



UNIVERSITY OF
KWAZULU-NATAL™
INYUVESI
YAKWAZULU-NATALI

COLLEGE OF AGRICULTURE,
ENGINEERING AND SCIENCE

PRIS²⁰²⁶

POSTGRADUATE RESEARCH & INNOVATION SYMPOSIUM



DATE

**28 & 29
October
2026**

VENUE

**Coastlands
Hotel,
Musgrave, Durban**

THEME

**International
Year of
Rangelands and
Pastoralists**

pris.ukzn.ac.za

INSPIRING GREATNESS

*The College of Agriculture, Engineering and Science
would like to express its appreciation to the following external partners who have
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Professor David Lokhat, uMngeni Water Chair of Water Resources Research and Innovation

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Professor Gueguim Kana, Bioprocess Research Group

Professor Hussein Shimelis, African Centre for Crop Improvement

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Professor Kuveneshan Moodley, Thermodynamics Research Unit

Professor Mathew Moodley, Laser Material Research Group

Professor Moganavelli Singh, Nano-Gene and Drug Delivery Group

Professor Mohamed Mostafa Hassan Mostafa, KZNDOT Chair in Sustainable Transportation – Sustainable Transportation Research Group (STRg)

Professor Naven Chetty, Biomedical Optics Research Group

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The College of Agriculture, Engineering and Science would like to express its appreciation to the following Exhibitors at the 2026 College Postgraduate Research and Innovation Symposium:

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The College of Agriculture, Engineering and Science would like to express its appreciation to the following Chairs, Assistant Chairs, Moodle Co-ordinators and Judges of the 2026 Postgraduate Research and Innovation Symposium:

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Chair: Dr Ntombifuthi Nzimande

Assistant Chair: Dr Simphiwe Mngomezulu-Dube

Moodle Co-ordinator: Dr Hloniphile Sithole Mthethwa

Judges:

Dr Shaeden Gokool
Dr Mthembeni Mngadi

Dr Ntuthuko R Mkhize

Dr Nontokozo Mkhonza

FLASH PRESENTATIONS

Chair: Dr Simphiwe Mngomezulu-Dube

Assistant Chair: Dr Ntombifuthi Nzimande

Moodle Co-ordinator: Dr Hloniphile Sithole Mthethwa

Judges:

Dr Shaeden Gokool
Dr Ntuthuko R Mkhize

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Dr Nontokozo Mkhonza

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ORAL PRESENTATIONS

Chair: Prof Brenda Moodley

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Moodle Co-ordinator: Dr Vinodhani Paideya

Judges:

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Prof Ofentse Jacob Poore

FLASH PRESENTATIONS

Chair: Dr Karen Pillay

Assistant Chair: Dr Nontokozo Msomi

Moodle Co-ordinator: Dr Seipati Mokhosi

Judges:

Prof Irvin Booysen
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Dr Hogantharanni Govender
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Dr Matshawandile Tukulula

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ORAL PRESENTATIONS

Chair: Prof Evariste Gueguim Kana
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Moodle Co-ordinator: Dr Simo Mthethwa

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Chair: Prof Michael Lattorff
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Dr Nasiphi Bitani
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ORAL PRESENTATIONS

Chair: Prof Retius Chifurira
Assistant Chair: Dr Joseph Ntabeni Jere
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ORAL PRESENTATIONS

Chair: Prof Kuveneshan Moodley
Assistant Chair: Dr Phuti Tsipa
Moodle Co-ordinator: Mrs Rosanne Els

Judges:

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Dr Madison Lasich
FLASH PRESENTATIONS

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Dr Malusi Mkhize

Prof Pradeep Kumar
Prof Wayne Nelson

Chair: Dr Mwitwa Chilufya
Assistant Chair: Dr Mustapha Jaji
Moodle Co-ordinator: Mrs Rosanne Els

Judges:

Dr Nivaar Brijmohan
Dr Phuti Tsipa

Dr Madison Lasich

Dr Malusi Mkhize

PHYSICS

ORAL PRESENTATIONS

Chair: Prof Mathew Moodley
Assistant Chair: Prof Kingsley Obodo
Moodle Co-ordinator: Dr Nkosinathi Dlamini

Judges:

Prof Thomas Konrad
Dr Mervlyn Moodley

Dr Marco Mariola
Dr Benjamin Perez

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Prof Ilya Sinayskiy

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FLASH PRESENTATIONS

Chair: Prof Paul Kogeda
Assistant Chair: Dr Jesca Batidzirai
Moodle Co-ordinator: Mr Shridhar Singh

Judges:

Dr Andronicus Akinyelu
Mr Javhaid Hammujuddy
Dr Adam Mohanad Mohammed
Dr Zekhaya Benard Shozi

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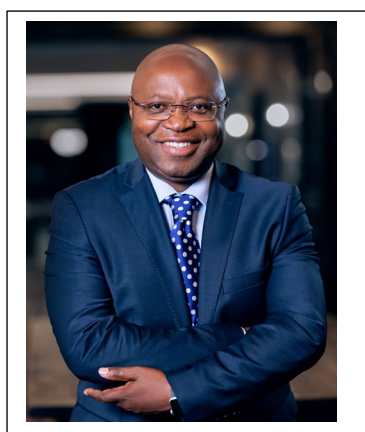
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MESSAGES OF SUPPORT



Welcome to PRIS 2026 – the sixteenth College of Agriculture, Engineering and Science Postgraduate Research and Innovation Symposium. We are striving to ensure that the research carried out by our postgraduate students is relevant to society and contributes to the wellbeing of South Africans. This event highlights the cutting-edge research conducted by our postgraduate students and provides them with an opportunity to present their work to peers, academic staff and research partners. I would like to thank and congratulate the large number of postgraduate students who have shown the courage and enthusiasm to present their work today. The standard of proceedings is very similar to what students can expect at national and international conferences. Many students have used occasions such as this to hone their presentation skills and have gone on to win awards at international conferences. Behind every postgraduate student is a supervisor or supervisory team, who challenges, encourages and today will be sharing in your success – we owe you a debt of gratitude. Finally, we are grateful to all the sponsors whose generous contributions made this day possible, and we continue actively to seek ongoing collaboration and partnerships with industry and with all relevant role players.

Professor Nana Poku, Vice-Chancellor and Principal, UKZN



One of the most influential scientists of modern times, Albert Einstein, stated, "If we knew what it was we were doing, it would not be called research, would it?" Given the pace at which our world is changing, it is no wonder that the human race is under increasing pressure to become "experts" – to know more and more about less and less. The big challenge for us is to rapidly discover, inform and implement our small and big discoveries to make real changes. We have economic, environmental, health and cultural questions to respond to, for the benefit of the present and future generations. The mission of UKZN is to be relevant to our local communities, South Africa and the world. Our postgraduate students have made it possible for UKZN to deliver on its mission. The College Postgraduate Research and Innovation Symposium is a significant moment for UKZN to highlight the efforts and successes of our students and their supervisors. Every presentation over these two days is valuable and I encourage that you should start working on publishing your work. We are thankful to all the students who took time to share their knowledge with us. We also thank their supervisors, who guided them to the point of being able to share their research with us. Without the support of our funders, partners and

collaborators in research, we would not be celebrating the global recognition we currently enjoy and showcase through this special symposium.

Professor Fhatuwani Mudau,

Deputy Vice-Chancellor and Head of College: Agriculture, Engineering and Science, UKZN



The research community from the College of Agriculture, Engineering and Science continues to set the pace in terms of research outputs produced across the university. An important part of UKZN's Strategy is the emphasis it places on growing the impact of the research that is produced at UKZN. Impact is not only measured in terms of the influence our research has on the community in which we function and the manner in which it shapes the policy environment but also the citations our published research attracts from the broader research community. This requires a focus on high-impact journals and increasing the international collaborations we engage with. These two factors alone will significantly strengthen the research profile of UKZN. Please use the opportunity afforded by this event to encourage all our students and academics to build their research

profiles and to focus on the quality of the research produced to ensure that UKZN becomes well-known for the transformative character of its research.

Professor Rituparno Goswami, Dean of Research: College of Agriculture, Engineering and Science, UKZN



Welcome to the sixteenth College of Agriculture, Engineering and Science Postgraduate Research and Innovation Symposium. This year, the School of Agriculture and Science is the proud host of this flagship College event and the two days we have lined up are aimed at showcasing our master's and PhD research across the College, under the banner: "International Year of Rangelands and Pastoralists". The scientific programme promises to be exciting with a good mix of fundamental and applied research presentations. Of particular importance is communicating this research to a wider audience, demonstrating the impact it has on communities and industry. It is my hope that the event will be a catalyst for interdisciplinary dialogue among academics and researchers, and for future collaborative projects with community, government and industry stakeholders.

Part of conducting scientific research is to improve the lives of mankind. These two days will provide a platform for our postgraduate students to demonstrate this to their peers, professors and to the public. I applaud all presenters who have come forward to present their research - This is not just a platform to present your research but also a steppingstone on your journey towards becoming thought leaders and change makers in science. Please enjoy the moment, embrace the feedback and let it inspire your pursuit of excellence. Hosting an in-person symposium at one of our premier hotels in Durban allows students to get the full experience of attending a conference similar to a national or international format. This is an experience every postgraduate student should have. The symposium will take place in two formats, the conventional oral presentations,

and flash presentations, which are a shorter, more concise version of the oral presentation. This is a common practice at many international conferences on various continents. As such, our students will be exposed to this way of presenting their research that will allow them to make an impact to a large audience

Professor Ademola Olaniran, Dean and Head of the School of Agriculture and Science, UKZN

PROGRAMME

Wednesday, 28 October and Thursday, 29 October 2026

DAY ONE: Wednesday 28 October

- 09:00 – 09:15 **OPENING PLENARY** (*Sapphire Hall*)
Introduction – Professor Rituparno Goswami, College Dean of Research
Official Welcome – Professor Anil Chuturgoon, Deputy Vice-Chancellor of Research, University of KwaZulu-Natal
- 09:15 – 09:45 **Keynote Lecture – Professor Frank Matose**, Professor and Environmental Sociologist in the Department of Sociology, University of Cape Town.
- 09:45 – 9:50 **Programme overview - Professor Rituparno Goswami**
- 10:00 – 11:20 **Session 1 – ORAL PRESENTATIONS** (*Suite 1 – 4 & Ruby 1 – 2*)

* Click on the blue text to jump to the list of presentation titles for each session

Timeslot	AEES	BCC	BS	CMS	ENG	PHYS
10:00 – 10:20	AEES-O-1- Dlodlo- Nduduzo	BCC-O-1- Apo- Kayode	BS-O-1- Dangana- Reuben	CMS-O-1- Apleni- Tembelihle	ENG-O-1- Ahmad- Fazeel	PHYS-O-1- Bauchoo- Yastheer
10:20 – 10:40	AEES-O-2- Gwala-Oscar	BCC-O-2- Basson- Aimee	BS-O-2- Dludla- Nhlanhla	CMS-O-2- Dure-Esau	ENG-O-2- Bennie- Francis	PHYS-O-2- Chitete- Isaac
10:40 – 11:00	AEES-O-3- Hadebe- Ntuthuko	BCC-O-3- Ghumran- Safiyah	BS-O-3- Harpal- Saiesha	CMS-O-3- Hodgson- Emma	ENG-O-3- Dube-Kyle	PHYS-O-3- Hlongwane- Michael
11:00 – 11:20	AEES-O-4- Khaba- Nkanyezi	BCC-O-4- Hajee- Mariam	BS-O-4- Khoza- Sthabile	CMS-O-4- Letsoalo- Marothi	ENG-O-4- Mbedzi- Confidence	PHYS-O-4- Jimoh- Saheed

11:20 – 11:40 **Tea and viewing of industry exhibits** (*Sapphire Hall*)

11:40 – 13:00 **Session 2 – ORAL PRESENTATIONS** (*Suite 1 – 4 & Ruby 1 – 2*)

Timeslot	AEES	BCC	BS	CMS	ENG	PHYS
11:40 – 12:00	AEES-O-5- Maharaj-Ishta	BCC-O-5- Magqira- Bavuyile	BS-O-5- Khwela- Thembeka	CMS-O-5- Mukhalela- Braiton	ENG-O-5- Mchunu- Londiwe	PHYS-O-5- Manqele- Mbhasobhi

