. Roots point to water sources of *Welwitschia mirabilis* in a hyperarid desert. *Ecohydrology* 12(1): 1-12 (Art. # e2039).

Hohne, D., De Lange, F., Esterhuyse, E. & Sherwood Lollar, B. 2019. Case study: Methane gas in a groundwater system located in a dolerite ring structure in the Karoo Basin, South Africa. *South African Journal of Geology* 122(3): 357-368.

Holt, S., Horwitz, L., Hoffman, J. & Codron, D. 2019. Structural density of the leopard tortoise (*Stigmochelys pardalis*) shell and its implications for taphonomic research. *Journal of Archaeological Science: Reports* 26 (August): 1-13 (Art. # 101819).

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Conference Contributions

Conference Papers/Posters

Avenant, M.F. 2019. *The role of fish in a suite of indicators for assessing the environmental water requirements of non-perennial rivers: Case studies from South Africa.* Paper delivered at the 22nd International River Symposium. Brisbane, Australia. 20-24 October 2019.

Avenant, N.L. 2019. *Feeding ecology of caracal and black-backed jackal in livestock areas – implications for predation management*. Paper delivered at the 51st Congress of the South African Society for 13th Animal Science (SASAS). Bloemfontein, South Africa. 10-12 June 2019.

Avenant, N., Smit, N. & Du Plessis, J. 2019. *Changes in small mammal community structure following open-cast mining in central South Africa: an indicator of ecosystem integrity?* Paper delivered at the 13th African Small Mammal Symposium (ASMS). Mekelle, Ethiopia. 16-21 September 2019.

Bergman, D.L, Avenant, N., Schutte, F. & Bodenchuk, M.J. 2019. *Providing education to enhance wildlife conservation in South Africa through the first wildlife school for game ranchers – a grassroots effort by government authorized conservationists*. Paper delivered at the 18th Wildlife Damage Management Conference. Starkville Mississippi, USA. 25-27 March 2019.

Blanche, C., Gresse, F., Grundling, P. & Tererai, F. 2019. *Could South Africa's environmental legislation better support wetland restoration efforts?* Paper delivered at the 8th World Conference On Ecological Restoration (CER). Cape Town, South Africa. 24-28 September 2019.

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Bosman, B.L., Grundling, A.T., Grundling, P. & Le Roux, J.J. 2019. *Geomorphological controls and hydrology of a peatland in the Kgatswane Mountain Reserve, Rustenburg*. Paper delivered at the National Wetland Indaba 2019. Tzaneen, South Africa. 7-11 October 2019.

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Ganem G., Dufour C.M-S., Avenant N.L., Kotze L. & Pillay N. 2019. *An update on* Rhabdomys *sp. distribution, ecology and behavioural characteristics*. Paper delivered at the 13th African Small Mammal Symposium (ASMS). Mekelle, Ethiopia. 16-21 September 2019.

Gangathele, A.M., Grundling, A.T., Grundling, P. & Le Roux, J.J. 2019. *Comparing two main tributaries feeding a peatland system in Kgaswane Mountain Reserve, Rustenburg*. Paper delivered at the National Wetland Indaba 2019. Tzaneen, South Africa. 7-11 October 2019.

Grundling, P. 2019. *Peatland restoration support from local to national level – case studies from South Africa*. Paper delivered at the 8th World Conference on Ecological Restoration (CER). Cape Town, South Africa. 24-28 September 2019.

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Grundling, P. 2019. *Towards achieving peatland conservation objectives in multilateral environmental agreements: The role of formal and informal initiatives in southern Africa*. Paper delivered at the UN Environment Programme, Global Peatland Initiative: "Exploring Synergies for Peatlands – Detecting and enhancing the global importance of peatlands in achieving the Sustainable Development Goals". Isle of Vilm, Germany. 21-25 May 2019.

Grundling, P. & Tererai, F. 2019. *Hillslope seep restoration monitoring – the impact of fill material on hydrology*. Paper delivered at the National Wetland Indaba 2019. Tzaneen, South Africa. 7-11 October 2019.

Grundling, P., Tererai, F. & Grundling, A.T. 2019. *Peatland degradation: from fire to restoration – southern African case studies*. Paper delivered at the 8th World Conference On Ecological Restoration (CER). Cape Town, South Africa. 24-28 September 2019.

Grundling, P-L. & Grundling, A. 2019. *Peat fire – an erosion catalyst in southern African mires?* Paper delivered at the Southern African Geomorphology (SAAG) 2019. East London, South Africa. 16-17 September 2019.

Kemp, M. 2019. *Exploring the dendroecological potential of riparian Poplar trees, Caledon River, South Africa*. Paper delivered at the Eurodendro 2019 Conference. Brno, Czech Republic. 9-13 September 2019.

Le Roux, J., Beckedahl, H., Grundling, A., Grundling, P-L. & Sumner, P. 2019. *The hydrogeomorphic distribution of wetlands in Eswatini*. Paper delivered at the Southern African Geomorphology (SAAG) 2019. East London, South Africa. 16-17 September 2019.

Mavimbela, S., Ololade, O.O., Van Tol, J.J. & Aghoghovwia, M.P. 2019. *Leachate migration potential of a Duplex soil type at the Bloemfontein Southern Solid-waste landfill.* Paper delivered at the Combined Congress of Southern African Society for Horticultural Sciences; Crop production; Weed Science and Soil Science. Bloemfontein, South Africa. 21-25 January 2019.

Munzhedzi, E., Tererai, F., Kotze, D., Chavalala, T. & Grundling, P. 2019. *Assessing the structural integrity and functionality of wetland restoration interventions: a case from working for wetlands, South Africa*. Paper delivered at the 8th World Conference On Ecological Restoration (CER). Cape Town, South Africa. 24-28 September 2019.

Nemakhavhani, L., Grundling, A. & Grundling, P-L. 2019. *Assessment of wetland rehabilitation interventions using hydrology, geomorphology and vegetation in Kgaswane Mountain Reserve*. Paper delivered at the National Wetland Indaba 2019. Tzaneen, South Africa. 11 October 2019.

Ololade O.O. & Bonokwane, L.P. 2019. *Factors that influence smallholder farmers' willingness to adopt a biodigester technology: A South Africa case study*. Paper delivered at the 2nd International Conference on Energy and Social. Phoenix, USA. 28-31 May 2019.

Orimoloye, I.R. 2019 *Space-based solutions for disaster management in Africa: Challenges, applications, partnerships*. Paper delivered at the UN-SPIDER Bonn International Conference (Training and workshop). Bonn, Germany. 6-8 November 2019.

Orimoloye, I.R. & Ololade O.O. 2019. *Global trends assessment of environmental health degradation studies from 1990 to 2018*. Paper delivered at the 4th World Academy of Sciences (TWAS)-Young Affiliates Network (TYAN) International Thematic Workshop and 1st African Symposium. Akure, Nigeria. 10-14 June 2019.

Paine, O.C., Koppa, A., Henry, A.G., Leichliter, J.N., Devereux, E.J., Ryder, C., Codron, D., Codron, J. & Sponheimer, M. 2019. *The mechanical and nutritional properties of African savanna vegetation: potential implications for early hominin feeding behavior.* Poster presented at the 88th Annual Meeting of the American Association of Physical Anthropologists. Cleveland Ohio, USA. 27-30 March 2019.

Pinceel, T., Thoré, E., Phillippe, C. & Brendonck, L. 2019. *African killifish as model organisms in aquatic sciences.* Paper delivered at the ASLO 2019 Aquatic Sciences Meeting. San Juan, Puerto Rico. 23 February-2 March 2019.

Tererai, F. & Grundling, P. 2019. *Wetlands mitigate against the effects of climate change: Fallacy of the assumed premise*. Paper delivered at the National Wetland Indaba 2019. Tzaneen, South Africa. 7-11 October 2019.

Tererai, F., Grundling, P. & Kotze, D. 2019. *Assessing ecological outcomes of wetland restoration under resource constraints in South Africa*. Paper delivered at the 8th World Conference On Ecological Restoration (CER). Cape Town, South Africa. 24-28 September 2019.

Thoré, E., Steenaerts, L., Philippe, C., Brendonck, L. & Pinceel, T. 2019. *Turquoise killifish (*Nothobranchius furzeri*) as a new model organism in behavioural ecotoxicology.* Paper delivered at the 8th Young Environmental Scientists Meeting (YES2019). Ghent, Belgium. 5-10 February 2019.

Thoré, E., Steenaerts, L., Philippe, C., Brendonck, L. & Pinceel, T. 2019. *Turquoise killifish (*Nothobranchius furzeri*) as a new model organism in behavioural ecotoxicology.* Paper delivered at the Setac Europe 29th Annual Meeting. Helsinki, Finland. 26-30 May 2019.

Conference Proceedings

Bergman, D.L., Avenant, N., Schutte, F. &. Bodenchuk, M.J. 2019. Providing education to enhance wildlife conservation in South Africa through the First Wildlife School for Game Ranchers – a grassroots effort by government authorized conservationists. In: *Proceedings of the 18th Wildlife Damage Management Conference*. Starkville, USA, 25-27 March 2019. J.B. Armstrong & G.R. Gallagher (Eds). pp. 68-76.

STAFF (2019)

Director: Prof PJ Oberholster

Senior Lecturers: Dr FT Buschke and Dr OO Ololade

Lecturers: Mrs MF Avenant, Mrs SE Esterhuyse and Mr F Sokolic (units)

Affiliated Professors: Prof NA Kgabi and Prof A Turton

Research Associates: Dr NL Avenant, Dr JS Brink, Dr J Codron, Dr NB Collins, Dr PL Gründling, Dr JR Henschel, Dr SA Mitchell, Dr T Pinceel, Prof MT Seaman, Dr DF Toerien, Dr C van Ginkel, Prof B Vanschoenwinkel and Dr PC Zietsman

Programme Director: Mrs MF Avenant

Professional Officer: Dr AT Vos

Senior Officer - Professional Services: Mrs ME Kemp

Course Coordinator: Mrs V Padayachee

Senior Assistant Officer: Mrs DM Kolesky

Research Assistant: Miss F Mudau

Student Assistant: Mr S Malindie

Messenger: Mr PS Thabiri

CENTRE FOR MICROSCOPY

CONTACT DETAILS

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OVERVIEW OF 2019

The Centre for Microscopy is a faculty-based research facility that primarily supports researchers and students from the UFS in gathering structural information using the scanning electron microscope (SEM) and the transmission electron microscope (TEM). In addition to the UFS, local and international institutes also utilise the facilities available at the Centre. The Central University of Technology (CUT) regularly makes use of the facilities, while international institutes usually work in association with other departments in the UFS.

In 2019 our staff supported 86 researchers and students at the Centre, covering a range of disciplines involving microscopy research. Centre staff, in addition to operating the research equipment, handle the necessary microscopic preparations for most of the samples according to the applicant's requirements. This forms an integral part of the support service provided by the Centre.

The table below presents the number of users over the past four years.

Table 1: Number of users of Centre facilities (2016-2019)

2016	2017	2018	2019
90	59	51	86

Variations in each year are due to researchers either completing current or starting new projects.

ACTIVITIES

The total hours amounted to 1 179 hours for the use of the microscopes combined.

The microscope usage by the various departments is set out in the table below.

Table 2: Internal and external usage (2019)

UFS Department	Usage hours		
	SEM	TEM	Total
Animal, Wildlife and Grassland Sciences	70	-	70
Cardiothoracic Surgery	4	26	30
Chemistry	104	63	167
Consumer Science	13	-	13
Genetics	6	-	6
Geology	8	-	8
Institute for Groundwater Studies (IGS)	4	-	4
Microbiology	25	18	43
Pharmacology	4	4	8
Physics	638	35	673
Plant Sciences	43	3	46
Zoology and Entomology	91	-	91
External Researchers/Projects			
Central University of Technology (CUT)	20	-	20
TOTAL USAGE	**1030**	**149**	**1179**

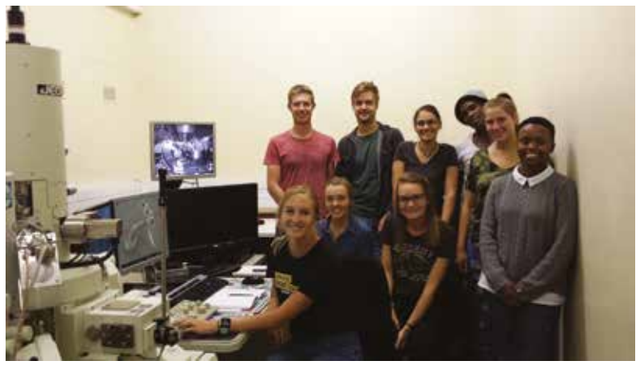
This year our staff attended the Microscopy Society of Southern Africa (MSSA) conference hosted by the University of Cape Town (UCT) at Club Mykonos, Langebaan. This conference, which takes place once every two years, gives microscopists and students around southern Africa an opportunity to meet and build connections with professionals in various fields of microscopy. The conference hosts technical forums where microscope manufacturers present their latest products and forthcoming advances in the field of microscopy.

Ms Hanlie Grobler (left) and Prof Linda Basson (right) at the MSSA learning zone

TEACHING

Each year our staff present practical sessions to Honours students from the Departments of Genetics (FORS6816), Zoology and Entomology (ZLGY6814 and ENTO6814), and Microbial, Biochemical and Food Biotechnology (MCBT6814 and BOCT6814). The practical sessions consist of a tour through the Centre, during which the staff guide the students through the preparation of various materials, as well as the functioning and handling of the research equipment.

In addition to the tour, the Zoology and Entomology Honours students are each given an opportunity to examine one of their own samples which they have pre-prepared and which will later form part of their Honours projects.



Zoology and Entomology students analysing samples they have prepared

RESEARCHER SUPPORT

We accommodated 86 users in 2019. The Centre's staff prepare the majority of the samples submitted according to the specific requirements for analysis by each type of microscope. This would have been discussed and prearranged with the researchers.

Chemicals used for microscopy preparation are generally very expensive with a limited shelf-life. As the Centre has all the necessary chemicals and supplies readily available for basic sample preparation, researchers are saved both time and funds, allowing them to conduct smaller projects, which would normally be too costly. This overall support-service approach, initiated in 2012, has been very successful and provides researchers with an economically viable route to incorporate microscopy in their research.

Electron Microscopes

The average annual operating hours over four years (2016 to 2019) of the SEM was 716 hours, while for the TEM it was 144 hours. The SEM is more popular with researchers due to the impressive dimensional images it delivers. The TEM requires nano-scaled or ultra-thin samples in order to utilise its full capabilities. These samples can be time-consuming to prepare and may require specialist equipment, such as a microtome, for preparing ultra-thin samples.

The TEM has been in use for more than 20 years, and, though still fully functional, the manufacturer no longer supports or makes any service parts. A major focus in 2019 for both the Faculty and the University was to gather the necessary funds to purchase a high-resolution TEM. Such a system will exceed the resolution of the current TEM, providing opportunities for projects which were previously not feasible.

New Leica Sputter Coater

The Leica LM ACE600 sputter coater was delivered and installed in June 2019. This apparatus is equipped with an iridium metal sputtering target, which is capable of depositing a significantly smoother conductive coating compared to the gold BIORAD sputter coater equipped with a gold target, which is still operational. Having such a system is crucial to researchers working with nano-sized material, as any artefacts introduced by the sputter coater may alter the true structure and shape of their material.

Renovation

Renovation to the room located outside the Centre began in August 2019. The primary purpose of the room is to house all the chillers used to maintain the temperature of the electron microscopes. Having the chillers placed in a separate room not only helps reduce the noise level, but also reduces the ambient temperature within the Centre allowing for a more comfortable working environment for the staff.

STAFF MATTERS

A new full-time support staff member, Ms Nonkululeko Phili, was appointed as Assistant Officer at the Centre.

Prof Pieter van Wyk, retired as the Director of the Centre in April 2019 and Prof Koos Terblans was appointed as the new Director.

RESEARCH OUTPUTS

Research Articles

Haddad, C.R., Henrard, A. & Jocqué, R. 2019. Revision of the ant-eating spider genus *Mallinus* Simon, 1893 *(Araneae, Zodariidae). ZooKeys* 822: 141-158.

Hasabeldaim, E.H.H., Ntwaeaborwa, O.M., Kroon, R.E., Coetsee, E. & Swart. **H.C.** 2019. Cathodoluminescence degradation study of the green luminescence of ZnO nanorods. *Applied Surface Science* 484: 105-111.

Hasabeldaim, E.H.H., Ntwaeaborwa, O.M., Kroon, R.E., Coetsee, E. & Swart, H.C. 2019. Enhanced green luminescence from ZnO nanorods. *Journal of Vacuum Science and Technology B* 37(1): 011201.

Hasabeldaim, E.H.H., Ntwaeaborwa, O.M., Kroon, R.E., Coetsee, E. & Swart, H.C. 2019. Photoluminescence and cathodoluminescence of spin coated ZnO films doped with up to 4 mol% Eu^{3+}. *Vacuum* 169: 10888921.

Hile, D.D., Swart, H.C., Motloung, S.V., Motaung, T.E., Egbo, K.O. & Koao, L.F. 2019. Comparative study of photo and non-photo assisted chemical bath deposition of ZnSe thin films using different volumes of hydrazine hydrate. *Superlattices and Microstructures* 134: 10622220.

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Lee, E., Terblans, J.J., Cracium, V. & Swart, H.C. 2019. Structural and luminescence properties of Y_2O_3:$Bi_{2.0\ mol\%}$, $Yb_{10.0\ mol\%}$ thin films prepared using the pulsed laser deposition and spin coating technique. *Surfaces and Interfaces* 16: 101-107.

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Ogugua, S.N., Shaat, S.K.K., Swart, H.C., Kroon, R.E. & Ntwaeaborwa, O.M. 2019. Structure and optical properties of $La_{2-x}Gd_xSiO_5$:Dy^{3+} phosphors. *Journal of Alloys and Compounds* 775: 950-968.

Saeed, N.A.M., Coetsee, E. & Swart, H.C. 2019. Photoluminescence studies of a YOF phosphor synthesized by the pyrolysis method. *Optical Materials* 96: 109331.

Shivaramu, N.J., Coetsee, E. & Swart, H.C. 2019. Cathodoluminescence degradation behavior of Y_2O_3:Dy^{3+} nanophosphor for field emission displays. *Journal of Vacuum Science and Technology A* 37: 0614052019.

Tsai, C.W., Kroon, R.E., Swart, H.C., Terblans, J.J. & Harris, R.A. 2019. Photoluminescence of Metal-Imidazolate complexes with Cd(II), Zn(II), Co(II) and Ni(II) cation nodes and 2-methylimidazole organic linker. *Journal of Luminescence* 207: 454-459.

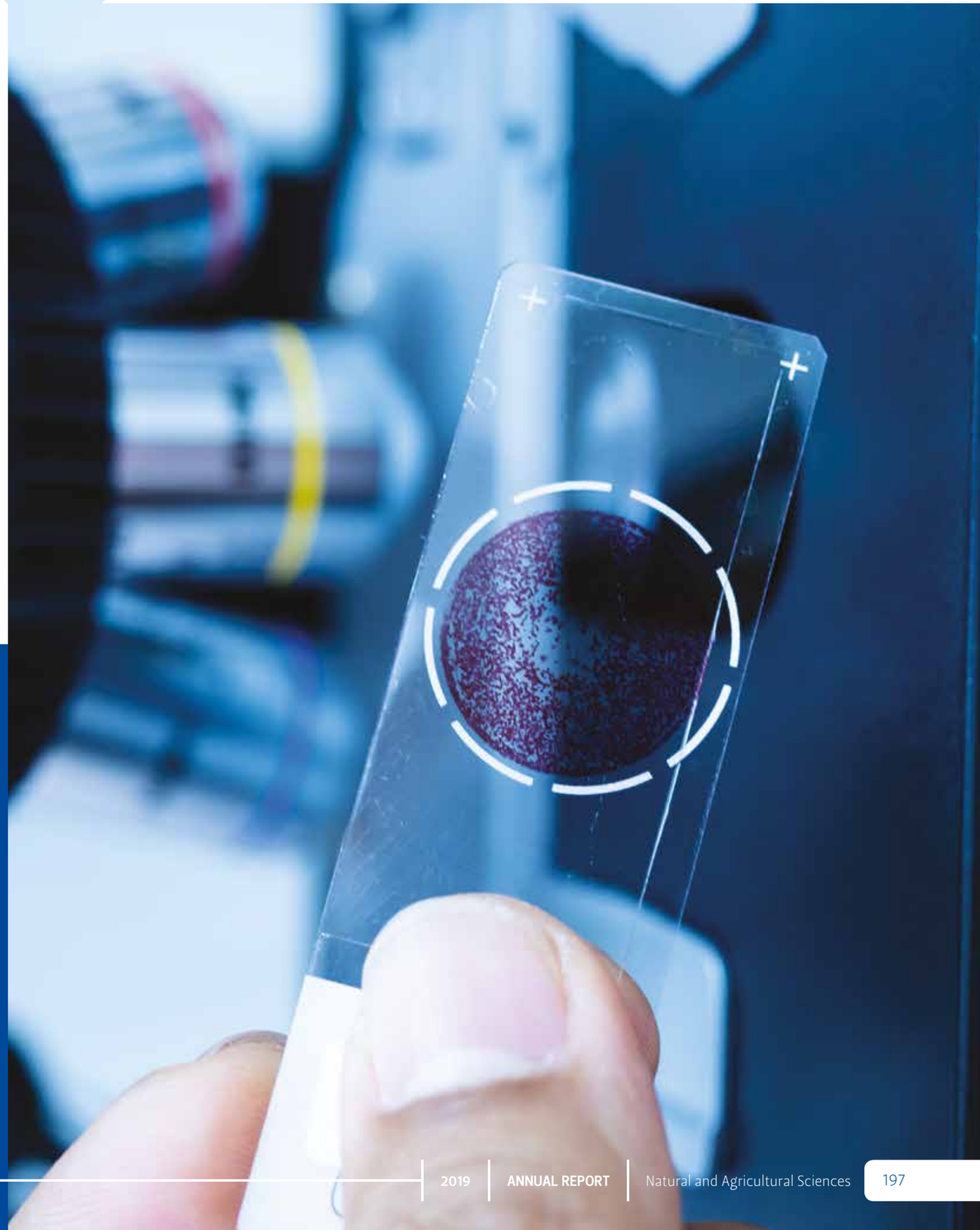
Ungula, J. & Swart, H.C. 2019. Controlling the morphology of ZnO NRs grown on GZO seed layer, by use of ethylenediamine and L-cysteine as crystal growth modifiers (Complexing agents). *Applied Surface Science* 487: 1198-1208.

Ungula, J. & Swart, H.C. 2019. Structural, morphological and optical properties of ZnO nanorods grown on a ZnO:Ga seeded thin film: The role of CBD precursor concentration at constant and varying II/VI molar ratios. *Thin Solid Films* 687: 137483.

STAFF (2019)

Director: Prof PWJ van Wyk (retired April 2019) and Prof JJ Terblans (appointed May 2019)

Professors: Prof PWJ van Wyk (to April 2019) and Prof JJ Terblans (from May 2019)
Senior Assistant Officer: Ms H Grobler
Junior Researcher/Lecturer: Mr E Lee
Assistant Officer: Ms N Phili



CENTRE FOR

SUSTAINABLE AGRICULTURE, RURAL DEVELOPMENT AND EXTENSION

CONTACT DETAILS

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OVERVIEW OF 2019

After the successful implementation of the new postgraduate qualifications in Sustainable Agriculture – the Postgraduate Diploma (PGDipSA) and the Master of Sustainable Agriculture (MSA) – the Centre for Sustainable Agriculture, Rural Development and Extension (CENSARDE) focused on creating awareness for agriculture on a global level, through community engagement and research collaboration initiatives.

ACHIEVEMENTS

Staff Achievements

Prof Johan van Niekerk was elected to the board of SASAE (South African Society for Agricultural Extension) for a further two-year period.

Dr Hlamalani Ngwenya chaired a session on 'Monitoring CFS policy recommendations on smallholders' at the 46th Session of the United Nations Committee on World Food Security (CFS), held at the Food and Agriculture Organization (FAO) headquarters in Rome from 14 to 18 October 2019.

RESEARCH

Innovations in the agriculture and food sector have increased the incomes of small farming enterprises, boosted employment and improved the regional food supply in the rural target regions. The Centre, in collaboration with the Department of Consumer Sciences, is in the process of developing plans to establish the *Food Systems Innovation and Research Plan*, which will complement the University of the Free State's Strategic Research Plan. Its purpose is to distil the objectives and elaborate the strategies and measures to advance the Centre's research performance.

Much of the research undertaken by the Centre has a strong emphasis on community engagement. An innovative project in collaboration with the Regional Universities Forum for Capacity Building in Africa (RUFORUM), focuses on communal wool producers. The overall objective of this collaboration is to transform communal woolgrowers' production from an underachieving enterprise to a profitable, sustainable, and renewable venture, and in so doing, enhance the livelihoods of communal wool producers in the Free State. In addition, the extension of the value chain, i.e. processing of the wool by the community members, will facilitate job creation and development, which plays a vital role in supporting the South African National Treasury's strategy. This collaborative project is thus designed to combine research and community engagement. The research component includes the evaluation, testing and further development of certain technologies and social and economic scenarios. In total, one PhD, four master's and ten intern students will directly benefit from this collaboration. The community engagement component includes training members from the community to produce wool products.

RUFORUM collaboration

ENGAGED SCHOLARSHIP

Prof Johan van Niekerk and Dr Jan Swanepoel visited the Wits Food Sovereignty Centre in February 2019, with the aim of establishing similar food gardens and a student-feeding scheme at the UFS. Under the directive of the 'No student hungry' drive and with the full support of our Vice-Chancellor and the Dean of Natural and Agricultural Sciences, a task team set out to investigate options for implementation at the UFS. CENSARDE and Kovsie ACT joined forces to address this burning issue. With the assistance of industry experts, Prof Michael Rudolph and Dr Evans Muchesa, funds were obtained from Tiger Brands to embark on this community project. Two tunnel structures were erected on the Bloemfontein Campus, and concrete slabs for water tanks and the water tanks themselves were constructed. The initial phase of the project was concluded with the installation of the netting for the tunnels, pumps, pipes and building of plant boxes. Prof Rudolph and Dr Muchesa will be invited to conduct training (which will commence in 2020), together with other interested and relevant departments in the Faculty. Residence Committee members with civic and social responsibility portfolios, as well as civic and social responsibility student associations, will be trained in relevant aspects of agriculture and will contribute by planting the first seedlings. Each residence and department will be responsible for their particular plant box.

Food tunnels

NATIONAL AND INTERNATIONAL COLLABORATION

In partnership with Standard Bank, the UFS proposed the establishment of an 'Agribusiness Transformation Programme'. The programme leverages existing expertise, skills and infrastructure to develop black commercial farmers and black-owned sustainable agribusinesses in the Free State. The initial focus of the programme will be on emerging farmers who have access to land, including redistributed land. Candidates for the programme were identified in conjunction with the Free State Department of Agriculture and Rural Development. The Centre, which has a solid record of developing entrepreneurs and agricultural experts, will be the implementing agents. Standard Bank agreed to be involved through funding the programme for five years. In the process, the partnership will develop a replicable model for the rest of South Africa and Africa.

As reported above, the collaboration with RUFORUM includes both a research and a strong community engagement focus – on training members from the community to produce quality wool products. The UFS Facilities department has upgraded UFS facilities for training and wool production.

Processing wool as part of RUFORUM collaboration

POSTGRADUATE STUDENTS

Sixty (60) students graduated in 2019 with the structured Master of Sustainable Agriculture (MSA), while a further 42 students graduated with the Postgraduate Diploma in Sustainable Agriculture (PGDipSA) – four with distinction, namely Sue-Allen Vianca Erasmus, Albertus van der Merwe Greeff, Oscar Bulela Phoswa, and Johannes Herculas Strydom.