12:00 – 12:20	AEES-O-6-Mngomezulu-Lindelwe	BCC-O-6-Majebe-Mongezi	BS-O-6-Mntambo-Sinenhlanhla	CMS-O-6-Nkompela-Pamela	ENG-O-6-Mohabeer-Breyton	PHYS-O-6-Massinga-King
12:20 – 12:40	AEES-O-7-Ndlazi-Sabelo	BCC-O-7-Majola-Nonhlelo	BS-O-7-Mntungwa-Phindile	CMS-O-7-Nwajeri-Kizito	ENG-O-7-Mutuku-Peter	PHYS-O-7-Mnikathi-Ayanda
12:40 – 13:00	AEES-O-8-Nsukwini-Sakhile	BCC-O-8-Mthembu-Zwanani	BS-O-8-Ndlazi-Nkosinathi	CMS-O-8-Nwibo-Innocent	ENG-O-8-Naidoo-Leesan	PHYS-O-8-Naicker-Mishka

13:00 – 14:00 **Lunch** (*Sapphire Hall*)

14:00 – 15:20 **Session 3 – ORAL PRESENTATIONS** (*Suite 1 – 4 & Ruby 1 – 2*)

Timeslot	<u>AEES</u>	<u>BCC</u>	<u>BS</u>	<u>CMS</u>	<u>ENG</u>	<u>PHYS</u>
14:00 – 14:20	AEES-O-9-Phala-Mahlomola	BCC-O-9-Nyanda-Frank	BS-O-9-Ngozi-Lwandile	CMS-O-9-Onifade-Olayinka	ENG-O-9-Ncube-Dumoluhle	PHYS-O-9-Nxumalo-Sifiso
14:20 – 14:40	AEES-O-10-Chatara-Tinashe	BCC-O-10-Sekaleli-Bafokeng	BS-O-10-Ojo-Abiodun	CMS-O-10-Raghunan-Jadene	ENG-O-10-Ramlakhan-Yashmika	PHYS-O-11-Teliat-Rasheed
14:40 – 15:00	AEES-O-11-Sigenu-Xola	BCC-O-11-Sithole-Thandokuhle	BS-O-11-Persadh-Jahnavi	CMS-O-11-Raji-Wasiu	ENG-O-11-Sithole-Siyabonga	
15:00 – 15:20	AEES-O-12-Tswane-Simphele	BCC-O-12-Thomas-Tatum	BS-O-12-Singh-Savarna	CMS-O-12-Zwane-Siphele	ENG-O-12-Vundla-Mxolisi	

16:30 – 18:00 **SCIENCE WITH JAZZ** (*Suite 1- 4*)

Speaker: Professor David Lokhat, *Director, Centre for Water Resources Research, University of KwaZulu-Natal*

Musicians: Lu Dlamini, *Durban-Based Vocalist, Composer and a Traditional Instrumentalist*

18:00 – 22:00 **Gala Dinner** (*Sapphire Hall*)

Master of Ceremonies: Professor Alan Mathews

Welcome: Professor Ademola Olaniran, *Dean: School of Agriculture and Science, University of KwaZulu-Natal*

Keynote Speaker: Dr Kiara Worth, *Documentary Photographer, Storyteller, and Sustainability Activist*

Entertainment: Ms Ashleigh Joseph

Acknowledgement of PRIS Supporters: Professor Fhatuwani Mudau,
Deputy Vice-Chancellor and Head of College and Professor Ademola
Olaniran, Dean, School of Agriculture and Science

Entertainment: Ms Ashleigh Joseph

Closing Remarks

Dinner and Dancing

DAY TWO: Thursday, 29 October

FLASH PRESENTATIONS (Suite 1 – 4 & Ruby 1)

* Click on the blue text to jump to the list of presentation titles for each session

Timeslot	AEES	BCC	BS	CMPS	ENG
09:00 – 11:20	AEES-F-1-Auma-Herine	BCC-F-1-Afolabi-Olumide	BS-F-1-Abe-Fayoke	CMPS-F-1-Adepoju-Adebayo	ENG-F-1-Abejide-Kolawole
TEA: 11:25 – 11:45 <i>Cont.</i> 11:50 – 13:00	AEES-F-3-Chetty-Evania	BCC-F-2-Ally-Numeerah	BS-F-2-Adam-Ahmed	CMPS-F-2-Ahmed-Bakri	ENG-F-2-Almeida-André
	AEES-F-4-Gule-Melisa	BCC-F-3-Dlamini-Noluthando	BS-F-3-Adelola-Rebecca	CMPS-F-3-Badu-Godfred	ENG-F-3-Bala-Innocent
	AEES-F-5-Kamwana-Florence	BCC-F-4-Elsiad-Hassan	BS-F-4-Alabi-Mercy	CMPS-F-4-Bhengu-Neliswa	ENG-F-4-Biyela-Sandile
	AEES-F-6-Khumalo-Sinikiwe	BCC-F-5-Fayomi-Samuel	BS-F-6-Bhengu-Sphelele	CMPS-F-5-Cele-Lindani	ENG-F-5-Capelo-Danel
	AEES-F-7-Madonda-Anele	BCC-F-6-Gcabashe-Nontobeko	BS-F-7-Chonco-Thembalinye	CMPS-F-6-Dukhi-Shahil	ENG-F-6-Chakawa-Kudzanai
	AEES-F-8-Makhaye-Siyasanda	BCC-F-7-Khanyile-Nokukhanya	BS-F-8-Ebrahim-Zahra	CMPS-F-7-Haroon-Ali	ENG-F-7-Chetty-Prinell
	AEES-F-9-Mangwanya-Shelter	BCC-F-8-Kontile-Lelethu	BS-F-9-Gumenku-Lemohang	CMPS-F-8-Helarie-Rose-Medie-Fah	ENG-F-8-Chinobva-Nyasha
	AEES-F-10-Mbambo-Neliswa	BCC-F-9-Madlala-Asanda	BS-F-10-Jaca-Lubabalo	CMPS-F-9-Ibrahim-Amna	ENG-F-9-Dada-Talha
	AEES-F-11-Mdadane-Londeka	BCC-F-10-Magwaza-S'thandiwe	BS-F-11-Lushaba-Andiswa	CMPS-F-11-Mchunu-Bongekile	ENG-F-10-Dayanund-Jadin
	AEES-F-12-Mgoyana-Sinobom	BCC-F-11-Maphumulo-Nkosiphendule	BS-F-12-Maci-Bongeka	CMPS-F-12-Mncube-Mbongeni	ENG-F-11-Ganapathie-Adheesh

	AEES-F-13-Mshengu-Buhle	BCC-F-12-Mbatha-Thandeka	BS-F-13-Madikizela-Snothile	CMPS-F-13-Mngadi-Siyamthanda	ENG-F-12-Hlabisa-Sanele
	AEES-F-14-Naiker-Kiresnhi	BCC-F-13-Mnyandu-Hopewell	BS-F-14-Masuku-Bandile	CMPS-F-14-Mnisi-Siyamthanda	ENG-F-13-Iorshagher-Akuha
	AEES-F-15-Ndlazi-Sfundo	BCC-F-14-Mpungose-Minawe	BS-F-15-Mbonambi-Sithabile	CMPS-F-15-Moodley-Kavi	ENG-F-14-Jackpersad-Shivani
	AEES-F-16-Nyawo-Bongizenzo	BCC-F-15-Mthethwa-Lindokuhle	BS-F-16-Moodley-Tyrique	CMPS-F-16-Mpontshane-Asande	ENG-F-15-Macharia-Andrew
	AEES-F-17-Sibudugu-Luitiwe	BCC-F-16-Mthethwa-Khethabahle	BS-F-17-Mtolo-Aphiwe	CMPS-F-17-Msweli-Cebolenkosi	ENG-F-16-Masoga-Ivory
	AEES-F-18-Tsoananyana-Tanki	BCC-F-17-Mtshali-Sinakhokonke	BS-F-18-Nene-Fezile	CMPS-F-18-Mthembu-Thalente	ENG-F-17-Mdunge-Lindokuhle
	AEES-F-20-Vetman-Onke	BCC-F-18-Mupeti-Tonderai	BS-F-19-Ngubo-Zenande	CMPS-F-19-Nyakujipa-Evangelista	ENG-F-18-Mkhonza-Asande
	AEES-F-21-Xaba-Sindiswa	BCC-F-19-Nagiah-Kamoana	BS-F-20-Nyide-Babalwa	CMPS-F-20-Onyeabor-Ifeanyi	ENG-F-19-Moyo-Talent
	AEES-F-22-Yacoob-Ameera	BCC-F-20-Nomnganga-Busisiwe	BS-F-21-Phori-Pabalelo	CMPS-F-23-vanWyk-JoAnne	ENG-F-20-Muhammad-Ahad
	AEES-F-23-Zulu-Khumbuzile	BCC-F-21-Rajkumar-Nerissa	BS-F-22-Radebe-Nkanyezi	CMPS-F-24-Zondi-Mthobisi	ENG-F-21-Naidoo-Kyle
		BCC-F-22-Sokhela-Ntokozo	BS-F-23-Radzilani-Isaac		ENG-F-22-Ngcobo-Khethukuthula
		BCC-F-23-Wahab-Tasmia	BS-F-24-Sibuta-Aphiwe		ENG-F-24-Okem-Eche
			BS-F-25-Sithole-Slindile		ENG-F-25-Rajdev-Yarish
			BS-F-26-Tshwenyana-Eunice		ENG-F-26-Ramruthan-Caleb
			BS-F-27-Zuma-Olieve		ENG-F-27-Reddy-Byron
					ENG-F-28-Sebata-Gerald
					ENG-F-29-Sibanda-Sithandazile
					ENG-F-30-Tanyanyiwa-Jimson
					ENG-F-31-Thabethe-Zwelethu

					ENG-F-32- Wilson- Maimuna
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09:00 – 11:05 **CONCURRENT INDUSTRY SESSION** (*Ruby 2*)

09:00: **Welcome and Introduction:** Professor Neil Koorbanally

09:05: **Sasol:** Dr Tanya Hughes

09:25 **Discovery Bank:** Mr Nikhil Naik & Ms Leandra Naicker

09:45: **uMngeni-uThukela Water:** Ms Nelisiwe Mbatha

10:05: **First National Bank:** Mr Manqoba Sihwa

10:25: **National Research Foundation:** Mr Tsepiso Masemola

10:45: **SANRAL:** Ms Rhona Erasmus

11:05: **Standard Bank:** Ms Venessa Oger

11:05 – 11:45 **Tea and viewing of industry exhibits** (*Sapphire Hall*)

11:50 – 12:50 **CONCURRENT INDUSTRY SESSION** (*Ruby 2*)

11:50: **AgriSETA:** Mr Frikkie Fouche

12:10 **Eskom:** Mr Xolani Ngubeni

12:30: **Department of Agriculture:** Mrs Mpumelelo Gumede

13:00 – 14:00 **Lunch** (*Sapphire Hall*)

14:05: **Mintek:** Dr Ndivhuwo Shumbula

14:30 – 16:00 **Networking Session:** Tea and Coffee (*Suite 1 – 4*)

16:00 – 17:00 **Closing, Prize-Giving, and Lucky Draws** (*Sapphire Hall*)

Professor Rituparno Goswami, *College Dean of Research*

Professor Ademola Olaniran, *Dean, School of Agriculture and Science*

Professor Glen Bright, *Dean, School of Engineering*

Professor Fhatuwani Mudau, *Deputy Vice-Chancellor and Head of College*

Dr Sally Frost, *College Public Relations Manager*

Keynote Lecture

“Forests/Grasslands and the Power of Marginalised People in Southern Africa: Politics of Chronic Liminality”

by

PROFESSOR FRANK MATOSE

Professor of Environmental Sociology in the Department of Sociology, University of Cape Town

Decades after independence and the end of apartheid, why do communities in Southern Africa still struggle to reclaim land and resource rights lost under colonialism? [In my recent book: “Forests and the power of marginalised people in Southern Africa”](#), I examine this stagnation through the lens of ‘chronic liminality’, a state of perpetual waiting between states and local people. The examination offers a new perspective for scholars in different disciplines who are interested in interrogating power, collective action and the slow pace of reform.

Drawing on case studies from South Africa’s Dwesa-Cwebe Nature Reserve and Zimbabwe’s Gwayi and Mafungabusi Forests I examine how neoliberal conservation and colonial-era property relations keep communities in limbo. Overall, the speech advances scholarship on conservation in Africa and other postcolonial regions by providing a different perspective on the continued marginalisation of local people and arguing for the need to rethink ownership and management around forests, rangelands and other natural resources. As such, it explains why frustrated people in many marginal situations wait indefinitely for the state to act on their lost rights and has resonance for scholars in development studies, labour studies, and general sociology whose interests lie in interrogating power and justice. Ultimately, this speech interrogates why communities remain trapped, the politics behind state prevarication and the urgent need to rethink natural resource ownership and justice in post-colonial contexts.