During the year, PhD qualifications were awarded to:

Muchesa, Evans
Thesis: Efficiency of communal farmers` market systems in the Mhondoro-Mubaira district, Mashonaland West, Zimbabwe
Promoter: Prof JA van Niekerk

Ngwenya, Hlamalani Judith
Thesis: Facilitation of systemic change: Outcomes and Impact of competence development towards transformation of Agricultural Extension Service delivery system in South Africa
Promoter: Prof JA van Niekerk

Odunze, Daisy Ifeoma
Thesis: Analysis of the impact of entrepreneurship in agribusiness value chains on household food security levels in Nigeria; Constraints, prospects, and policies
Promoters: Prof I Mohammed and Prof JA van Niekerk

STAFF MATTERS

Anathi Makamane was appointed as Junior Lecturer for the undergraduate Agricultural Extension programme and Johan van Niekerk was promoted to Associate Professor.

Hlamalani Judith Ngwenya obtained her PhD degree.

Prof Van Niekerk attended the International Centre for Development Oriented Research in Agriculture (ICRA) course on *Making Innovation Work* in Wageningen, the Netherlands, from 3 to 14 June 2019. He implemented several of the online evaluation techniques in the continuous assessment of the Centre's postgraduate qualifications.

RESEARCH OUTPUTS

Research Articles

Bastian, R., Swanepoel, J.W. & Van Niekerk, J.A. 2019. Effectiveness of the implementation of the mechanisation programme for emerging farmers in the Overberg and Eden districts of the Western Cape. *South African Journal of Agricultural Extension* 47(2): 58-71.

Esabu, A. & Ngwenya, H.J. 2019. Socio-economic factors influencing adoption of conservation agriculture in Moroto district, Uganda. *South African Journal of Agricultural Extension* 47(2): 105-117.

Jepthas, G. & Swanepoel, J.W. 2019. Implications of the environmental impact assessment regulations on the agricultural sector in the Overberg district in the Western Cape for emerging farmers. *South African Journal of Agricultural Extension* 47(2): 128-139.

Nkosi, B.D., Meeske, R., Van Niekerk, J.A., Muya, M., Langa, T., Thomas, R., Malebana, I. & Motiang, M. 2019. Microbial additives affect silage quality and ruminal dry matter degradability of avocado (*Persia americana*) pulp silage. *South African Journal of Animal Science* 49(6): 99-1007.

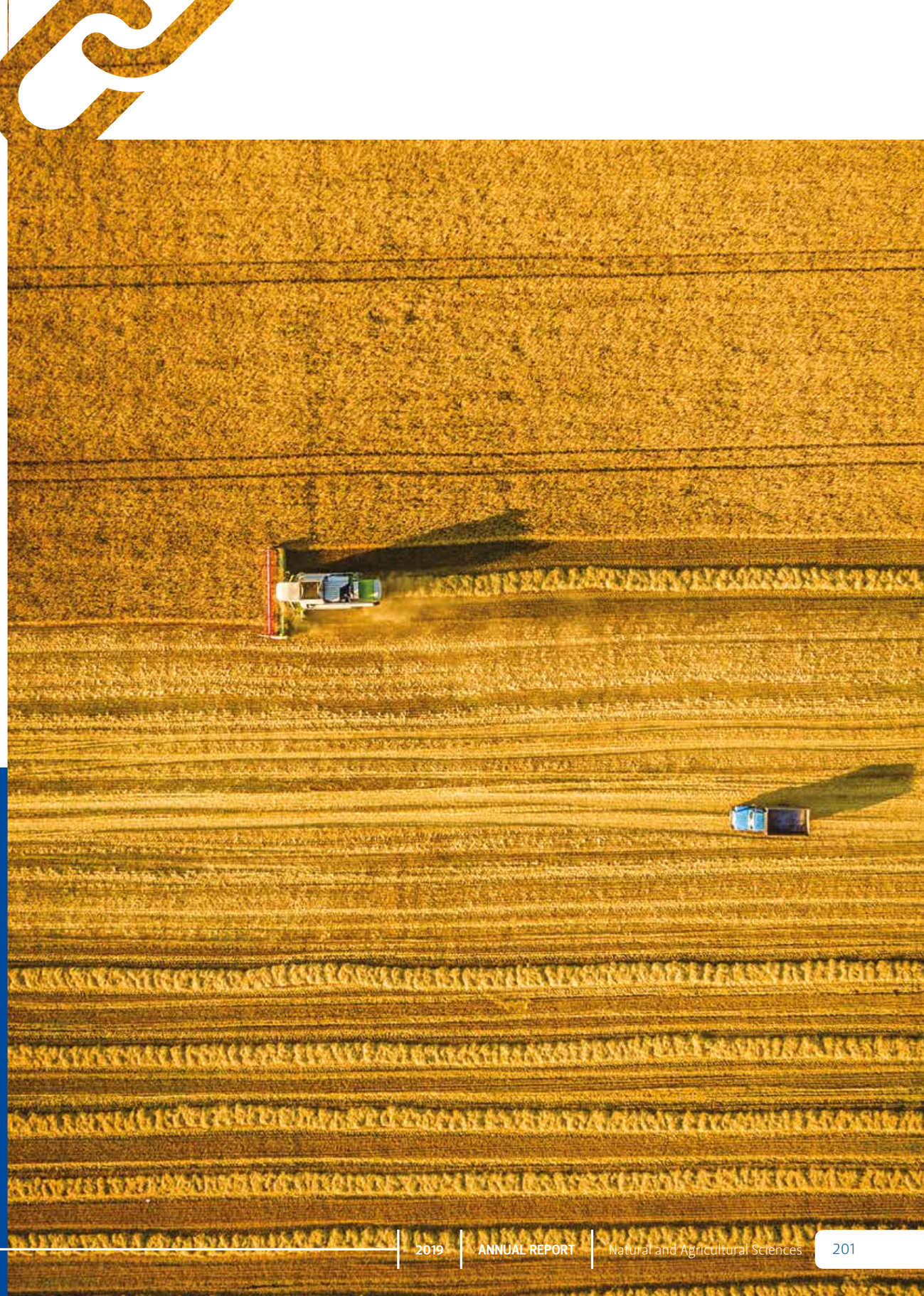
Nkosi, B.D., Muchesa, E., Zwane, E.M. & Van Niekerk, J.A. 2019. The role of extension support in a communal farmers' market system in Mhondoro-Mubaira, Zimbabwe. *South African Journal of Agricultural Extension* 47(2): 72-80.

Nkosi, B.D., Phenya, J., Malebana, I., Muya, M. & Motiang, M. 2019. Nutrient evaluation and ruminal degradation of dry matter and protein from amarula (*Sclerocarya birrea*), macadamia (*integrifolia*) and baobab (*Adansonia digitata* L.) oil cakes as dietary supplements for ruminants. *Tropical Animal Health and Production* 51: 1981-1988.

STAFF (2019)

Director: Prof JA van Niekerk

Lecturers/Researchers (permanent): Mrs A Makamane, Dr HJ Ngwenya and Dr JW Swanepoel,
Lecturers/Researchers (part-time): Dr JH Barnard, Ms K Green, Dr E Kotze, Mr L Kruger, Dr P Malan, Prof F Neser, Dr D Nkosi, and Ms A Silwana, Ms K Thobejane, Mr J van Den Berg, Prof J van Rooyen and Prof E Zwane
Programme Director: Prof JA van Niekerk
Senior Officers: Ms A Calitz and Ms G Green
Officer: Ms R Coetzee



DISASTER MANAGEMENT

TRAINING AND EDUCATION CENTRE FOR AFRICA

CONTACT DETAILS

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OVERVIEW OF 2019

The 2019 academic year has been a remarkable one for DiMTEC. The leadership in DiMTEC changed hands at the beginning of the year following the retirement at the end of 2018 of Prof Andries Jordaan, who had been the Director of DiMTEC since 2005. Dr Johanes Belle took over at the helm of the Centre as the Acting Director from January 2019.

DiMTEC offers three postgraduate programmes – the Postgraduate Diploma in Disaster Management (PGDip [Disaster Management]), the Master of Disaster Management (MDM) and the PhD majoring in Disaster Management – as well as various short courses. In 2019 there was a high demand for all the programme offerings.

ACHIEVEMENTS

Staff Achievements

Ms Olivia Kunguma, one of the permanent staff members, has made considerable progress with her PhD studies and will possibly graduate in 2020.

The DiMTEC secretary, Annelene van Straten, is to be congratulated on obtaining her PhD in 2019.

The Executive Mayor of the City of Tshwane, Stevens Mokgalapa, and Local Governments for Sustainability (ICLEI) Africa invited Dr Johannes Belle to be the guest speaker at the 2019 African Capital Cities Sustainability Forum (ACCSF) (from 24 to 26 June 2019). Dr Belle's presentation was titled 'The Role of Disaster Management in Urban Safety'.

RESEARCH

Ms Olivia Kunguma and Dr Alice Ncube were invited to attend the International Summer School on Disaster Management, held at Babeș-Bolyai University in Cluj Napoca, Romania from 12 to 19 July 2019. It was well-attended by many students from Hungary, Romania, Brazil, Italy and Germany. The programme explored in-depth topics including information management systems, water, sanitation and hygiene, and public awareness. The trainers were officials from the European Union (EU) Civil Protection Mechanism who shared practical experience from their various missions, with the most recent one being the cyclones in Mozambique. The Summer School was concluded with an intensive field exercise, during which participants had to plan and set up camp in the forest for two nights, planning for a deployment to a mission, looking at initial assessments, logistics, travelling arrangements, coordination with other responding organisations and the overall process of responding to the event.

DiMTEC's programmes currently focus on disaster risk reduction with less emphasis on disaster response. The exposure to the Summer School programme has fuelled the idea of developing a new programme that focuses entirely on disaster response. It is anticipated that the programme will be ready for implementation by 2021.

Dr Ncube and Ms Kunguma at the International Summer School on Disaster Management in Romania

DiMTEC was invited to the regional Africa Sustainable Cities workshop to give a presentation on '*Urban Safety and Disasters*'.

ENGAGED SCHOLARSHIP

Together with the Central University of Technology (CUT), DiMTEC jointly hosted the Provincial National Science Week (NSW) with great success.

DiMTEC was also very active in the preparation of the International Day for Disaster Reduction (IDDR), the national commemoration of which was held in Mangaung on 4 and 5 December 2019.

NATIONAL AND INTERNATIONAL COLLABORATION

The year also witnessed many international and national engagements in terms of staff exchange, mobility programmes, international and national conferences, workshops and staff development training.

In 2019 DiMTEC, representing the UFS, together with six other universities in Africa formed a consortium and presented a winning proposal to the Intra-Africa Academic Mobility Scheme sponsored by the EU, to the value of 1.3 million Euros. This programme provides financial support to partnerships of African higher education institutions for the organisation and implementation of student and staff mobility in high quality master's and doctoral programmes within African countries. Thus, from 2020, this project will sponsor many students from all over Africa to study at DiMTEC and DiMTEC staff will also have the opportunity to lecture at other universities within the consortium.

Dr Zoltán Torok of Babeș-Bolyai University, Romania

The Annual Block Course that is jointly presented by DiMTEC and the United Nations University in Bonn, Germany, was successfully held in Cape Town in February 2019. DiMTEC hosted Dr Zoltán Torok from Babeș-Bolyai University, Romania as an academic staff member on Erasmus+ to lecture participants during the Block Course.

Dr Johannes Belle and five National Executive Committee (NEC) members of the Disaster Management Institute of Southern Africa (DMISA), facilitated a one-day workshop on 31 July 2019 in Maseru, Lesotho on the professionalisation of the disaster management function in southern Africa. Dr Belle was the programme director for the workshop, which was well-attended by disaster management practitioners in Lesotho. The workshop, hosted by the Disaster Management Authority (DMA) of Lesotho, laid the groundwork for future close collaboration between disaster management practitioners from both countries.

Mr Haretsebe Mahosi, CEO of DMA Lesotho, and the NEC delegation of DMISA, at a workshop in Maseru, Lesotho

During 2019, DiMTEC hosted a range of international visitors, including:

Visitors from Romania (Babeș-Bolyai University, Cluj Napoca) and Hungary (National University of Public Services [NUPS]) presented lectures to our students during contact sessions in January.

From the left: Mr L Lagrange (UFS Department of Engineering), Prof A Ozunu (Dean of Engineering Faculty, Babeș-Bolyai University), Dr M Ozunu (Civil Engineer, Romania), Prof A Restas (NUPS, Budapest)

Prof Agoston Restas from NUPS visited DiMTEC in January, as part of the Erasmus+ Mobility Program as academic personnel.

Prof Agoston Restas (NUPS) with Prof Francis Petersen (UFS Vice-Chancellor)

Staff from NUPS and Dr Joerg Szarzynski from the United Nations University Institute for Environment and Human Security (UNU-EHS), Bonn, Germany, who is also Associate Professor of DIMTEC, visited us in May.

From the left: Prof A Membretti (Eurac), Dr J Szarzynski (UNU-EHS), Mr L Bodnar (NUPS), Prof A Restas (NUPS) and Prof M Bordas (NUPS)

Prof Peter Ruzsonyi, Dean of the Faculty of Correctional Services at NUPS, visited as part of the Erasmus+ Mobility Program in July.

Prof Peter Ruzsonyi (on the right) together with Goodwood Correctional Services

In July 2019 Mrs Gerdamarie van Coppenhagen, the DiMTEC Erasmus Officer, visited Babeș-Bolyai University in Romania as an administrative staff member on the Erasmus+ Mobility Program.