Science With Jazz Seminar Series

“The Big Convergence – are we prepared for a new way of research?”

by

PROFESSOR DAVID LOKHAT

uMngeni-uThukela Water Chair in Water Resources Research and Innovation, African Rainbow Minerals Chair in Sustainable Engineering and Process Intensification, and the Director of the Centre for Water Resources Research

Most contemporary social and environmental problems are increasingly “wicked”, having no clear definitions nor solutions, and intersecting multiple and often conflicting societal needs. We have seen great efforts to merge overlapping disciplines and challenge areas, defining various nexuses between water, energy, health, food and climate. Recently, convergence research has emerged as an effective framework for tackling complex interdependent problems. It intentionally integrates seemingly disparate knowledge systems, methodologies, and expertise in a way that enables asking and answering research questions in completely new, and successful ways. What is convergence, and how can we apply it? This talk will introduce the fascinating concept.

Gala Dinner Keynote Address

“The Ground Between Us - Lessons of land, connection and policy from the Mongolian steppe”

by

Dr Kiara Worth

Documentary Photographer, Storyteller, and Sustainability Activist

As part of the United Nations Convention to Combat Desertification's (UNCCD) 17th Conference of the Parties (COP17), hosted by Mongolia in Ulaanbaatar, a UNCCD Silk Caravan undertook a 6,000-kilometre Eurasian journey from Türkiye, across Russia, Uzbekistan, Kazakhstan, Kyrgyzstan, and China to Mongolia, documenting land restoration efforts, pastoralist knowledge and local solutions, showcasing approaches to restoration that can be exchanged across diverse rangeland landscapes. Kiara travelled

with a caravan of pastoralists through Mongolia to exchange ideas and knowledge around indigenous leadership, local communities, and related concepts to set the tone for the negotiations.

Kiara's presentation will provide insight into the global challenge of land degradation and desertification, the role of the UNCCD and the COP17 negotiations, and the importance of restoring land, supporting rangelands and pastoralist communities, and strengthening international cooperation around this. It will also highlight the import role of storytelling in ensuring voices from the ground are heard.

PROFESSOR FRANK MATOSE

Biography:



Frank Matose is a professor and environmental sociologist in the Department of Sociology, University of Cape Town, South Africa.

His research focuses on the political ecology of conservation, collaborative forest management, and commons governance in Africa. His current research project is titled Resilient and Equitable Nature-based Pathways in Southern African Rangelands (REPAiR).

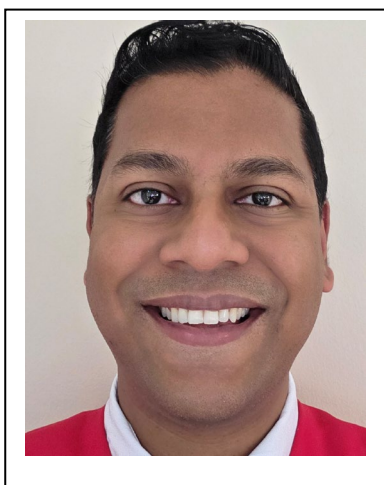
His latest book is titled: Forests and the power of Marginalised People in Southern Africa: Politics of Chronic Liminality, James Currey (2025). He recently co-published Reclaiming African Environmentalism: Ecological Struggles for Wellbeing and Habitability, with Lesley Green, Anselmo Matusse and Nikiwe Solomon, HSRC Press: Cape Town (2025) and The Violence of Conservation in Africa with Maano Ramutsindela and

Tafadzwa Mushonga (2022).

He serves on the advisory board of The Institute for African Alternatives (IFAA). He also serves as an interim of chair of the Advisory Committee of the Collaborating for Resilience (CoRe) and an affiliate editor of World Development.

PROFESSOR DAVID LOKHAT

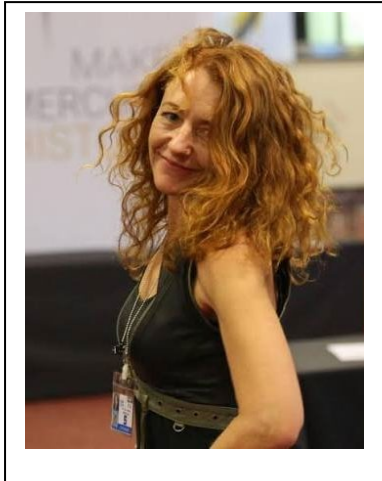
Biography:



Professor David Lokhat is the uMngeni-uThukela Water Chair in Water Resources Research and Innovation, African Rainbow Minerals Chair in Sustainable Engineering and Process Intensification, and the Director of the Centre for Water Resources Research at the University of KwaZulu-Natal. He is a Fellow of the South African Institution of Chemical Engineers, the Nigerian Society of Chemical Engineers, the Royal Society of Chemistry and the South African Academy of Engineering. He has been actively engaged in the advocacy and promotion of chemical engineering as a discipline, and has held numerous leadership roles within professional and academic societies.

DR KIARA WORTH

Biography:



Dr Kiara Worth is a storyteller and photographer based in Cape Town, South Africa, known for her work in sustainability activism and international negotiations. She has a background in political science and agriculture, and she covers topics such as climate change, biodiversity, and sustainable development in her photography and writing.

Kiara has been featured in major publications like the New York Times and The Guardian, and she has worked as a photo-journalist in Papua New Guinea, using her stories to communicate sustainability issues.

ORAL PRESENTATIONS

AGRICULTURAL, EARTH AND ENVIRONMENTAL SCIENCES

Chair: Dr Ntombifuthi Nzimande			
10:00 – 11:20	Session One		
Time	Presenter	Title	Page No.
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10:20 – 10:40	AEES-O-2: Oscar Gwala PhD 213531236	Multi-Temporal Land Use/Land Cover Dynamics (2005–2025) and Machine Learning Algorithm Comparison in and around Kruger National Park	38
10:40 – 11:00	AEES-O-3: Ntuthuko Hadebe PhD 217021326	Impacts of Pluralistic Extension Service Delivery on Farmers' Production in Kwazulu-Natal, South Africa	39
11:00 – 11:20	AEES-O-4: Nkanyezi Khaba PhD 224026919	Morpho-physiological responses of selected citron watermelon (<i>Citrullus amarus</i>) genotypes under low nitrogen stress	40
11:40 – 13:00	Session Two		
11:40 – 12:00	AEES-O-5: Ishta Maharaj MSc 221006806	Detailed Bedrock Morphology and Structural Geology Controls on Diamond Traps Offshore Hottentot's Bay, Southern Namibia	40
12:00 – 12:20	AEES-O-6 Lindelwe Mngomezulu MSc 221059466	Catena-scale hydrological controls on peat decomposition and carbon stock vulnerability in the Nkandla peatlands, KwaZulu-Natal: A landscape-scale assessment.	41
12:20 – 12:40	AEES-O-7: Sabelo Ndlazi PhD 222130278	Socio-Economic Factors and Cropping Systems in Provitamin A Biofortified Yellow Maize (<i>Zea Mays</i> L.) Production In KwaZulu-Natal, South Africa	42
12:40 – 13:00	AEES-O-8: Sakhile Nsukwini PhD 208527210	Conservation Boundaries, Rangeland Livelihoods and Human–Wildlife Conflict: Community Experiences from Hluhluwe-iMfolozi Park and Somkhanda Game Reserve, South Africa	43
14:00 – 15:20	Session Three		
14:00 – 14:20	AEES-O-9: Mahlomola Phala PhD 224196641	Unequal Burdens: How Socio-Demographic Variables Shape the Environmental, Health, and Socio-Economic Effects of Illegal Waste Dumping	44
14:20 – 14:40	AEES-O-10: Tinashe Chatara PhD 219098910	Integrating Mixed Models and Multi-Trait Indices to Improve Selection for Drought Tolerance in African Spider Plant (<i>Gynandropsis gynandra</i>)	45
14:40 – 15:00	AEES-O-11: Xola Sigenu PhD 218018026	Effect Of Different Water Regimes and Potassium Fertilisation on Tuber Quality and Bioactive Compounds in Three Potato Cultivars	45

15:00 – 15:20	AEES-O-12: Simphiwe Tswane MSc 221026525	Spatiotemporal Dynamics of Vegetation Cover and Land Surface Temperatures from Landsat 8 (2015–2025)	46
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ORAL PRESENTATIONS

BIOCHEMISTRY AND CHEMISTRY

Chair: Professor Brenda Moodley			
10:00 – 11:20	Session One		
Time	Presenter	Title	Page No.
10:00 – 10:20	BCC-O-1: Kayode Apo PhD 223039684	Green Synthesis of Selenium Nanoparticles from Ocimum Leaf: Characterization, Antioxidant, Antibacterial, and Cytotoxicity Properties	48
10:20 – 10:40	BCC-O-2: Aimee Basson MSc 225085268	Selenium-Integrated Iron Oxide Nanocomposites: Structural Features and Cytotoxicity In Cancer Cells	49
10:40 – 11:00	BCC-O-3: Safiyah Ghumran PhD 214524354	Design, Synthesis, in Vitro, and in Silico Studies of Rhodanine-Isoniazid Molecular Hybrids	49
11:00 – 11:20	BCC-O-4: Mariam Hajee PhD 219014170	Comparison Of Graphitic Carbon Nitride Synthesised from Melamine and Urea for the Electrochemical Detection of Ciprofloxacin	50
11:40 – 13:00	Session Two		
11:40 – 12:00	BCC-O-5: Bavuyile Magqira PhD 220010172	Conversion of Coal Fly Ash to Zeolite for Adsorption of Different Pharmaceutical Contaminants from Water: Isotherms, Kinetics, Regeneration and Leaching Assessment	51
12:00 – 12:20	BCC-O-6: Mongezi Majebe MSc 218007732	Electrospun nanofiber conjugates encompassing ruthenium benz(imidazole/othiazole) compounds: Nanofabrication, characterization, drug-release profiles, and time-dependent anticancer studies	52
12:20 – 12:40	BCC-O-7: Nonhlelo Majola PhD 216047087	Oxidative Synthesis of 2,4,5-Trisubstituted Imidazoles Commencing from Methylarenes using Cobalt/NHPI in HFIP	53
12:40 – 13:00	BCC-O-8: Zwanani Mthembu MSc 221094202	Engineering a hybrid electron transport layer and biomass-derived carbon counter electrode for perovskite solar cells	54
14:00 – 15:20	Session Three		
14:00 – 14:20	BCC-O-09: Frank Nyanda PhD 224198007	Polystyrene Nanoparticles as a Model for Environmental Studies: Synthesis, Characterization, Stability, Detection, and Quantification	55
14:20 – 14:40	BCC-O-10: Bafokeng Sekaleli PhD 225111039	Effect of Zn and Zr on catalyst performance for methanol production from carbon dioxide	56
14:40 – 15:00	BCC-O-11: Thandokuhle Sithole MSc 217002844	Isolation and Characterization of Cannabis-Derived Extracellular Vesicles	57
15:00 – 15:20	BCC-O-12: Tatum Thomas MSc 218069283	Isolation, characterization and cargo loading of mammalian extracellular vesicles	58

ORAL PRESENTATIONS

BIOLOGICAL SCIENCES

Chair: Professor Evariste Gueguim Kana			
10:00 – 11:20	Session One		
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10:00 – 10:20	BS-O-1: Reuben Dangana PhD 225195108	Network Pharmacology and Molecular Docking Reveal Multi-Target Anti-Malarial Mechanisms of a Polyherbal Extract from <i>A. indica</i> , <i>P. americana</i> , and <i>M. indica</i>	59
10:20 – 10:40	BS-O-2: Nhlanhla Dludla MSc 217001391	Seasonality Influences C, N, and P-Cycling Extracellular Enzyme Activities Under an Extended El-Niño Cycle	60
10:40 – 11:00	BS-O-3: Saiesha Harpal MSc 217012042	DNA Metabarcoding Reveals Spatial Patterns of Zooplankton Biodiversity Across the Agulhas Current	60
11:00 – 11:20	BS-O-4: Sthabile Khoza MSc 222002124	Language Model-Assisted Response Surface Optimization of Napier Grass Saccharification and Co-Fermentation for Efficient Lignocellulosic Bioethanol Production	61
11:40 – 13:00	Session Two		
11:40 – 12:00	BS-O-5: Thembeka Khwela MSc 219003364	Microbiological quality of the uMsunduzi River water and genomic analyses of representative <i>E. coli</i> isolates	62
12:00 – 12:20	BS-O-6: Sinenhlanhla Mntambo PhD 213509230	Medicinal Invertebrates Used in African Traditional Medicine: A Systematic Review	63
12:20 – 12:40	BS-O-7: Phindile Mntungwa MSc 220012167	Metabolomics Reveals Bacterial–Algal Cross-Feeding Enhances Nutrient Removal and PUFA-Enriched Biomass in Poultry Processing Wastewater	64
12:40 – 13:00	BS-O-8: Nkosinathi Ndlazi PhD 217019510	Antibiotic Resistance Surveillance Along the Msunduzi River: An Integrated One Health Approach	65
14:00 – 15:20	Session Three		
14:00 – 14:20	BS-O-9: Lwandile Ngozi PhD 217052416	Water quality and macroinvertebrate responses to land use and climate change in KwaZulu-Natal rivers, South Africa	65
14:20 – 14:40	BS-O-10: Abiodun Ojo PhD 224195273	Diversity and Evolutionary Analysis of the Transposable Elements in Chicken <i>Eimeria</i> Genomes	66
14:40 – 15:00	BS-O-11: Jahnvi Persadh PhD 214528400	Biodiversity Representation in Ecosystem Models of Marine Nursery Habitats	67
15:00 – 15:20	BS-O-12: Savarna Singh MSc 223115041	Development of a novel disinfectant, tLox-23, to reduce fungal infections in healthcare settings	68