Ms O Cozmuta (Erasmus Officer, Babeș-Bolyai University), Mrs G van Coppenhagen and Ms R Fader (Erasmus+ Officer, Babeș-Bolyai University)

POSTGRADUATE STUDENTS

The year saw an upsurge of student enrolments in all three DiMTEC programmes, with 49 students registering for the Postgraduate Diploma (PGDip [Disaster Management]), 59 for the Master of Disaster Management (MDM) programme and 13 for the PhD programme. The high number for the master's and PhD students posed a big challenge for supervision; however, with the assistance of external supervisors, each registered student was allocated a supervisor/promoter.

In 2019, 30 students graduated with the PGDip (Disaster Management), while 21 students graduated with the MDM. Among the 20 master's graduates is a DiMTEC Research Assistant, Miss Vallery Poto, who graduated with a distinction.

In 2019, the National Disaster Management Centre (NDMC) awarded 15 DiMTEC students with comprehensive bursaries for their studies towards their PGDip (seven bursaries) and master's (eight bursaries) degrees. This bursary targeted mostly students from poor and disadvantaged backgrounds.

Some NDMC bursary holders with DiMTEC and NDMC staff

STAFF MATTERS

Dr Belle participated in a training of instructors (ToI) course on Ecosystem-based Disaster Risk Reduction and Climate Change Adaptation (Eco-DRR/CCA) in Africa, held at Kenyatta University from 30 September to 4 October 2019. Participants from 24 universities across Africa, as well as a few NGOs and UN offices, received hands-on training on Eco-DRR/CCA, culminating with planned actions for teaching this topic at African universities (which DiMTEC already does), as well as for creating an African Eco-DRR/CCA Knowledge Hub and Science Policy Network.

RESEARCH OUTPUTS

Research Articles

Belle, J.A. 2019. Culture, gender bias and the vulnerability of black African women to HIV and AIDS: a study of Lesotho. *Indilinga – African Journal of Indigenous Knowledge Systems* 18(1): 1-11.

Belle, J.A. & Gamedze, N.N. 2019. Behavioural factors contributing to the transmission of HIV and AIDS amongst young women of Mbabane in Swaziland. *African Health Sciences* 19(3): 2302-2311.

Ncube A., Bahta, J.T. & Jordaan, A.J. 2019. Exploring short- and long-term survival mechanisms and perception of job market by Zimbabwean migrant women in South Africa. *Ìrìnkèrindò: A Journal of African Migration* 10: 82-105.

Ncube, A., Jordaan, A.J. & Bahta, Y.T. 2019. Coping and adaptation mechanisms employed by sub-Saharan African migrant women in South Africa. *Journal of Disaster Risk Studies (JAMBA)* 11(1): 645.

Ncube, A., Jordaan, A.J. & Bahta, Y.T. 2019. 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*. DOI: 10.1007/s12134-019-00704-w.

Ncube, A. & Tawodzera. 2019. Communities' perceptions of health hazards induced by climate change in Mount Darwin district, Zimbabwe. *Journal of Disaster Risk Studies (JAMBA)* 11(1):748.

Nyam, Y.S., Matthews, N. & Bahta, Y.T. 2019. Improving livelihood of smallholder farmers through region specific strategies: a case study of South African sheep production. *Agrekon* 59(1): 1-15.

STAFF (2019)

Acting Director: Dr JA Belle

Professors: Prof AJ Jordaan, Prof R Bragg (affiliated) and Prof B Grové (affiliated)

Senior Lecturers: Dr J Belle, Dr M Coetzee, Dr A Ncube, Dr C Barker (affiliated), Dr D Chikobvu (affiliated), Dr E du Plessis (affiliated), Dr B Falko (affiliated), Dr N Matthews (affiliated), Dr M Schutte-Smith (affiliated) and Dr M Tesfuhuney (affiliated)

Lecturers: Mr W Ellis, Ms O Kunguma, Ms L de Wet (affiliated) and Mr M Serekoane (affiliated)

Junior Lecturers: Mrs D Banyane, Ms M Joubert (affiliated), Ms Nongabe (affiliated) and Mr Procter (affiliated)

Affiliated Professors: Prof A Ozuno, Prof F Renaud and Prof J Szarzynski

Programme Director: Dr JA Belle

Officer: Mrs G van Coppenhagen

Senior Assistant Officer: Dr A van Straten

Research Assistants: Mr SY Nyam and Miss ZV Poto

Messenger: Ms CS Mkhafu

INSTITUTE FOR

GROUNDWATER STUDIES

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OVERVIEW OF 2019

For the Institute for Groundwater Studies (IGS), 2019 was a year filled with publications, conferences, sharing of expertise, graduations and the excellent performance of our staff and students. Each year we have improved our research outputs, and various academics and students attended conferences where they presented their research outputs.

ACHIEVEMENTS

Staff Achievements

Amy Allwright successfully completed her PhD degree under the supervision of Prof Abdon Atangana, and she was awarded the prize for the best presenter at the 16th Biennial Groundwater Conference of the Groundwater Division (GWD) of the Geological Society of South Africa (GSSA: Conservation, Demand and Surety.

Dr Modreck Gomo attained a C2 NRF-rating in 2019. He also received an award for best presentation at the International Conference on Applied Environmental Geology and Environmental Systems (ICAEGES 2019) in Dubai, UAE.

Lorinda Rust received the Natural and Agricultural Award for Best Support Staff of 2019.

Student Achievements

The IGS Dux Prize for the Best MSc student in Geohydrology was awarded to Mr MC Mathobo. The title of his dissertation was 'Analysis of exact groundwater model within a confined aquifer', for which he obtained a final mark of 91%. The prize was awarded by Prof Abdon Atangana at the Faculty prize-giving ceremony.

Dr Amy Allwright (right) receiving the Best Presenter award at the GWD Conference

Dr Modreck Gomo (second from the right) receiving the Best Presentation award at ICAEGES 2019

Tshanduko Mutandanyi

The Dean's Medal was awarded to Tshanduko Mutandanyi who achieved the best results in respect of a master's degree in the Faculty of Natural and Agricultural Sciences.

She also received the Senate Medal for the 'Best Overall results in respect of Undergraduate and Post-graduate Qualifications in all Faculties at the University'.

RESEARCH

Research at the IGS can be divided into two major streams – public- and private sector research – depending on the origin of the funding. Public sector research includes research related to the Water Research Commission (WRC) while the private sector research includes research for Coaltech, SASOL and the International Groundwater Resources Assessment Centre (IGRAC).

Experts have revealed details of the mysterious 8 000-year-old rock carvings found in the world's largest asteroid crater. The petroglyphs were found in the Vredefort Impact Structure, a 186-mile wide crater that was formed by an asteroid strike around 2 billion years ago. Results of this work could mean a better understanding of the effects of such impacts and the greater safety of the earth. An international team of scientists (GRAVITAS), led by principal investigator Dr Matthew Huber of the UFS Department of Geology, includes Dr Francois Fourie from IGS, Dr Elizaveta Kovaleva and Dr Martin Clark from the Department of Geology, and Liezel Blomerus from the Department of Anthropology. The UFS will combine geological investigations with cultural investigations to provide a unique perspective on the Vredefort Impact Structure that is both scientifically advanced and grounded in humanity.

ENGAGED SCHOLARSHIP

Dr Gomo prepared training material and facilitated training for industry participants on *Understanding the principles and practice of aquifer-pumping test.* The training session was held from 8 to 10 October 2019 in Randburg, Johannesburg.

Dr Francois Fourie presented an invited talk on Groundwater Geophysics to the Groundwater Association of KwaZulu-Natal (GAKZN) meeting in Durban on 23 May 2019.

NATIONAL AND INTERNATIONAL COLLABORATION

GRAVITAS is an international multidisciplinary collaboration involving academics from South Africa, Russia, the USA and Canada. Dr Francois Fourie is a member of the GRAVITAS research group, which, *inter alia*, aims to better understand impact melt dykes of the Vredefort Impact Structure, one of the largest and oldest meteorite craters on Earth. Learning about impact processes allows us to better understand how our planet and life developed. The impact melt dykes were created through melting of the meteorite and the Earth's impacted crust, which injected into cracks in the crater floor. The impact melt allows us to understand large-scale impact processes, composition of the meteorite, age of the impact, and long term post-impact processes in the crust.

POSTGRADUATE STUDENTS

The IGS is a postgraduate institute, offering postgraduate studies in Geohydrology at BSc Honours, MSc and PhD levels.

All Honours students are required to attend lectures which are conducted in seven modules. The modules are presented in two- or three-week blocks to enable working students to attend the lectures. The classwork is complemented by fieldwork and practical assignments. As we are unique not only in South Africa but in the whole of Africa, many of our students come from beyond our borders.

Dr Francois Fourie at the Vredefort Impact Structure

The annual Winter School for the Honours students took place from 2 to 6 July 2019. In order to provide the students with exposure to the practical aspects of groundwater, the students visited Rustfontein Dam Water Purification Works at Bloemwater, Finsch Mine and the Barkly East area.

During 2019, we awarded a total of 42 degrees – 18 BSc Honours, 21 MSc degrees and 2 PhD degrees. Ten master's students passed with distinctions.

The following students obtained their MSc degrees in 2019:

- Amakali, Sarti Rautia (with distinction)
- Magingi, Awodwa (with distinction)
- Mahantane, Mohau Laurenti (with distinction)
- Mbah, Hans Tah (with distinction)
- Mutandanyi, Tshanduko (with distinction)
- Myeko, Palesa (with distinction)
- Ramakatsa, Dineo Gifts (with distinction)
- Ramasala, Rofhiwa Joyce
- Govender, Nishen
- Mazibuko, Jemias Clifford (with distinction)
- Sekiba, Fhatuwani Matome Adolph
- Makiwane, Nwabisa Veliswa Andisiwe
- Gomo, Benard Tembo
- Steyn, Alberta Johanna (with distinction)
- Beyers, Marisca
- Goosen, Nadene
- Jansen van Vuuren, Jacobus Lukas
- Peek, Charles Michael (with distinction)
- Ojo, Olumayowa Olaposi
- Lombard, Jan-Michael
- Pretorius, Adriaan

The following students were awarded their PhD degrees in 2019:

Ibrahim, Kehinde Olojoku
Thesis: Estimation of hydraulic conductivity in shallow unconfined aquifers using concrete-lined large-diameter hand-dug wells
Promoter: Dr Modreck Gomo

Allwright, Amy Jane
Thesis: Development of a fractal advection-dispersion equation and new numerical schemes for the classical, fractal and fractional advection-dispersion transport equations
Promoter: Prof Abdon Atangana

Some IGS postgraduate students attended the International Association for Hydrogeologists (IAH) Conference held in September 2019 in Malaga City, Spain.

From the left, Fanus Fourie (MSc student), Alba Gomez-Arias (PhD student) and Paul Lourens (IGS lecturer) at IAH Conference

A number of our postgraduate students, together with lecturers, attended the Groundwater Division (GWD) of the GSSA 16th Biennial Groundwater Conference: Conversation, Demand and Surety held in Port Elizabeth from 20 to 23 October 2019. The biennial groundwater conference has been pivotal in sharing knowledge about groundwater in South Africa.

IGS participants at the GWD Conference, from the left, Unarine Mukhwathi, Adriaan Pretorius, Marco van Heerden, Nadene Goosen, Ntsako Mabaso, Dr Francois Fourie, Mr Paul Lourens, Dr Modreck Gomo and Dr Amy Allwright

STAFF MATTERS

Two staff members, Ms E de Necker (Assistant Director: IGS Laboratory) and Ms K NciNci (Cleaner: IGS Laboratory) retired at the end of December 2019.

Prof Jopie Botha (Affiliated Researcher) recently celebrated 50 years at the University, most of which were at IGS. He was part of the first group of scientists in South Africa evaluated by the former Foundation for Research Development (FRD) (with a B-rating), and was for many years the go-to-guy to describe groundwater problems in a mathematical way.

RESEARCH OUTPUTS

Research Articles

Abdeljawad, T., Atangana, A., Gomez-Aguilar, J. & Jarad F. 2019. On a more general fractional integration by parts formulae and applications. *Physica A-Statistical Mechanics and its Applications* 536: 122494_1-122494_17.

Allwright, A.J. & Atangana, A. 2019. 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.

Alqahtani, R. & Atangana, A. 2019. Competition model in groundwater: Three boreholes taping water out from same aquifer. *Chaos, Solitons & Fractals* 128: 98-103.

Atangana, A. & Alqahtani, R. 2019. A new approach to capture heterogeneity in groundwater problem: An illustration with an earth equation. *Mathematical Modelling Of Natural Phenomena* 14: 313_1-313_13.

Atangana A. & Araz, S. 2019. Analysis of a new partial integro-differential equation with mixed fractional operators. *Chaos, Solitons & Fractals* 127: 257-271.

Atangana, A. & Araz, S. 2019. Fractional stochastic modelling illustration with modified Chua attractor. *European Physical Journal Plus* 134: 160_1-160_23.

Atangana, A. & Bonyah, E. 2019. Fractional stochastic modeling: New approach to capture more heterogeneity. *Chaos* 29: 013118_1-013118_14.

Atangana, A. & Goufo, E. 2019. The Caputo-Fabrizio fractional derivative applied to a singular perturbation problem. *International Journal of Mathematical Modelling and Numerical Optimisation* 9(3): 241-253.

Atangana, A. & Hammouch, Z. 2019. Fractional calculus with power law: The cradle of our ancestors. *European Physical Journal Plus* 134: 429_1-429_15.

Atangana, A. & Jain, S. 2019. Models of fluid flowing in non-conventional media: New numerical analysis. *Discrete And Continuous Dynamical Systems-Series S* 12: 467-484.

Atangana, A. & Khan, K. 2019. Dynamics of Ebola disease in the framework of different fractional derivatives. *Entropy* 21: 303_1-303_32.

Atangana, A. & Khan, M. 2019. Validity of fractal derivative to capturing chaotic attractors. *Chaos, Solitons & Fractals* 126: 50-59.

Atangana, A. & Mekkaoui, T. 2019. Capturing complexities with composite operator and differential operators with non-singular kernel. *Chaos* 29: 023103_1-023103_16.

Atangana, A. & Mekkaoui, T. 2019. Trinition the complex number with two imaginary parts: Fractal, chaos and fractional calculus. *Chaos, Solitons & Fractals* 128: 366-381.

Atangana, A. & Owolabi, K. 2019. On the formulation of Adams-Bashforth scheme with Atangana-Baleanu-Caputo fractional derivative to model chaotic problems. *Chaos* 29: 023111_1-023111_13.

Atangana, A. & Qureshi, S. 2019. Modeling attractors of chaotic dynamical systems with fractal-fractional operators. *Chaos, Solitons & Fractals* 123: 320-337.

Atangana, A. & Shafiq, A. 2019. Differential and integral operators with constant fractional order and variable fractional dimension. *Chaos, Solitons & Fractals* 127: 226-243.

Atangana, A., Spannenberg, J.M. & Vermeulen, P.D. 2019. New approach to groundwater recharge on a regional scale: uncertainty analysis and application of fractional differentiation. *Arabian Journal of Geosciences* 12: 511_1-511_12.

Atangana, E. & Chiweshe, T.T. 2019. Metal adsorbance in abattoir wastewater using cross-linked chitosan derivatives. *Journal of Polymers and the Environment* 27: 2624-2636.

Atangana, E., Chiweshe, T.T. & Roberts, H. 2019. Modification of novel chitosan-starch cross-linked derivatives polymers: Synthesis and characterization. *Journal of Polymers and the Environment* 27: 979-995.

Avalos-Ruiz, L., Gomez-Aguilar, J., Atangana, A. & Owolabi, K. 2019. On the dynamics of fractional maps with power-law, exponential decay and Mittag-Leffler memory. *Chaos, Solitons & Fractals* 127: 364-388.

Chiweshe, T.T. 2019. Characterization of molybdenum and tungsten phosphates compounds prepared using ammonium phosphate salt as flux bulletin of the chemical. *Society of Ethiopia* 33: 103-112.

Djida, J., Feulefack, P. & Atangana, A. 2019. A new model of groundwater flow within an unconfined aquifer: Application of Caputo-Fabrizio fractional derivative. *Discrete and Continuous Dynamical Systems-Series B* 24(7): 3227-3247.

Esterhuyse, S., Vermeulen, P.D. & Glazewski, J. 2019. Regulations to protect groundwater resources during unconventional oil and gas extraction using fracking. *Wiley Interdisciplinary Reviews-Water* 6 (e1382): 1-19.

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Gomez-Aguilar, J. & Atangana, A. 2019. Power and exponentials laws: Theory and application. *Journal of Computational and Applied Mathematics* 354: 52-65.

Gomez-Aguilar, J. & Atangana, A. 2019. Time-fractional variable-order telegraph equation involving operators with Mittag-Leffler kernel. *Journal of Electromagnetic Waves And Applications* 33(2): 165-177.

Gomo, M. 2019. On the interpretation of multi-well aquifer-pumping tests in confined porous aquifers using the Cooper and Jacob (1946) method. *Sustainable Water Resources Management* 5: 935-946.

Gomo, M., Kotze, Y.L. & Vermeulen, P.D. 2019. Large diameter hand-dug wells in South Africa. *Water Policy* 21:197-205.

Heydari, M. & Atangana, A. 2019. A cardinal approach for nonlinear variable-order time fractional Schrödinger equation defined by Atangana-Baleanu-Caputo derivative. *Chaos, Solitons & Fractals* 128: 339-348.

Hohne, D., De Lange, S.S., Esterhuyse, S. & Sherwood Lollar, B. 2019. Case study: methane gas in a groundwater system located in a dolerite ring structure in the Karoo Basin, South Africa. *South African Journal Of Geology* 122(3): 357-368.

Morales-Delgado, V., Gomez-Aguilar, J. & Atangana A. 2019. Modelling the oxygen diffusion equation within the scope of fractional calculus. *Thermal Science* 23(2B): 1279-1287.

Owolabi, K. & Atangana A. 2019. Computational study of multi-species fractional reaction-diffusion system with ABC operator. *Chaos, Solitons & Fractals* 128: 280-289.

Owolabi K. & Atangana A. 2019. Mathematical analysis and computational experiments for an epidemic system with nonlocal and nonsingular derivative. *Chaos, Solitons & Fractals* 126: 41-49.

Qureshi, S. & Atangana, A. 2019. Mathematical analysis of dengue fever outbreak by novel fractional operators with field data. *Physica A-Statistical Mechanics and Its Applications* 526: 121127_1-121127_19.

Qureshi, S., Shaikh, A. & Atangana, A. 2019. Strange chaotic attractors under fractal-fractional operators using newly proposed numerical methods. *European Physical Journal Plus* 134: 523_1-523_21.

Sakala, E., Fourie, F.D., Gomo, M. & Coetzee, H. 2019. Groundwater vulnerability mapping of Witbank coalfield in South Africa using deep learning artificial neural networks. *South African Journal of Geomatics* 8(2): 282-293.

Shakhane, T. & Fourie, F.D. 2019. An investigation into structural discretisation as a first-order and pilot framework to understand groundwater-stream water connectivity at a reach scale. *Sustainable Water Resources Management* 5: 883-900.

Solis-Pérez, J., Gomez-Aguilar, J. & Atangana, A. 2019. A fractional mathematical model of breast cancer competition model. *Chaos, Solitons & Fractals* 127: 38-54.

Zielke-Olivier, J.S.D.R. & Vermeulen, P.D. 2019. A geochemical weathering profile of a fine ash tailings dam and its impact on the underlying aquifers. *Journal of Environmental Management* 242: 162-170.

Books

Owolabi, K.M. & Atangana, A. 2019. *Numerical Methods for Fractional Differentiation*. Singapore: Springer.

Chapters in Books

Atangana, A. 2019. A new numerical approximation of fractional differentiation: Upwind discretization for Riemann-Liouville and Caputo Derivatives. Edition:24. In: *Mathematical Methods in Engineering, Nonlinear Systems and Complexity.* K. Tas, D. Baleanu & T. Machado (Eds.). Cham: Springer. pp. 193-212.

Gomo, M., & Magner, J. 2019. Sustainability of human, plant, and aquatic life: A theoretical discussion from recharge to discharge. In: *Groundwater Resource Characterisation and Management Aspects.* M. Gomo (Ed.). London: IntechOpen. pp. 53-69.

Conference Contributions

Conference Papers/Posters

Allwright, A. *Groundwater transport modelling: A fractional/fractal perspective.* Paper delivered at the GWD Conference, Port Elizabeth, South Africa. 21-23 October 2019.

Fourie, F.D., Kovaleva, E. & Huber, M. 2019. *Geophysical surveys across the Daskop Granophyre Dyke*. Paper delivered at the 16th SAGA Biennial Conference & Exhibition 2019, Durban, South Africa. 7-9 October 2019.

Gomo, M. 2019. *Emerging Contaminants (ECs) in water resources in Southern Africa.* Paper delivered at the Water Resources Dialogue: China-Africa Water Forum Series No 7 Conference, Windhoek, Namibia. 22-24 July 2019.

Gomo, M. 2019. *Groundwater sampling: Measurement uncertainties and their implications for decision making.* Paper delivered at the GWD Conference, Port Elizabeth, South Africa. 21-23 October 2019.

Gomo, M. 2019. *On the methods to estimate borehole sustainable yield.* Paper delivered at the GWD Conference, Port Elizabeth, South Africa. 21-23 October 2019.

Gomo, M. 2019. *Preliminary site investigation of a petroleum hydrocarbon contaminated aquifer.* Paper delivered at ICAEGES 2019: International Conference on Applied Environmental Geology and Environmental Systems. Dubai, UAE. 7-8 November 2019. [Award for Best Presentation].

Gomo, M. 2019. *Water balance model as a preliminary tool to assess groundwater-surface water interaction: Technical note.* Paper delivered at ISER 585th International Conference on Chemical and Environmental Science (ICCES-2019), Dubai, UAE. 14-15 May, 2019.

Mazibuko, J.C. & Fourie F.D. 2019. *Estimating hydraulic conductivities through the measurement of streaming potentials*. Paper delivered at 16th Biennial Groundwater Division Conference and Exhibition, Port Elizabeth, South Africa. 21-23 October 2019.

Mukhwathi, U. & Fourie F.D. 2019. *The impact of angled survey lines on ERT surveys using the Wenner (α) array*. Paper delivered at 16th Biennial Groundwater Division Conference and Exhibition, Port Elizabeth, South Africa. 21-23 October 2019.

Sekiba, M. & Fourie F.D. 2019. *Airborne and ground geophysical surveys to investigate the deep geology and geohydrology in the Beaufort West Area, Western Karoo, South Africa*. Paper delivered at 16th Biennial Groundwater Division Conference and Exhibition, Port Elizabeth, South Africa. 21-23 October 2019.

Conference Proceedings

Vermeulen, P.D. & Zielke-Olivier, J.S.D.R. 2019**.** Developing a risk assessment for local groundwater degradation by mine waste storage facilities. In: *Proceedings of IMWA 2019 Conference – Mine water: Technological and Ecological Challenges 2019.* Perm, Russia, 15-19 July 2019. pp 711-718.

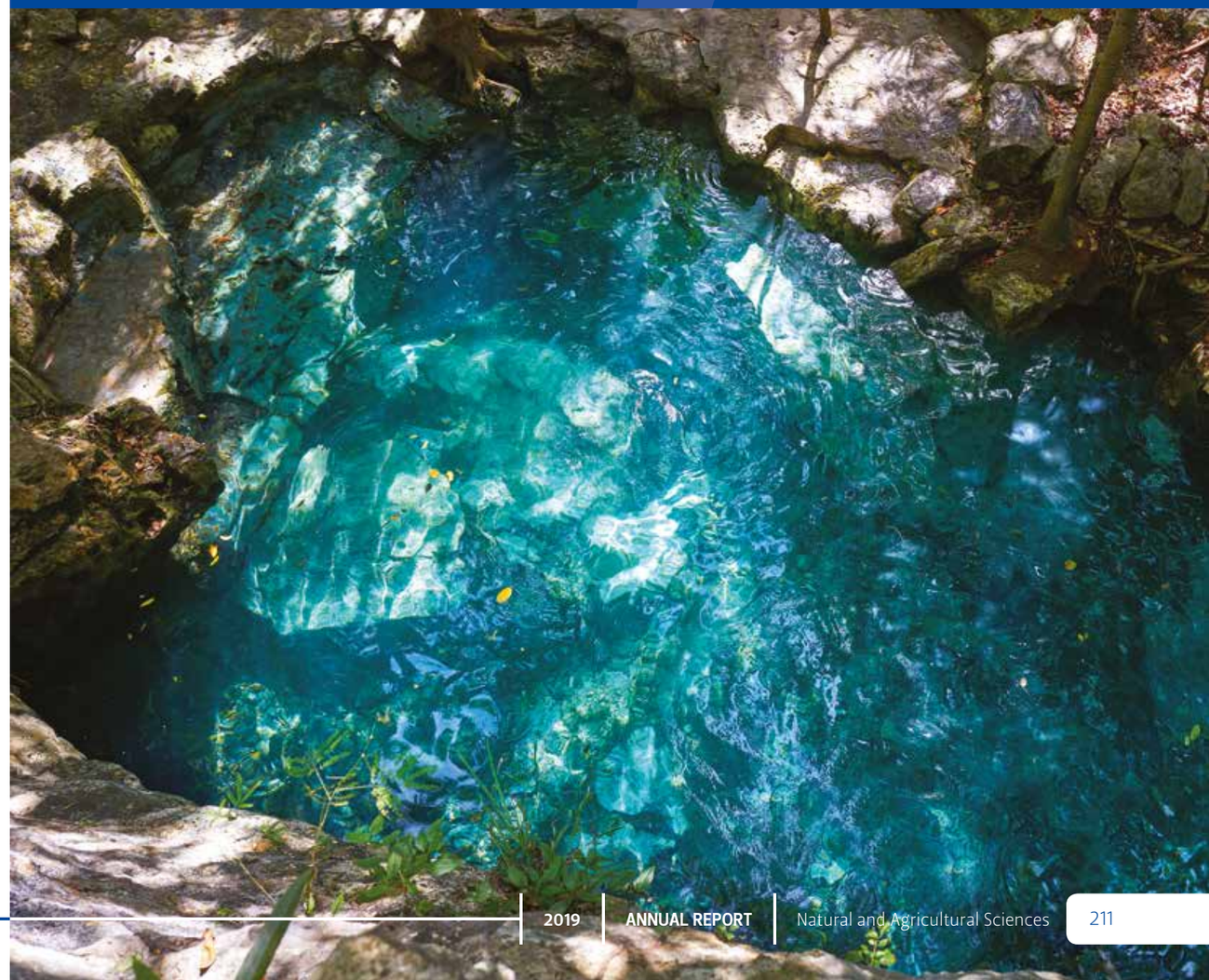
STAFF (2019)

Director: Mr E Lukas

Professor: Prof A Atangana
Senior Lecturer: Dr F Fourie
Senior Researcher: Dr M Gomo
Lecturers: Dr A Allwright, Mr SS de Lange and Mr PJH Lourens
Affiliated Associate Professor: Prof KT Witthüser
Affiliated Researcher: Prof JF Botha
Programme Director: 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
Assistant Director (IGS Laboratory): Mrs E de Necker
Quality Manager: Mrs G Ntwaeaborwa
Officers: Ms WC Geyer and Ms T Letebele
Senior Officer: Mrs NV Ntswabule
Senior Assistant Officer: Ms A Hadebe
Cleaner: Ms K NciNci



PARADYS

EXPERIMENTAL FARM

CONTACT DETAILS

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OVERVIEW OF 2019

During the gripping drought this year, the farm and its enterprises persisted in ensuring that enough fodder was produced to meet the needs of the research animals on the farm. Both the cattle and sheep enterprises performed exceptionally well in spite of the continuing drought. The respective conception rates were 80% and 95%. The pig production unit also performed well, with an average litter size of 15 piglets and a weaning percentage of 90%.

The dairy now consists of 43 Jersey animals in the herd – 36 cows, 5 heifers born in 2018 and 2 heifers born in 2019 – currently yielding 13.7 litres per animal per day.