ORAL PRESENTATIONS

COMPUTING, MATHEMATICS, AND STATISTICS

Chair: Professor Retius Chifurira			
10:00–11:20	Session One		
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10:00–10:20	CMS-O-1: Tembelihle Apleni MSc 225157827	Attention-Enhanced Ensemble Deep Learning Models for Multi-Crop Disease Classification	69
10:20–10:40	CMS-O-2: Esau Dure PhD 226156957	Value at Risk Estimation Under Global Financial Uncertainty: A Heavy-Tailed Student's t Mixture Autoregressive Approach	70
10:40–11:00	CMS-O-3: Emma Hodgson MSc 223144118	Mathematical models for Tuberculosis	71
11:00–11:20	CMS-O-4: Marothi Letsoalo PhD 224198826	Baseline Vulnerability Phenotypes in Pregnancy and Severe Maternal Outcome Among Women Living with HIV	72
11:40–13:00	Session Two		
11:40–12:00	CMS-O-5: Braiton Mukhalela PhD 225190874	A Multi-Station Multivariate LSTM Framework for Short-Term Extreme Rainfall Prediction in KZN, SA	73
12:00–12:20	CMS-O-6: Pamela Nkompela MSc 226217332	On The Number of 1-Nearly Independent Vertex Subsets	74
12:20–12:40	CMS-O-7: Kizito Nwajeri PhD 223153151	Artificial Neural Network and Response Surface Analysis of Heat and Mass Transfer in Cattaneo-Christov Oldroyd-B Flow over a Rotating Stretching Sheet	74
12:40–13:00	CMS-O-8: Innocent Nwibo PhD 225197177	Approximation of the Solutions of Pseudomonotone Equilibrium Problems by Modified Subgradient Extragradient Method with Application	75
14:00–15:20	Session Three		
14:00–14:20	CMS-O-9: Olayinka Onifade PhD 222121238	A Relaxed Inertial Subgradient Extragradient Method for Solving Variational Inequality and Multivalued Fixed-Point Problems.	77
14:20–14:40	CMS-O-10: Jadene Raghunan MSc 222008567	On minimal degrees of faithful permutation representation of finite groups	78
14:40–15:00	CMS-O-11: Wasiu Raji PhD 224196841	Cross-Dataset Cell Segmentation with a Domain-Adaptive ResNet50 Attention U-Net	78
15:00–15:20	CMS-O-12: Siphiwe Zwane MSc 224192364	The acceptance of a quick response code model to enhance South African banknote security	79

ORAL PRESENTATIONS

ENGINEERING

Chair: Professor Kuveneshan Moodley			
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10:20 – 10:40	ENG-O-2: Francis Bennie MSc 210500546	Assessing the Sensitivity of Harmonic Distortion and Distribution Transformer Risk to Feeder Impedance in Low-Voltage Networks with Distributed Energy Resources	81
10:40 – 11:00	ENG-O-3: Kyle Dube MSc 226219563	Simulating Growth and Decay Kinetics of Non-Pathogenic Escherichia coli Under Controlled Laboratory Conditions for Application to the Isipingo River	81
11:00 – 11:20	ENG-O-4: Confidence Mbedi MSc 225197313	Life Cycle Cost and Benefit Analysis of Modern Drip Irrigation Systems: A Systematic Review	82
11:40 – 13:00	Session Two		
11:40 – 12:00	ENG-O-5: Londiwe Mchunu MSc 220068885	Valorisation of Sanitation Waste for Alternative Building Material Synthesis	83
12:00 – 12:20	ENG-O-6: Breyton Mohabeer MSc 219081980	Investigating the Potential to Accurately Measure River Flow Discharge Using Remote Sensing Techniques	84
12:20 – 12:40	ENG-O-7: Peter Mutuku PhD 218088282	Experimental Physical Benchmark for Accurate Software Emulation of a Transmission Line: A Foundation for Hardware-in-the-Loop Validation	85
12:40 – 13:00	ENG-O-8: Leesan Naidoo MSc 219014486	Low-Cost Online Water Quality Monitoring of Water Efficient Sanitation Systems using Soft Sensors	86
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14:00 – 14:20	ENG-O-9: Dumoluhle Ncube MSc 219014486	Developing a Provincial-Scale Transport–Emissions Modelling Architecture for Data-Constrained Regions: A Case Study of KwaZulu-Natal, South Africa	87
14:20 – 14:40	ENG-O-10: Yashmika Ramlakhan PhD 217020357	Sustaining waste management gains in informal settlements: Beyond parachute solutions	88
14:40 – 15:00	ENG-O-11: Siyabonga Sithole MSc 221060172	Innovative Application of Nuclear in Isotopic-Pathogen Tracer Study in Peri-Urban Rivers	89
15:00 – 15:20	ENG-O-12: Mxolisi Vundla MSc 219012994	A Decision Framework for Sludge Management and Valorization to De-risk Water-Efficient Sanitation Systems	89

ORAL PRESENTATIONS

PHYSICS

Chair: Professor Mathew Moodley			
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Time	Presenter	Title	Page No.
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10:20-10:40	PHYS-O-2: Isaac Chitete MSc 224174991	Measurement of the Dark Energy Spectroscopic Instrument (DESI) Galaxy cluster bulk velocity with kinematic Sunyaev-Zeldovich (kSZ) signals from Atacama Cosmology Telescope Polarimeter (ACTPol) Data Release 4	91
10:40-11:00	PHYS-O-3: Michael Hlongwane PhD 220046398	BiFeO ₃ Multifunctional Thin Films for Energy Storage and Non-Volatile Memory Devices	92
11:00-11:20	PHYS-O-4: Saheed Jimoh PhD 223152536	Wind Resource and Energy Potential Assessment in Ten Nigerian Cities Based on a Modified Bimodal Mixture Weibull Probability Density Function	93
11:40-13:00	Session Two		
11:40-12:00	PHYS-O-5: Mbhasobhi Manqele MSc 219037124	Development of a Remote, Self-Sustaining, Low-Cost, Low-Power GNSS RTK Base Station for CORS Applications	93
12:00-12:20	PHYS-O-6: King Massinga MSc 218060168	Variational Quantum Eigensolver and The Measurement Test Algorithm	94
12:20-12:40	PHYS-O-7: Ayanda Mnikathi MSc 220091068	Detection of Kinematic Sunyaev Zel'dovich Signals Using the Pairwise Momentum Estimator	95
12:40-13:00	PHYS-O-8: Mishka Naicker PhD 219002322	Variational Monte Carlo and the Quantum-Enhanced Metropolis-Hastings Algorithm	96
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14:00-14:20	PHYS-O-9: Sifiso Nxumalo PhD 223153020	Effect of Nickel Substitution on Magnesium Ferrite Nanoparticles and Their Application in Spinach Cultivation	96
14:20-14:40	PHYS-O-10: Rasheed Teliat PhD 226202834	Assessment of Wind Resources and Energy Potential in Bisho, Eastern Cape Province, South Africa, Using a Bimodal Weibull Probability Density Function	97
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15:00-15:20			

FLASH PRESENTATIONS

AGRICULTURAL, EARTH AND ENVIRONMENTAL SCIENCES

Chair: Dr Simphiwe Mngomezulu-Dube			
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AEES-F-3	Evania Chetty PhD 219051491	Integrating Remote Sensing and Citizen Science for Inland Water Quality Monitoring: A Systematic Literature Review and Bibliometric Analysis	100
AEES-F-4	Melisa Gule MSc 220089824	Empowering Smallholder Farmers: Leveraging South African Weather Services Seasonal Climate Information for Climate Adaptation and Enhanced Food Security in Kwazulu-Natal	100
AEES-F-5	Florence Kamwana PhD 224191331	Assessing Sustainable Intensification Options for Maize Across Diverse Farm Types in central Malawi	101
AEES-F-6	Sinikiwe Khumalo PhD 219002761	Circular Economy Approaches for Resource Recovery from Drinking Water Treatment Residues: A Scoping Review	102
AEES-F-7	Anele Madonda MSc 222029634	Seafloor mapping and geophysical characterization of the central Agulhas Slide on the Southern Cape Margin.	102
AEES-F-8	Siyasanda Makhaye MSc 225196609	Comparative and Integrated Remote Sensing: Using Multispectral UAV and Satellite Based Imagery to Assess the Distribution and Risk of Invasive Alien Riparian Vegetation	103
AEES-F-9	Shelter Mangwanya PhD 224190492	A Bottom-Up Approach to Mapping Water-Energy-Food Nexus Interactions Towards Sustainable and Resilient Agrifood Systems in Socio-Ecologically Vulnerable Context	104
AEES-F-10	Neliswa Mbambo MSc 222023197	A Review of Diagnostic Performance of Indigenous Soil Indicators for Rapid Soil Assessment in Smallholder Farming Systems	105
AEES-F-11	Londeka Mdadane MSc 226149076	Optimizing vinegar marination and wood smoking for safe and consumer acceptable rabbit biltong production in KwaZulu-Natal, South Africa	105
AEES-F-12	Sinobom Mgoyana MSc 222048683	Comprehensive Characterization of Juncao Grass (<i>Cenchrus fungigraminus</i>) Biochar: Chemical, Structural and Surface Properties	106
AEES-F-13	Buhle Mshengu MSc 219024922	Consumer and Retailer Perceptions Towards Broiler, Indigenous, And Crossbred Chicken Meat in the uMgungundlovu District, KwaZulu-Natal, South Africa	107
AEES-F-14	Kireszni Naiker MSc 211510568	Evaluating the Impact of Milk Replacer Supplementation and Calf Starter Feed Physical Form and Crude Protein Content on Feed Intake and Growth Performance in Female Holstein Friesian Calves: Two Separate Trials	108

AEES-F-15	Sfundo Ndlazi MSc 216011016	The Use of Endophytic Strains of Trichoderma to Prevent Pre- and Post-harvest Diseases of Avocado Caused by Pseudocercospora, Colletotrichum and Lasiodiplodia.	109
AEES-F-16	Bongizenzo Nyawo PhD 222130773	Groundwater Salinity Evolution Using PHREEQC Geochemical Modelling in the Fractured Basement Aquifer of the Hout River Catchment, Limpopo Province, South Africa	110
AEES-F-17	Luitiwe Sibudugu MSc 224198841	Living Alongside Kruger National Park: A Comparative Study of Conservation Perceptions and Human Wildlife Conflict in Matsulu and Phalaubeni	111
AEES-F-18	Tanki Tsoananyana MSc 219027030	An exploratory study on consumer behaviour regarding food waste in Msunduzi & uMngeni Municipalities: Implications for household food security	112
AEES-F-20	Onke Vetman MSc 222025640	The Feasibility of ML For Optimising Non-Yielding Pillars in Hard-Rock Bord-And-Pillar Designs in Underground Mines	113
AEES-F-21	Sindiswa Xaba PhD 220100225	Enhancing Drought Tolerance in Potatoes by Exogenous Application of Moringa Leaf Extract from Aqueous-Based Methods	114
AEES-F-22	Ameera Yacoob PhD 218023873	UAS-Based Hyperspectral and Lidar Observations for Cross-Scale Ecohydrological Monitoring in the Northern Drakensberg Strategic Water Source Area	115
AEES-F-23	Khumbuzile Zulu PhD 224195879	Whose Conservation? Re- Writing History with Archives, Indigenous Knowledge, and Community Stories	116

FLASH PRESENTATIONS

BIOCHEMISTRY AND CHEMISTRY

Chair: Dr Karen Pillay			
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BCC-F-2	Numeerah Ally PhD 218033284	Monitoring Contaminants of Emerging Concern in Wastewater Using Gas Chromatography-Mass Spectrometry	118
BCC-F-3	Noluthando Dlamini MSc 221001965	Synthesis of N ⁺ O-donor Mg(II) and Zn(II) complexes as catalysts for the production and depolymerization of PLAs	118
BCC-F-4	Hassan Elsiad PhD 224195395	Development of 1,2,3-Triazole-Based Bioisosteric Scaffolds for C-Terminal and Histidine Modification of Antimicrobial Peptides via Solid-Phase Peptide Synthesis	119

BCC-F-5	Samuel Fayomi PhD 224196085	Preliminary Evaluation of Isoleucine, Lysine and Serine On Glucose Handling In Ex Vivo And Diabetic Rat Models	120
BCC-F-6	Nontobeko Gcabashe PhD 220012265	Greener Synthesis Of N-Acyl Hydrazones of Isoniazid in Deep Eutectic Solvent	121
BCC-F-7	Nokukhanya Khanyile MSc 220014288	Development Of Sustainable Magnetic Molecularly Imprinted <i>Lippia Javanica</i> for The Selective Removal of Pharmaceuticals from Wastewater: Adsorption Kinetics & Isotherms	122
BCC-F-8	Lelethu Kontile MSc 218022087	<i>Eucalyptus Gunnii</i> Essential Oil: An Ecofriendly and Cost-Effective Adsorbent for Sulfonamides Removal in Wastewater	123
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ORAL ABSTRACTS

AGRICULTURAL, EARTH AND ENVIRONMENTAL SCIENCES

AEES-O-1

Physico-chemical quality of meat produced from weaned Californian rabbit's fed formulated cereal-based diets

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The objective of the current study was to evaluate the effect of cereal-based diets on physico-chemical quality of meat produced from weaned Californian rabbits. A total of thirty weaned Californian rabbits were randomly assigned to individual grower pens in a completely randomised design and fed grower maize, grower wheat and grower oats diets at the age of 45 days for 56 days. Grower maize diet contained 280 g/kg of maize, grower wheat diet contained 280 g/kg of wheat, and grower oats diet contained 280 g/kg of oats. Rabbits used in the trial were given *ad libitum* access to experimental diets and clean water throughout the experiment. Each dietary treatment had 10 rabbits (5 males and 5 females). At the end of the feeding trial, six animals were taken from each treatment group, 3 per sex. Rabbits were then humanely slaughtered through an electric stunner and hot carcass was weighed (CBW). Meat pH was recorded at 45 minutes after slaughter in the carcass and after 24hrs in the vacuum sealed samples. Samples for meat tenderness (WBSF), water holding capacity (WHC), drip loss (DL) and cooking loss (CL) quality analysis were taken from thigh muscles. These samples were transported to UKZN animal science laboratory cold storage (4 °C) and stored for 24hrs. Meat colour (L^* , a^* , b^*) samples were vacuum sealed in the abattoir and stored in the cooler box at 4 °C and immediately transported to UKZN dietetics laboratory to do meat colour analysis.

The results show that meat colour (L^* , a^* , b^*), pH, water holding capacity (WHC), drip loss (DL) and cooking loss (CL) were not affected by experimental diets. There was a significant difference ($P < 0.05$) between warner-Bratzler shear force (WBSF) of meat from oats (76.7) and maize diet (44.1) whereas wheat (58.5) diet showed no difference amongst them. Gender had a significant ($P < 0.05$) influence in the lightness (L^*) of meat from oats diet, bucks (47.2) had lower values compared to does (51.2). There was a significant difference ($P < 0.05$) in rabbit meat redness between bucks (11.3) and does (6.22) from wheat diet. The WBSF for meat from oats diet was significantly ($P < 0.05$) different between bucks (40.8) and does (77.6). Drip loss was significantly ($P < 0.05$) different between meat from bucks (5.44) and does (9.49) that were fed oats diet. It was therefore, concluded that cereal-based diets do not have an influence on meat-quality of growing Californian rabbits, except for warner-Bratzler shear-force (WBSF).

Keywords: Meat quality, rabbits, cooking loss, drip loss, meat colour

AEES-O-2

Multi-Temporal Land Use/Land Cover Dynamics (2005–2025) and Machine Learning Algorithm Comparison in and around Kruger National Park

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Land Use/Land Cover (LULC) change detection is fundamental to understanding landscape dynamics and supporting sustainable environmental management, particularly in ecologically sensitive and transboundary conservation areas such as Kruger National Park in South Africa. Rapid urban expansion, agricultural intensification, and environmental change have accelerated landscape transformation, highlighting the need for accurate and reliable LULC monitoring. This study aimed to evaluate long-term LULC dynamics in and around Kruger National Park during 2005, 2015, and 2025 using multi-temporal Landsat imagery and four machine learning classifiers: Random Forest (RF), Support Vector Machine (SVM), Gradient Tree Boosting (GTB), and K-Nearest Neighbors (KNN). In addition, RF-based transition matrices were employed to quantify long-term land cover transformations. The results showed that the Random Forest classifier consistently outperformed the other algorithms, achieving the highest Overall Accuracy (up to 92%) and Kappa coefficient (0.87) across all study years. Gradient Tree Boosting and K-Nearest Neighbors produced satisfactory results, whereas Support Vector Machine exhibited comparatively lower classification performance.

Spatial analysis indicated that woodland/shrubland remained the dominant land cover class but experienced progressive fragmentation and conversion to grassland, agricultural land, and bare land. Built-up areas expanded substantially, particularly between 2005 and 2015, while agricultural land also increased, reflecting growing anthropogenic pressure. Water bodies exhibited a declining trend throughout the study period, suggesting increasing hydrological and environmental stress. These findings demonstrate that ensemble-based machine learning methods, particularly Random Forest, provide a robust and reliable approach for monitoring complex and heterogeneous savanna landscapes. The observed LULC changes highlight the increasing influence of human activities on ecosystem structure and emphasize the importance of continuous geospatial monitoring to support biodiversity conservation, sustainable land management, and evidence-based environmental planning. Overall, this study provides a reliable framework for long-term LULC mapping and change detection applicable to protected areas and other ecologically sensitive landscapes.

**IMPACTS OF PLURALISTIC EXTENSION SERVICE DELIVERY ON FARMERS' PRODUCTION IN
KWAZULU-NATAL, SOUTH AFRICA**

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Smallholder farmers in South Africa increasingly rely on pluralistic agricultural extension systems comprising public, private, non-governmental and farmer-based organisations to access agricultural information and support. However, limited empirical evidence exists regarding the effectiveness of these systems, the extent of collaboration among extension service providers, and their contribution to sustainable livelihoods. This study evaluated the effectiveness of pluralistic agricultural extension services, examined collaboration among extension service providers, and assessed their contribution to the sustainable livelihoods of smallholder farmers in KwaZulu-Natal Province. An ex post facto research design was employed, and data were collected from 120 smallholder farmers selected through a multistage sampling procedure across four districts of KwaZulu-Natal. Data were analysed using descriptive statistics and Binary Logistic Regression.

The findings revealed that the KwaZulu-Natal Department of Agriculture and Rural Development (80.8%), Cedara College of Agriculture (78.3%), and the Agricultural Research Council (75.8%) were the major providers of extension services, while private and non-governmental organisations complemented public sector support by providing specialised technical, market and enterprise development services. Collaboration among extension service providers was constrained by differences in organisational mandates, operational approaches, geographical coverage and institutional priorities, resulting in fragmented service delivery. Despite these challenges, pluralistic extension services significantly improved farmers' livelihoods. Following extension support, farmers reporting high knowledge of access to bank credit increased from 0% to 78.3%, while high adoption of climate adaptation techniques increased from 0% to 93.3%. Similarly, high knowledge of extension services increased from 0% to 92.5%, high adoption of agricultural value chain activities increased from 0% to 93.3%, and high knowledge of transport infrastructure increased from 0% to 93.3%, indicating substantial improvements in financial, human, and physical capital. Overall, pluralistic extension services enhanced farmers' knowledge, attitudes, skills, and adoption of improved agricultural practices across the sustainable livelihood capitals.

The study concludes that strengthening institutional coordination and partnerships among extension service providers can improve the effectiveness of pluralistic extension systems and contribute to sustainable livelihood outcomes among smallholder farmers. The findings provide valuable evidence for policymakers and extension practitioners seeking to strengthen agricultural advisory systems and promote inclusive rural development in South Africa.

Keywords: Pluralistic agricultural extension; sustainable livelihoods; smallholder farmers; extension service providers; collaboration; KwaZulu-Natal.

AEES-O-4

Morpho-physiological responses of selected citron watermelon (*Citrullus amarus*) genotypes under low nitrogen stress

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Citron watermelon (*Citrullus amarus*), an underutilised cucurbit crop rich in essential nutrients and phytochemicals, possesses natural adaptations to various abiotic stressors, including cold, drought, and heat. Hence, the objective of this study was to decipher the morpho-physiological responses and NUE of selected citron watermelon genotypes cultivated under low-nitrogen stress to identify superior germplasm for cultivation and breeding. Citron watermelon genotypes (i.e., WWM-Ranoto, WWM-16, WWM-58, and WWM-65) were evaluated under greenhouse (GH) and shade house (SH) environments using a Randomised Complete Block Design with three replications. Two nitrogen levels, i.e., low nitrogen (LN) and optimum nitrogen (ON), were tested. Traits data collected were: [(fruit length (*FL*), fruit diameter (*FD*), nitrogen use efficiency (*NUE*) and fruit weight (*FW*)) and physiological traits (i.e., photosynthetic rate (*A*), intercellular CO₂ concentration (*C_i*) and photochemical quenching (*qP*)). Analysis of variance revealed that genotype-by-nitrogen interaction effects were non-significant for most traits; NUE for test genotypes was higher in LN conditions compared to ON conditions. Pearson's correlation analysis revealed strong positive relationships, suggesting potential associations among traits, for *FW* with *NUE* ($r = 0.99$) under LN conditions in the GH environment. In the SH environment, LN, strong positive associations were observed for *FW* with *C_i* ($r = 0.99$) and for *FD* with *qP* ($r = 0.98$). Genotype-trait association using PCA biplot revealed genotypes WWM-58 and WWM-16 maintained higher fruit yield, NUE, and physiological functioning under LN conditions. The results suggest that it has potential suitability for production under low-input systems and as a candidate for further evaluation in breeding programmes. This reflects that citron watermelon is suitable for production under low-input systems or for breeding programmes under nitrogen stress.

Keywords: Citron watermelon; *Citrullus amarus*; nitrogen stress; morpho-physiology; nitrogen use efficiency; photochemistry

AEES-O-5

Detailed Bedrock Morphology and Structural Geology Controls on Diamond Traps Offshore Hottentot's Bay, Southern Namibia

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The world's largest diamond placer deposit occurs along the coast of Namibia, significantly contributing to the blue economy of southern Africa. Offshore Hottentot's Bay, an inner continental shelf occurs with outcrops of the Gariep Belt and the Namaqua-Natal Metamorphic Complex. Deformation produced a structurally complex morphological pattern that controls the distribution and accommodation of overlying diamondiferous gravel beds that were eroded from kimberlite pipes and deposited through density settling. However, the precise relationship between the underlying bedrock structures and diamond concentration is poorly understood, and this project aims to rigorously test this relationship using machine learning techniques.

Bedrock structures were manually digitised using ArcGIS Pro, where they were classified into primary and secondary lineaments. Three sets of secondary lineaments were identified from rose diagrams that were produced using Python version 3.13. Structural analyses revealed five deformation events recorded in the region. During D₁, N-S trending primary lineaments developed due to NW-SE directed shortening and greenschist facies metamorphism. D₂ involved sinistral transpression that occurred during the SE-directed, oblique collision between the Gariep Belt and the Namaqua-Natal Metamorphic Complex, which produced a NNW-SSE to N-S trending thrust zone between these terranes that is associated with intense deformation and folding. East-west compression during D₂ produced a series of N-S oriented ridges, revealing a fold-and-thrust style system. A second phase of sinistral transpression (D₃) invoked the development of WNW-ESE trending sinistral faults that displace ridges and were reactivated by dextral faulting that preserved Riedel shear patterns, indicating a NNW-SSE direction of maximum compression. D₄ involved the development of NNW-SSE dextral faults that offset older sinistral faults and promoted dextral shearing, clockwise lateral drag and block rotation. The final event (D₅) resulted in E-W trending dextral faults and dip-slip faulting associated with crustal relaxation. The offshore analysis further revealed key insights into the geometry of Gondwana reconstructions, which were previously limited to onshore exposures that do not define the true extent of the Gariep Belt.

A detailed prospectivity pattern was modelled by coupling structural data and geological distributions, obtained from >8000 boreholes at a 50 m x 50 m grid, which revealed structural zones with the highest diamond concentration, a first for southern African offshore placer resource estimation. The effects of longshore drift, density, structural orientation and deformation intensity contributed to the accumulation of alluvial stones, revealing prospective areas for future drilling.