The farm is establishing a wool processing plant for the production of locally produced wool products. Wool produced on the farm will be utilised so that the whole value chain is on site. People from the local community will be trained and work in the factory, while students will experience the entire process. There will also be opportunities for postgraduate students to be involved.

Pecan orchards were established on the farm for future research on diseases that may affect the trees. All available cultivars in the country are represented. The trees are well-established, and there are plans to plant more trees in the coming year.

The farm serves as a training hub for students and the public. During these practical days the UFS and school learners are exposed to the practical activities of the agricultural industry, related to livestock and fodder production. The farm also hosted some social functions for the public and students in the Lapa.

RESEARCH

Various field trials were conducted on the farm during 2019, including:

Data collection on the Afrikaner cattle breed

Data was collected for:

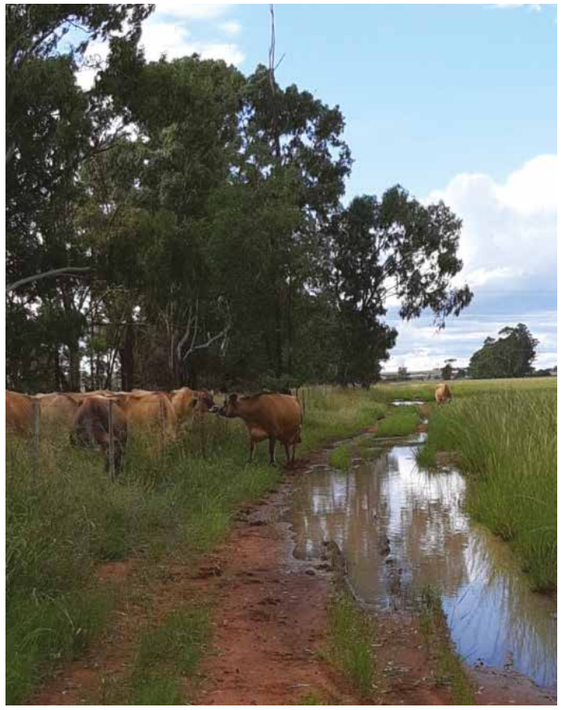
- Fertility – the age at which the animals reach puberty and the average fertility of the herd as a whole.
- Growth – as the production system is based on an ox production system, the animals are weighed regularly to analyse the quality and quantity of veld fed beef. The animals are given various production lick treatments to determine the effect these have 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 Breeders' 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 cattle breed as they are very 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 very rare occurrence.
- Crossbreeding – the Afrikaner maternal line has been crossbred with Simmentaler and Simbra over the last four years to obtain F1 crosses similar to a synthetic breed called the Afrisim. The increased weaning weight of the crosses is more acceptable to feedlots and this provides an alternative market for animals produced on the farm as well as further research possibilities. Currently an Angus bull is used as part of a terminal crossbreeding plan, which provides the possibility to breed some Afrigus cattle.
- Selective breeding – the main herd has been selectively bred, using excellent bull stock, to improve the genetic composition of the herd and particularly to increase the weaning weight of calves, while lowering the mature weight of their dams, thereby ensuring optimal producing animals.

Angus bull used in herd

Data collection on the dairy herd

Data was collected for:

- Fertility – the mating of heifers and cows using AI (artificial insemination) ensuring a respectable inter-calving period and outstanding genetics.
- Feed to milk conversion – the feeding of production animals for cost-effective milk production.
- Feeding of calves for early weaning and rapid growth.



Jersey herd

Feeding trials on cattle and sheep

The following feeding trials were conducted:

- Feeding of weaned lambs – different types of feed were 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 consumed).
- Feeding of bulls for slaughter – to research the economic viability of feeding Afrikaner bulls for slaughter and determining their feed conversion.
- Lick supplementation – animals were given various types of production lick to research the effect they have on growth and condition, and to determine the economic viability of supplementing lick during the winter.

Crop production trials

Crop production trials were conducted on irrigated and dry land pastures:

- 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 for effective fodder production under various plant population densities.

Planting maize

ENGAGED SCHOLARSHIP

Farmers' days were held at the farm for the general public and students to create awareness and provide information about certain services and marketing, in particular with respect to:

- Lucerne (crop for cultivated pastures)
- Pig production
- Branding of animals
- Agricultural engineering (irrigation systems)
- Feed catalogue (various feeds and supplying companies)
- Animal health week

The farm was also involved in community training activities, such as:

- Demonstrating and illustrating the correct manner in which to handle animals without causing stress or injury;
- Assistance with breeding goals, determining the type of production system needed and advising on the best possible breed and breeding plan to follow, and how to achieve it;
- Training on the correct way to vaccinate animals, and the type of vaccinations to be administered;
- Training on correct marking and branding of animals; and
- Training in stockman best practice.

In addition, the farm hosted practical days for schools, providing opportunities for school learners to familiarise themselves with the practical aspects of farming and the farming industry.

Student practical training

STAFF (2019)

Farm manager: Mr J Barnard

Lecturer: Mr L Kruger

Assistant Officer: Ms AM Smith

Research Assistants: Mr W Augustyn, Mr B Coffee, Mr B Madyibi, Mr OM Mavhungu, Mr EE McDonald and Mr NN Mkhonza

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

CONTACT DETAILS

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OVERVIEW OF 2019

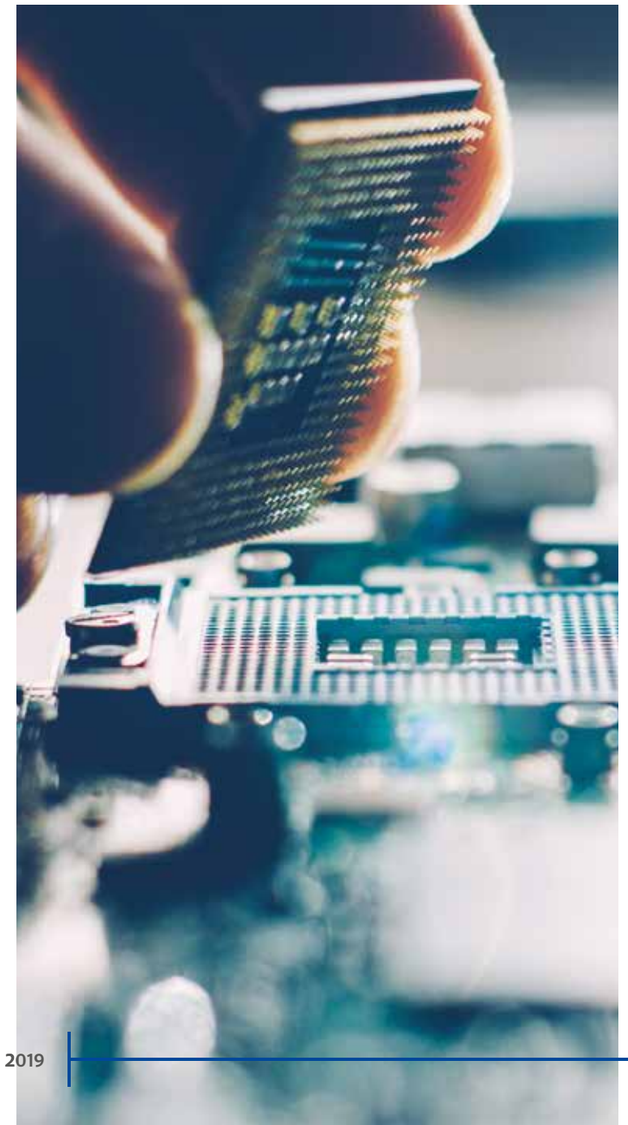
The Electronics Division took over the contract for servicing and repairing the booms on all three University of the Free State (UFS) campuses. According to UFS Security Services there was a substantial cost saving of R291 353 for the University. At times there was more work than we could handle and we had a backlog of a few weeks. We are trying our best to give the best possible service to the Faculty and the University.

In terms of expensive apparatus, a Versaprobe, XPS, SAM700, and AA were repaired during 2019, as well as numerous other instruments. Savings through these repairs and other cost saving initiatives, led to an estimated total saving of approximately R8.4 million.

WORK ACTIVITIES

A total of 634 work requisitions were received in 2019, representing 987 pieces of apparatus. Twenty-seven (27) of these requisitions were for development and installation projects. Some were new and others were extensions of existing systems as well as the upgrading of older systems, as shown in Tables 2 and 3 below. Of a possible 6 763 working hours (based on 7.5 hours per day per person present), 6 708 were actively used (i.e. 99%).

Innes Basson and Mark Jackson



The table below illustrates the time spent on work for the 50 clients which made use of the services of the Electronics Division in 2019.

Table 1: Use made of the Electronics Division (2019)

Client	Total Time Spent (Hours)	% Time Spent
Chemistry	986	14.70%
Physics	889	13.26%
Internal Administration	762	11.37%
Soil, Crop and Climate Sciences	721	10.76%
Animal, Wildlife and Grassland Sciences	471	7.03%
Biotechnology	413	6.17%
Qwaqwa Campus	339	5.06%
Protection Services	319	4.76%
Institute for Groundwater Studies (IGS)	300	4.47%
External Work	282	4.20%
Plant Sciences	205	3.06%
Engineering Sciences	111	1.65%
Electronics Division	109	1.62%
Computer Science and Informatics	82	1.22%
Geology	72	1.07%
Urban and Regional Planning	61	0.91%
Zoology and Entomology	57	0.85%
Centre for Microscopy	45	0.67%
Architecture	43	0.64%
University Estates	42	0.63%
Medical Virology	42	0.63%
South African Doping Control Laboratory (SADoCoL)	39	0.58%
Instrumentation Division	36	0.54%
Faculty of Health Sciences	36	0.54%
Centre for Environmental Management (CEM)	32	0.48%
KovsieFit	21	0.31%
Facilities Air-conditioning	20	0.30%
Facilities Management	19	0.28%
Mathematics and Applied Mathematics	19	0.28%
National Control Laboratory (NCL)	15	0.22%
Medical Physics	12	0.18%
Internal Medicine	12	0.18%
South Campus	11	0.16%
Clinical Simulation Units	11	0.16%
Haematology and Cell Biology	10	0.15%
Human Molecular Biology Unit	10	0.15%
Pharmacology	9	0.13%
Agricultural Economics	7	0.10%
Basic Medical Sciences – Anatomy	5	0.07%
Sports Science	5	0.07%

Client	Total Time Spent (Hours)	% Time Spent
Office of the Dean	5	0.07%
Centre for Sustainable Agriculture, Rural Development and Extension (CENSARDE)	5	0.07%
Business Management	3	0.04%
School of Biomedical Sciences	3	0.04%
Assets	3	0.04%
Genetics	2	0.03%
Fine Arts	2	0.03%
Industrial Psychology	2	0.03%
Residential Services	2	0.03%
Geography	1	0.01%
Total	**6 708**	**100.00%**

In total, 1 694 hours were spent on development (25.25%), 4252 hours on maintenance (63.39%), and 762 hours on administration (11.36%).

Work for the Faculty of Natural and Agricultural Sciences amounted to 5 827 hours (86.9%), while 881 hours were spent on work for departments and divisions outside of the Faculty.

The table below provides information on the projects completed in 2019 per department and division.

Table 2: Completed projects (2019)

Client	Apparatus
Animal, Wildlife and Grassland Sciences	7 x Assess control expansions 4 x Circulating heads 2 x Calorie meters 1 x 8.7KV Power supply 1 x Thermocouple display for chemical reaction
Physics	3 x Access control expansions
Biotechnology	6 x Access control expansions
Soil, Crop and Climate Sciences	8 x Water pressure meters
Plant Sciences	1 x SMS freezer alarm 1 x Access control
Engineering Sciences	5 x Access control expansions 1 x Boom Instalment
Institute for Groundwater Studies (IGS)	15 x Maglocks
Computer Sciences and Informatics	1 x Camera system
Architecture	1 x Access control

At the end of 2019, there were two unfinished projects.

Table 3: Unfinished projects (2019)

Client	Apparatus
Qwaqwa Campus	54 x Access control
Physics	1 x Ball miller

The Electronics team, back row from the left: Denver de Koker, Innes Basson, Mark Jackson, Henri Roodt and Alicia Kasper. Front row: Adriaan Hugo

STAFF (2019)

Head of Division: Mr AB Hugo

Assistant Head: Mr I Basson
Control Technicians: Mr MH Jackson and Mr HJ Roodt
Technical Assistant: Mr D de Koker
Secretary: Ms A Kasper (shared with the Instrumentation Division)

INSTRUMENTATION

DIVISION

CONTACT DETAILS

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OVERVIEW OF 2019

The Instrumentation Division had a very good year workwise. We rebuilt the maize planter for the experimental farms and also built two fume extractors for the Department of Chemistry. By doing this, new sources of income have been explored and it also raised the expertise level of the personnel. We endeavoured to accommodate all types of work to give the best possible service to our clients and rebuild the trust of our Faculty. We are very thankful for the assistance of the Faculty in obtaining two new Laser cutters. These instruments helped us to obtain a valuable Plexiglas cutting order.

The income for the year amounted to R1 322 999 with a repayment of R535 000 to the University for the loan agreement. We worked hard to get stock levels back to normal and also spent resources (time and funds) to repair faulty equipment and build new equipment. We are thankful for substantial return of the University as our primary client, and are grateful to the various departments for their support.

WORK ACTIVITIES

In 2019 a total of 428 work orders were received, 25 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 31 clients which made use of the services of the Instrumentation Division in 2019.