AEES-O-6

Catena-scale hydrological controls on peat decomposition and carbon stock vulnerability in the Nkandla peatlands, KwaZulu-Natal: A landscape-scale assessment.

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Peatlands store large quantities of soil organic carbon relative to their spatial extent. Yet, African peatlands remain poorly quantified, especially at sub-catchment scale where different decomposition pathways are driven by hydrological heterogeneity. This study integrated catena-scale soil profile characterisation with a systematic peatland depth survey (54 measurement points) to quantify carbon stocks and identify climate-vulnerable zones within the Nkandla (Equden) upland peatland (~16.5 ha), KwaZulu-Natal, South Africa. Water table depth, pH, and redox potential (Eh) were determined at nine sampling points along a downslope, middleslope and upslope (DS, MS and UPS) catena transect over six hydrological phases over the 2025/26 wet-dry transition; early wet season (12 November 2025); peak wet season (19 January 2026); late wet season (25 February 2026), early dry season (15 April 2026); peak dry season (29 May) and Late dry season (1 August 2026). Bulk density and Von Post humification index were determined upon first sampling date. Humification was most advanced at the upslope position (Von Post H9; sapric), where no water seepage was recorded in any campaign, relative to hemic material at the downslope (H4) and middleslope (H5) positions. BD increased with depth at all catena positions, consistent with a transition from organic-dominated surface horizons to more consolidated subsurface material; the downslope position exhibited the greatest range and steepest depth gradient in BD (0.28-1.16 g cm⁻³), middleslope was intermediate (0.36-1.06 g cm⁻³), and upslope showed the narrowest range (0.40-0.84 g cm⁻³).

During the wet season, downslope sites remained fully saturated, but water tables declined by up to 77 cm during the dry season and were accompanied by higher Eh values, indicating increasingly oxidising conditions. A similar pattern was observed at the midslope position before monitoring ended. Peat depth ranged from 15 to 100 cm (mean = 45 cm), with the deepest deposits concentrated in the central and eastern parts of the peatland. Estimated SOC stocks averaged 273, 338 and 304 Mg C ha⁻² at the downslope, midslope and upslope positions, respectively. The pronounced seasonal decline in water table depth at the downslope and midslope positions occurred in areas containing the largest carbon stocks, suggesting that these carbon-rich sections of the peatland are becoming increasingly exposed to aerobic conditions during the dry season. Continued seasonal drying may therefore accelerate peat decomposition and carbon loss unless hydrological conditions are maintained. These findings demonstrate that hydrological variability within a single peatland strongly influences peat decomposition and carbon storage, highlighting the importance of protecting water regimes to maintain peatland carbon stocks under a changing climate.

Keywords: Soil organic carbon; hydrological heterogeneity; catena hydrology; peat humification; bulk density; water table depth; carbon mineralisation; climate change.

AEES-O-7

SOCIO-ECONOMIC FACTORS AND CROPPING SYSTEMS IN PROVITAMIN A BIOFORTIFIED YELLOW MAIZE (*ZEA MAYS* L.) PRODUCTION IN KWAZULU-NATAL, SOUTH AFRICA

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Provitamin A-biofortified yellow maize (PVABYM) is a critical food and nutrition security crop in sub-Saharan Africa (SSA) including South Africa. However, smallholder productivity remains a challenge in KwaZulu-Natal (KZN). A study was conducted to characterise the socio-economic status and cropping systems of PVABYM cultivation, and to identify constraints and opportunities for sustainable production among smallholders. Using a participatory rural appraisal (PRA) approach, data were collected from 145 smallholder farmers across three distinct regions: uMsunduzi, Makhathini, and Ndumo. Data collection instruments included structured surveys, focus group discussions and direct field observations.

Women constituted 55% of the respondent PVABYM farmers. White maize, PVABYM, cabbage, spinach, and potatoes were ranked as the primary crops cultivated across study sites. Approximately 67% of the farmers practiced crop rotation across the studied regions. Most smallholders (55%) achieved yields exceeding 1 t ha⁻¹. High yield (37%), disease and pest tolerance (14%), sweet taste (12%), drought tolerance (10%), marketability (8%), and uniformity (7%) were identified as the most preferred maize ideotype attributes by the respondents. Conversely, diseases and pests (53%), limited access to propagating material (21%), inadequate agricultural extension services (10%), high costs of organic manure (9%), and poor market access were identified as the primary constraints to cultivation. Most farmers (73%) utilized inorganic fertilizers as their primary source of plant nutrients, demonstrating a high reliance on synthetic inputs across the study regions.

The study recommends enhancing smallholder access to certified seed, agricultural extension services, and formal markets, alongside deliberate strategies for women's empowerment. Furthermore, raising awareness regarding the nutritional benefits of PVABYM, enhancing rural irrigation infrastructure, and strengthening agricultural policies are emphasized as vital steps to improve maize production and climate resilience in KZN.

Keywords: Participatory rural appraisal; Provitamin A-biofortified yellow maize; Smallholder farmers; Food and nutrition security; Crop production constraints.

AEES-O-8

Conservation Boundaries, Rangeland Livelihoods and Human–Wildlife Conflict: Community Experiences from Hluhluwe-iMfolozi Park and Somkhanda Game Reserve, South Africa

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Protected areas and community conservation initiatives are increasingly expected to conserve biodiversity while supporting the livelihoods of rural communities dependent on land, livestock and natural resources. However, the expansion and management of conservation areas may generate competition over rangeland resources and intensify human–wildlife conflict. This study comparatively examines community experiences of human–wildlife conflict and conservation-related livelihood impacts among communities adjacent to Hluhluwe-iMfolozi Park (HiP), a state-managed protected area, and Somkhanda Game Reserve (SGR), a community-owned conservation area, in KwaZulu-Natal, South Africa. A sequential explanatory mixed-methods approach was employed,

involving household surveys with 300 households, supplemented by key informant interviews, focus group discussions and field observations. The findings demonstrate that communities surrounding both conservation areas experience a complex interaction between biodiversity conservation and rural livelihood security. Crop and property damage caused by wildlife was significantly more prevalent among households adjacent to HiP than SGR ($p < 0.001$). Competition with wildlife for water and grazing resources was also significantly higher around HiP (35.3%) than SGR (14.7%; $p < 0.001$), highlighting the importance of access to rangeland resources in shaping conservation-related livelihood vulnerability. Although SGR communities reported stronger access to certain community-based conservation benefits, poverty, inadequate conservation incentives and limited participation in decision-making were identified as important drivers of poaching and illegal encroachment. The findings suggest that conservation boundaries can create contested spaces where biodiversity objectives intersect with livestock production, grazing access and rural livelihood needs. Sustainable coexistence, therefore, requires participatory rangeland governance, equitable benefit-sharing, improved management of problem animals and greater recognition of local knowledge and livelihood practices. The study concludes that integrating pastoralist and livestock-dependent communities into conservation planning is essential for building resilient rangeland systems and achieving socially just biodiversity conservation.

Keywords: human–wildlife conflict; rangelands; community conservation; protected areas; livelihoods;

AEES-O-9

UNEQUAL BURDENS: HOW SOCIO-DEMOGRAPHIC VARIABLES SHAPE THE ENVIRONMENTAL, HEALTH, AND SOCIO-ECONOMIC EFFECTS OF ILLEGAL WASTE DUMPING

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Illegal waste dumping (IWD) remains a major challenge for many developing municipalities, contributing to environmental degradation, public health risks, and socio-economic burdens. This study aimed to assess the environmental, health, and socio-economic impacts of IWD and to examine how socio-demographic variables (gender, education, age, and income) influence perceived impacts. Primary data were collected through a quantitative survey of 381 participants from the Thabazimbi Local Municipality. The Mann–Whitney test was used to compare perceived IWD impacts between gender groups, and the Kruskal–Wallis test was used to compare perceived IWD impacts across education, age, and income groups. The findings revealed strong community agreement (>80%) on the environmental, health, and socio-economic impacts of IWD, indicating that it is a widespread and shared challenge across the municipality. Statistical analysis further showed significant differences in perceptions of the environmental and socio-economic impacts of IWD among income and education groups ($p < 0.05$). However, these differences were relatively small across the impact statements. After applying the Bonferroni correction, significant differences remained only among the four income groups, whereas no statistically significant differences were observed among the educational groups ($p >$

0.05). This suggests that income level may have a greater influence on perceptions of IWD impacts than educational attainment. The study provides valuable insights by integrating social, environmental, and governance considerations. By doing so, municipalities can develop more sustainable waste management systems that reduce IWD and support broader sustainability objectives, including environmental protection, public health improvement, and socio-economic development.

Keywords: illegal waste dumping; environmental impacts; health impacts; socio-economic impacts; socio-demographic variable

AEES-O-10

Integrating Mixed Models and Multi-Trait Indices to Improve Selection for Drought Tolerance in African Spider Plant (*Gynandropsis gynandra*)

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Drought tolerance is a critical breeding target for the African Spider Plant, yet its complex genetic basis requires integrative approaches that balance accuracy and efficiency in selection. In this study, 18 Spider plant genotypes were evaluated under greenhouse conditions across two seasons, under both drought stress and optimum water regimes. To identify superior genotypes, we compared the performance of aggregate selection indices, the multi-trait genotype-ideotype distance index (MGIDI), and mixed-model approaches based on best linear unbiased estimators (BLUE) and predictors (BLUP). The indices incorporated yield-related, physiological, and morphological traits associated with drought adaptation. Results revealed that MGIDI provided a balanced multi-trait assessment, effectively discriminating genotypes with consistent performance across environments. BLUPs captured genetic variance more efficiently than BLUEs, enhancing prediction accuracy under stress conditions. Aggregate indices, while useful, tended to overemphasize single-trait contributions, limiting their robustness under variable water regimes. Overall, the integration of MGIDI with BLUPs offered the most reliable framework for selecting drought-tolerant genotypes, combining statistical rigor with biological relevance. These findings highlight the value of multi-trait and mixed-model approaches in accelerating genetic improvement of Spider plant for resilience under climate-induced water limitations.

AEES-O-11

EFFECT OF DIFFERENT WATER REGIMES AND POTASSIUM FERTILISATION ON TUBER QUALITY AND BIOACTIVE COMPOUNDS IN THREE POTATO CULTIVARS

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Studies investigating water stress on potatoes have largely focused on bioactive compounds at the leaf level, primarily within the framework of osmotic adjustment, while their contribution to tubers remains relatively underexplored. This study investigated the combined effects of irrigation regimes and potassium fertilisation on quality attributes and bioactive compounds of three potato cultivars.

The experiment was conducted in a tunnel using a split-split plot design within a completely randomised design. Treatments included three irrigation regimes (40%, 70%, and 100% of crop evapotranspiration, ET_c) and four potassium fertilisation levels (0, 100, 150, and 200 kg K ha⁻¹). Three potato cultivars, including 'Mondial', 'Markies', and 'Panamera' were used for evaluations since they are among the widely cultivated and commercially marketed potato cultivars in South Africa. Irrigation regimes were assigned to main plots, potassium levels to subplots, and cultivars to sub-subplots. Key response variables included dry matter content, soluble sugars, total phenolic content, and ascorbic acid.

Results showed that dry matter content was significantly affected by both irrigation and cultivar, with higher values observed under deficit irrigation. Furthermore, sucrose concentration was influenced by both irrigation regime and potassium fertilisation, while glucose and fructose were primarily governed by cultivar. Moreover, total phenolic content was significantly ($p < 0.01$) higher under full irrigation (100% ET_c) with 0.15 mg of gallic acid equivalent (GAE) g⁻¹ DW (dry weight) compared to moderate (70% ET_c) and deficit (40% ET_c) irrigation, which accumulated 0.118 mg and 0.113 mg of GAE g⁻¹ DW, respectively. On the other hand, ascorbic acid content increased under deficit irrigation by 5 and 17 % under 40 and 70 ET_c, respectively, compared to full irrigation (0.41 mg GAE g⁻¹).

Overall, the findings demonstrate the complex interaction between irrigation, potassium fertilisation, and cultivar in determining potato tuber composition and quality, with important implications for optimising production under water-limited conditions.

AEES-O-12

Spatiotemporal Dynamics of Vegetation Cover and Land Surface Temperatures from Landsat 8 (2015–2025)

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Anthropogenic land-use changes have transformed natural landscapes into barren and impervious surfaces, leading to elevated land surface temperatures that strain public health, increase cooling energy demands, and undermine rural-urban sustainability. Vegetation cover plays a critical role in mitigating urban heat by acting as local thermal buffers through mechanisms such as evapotranspiration and shading. Using the Landsat 8 satellite archive, this study assesses the spatiotemporal relationship between changes in vegetation coverage and LSTs in the Ugu District Municipality over a ten-year period (2015–2025). Landsat 8 optical and thermal bands were processed in Google Earth Engine to

generate vegetation cover and land surface temperature maps. Supervised classification using the Random Forest algorithm, trained on reference samples from satellite imagery and field data, distinguished four land cover classes (vegetation, built-up, bare soil, and water), achieving overall accuracies between 82.02% and 84.11%. LST values were classified as low (7 to 18 °C), moderate (18 to 28 °C) and high (28 to 39°C). This enabled the quantification of vegetation loss and associated thermal patterns. Results indicate a substantial decline in vegetation cover, with approximately 25 387 ha (5.3%) lost during the study period. Concurrently, built-up areas expanded by 7 520.3 ha (1.57%), while 21 938.2 ha (4.58%) of the study area transitioned from vegetation into bare soil, further contributing to vegetation depletion. Compatibly, areas characterized by high LSTs increased by 12 590 ha (27.93%), while low-temperature zones decreased by 2 859 ha (3.23%). A linear regression analysis revealed moderate inverse relationships between NDVI and LSTs, with correlation coefficients of -0.64 (2015), -0.66 (2020), and -0.63 (2025). Reductions in vegetation cover were consistently associated with rising surface temperatures across rural and urban areas, underscoring the role of greenery in regulating thermal environments and highlighting the need to preserve and expand green infrastructure to mitigate heat stress and strengthen climate resilience.

Keywords: Vegetation Cover, Land Surface Temperatures (LST), Landsat 8, LULC change, climate resilience, heat stress.

ORAL ABSTRACTS

BIOCHEMISTRY & CHEMISTRY

BCC-O-1

GREEN SYNTHESIS OF SELENIUM NANOPARTICLES FROM *Ocimum* LEAF: CHARACTERIZATION, ANTIOXIDANT, ANTIBACTERIAL, AND CYTOTOXICITY PROPERTIES

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The development of nanosized particles has been an exciting area of research, and their applications are rapidly growing in drug delivery, aesthetics, tissue engineering and agriculture. *Ocimum* is an aromatic medicinal plant that is widely distributed and has been employed in the synthesis of nanoparticles. The SeNPs were characterized using UV-visible spectroscopy, scanning electron microscopy, energy-dispersive X-ray, high-resolution transmission electron microscopy, nanoparticle tracking analysis, and Fourier transform infrared spectroscopy analysis. Total phenolic content was determined. Antioxidant activity was conducted using DPPH and FRAP assays. Antibacterial activity was performed against four bacterial strains using the agar well diffusion method. *In vitro* cytotoxicity was determined using 3-(3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide (MTT) assay against human embryonic kidney (HEK293) and colorectal adenocarcinoma (CACO). The findings confirmed the synthesis of SeNPs at the absorption peak between 517 – 523 nm using UV-vis spectroscopy. Synthesized SeNPs were spherical and irregular in shape and partly agglomerated. EDX analysis confirmed the presence of Selenium peaks at 1.3 keV, 11.25 keV and 12.50 keV with the highest and lowest percentages displayed in OAC-SeNPs (4.09%) and OAA-SeNPs (0.56%) respectively. NTA analysis showed larger size SeNPs compared to HRTEM. The OAA-SeNPs (157.8 ± 1.4 nm) had the largest size, followed by OAC-SeNPs (146.7 ± 1.8 nm) and OAM-SeNPs (119.5 ± 7.7 nm). The zeta potential for all the SeNPs was negatively charged, OAC-SeNPs (-54.3 ± 0.1 mV), OAM-SeNPs (-48.4 ± 0.1) and OAA-SeNPs (-12.7 ± 0.1 mV). FTIR analysis confirmed that functional groups in bioactive compounds, such as phenol, amine, alkaloid, alkane and carboxylic acid effectively capped and stabilized SeNPs. The highest total phenolic content was found in OAM-SeNPs (18.13 ± 0.56 mg GAE/g DW), followed by aqueous (13.27 ± 0.32) while OTC-SeNPs (7.95 ± 0.14 mg GAE/g DW) had the lowest. However, the OAM-SeNPs exhibited the highest antioxidant activity while the OAA-SeNPs had the lowest antioxidant activity. At 200 mg/mL, all SeNPs displayed antibacterial activity against SA, MRSA and EC, whereas PA was resistant to all synthesized SeNPs. The SeNPs exhibited considerable cytotoxic activity against CACO and HEK293 cell lines. The findings from the present study showed that the particle size, zeta potential and functional groups contributed to the medicinal properties exhibited by OA-SeNPs. Therefore, OA-SeNPs can be considered an alternative to chemically synthesized medicines for antioxidant, antibacterial and anticancer activities.

BCC-O-2

SELENIUM-INTEGRATED IRON OXIDE NANOCOMPOSITES: STRUCTURAL FEATURES AND CYTOTOXICITY IN CANCER CELLS

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Selenium (Se), an essential micronutrient, exhibits bimodal redox properties, making it a promising candidate for cancer therapeutics. Its anticarcinogenic potential can be amplified by doping iron oxide nanoparticles (IONPs), thereby enhancing the generation of reactive oxygen species (ROS) via the Fenton pathway and promoting ferroptosis in cancer cells while maintaining biocompatibility in healthy cells. IONPs offer additional advantages, including magnetic targeting, enhanced biocompatibility, and the ability to absorb heavy metals. In this study, selenium-doped IONPs (Se-IONPs) were synthesized using a hydrothermal method with two selenium precursors: selenium dioxide (SeO_2) and selenium tetrachloride (SeCl_4). SeO_2 produced hematite-based nanoclusters ($\text{Se}-\alpha\text{-Fe}_2\text{O}_3$) with primary particle sizes of ~ 3 nm, aggregating into clusters of ~ 202 nm, while SeCl_4 yielded maghemite-based nanoclusters ($\text{Se}-\gamma\text{-Fe}_2\text{O}_3$) with a similar primary size but smaller clusters (~ 196 nm), which were reduced by $>50\%$ following ethanol and water washing. Although bare nanoclusters lacked DNA-binding capability, they demonstrated strong antioxidant activity ($>70\%$), which decreased at higher concentrations, indicating prooxidant behaviour. Cytotoxicity assays revealed high biocompatibility in HEK293 cells ($>60\%$ viability). Conversely, Se-IONPs exhibited potent anticancer activity against MDA-MB-231 and Caco-2 cell lines, reducing viability to $\sim 10\%$ and $\sim 20\%$, respectively. These findings suggest that Se-IONPs possess significant therapeutic potential for oncological applications, with further optimization required for gene delivery and neurological studies.

BCC-O-3

Design, Synthesis, *in Vitro*, and *in Silico* Studies of Rhodanine-Isoniazid Molecular Hybrids

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Tuberculosis (TB) is an infectious disease, caused by *mycobacterium tuberculosis* (*Mtb*), that is responsible for millions of deaths annually. The emergence of drug-resistant strains of TB has resulted in the need for the development of new TB drugs.¹

Isoniazid (INH) is one of the best first-line prodrugs for treating TB, there are also various reports on the molecular hybridisation of INH to improve its potency and overcome associated resistances. Rhodanine (Rh) is also reported to have anti-TB properties,³ as such

this work focuses on the synthesis, biological testing, and computational studies of some Rh-INH hybrids.

5-benzylidene-2-thioxothiazolidin-4-ones (**3a-t**) were prepared via the condensation of substituted aromatic aldehydes with Rh in sodium acetate and acetic acid. The compounds were then S-methylated using methyl iodide, triethylamine and DCM. Thereafter they were hybridised with INH in ethanol to form the Rh-INH molecular hybrids (**9a-t**).

Three compounds displayed the most potent *Mtb* activity with MIC values of 1.56 µg/ml (**9d**), 12.50 µg/ml (**9j**), and 12.50 µg/ml (**9n**). However, limited efficacy was observed against INH-resistant *Mtb* strains harbouring mutations in KatG while strains overexpressing the enoyl acyl carrier protein reductase (InhA) exhibited significant resistance — suggesting InhA as their likely target.

Molecular docking studies showed the binding modes and key intermolecular interactions closely resembled those of INH, a known inhibitor of InhA. ADME/T analysis indicated favourable pharmacokinetic and safety profiles for the hybrids.

The study underscores the potential of Rh-INH hybrids as promising leads for the development of new anti-TB agents. Further structural optimization could lead to the identification of potent lead compounds with improved therapeutic profiles.

1. KL. Chin et al., *Curr Res Microb Sci*, 2024, **7**, 100295.
2. S. Sreelatha, U. Nagarajan, and S. Natarajan, *Int. J. Biol. Macromol*, 2023, 125022.
3. S. Cheng et al., *Eur. J. Med. Chem*, 2023, **258**, 115571.

BCC-O-4

COMPARISON OF GRAPHITIC CARBON NITRIDE SYNTHESISED FROM MELAMINE AND UREA FOR THE ELECTROCHEMICAL DETECTION OF CIPROFLOXACIN

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South Africa, ranked second globally for antibiotic consumption in 2022, faces significant negative environmental impacts from the release of these pharmaceuticals into aquatic systems. Antibiotic contamination is primarily driven by incomplete metabolism in humans and animals, leading to its excretion via urine and faeces, as well as inadequate wastewater treatment and improper disposal from healthcare facilities and the pharmaceutical industry. Conventional analytical techniques, such as high-performance liquid chromatography, and gas chromatography, are widely used for the detection and quantification of pharmaceuticals; however, these methods are often costly, time-consuming, and unsuitable for rapid in situ monitoring. Therefore, there is a growing need for simple, cost-effective, and sensitive detection approaches. Electrochemical sensing presents a promising alternative due to its rapid response, ease of operation, and high sensitivity. In this study, graphitic carbon nitride (g-C₃N₄) synthesised from melamine (M-

GCN) and urea (U-GCN) via thermal polymerisation was used to modify glassy carbon electrodes (GCE) for the detection of ciprofloxacin in aqueous systems (Figure 1). The synthesised materials were characterised by means of Fourier transform infrared spectroscopy, X-ray diffraction, cyclic voltammetry, and electrochemical impedance spectroscopy to evaluate their physicochemical and electrochemical properties. The modified electrodes were fabricated by drop-casting and applied for the electrochemical detection of ciprofloxacin in wastewater. Differential pulse voltammetry showed that U-GCN/GCE exhibited higher peak currents than M-GCN/GCE. Ciprofloxacin oxidation occurred optimally at pH 4 in Britton–Robinson buffer and followed an irreversible, adsorption-controlled process. The limits of detection and quantification for M-GCN/GCE were 1.060 μM and 3.533 μM , respectively, whereas U-GCN/GCE exhibited lower values of 0.6549 μM and 2.183 μM , respectively. These findings indicate that U-GCN/GCE demonstrates superior sensitivity and holds strong potential for the electrochemical detection of ciprofloxacin in environmental monitoring applications.

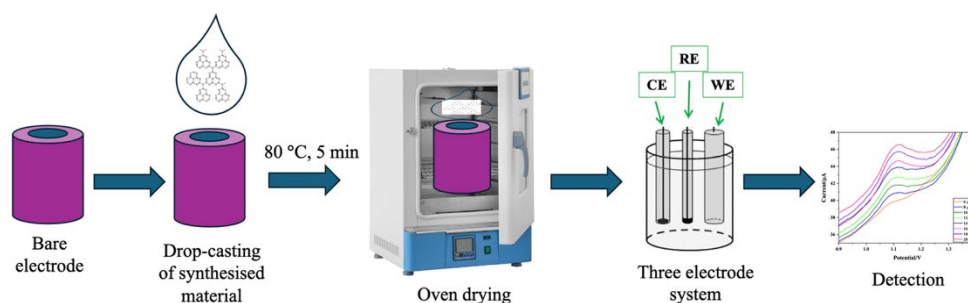


Figure 1: Preparation of the modified electrode.