Table 1: Use made of the Instrumentation Division (2019)

Client	Total Time Spent (Hours)	% Time Spent
Physics	1053	16.77%
External Work	825	13.14%
Chemistry	866	13.78%
Animal, Wildlife and Grassland Sciences	851	13.56%
Biotechnology	484	7.71%
Internal Administration	481	7.66%
Soil, Crop and Climate Sciences	389	6.20%
Electronics Division	279	4.44%
Plant Sciences	244	3.89%
Microbiology	193	3.07%
Zoology and Entomology	173	2.76%
Instrumentation Division	141	2.25%
Institute for Groundwater Studies (IGS)	67	1.08%
Medical Physics	39	0.62%
Centre for Microscopy	29	0.46%
Sports Science	22	0.35%
Basic Medical Sciences – Anatomy	20	0.32%
Geology	20	0.32%
National Control Laboratory (NCL)	17	0.27%
South African Doping Control Laboratory (SADoCoL)	13	0.21%
Animal Research Unit	12	0.19%
Office of the Dean	11	0.18%
Human Molecular Biology Unit	10	0.16%
Centre for Environmental Management (CEM)	9	0.14%
Engineering Sciences	7	0.11%
Medical Virology	5	0.08%
Genetics	5	0.08%
Act Eco	4	0.06%
Drama and Theatre Arts	4	0.06%
Protection Services	2	0.03%
University Estates	2	0.03%
Fine Arts	1	0.02%
Total	**6 278**	**100.00%**

Work for the Faculty of Natural and Agricultural Sciences amounted to 5 301 hours (84%), while 977 hours were spent on work for departments and divisions outside the Faculty.

The table below provides a list of the completed projects in 2019 per department and division.

Table 2: Completed projects (2019)

Client	Apparatus
Physics	28 x Louvers for 60-inch telescope 1 x Shelves for basement 1 x Ball miller 1 x Microscope mounting for Auger 600 1 x Trolley for cold finger 1 x Crystal sample holder
Animal, Wildlife and Grassland Sciences	1 x Trollies 1 x Feed mixer rebuild. 1 x Disc ploughs 1 x Water cooling system in lab 1 x Maize planter rebuild
Chemistry	4 x Stirrer heads 2 x Fume cabinets 2 x Calorie meters 1 x Cutting and making a cabinet for KMR
Plant Sciences	9 x Freezer trays 3 x Workbenches for lab 1 x Bench with granite top
Soil, Crop and Climate Sciences	8 x Dryer ovens
Biotechnology	1 x Fume extraction system 1 x Agitator 1 x Heavy duty trolley
Institute for Groundwater Studies (IGS)	1 x Water cleaning system
National Control Laboratory (NCL)	2 x Heating blocks
Zoology and Entomology	1 x Display cabinet

Planter for Paradys Experimental Farm

From the left: Wicus Storm, Lucas Odendaal, Sylvester Jones and Malakia Mokoena, building and installing the fume cabinet at the South Campus (Chemistry)

Articulated joints for a grader

The unfinished projects at the end of 2019, are reflected in Table 3 below.

Table 3: Unfinished projects (2019)

Client	Apparatus
Animal, Wildlife and Grassland Sciences	1 x Rebuilding of maize planter
Physics	1 x Parts for new filter system of the 60-inch telescope Planetarium Telescope

The Instrumentation team
Front row from the left: Barend Crous and Lucas Odendaal
Back row from the left: Wicus Storm, Malakia Mokoena, Adriaan Hugo, Alicia Kasper, Kobus Kruger and Jochemus Rautenbach

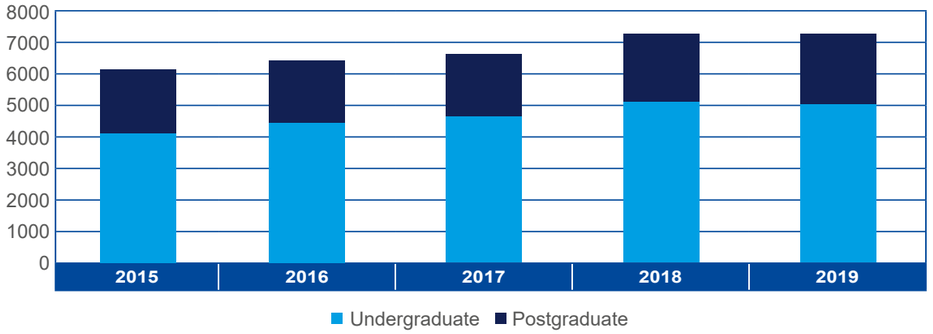
STAFF (2019)

Head of Division: Mr AB Hugo

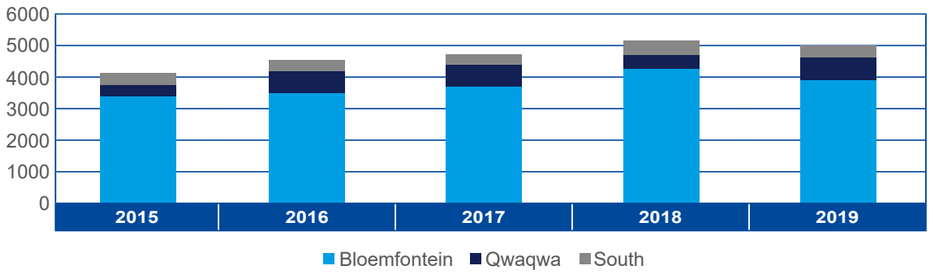
Assistant Head: Mr BJ Crouse
Control Technicians: Mr MJ Kruger, Mr L Odendaal and Mr JPW Rautenbach
Technical Assistant: Mr WJR Storm
Technical Aide: Mr L Mokoena
Secretary: Ms A Kasper (shared with the Electronics Division)

STATISTICAL
DATA

FACULTY REGISTRATIONS PER QUALIFICATION LEVEL (2015 – 2019)



FACULTY REGISTRATIONS BY CAMPUS (2015 – 2019)



FACULTY STUDENT NUMBERS BY NATIONALITY AND GENDER (2019)

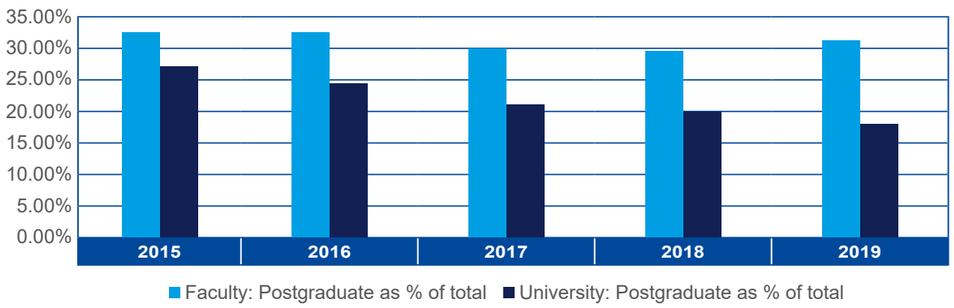
Registrations by nationality (2019)

	South African	International
Occasional	203	6
Undergraduate	4925	117
Postgraduate	1761	262

Registrations by gender (2019)

	Female	Male
Occasional	98	111
Undergraduate	2407	2635
Postgraduate	978	1045

POSTGRADUATE REGISTRATIONS AS % OF TOTAL (2015 – 2019)



FACULTY GRADUATIONS BY QUALIFICATION LEVEL (2015 – 2019)

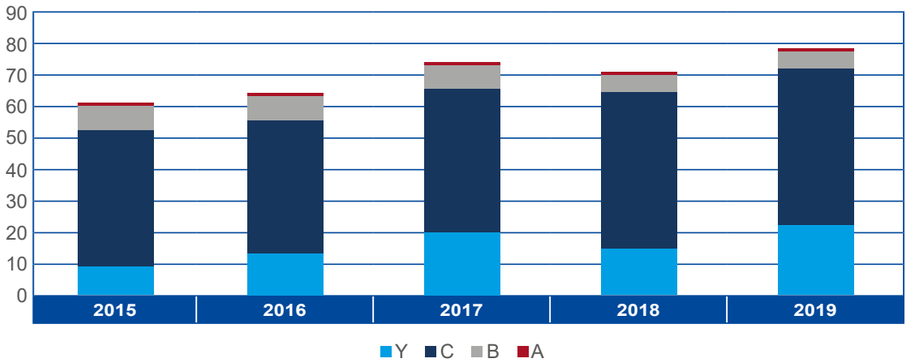
	2015	2016	2017	2018	2019
Total Undergraduate	821	721	734	878	844
Total Postgraduate	691	787	716	842	853

FACULTY SUCCESS RATE* BY STUDY LEVEL (2018 – 2019)

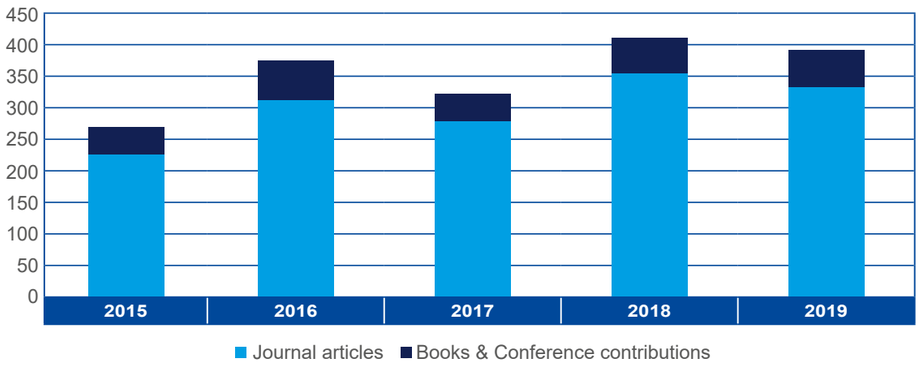
	2018	2019
Undergraduate	79.10%	80.50%
Postgraduate	77.90%	78.70%

* Success rate = Passed module enrolments/Total module enrolments

NRF-RATED RESEARCHERS (2015 – 2019)



FACULTY RESEARCH OUTPUTS (2015 – 2019)



FACULTY POSTDOCTORAL RESEARCH FELLOWS (2015 – 2019)

2015	2016	2017	2018	2019
63	70	85	64	93

ACRONYMS

LIST OF ACRONYMS

0 – 9

4IR	Fourth Industrial Revolution

A

ACCSF	African Capital Cities Sustainability Forum
ACS	American Chemical Society
ADF	Amsterdam Density Functional
AEASA	Agricultural Economics Association of South Africa
AFASA	African Farmers' Association of South Africa
AFMA	Animal Feed Manufacturers Association
AfRota	Antigens and Reassortant strains for rotaviruses circulating in Africa
AI	Artificial insemination
AI	Artificial Intelligence
ALFA	African Livestock Trade Fair
AMI	Advanced Metals Initiative
AP	Admission Point
APECSSA	Association of Polar Early Career Scientists of South Africa
ARC	Agricultural Research Council
ARC-GC	Agricultural Research Council-Grain Crops
ARC-ISCW	Agricultural Research Council-Institute for Soil, Climate and Water
ARC-ITSC	Agricultural Research Council-Institute for Tropical and Subtropical Crops
ARC-PHP	Agricultural Research Council-Plant Health and Protection
ARC-SG	Agricultural Research Council-Small Grain
ARC-VOP	Agricultural Research Council-Vegetable and Ornamental Plants
ARCOSH	Association of Researchers in Construction Safety, Health, and Well-being
ARS-USDA	Agricultural Research Service - United States Department of Agriculture
ARU	Afromontane Research Unit
ASCA	Agulhas System Climate Array
ASCOSA	Association of Schools of Construction of Southern Africa
ASU	Appalachian State University
A-WEAI	Abbreviated Women's Empowerment in Agriculture Index

B

BA	Bachelor of Arts
BAgric	Bachelor of Agriculture
BArch	Bachelor of Architecture
BArchHons	Bachelor of Architecture Honours
BCI	Brain-Computer Interface
BCompInfoSys	Bachelor of Computer Information Systems
BConsumer Science	Bachelor of Consumer Science
BfR	Bundesinstitut für Risikobewertung/Federal Institute for Risk Assessment
BSc	Bachelor of Science
BSc (Agriculture)	Bachelor of Science in Agriculture
BSc (Consumer Science)	Bachelor of Science in Consumer Science
BSc (Information Technology)	Bachelor of Science in Information Technology
BSPHons	Bachelor of Spatial Planning Honours

C

CAF	Central Analytical Facilities
CATSA	Catalysis Society of South Africa
CCDC	Cambridge Crystallographic Data Centre
CDC	Centers for Disease Control and Prevention
CDS	Centre for Development Studies
CEM	Centre for Environmental Management
CENSARDE	Centre for Sustainable Agriculture, Rural Development and Extension
CFS	Committee on World Food Security
CHIRA	Computer-Human Interaction Research and Applications
CHPC	Centre for High Performance Computing
CIB	International Council for Research and Innovation in Building and Construction
CIMERA	Centre of Excellence for Integrated Mineral and Energy Resource Analysis
CIMMYT	International Maize and Wheat Improvement Centre
CL	Cathodoluminescence
CLiPS	Computational Linguistics and Psycholinguistics Research Center
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
CSP	Concentrated solar power
CST-SA	Cereal Science and Technology – Southern Africa
CTL	Centre for Teaching and Learning
CUT	Central University of Technology

D

DEFF	Department of Environment, Forestry and Fisheries
DEA-NRM	Department of Environment Affairs - Natural Resource Management
DESTEA	Department of Economic, Small Business Development, Tourism and Environmental Affairs
DFG	Deutsche Forschungsgemeinschaft / German Research Foundation
DII	Development and Investment in Infrastructure
DiMTEC	Disaster Management Training and Education Centre for Africa
DIRAP	Directorate for Institutional Research and Academic Planning
DMA	Disaster Management Authority
DMISA	Disaster Management Institute of Southern Africa
DNA	Deoxyribonucleic Acid
DRD	Directorate Research Development
DSC	Differential Scanning Calorimetry
DSI	Department of Science and Innovation
DSSC	Dye-sensitized solar cells
DSS	Decision Support System

E

Eco-DRR/CCA	Ecosystem-based Disaster Risk Reduction and Climate Change Adaptation
EDHE	Entrepreneurship Development in Higher Education
EDP	Edamame Development Program
ESDA	Education for Sustainable Development in Africa
ESDA-NGR	Education for Sustainable Development In Africa - Next Generation Researchers
ESRC	Economic and Social Research Council
EU	European Union
EVT	Extreme Value Theory

F

FAO	Food and Agriculture Organization
FBIP	Foundational Biodiversity Information Programme
FEBS	Federation of European Biochemical Societies
FET	Further Education and Training
FHB	Fusarium head-blight
FRD	Foundation for Research Development
FSL	Forensic Science Laboratory
FWO	Fonds Wetenschappelijk Onderzoek – Vlaanderen (Research Foundation – Flanders)

G

GAKZN	Groundwater Association of KwaZulu-Natal
GBI	Green Building Index
GCRF	Global Challenges Research Fund
GFAAS	Graphite Furnace Atomic Absorption Spectroscopy
GGHNP	Golden Gate Highlands National Park
GIS	Geographic information systems
GPSS-GLI	Graduate Programme in Sustainability Science Global Leadership Initiative
GRAVITAS	Geophysical Research and Analysis of the Vredefort Impact with Timely Anthropological Studies
GSSA	Geological Society of South Africa
GWD	Groundwater Division
GWK	Griekwaland Wes Korporatief Ltd

H

H2020-MSCA-RISE-2019	Horizon 2020 Marie Skłodowska-Curie Actions Research and Innovation Staff Exchange 2019
HCI	Human-Computer Interaction
HoD	Head of Department
HPLC	High performance liquid chromatograph
HTCC	Hot Topics in Contemporary Crystallography

I

IAH	International Association of Hydrogeologists
ICAEGES	International Conference on Applied Environmental Geology and Environmental Systems
ICDP	International Continental Scientific Drilling Programme
ICID	International Commission on Irrigation and Drainage
ICLEI	Local Governments for Sustainability
ICP	Inductively Coupled Plasma
ICP-MS	Inductively Coupled Plasma Mass Spectroscopy
ICP-OES	Inductively Coupled Plasma Optical Emission Spectroscopy
ICRA	International Centre for Development Oriented Research in Agriculture
iCRAG	Irish Centre for Research in Applied Geosciences
ICSD	Inorganic Crystal Structure Database
ICSP	International Committee on Systematics of Prokaryotes
ICT	Information and Communications Technology
ICZ	International Congress of Zoology
IDC	Industrial Development Corporation
IDDR	International Day for Disaster Reduction
IDF	International Dairy Foundation
IFHE	International Federation for Home Economics
IGRAC	International Groundwater Resources Assessment Centre
IGS	Institute for Groundwater Studies
IITA	International Institute for Tropical Agriculture
INRA	Institut National de la Recherche Agronomique
INST	International Natural Sciences Tournament
INTI	National Institute of Industrial Technology
IoT	Internet of Things
IPM	Integrated Pest Management
IPTA	International Pulsar Timing Array
IRWH	In-field rainwater harvesting
IR	Infrared
ISI	International Scientific Indexing
IT	Information Technology
ITP	Institutional Transformation Plan
ITSA	Information Technology Students' Association
IUCN	International Union for Conservation of Nature
IWRF	International Water Rights Forum

J

JEMR	Journal of Eye Movement Research
JSPS	Japan Society for the Promotion of Science

K

KASMS	Kinetically Activated Subsurface Microbial Sampler
KAUST	King Abdullah University of Science and Technology
KEEP	Kalahari Endangered Ecosystem Project
KZN	KwaZulu-Natal

L

LA-ICP-MS	Laser ablation inductively coupled plasma source mass spectrometer
LA-MC-ICPMS	Laser ablation multi-collector inductively coupled plasma source mass spectrometer
LIGO	Laser Interferometric Gravitational-Wave Observatory
LLM	Master of Laws
LRF	Livestock Registering Federation

M

MArch	Master of Architecture
MCR	Mangaung Concerned Residents
MDM	Master of Disaster Management
MEM	Master of Environmental 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
MSSA	Microscopy Society of Southern Africa
MURP	Master of Urban and Regional Planning

N

NAFS	National Analytical Forensic Services
NAGOCAT	Nanoporous Gold Catalysts
NAMC	National Agricultural Marketing Council
NCL	National Control Laboratory
NDMC	National Disaster Management Centre
NDVI	Normalised Difference Vegetation Index
NEC	National Executive Committee
NECSA	Nuclear Energy Corporation of South Africa
NFOEB	National Forensic Oversight and Ethics Board
nGAP	New Generation of Academics Programme
NGS	Next Generation Sequencing
NLP	Natural Language Processing
NMR	Nuclear Magnetic Resonance
NMU	Nelson Mandela University
NRF	National Research Foundation
NRM	Natural Resource Management
NSF	National Science Foundation
NSFC	National Science Foundation of China
NSSA	Nematological Society of Southern Africa
NSW	National Science Week
NUPS	National University of Public Service
NWU	North-West University
NZG	National Zoological Garden

O

OA	Open access
OLED	Organic light emission device
OPDT	Oil and Protein Seeds Development Trust
OSINT	Open Source Intelligence

P

PCI Ecology	Peer Community in Ecology
PCT	Patent Cooperation Treaty
PGDip	Postgraduate Diploma
PGDip(IWM)	Postgraduate Diploma in Integrated Water Management
PGDip(SA)	Postgraduate Diploma in Sustainable Agriculture
PGE	Platinum-group elements
PI	Primary investigator
PMI	Post-mortem interval
PNNL	Pacific Northwest National Laboratory
PoW	Proof-of-Work
PPGI	Public-Private Growth Initiative
PRF	Protein Research Foundation
PSHB	Polyphagous shot hole borer
PV	Photovoltaic
Px	Protein Crystallography

Q

QPM	Quality protein maize

R

ReMec 2	2nd Symposium on Reaction Mechanisms
RGB	Red-Green-Blue
RMRD SA	Red Meat Research and Development South Africa
RPO	Red Meat Producers Organisation
RSA	Republic of South Africa
RSG	Radio Sonder Grense
RUFORUM	Regional Universities Forum for Capacity Building in Agriculture

S

SAAB	South African Association of Botanists
SAAE	South African Academy of Engineering
SAASA	South African Academy for Arts and Sciences
SAB	South African Breweries
SACLA	Southern African Computer Lecturers' Association
SACPLAN	South African Council for Planners
SACQSP	South African Council for the Quantity Surveying Profession
SADC	Southern African Development Community
SADoCoL	South African Doping Control Laboratory
SAEEC	South African Energy Efficiency Confederation
SAENSE	Screening Applications and Exploring Novelty in Specialised Environments
SAFHE	South African Federation of Hospital Engineers
SAIA	South African Institute of Architects
SAIAB	South African Institute of Aquatic Biodiversity
SAIEE	South African Institute of Electrical Engineers
SAIP	South African Institute of Physics
SALDi	South African Land Degradation Monitor
SAMEA	South African Monitoring and Evaluation Association
SANAE	South African National Antarctic Expedition
SANBI	South African National Biodiversity Institute
SANParks	South African National Parks
SANSA	South African National Space Agency
SANSA	South African National Survey of Arachnida
SANSOR	South African National Seed Organization
SAPBA	South African Plant Breeders' Association
SASCH	South African Society for Cultural History
SAPER	South African Planning Education Research
SAPPA	South African Pecan Nut Producers Association
SAPS	South African Police Service
SARChI	South African Research Chairs Initiative
SASAE	South African Society for Agricultural Extension
SASAS	South African Society for Animal Science
SASCH	South African Society for Cultural History
SASCP	South African Society of Crop Production
SASHG	Southern African Society for Human Genetics
SASHS	Southern African Society for Horticultural Sciences
SASPP	Southern African Society of Plant Pathology
SASRI	South African Sugarcane Research Institute
SASRN	South African Sclerotinia Research Network
SASUF	South Africa-Sweden University Forum
SAWMA	Southern African Wildlife Management Association
SAWSS	Southern African Weed Science Society
SAYAS	South African Young Academy of Sciences

SDG	Sustainable Development Goal
SEM	Scanning electron microscope
SGA	Society for Geology Applied to Mineral Deposits
SGC	Structural Genomics Consortium
SMEG	Soil and Microbial Ecology Group
SMEOS	Sensors, MEMS and Electro-Optical Systems
SSAG	Society of South African Geographers
SSAJRP	Swiss-South Africa Joint Research Programme
SSSSA	Soil Science Society of South Africa
START	Synchrotron Techniques for African Research and Technology
STERG	Solar Thermal Energy Research Group
SWAT	Soil and Water Assessment Tool

T

TalTech	Tallinn University of Technology
TEM	Transmission electron microscope
TGA	Thermal Gravimetric Analysis
TIA	Technology Innovation Agency
ToI	Training of instructors
TTF	Tetrathiafulvalene

U

UAP	University Access Programme
UCT	University of Cape Town
UFH	University of Fort Hare
UFRRJ	Federal University of Rural Rio de Janeiro
UFS	University of the Free State
UIA	International Union of Architects
UiT	The Arctic University of Norway
UJ	University of Johannesburg
UK	United Kingdom
UKZN	University of KwaZulu-Natal
UN	United Nations
UNESCO	United Nations Education, Scientific and Cultural Organization
UNICEF	United Nations Children's Fund
UNU-EHS	United Nations University Institute for Environment and Human Security
UNU-IAS	United Nations University Institute for the Advanced Study of Sustainability
USA	United States of America
USDP	University Staff Doctorate Programme
UV/Vis	Ultraviolet-visible
UWC	University of the Western Cape
UX	User experience

V

VDAU	Vaalharts District Agricultural Union
VE	Virtual Environment
VKB	Vrystaat Kooperasie Beperk
VLIR-UOS	Vlaamse Interuniversitaire Raad – Universiteit Ontwikkelingssamenwerking
VR	Virtual reality
VUB	Vrije Universiteit Brussel

W

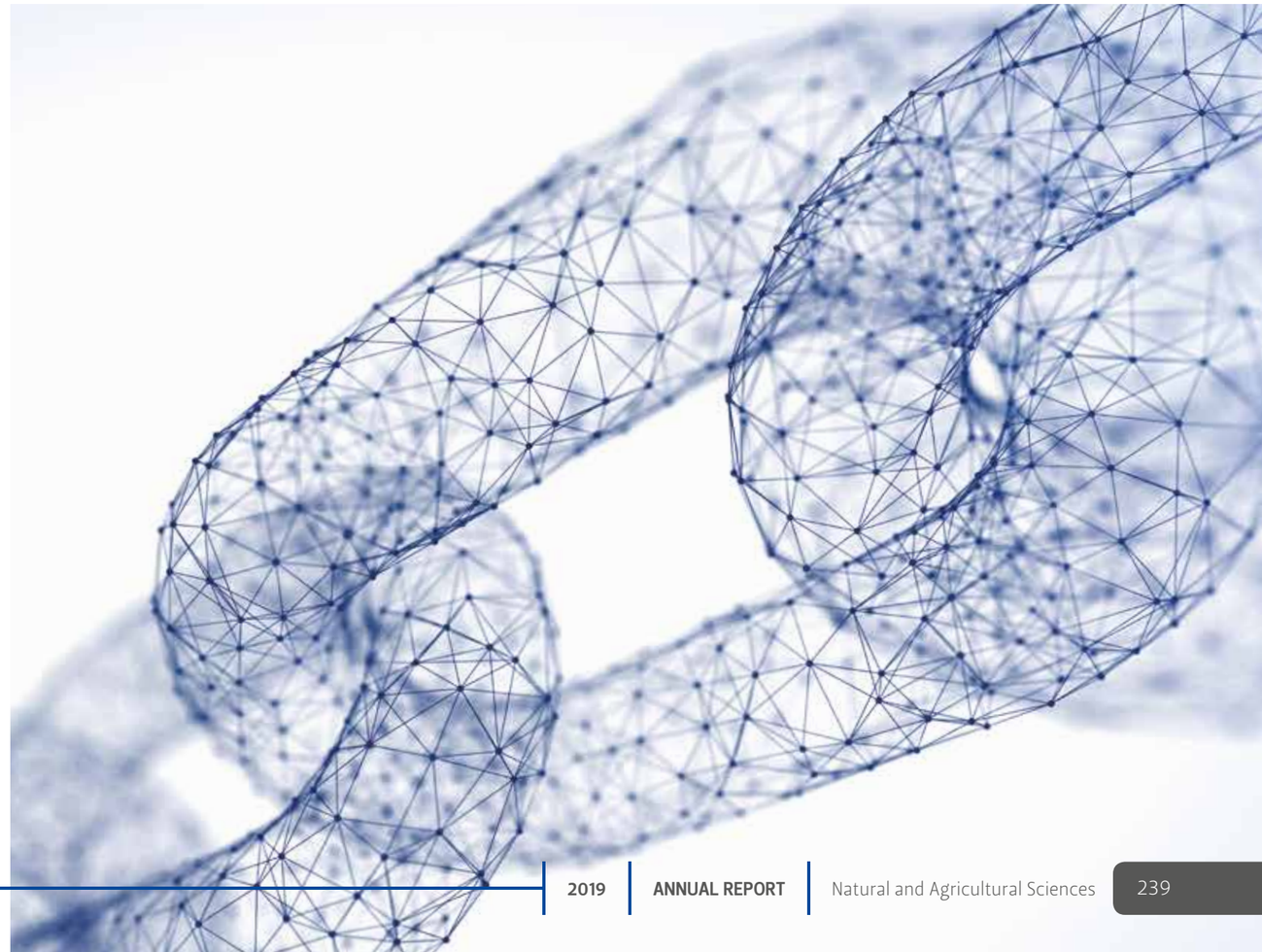
WADA	World Anti-Doping Agency
wbm	Wheat bread making
Wits	University of the Witwatersrand
WRB	World Reference Base
WRC	Water Research Commission
WWF	World Wildlife Fund for Nature

X/Y

XPS	X-ray Photoelectron Spectroscopy
XRD	X-ray Diffraction
XRF	X-ray Fluorescence

Z

ZSSA	Zoological Society of Southern Africa



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Prof Aliza le Roux, Department of Zoology and Entomology, Qwaqwa Campus (Zoology and Entomology: Bat eared fox - page 176)

A chain of KNOWLEDGE