BCC-O-5

CONVERSION OF COAL FLY ASH TO ZEOLITE FOR ADSORPTION OF DIFFERENT PHARMACEUTICAL CONTAMINANTS FROM WATER: ISOTHERMS, KINETICS, REGENERATION AND LEACHING ASSESSMENT

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The adsorption approach is considered the most effective and widely used method for removing pharmaceutical contaminants from water matrices. As adsorbents, zeolites have excellent adsorption capacity and reduced environmental impact. The zeolite adsorbent used in this work was synthesised from coal fly ash, an industrial by-product that is produced by coal power stations. Given the urgent need to reduce the environmental impact of coal fly ash disposal, it was used as a precursor for zeolite synthesis, transforming it into a valuable material for water remediation as part of the circular economy. The zeolite synthesis was performed using the hydrothermal method and characterised using Fourier Transform Infrared Spectroscopy, Scanning Electron Microscopy, Transmission Electron Microscopy,

Thermal Gravimetric Analysis, X-ray diffraction and the point of zero charge. The factors influencing the adsorption of trimethoprim, dolutegravir and ibuprofen were investigated. The effects of adsorbent dosage, contact time, sample pH, and initial concentration were investigated, and optimal removal efficiencies were obtained at 30 mg, 30 minutes, pH 7, and an initial concentration of 1 mg/L. The developed method was then validated for linearity, with a correlation coefficient above 0.95; removal efficiencies were above 85%; the relative standard deviation was below 5%; and the limits of detection and quantification were between 0.22 and 0.4 $\mu\text{g.L}^{-1}$ and 0.74 and 1.34 $\mu\text{g.L}^{-1}$, respectively. Application to real samples showed that ibuprofen was detected and removed, reaching 99%, while dolutegravir was detected the least. The adsorption models were also performed in order to understand the adsorption mechanisms and it was found that the adsorption data was conforming to Pseudo second order (1.09×10^{-5} - 1.34×10^{-4}) due to smaller chi-square values (χ^2) than those obtained from pseudo first order (2.76×10^{-5} - 3.16×10^{-4}), R^2 values (0.94-0.98) being higher than those obtained from pseudo first order (0.61-0.76), and experimental adsorption capacities (0.27-0.32 mg/g) being more comparable to those calculated from the pseudo second order model (0.28-0.32 mg/g) than those from pseudo first order model (0.24-0.31 mg/g). This suggested that the adsorption mechanism was chemisorption. The adsorption data also conformed to the Freundlich isotherm due to higher R^2 values (0.94-0.95) obtained compared to those obtained from the Langmuir isotherm (0.46-0.82), and the chi-square values (χ^2) for the Freundlich model were smaller (5.25×10^{-5} - 3.80×10^{-2}) than those obtained from the Langmuir model (6.96×10^{-3} - 9.18×10^{-2}), which showed accuracy for the Freundlich model. The reusability studies on the zeolite showed that it can be used for cycles exceeding 5. Overall, this study revealed that the zeolite synthesised from coal fly ash offers a cost-effective and sustainable alternative for removing pharmaceutical contaminants from water. This study supports circular economy principles, sustainable waste valorisation, cleaner water, improved public health, and resource reuse.

BCC-O-6

Electrospun nanofiber conjugates encompassing ruthenium benz(imidazole/othiazole) compounds: Nanofabrication, characterization, drug-release profiles, and time-dependent anticancer studies

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Cytotoxic mono- and bis-heterocyclic ruthenium(II) and -(III) compounds: cis-[RuII(Cl)(PPh₃)₂(ombb)](PF₆) (1) (ombb = 2,2'-[oxy-bis(methylene)]-bis-(1H-benzimidazole)), trans-[RuII(Cl)₂(PPh₃)₂(bbb)] (2) (bbb = 4,4'-bis(1H-benzimidazol-2-yl)-2,2'-bipyridine), [RuCl(Hobz)₂(PPh₃)]Cl (3) (Hobz = 2-hydroxyphenylbenzimidazole) and [RuIII(Cl)(obs)₂(PPh₃)] (4) (Hobs = 2-hydroxyphenylbenzothiazole) were imbedded into biodegradable polyvinylalcohol-chitosan (PVA-CS) electrospun nanofibers (ENFs). The stabilities of the respective metal compounds were investigated in DMSO and an aqueous buffer at physiological temperature. Inclusion of the respective metal compounds into the polymeric ENF matrix was confirmed by powder X-ray diffraction (XRD), Scanning Electron Microscopy in combination with Energy Dispersive X-ray spectroscopy (SEM-EDX), Fourier Transform

Infrared (FTIR) spectroscopy, and Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES). Differential Scanning Calorimetry (DSC) and Thermogravimetric Analysis (TGA) studies showed that incorporating the inorganic components into the polymeric ENFs altered their thermal stability profiles. Time-dependent electronic spectrophotometric studies revealed that the metal-based drug release efficiencies are pH-dependent and dictated by the hydration capacities of the ENF polymeric host. The inorganic nanocomposites were subjected to antioxidant studies, which corroborate the gradual release of the metal complexes.

Meticulously designed organoruthenium complexes can be promising alternatives as target-specific chemotherapy agents for GI cancers.[1] Among the recent design strategies is the "directed therapy" drug design approach, which places special emphasis on enhancing the selectivity and efficacy of a candidate ruthenium drug.[2] This approach involves the chemical attachment of ruthenium to various biologically active organic groups with known biological targets, directing the drugs to cancerous cells and thereby increasing cytotoxicity.[3] In fact, benzothiazole and benzimidazole groups have acted as pharmacophores in various established medicinal drugs, and their high stability in acidic media, as well as their high degrees of cell membrane permeability, make them ideal synthons for developing orally administered drugs. Furthermore, the utilisation of biodegradable electrospun nanofibers as drug delivery systems is emerging across various medicinal applications, as alterations to the polymer and electrospinning parameters can fine-tune the pharmacokinetic profiles of drugs. [4, 5] ENF blend of CS and PVA is used in this research study as a nano-drug carrier for the respective due to their optimal biocompatibility, electron spinnability.[6, 7]

References

- [1] M. Martínez-Alonso, G. Gasser, *Coordination Chemistry Reviews*, 434 (2021) 213736.
- [2] S. Vasaikar, P. Bhatia, P.G. Bhatia, K. Chu Yaiw, *Biomedicines*, 4 (2016).
- [3] W.M. Motswainyana, P.A. Ajibade, *Advances in Chemistry*, 2015 (2015) 859730.
- [4] A. Luraghi, F. Peri, L. Moroni, *Journal of Controlled Release*, 334 (2021) 463-484.
- [5] C. Cleeton, A. Keirouz, X. Chen, N. Radacsi, *ACS Biomaterials Science & Engineering*, 5 (2019) 4183-4205.
- [6] S. Farhaj, B.R. Conway, M.U. Ghor, *Fibers*, 11 (2023) 21.
- [7] E.J. Torres-Martínez, J.M. Cornejo Bravo, A. Serrano Medina, G.L. Pérez González, L.J. Villarreal Gómez, *Current drug delivery*, 15 (2018) 1360-1374.

BCC-O-7

Oxidative Synthesis of 2,4,5-Trisubstituted Imidazoles Commencing from Methylarenes using Cobalt/NHPI in HFIP

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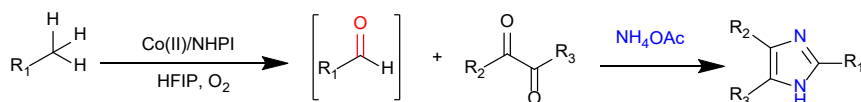
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Imidazoles are an important moiety present in various naturally occurring compounds and pharmacologically active drugs. Particularly, 2,4,5-trisubstituted imidazoles have been shown to display various biological activities such as antimalaria, antidiabetic, and antitubercular, to name a few [1]. The traditional methods documented for the preparation of imidazoles involves the cyclocondensation of aldehydes, 1,2-diketones and ammonia to furnish the desired trisubstituted imidazoles. However, many benzaldehyde derivatives are prone to autooxidation upon exposure to atmospheric oxygen, hence are converted to their corresponding acids and necessitating rigorous purification or specialized storage [2]. Additionally, benzaldehydes featuring complex substitution patterns are often expensive or requires multi-step *de novo* synthesis. Thus, there is a need for the development of synthetic approach commencing from simple, abundant and stable substrates. Methylarenes represents a superior class of chemical feedstocks due to their inherent chemical stability, low-cost and high availability. Therefore, they are used as potential substitutes of aldehydes upon oxidation [3]. To the best of our knowledge, synthesis of 2,4,5-trisubstituted imidazoles commencing from methylarenes has not been documented.

In this study, 2,4,5-trisubstituted imidazoles were prepared from methylarenes using cobalt/NHPI in HFIP. The first step involved the oxidation of methylarenes to generate the aldehydes *in-situ* followed by the cyclocondensation reaction between 1,2-diketones, aldehydes and ammonium acetate in one-pot furnishing the desired trisubstituted imidazoles (**Scheme 1**). The imidazoles were obtained in good to excellent yields. This presentation will highlight the substrate scope limitations and rationale of the mechanism.



Scheme 1: Synthesis of 2,4,5-trisubstituted imidazoles from methylarenes.

[1] A. Kumar, *Asian. J. Res. Chem.*, 2024, **17**, 368 - 376.

[2] M. S. H. Salem, C. Dubois, Y. Takamura, A. Kitajima, T. Kawai, S. Takizawa, and M. Kirihaara, *Green Chem.*, 2024, **26**, 375 – 383.

[3] C. Huang and H.-C Xu, *Angew. Chem. Int. Ed*, 2025, **64**, e202504612.

BCC-O-8

Engineering a hybrid electron transport layer and biomass-derived carbon counter electrode for perovskite solar cells

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Currently, the majority of global electricity production relies on the combustion of fossil fuels such as coal, oil, and natural gas. These sources are not only non-renewable and finite but also significantly contribute to atmospheric pollution and global warming. As a sustainable alternative, perovskite solar cells (PSCs) have emerged as one of the most promising thin-film photovoltaic technologies, owing to their rapidly rising power conversion efficiencies, low-temperature solution processability, and tunable optoelectronic properties. A crucial element of a PSC is the electron transport layer (ETL), which extracts and conducts photogenerated electrons from the perovskite absorber to the front contact while blocking recombination at the interface. Titanium dioxide (TiO₂) remains the most widely employed ETL material in PSCs. However, the commercial deployment of PSCs is hindered by the high cost of noble-metal back electrodes and the moisture and thermal instability introduced by organic hole-transport materials. To address these limitations, this study proposes an n-i-p, with a hole-transport-layer-free architecture built around a hybrid TiO₂ nanowire-mesoporous (TNW-MP) ETL paired with a carbon counter electrode derived from coconut shell biomass (Cs-GB). The TNW-MP component is expected to improve electron extraction, while the biomass-derived carbon offers an alternative, low-cost replacement for gold and enhances thermal and moisture stability. Together, the two materials are expected to yield a device that is simultaneously more affordable and more durable, advancing PSCs toward viable commercialisation.

BCC-O-9

Polystyrene Nanoparticles as a Model for Environmental Studies: Synthesis, Characterization, Stability, Detection, and Quantification

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The number of remediation studies investigating the removal of nanoplastic particles (NPs) from aquatic environments using polystyrene nanoparticles (PSNPs) as model NPs is increasing. However, most studies rely on commercially available PSNPs, which are expensive and typically monodisperse with uniform physicochemical properties that do not accurately represent the heterogeneous NPs found in aquatic systems. This study developed cost-effective and reproducible emulsion polymerization protocols to synthesize polydisperse PSNPs as realistic model NPs. The synthesized PSNPs were characterized using FTIR, XRD, SEM-EDX, HRTEM, and point of zero charge (pH_{PZC}) analyses. The synthesized PSNPs exhibited a similar chemical structure and surface morphology to those of commercially available PSNPs. FTIR confirmed successful synthesis without chemical alteration, while XRD indicated an amorphous polymer structure. SEM and HRTEM revealed predominantly smooth, spherical nanoparticles with minimal aggregation and an average diameter of 35.5 ± 27.2 nm ($N = 130$), confirming the formation of polydisperse PSNPs. EDX analysis showed that the nanoparticles consisted mainly of carbon (92.36%) and oxygen (7.64%), with no detectable elemental impurities, and that the pH_{PZC} was 5.16. A UV-Vis spectrophotometric method was developed for PSNPs detection and quantification at 260 nm, producing excellent linearity ($R^2 = 0.9969$). Stability studies demonstrated that PSNP

dispersions retained more than 97% of their initial concentration after 5 days of storage at room temperature. Overall, this study provides a practical and economical method for producing environmentally relevant polydisperse PSNPs, offering a suitable model for NPs remediation studies, particularly fixed-bed column adsorption applications.

Keywords: Polystyrene nanoparticles (PSNPs); Synthesis of PSNPs; Characterization of PSNPs; Stability of PSNPs; Detection and Quantification of PSNPs; Environmental model PSNPs.

BCC-O-10

Effect of Zn and Zr on catalyst performance for methanol production from carbon dioxide

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Since the advent of industrialization, atmospheric CO₂ levels have surged from 280 ppm to approximately 400 ppm, thus contributing to a temperature increase from 0.4°C in 1850 to 0.7°C in 2019. Climate change associated with increased CO₂ emissions leads to physical, health, and ecological challenges intensified by anomalous weather occurrences [1]. These effects have prompted the scientific community to find ways of recycling and repurposing CO₂. Transforming CO₂ into value-added chemicals represents a promising strategy for achieving a sustainable carbon cycle.

Green hydrogen can be used to hydrogenate CO₂ and produce value-added compounds such as methanol. In this project, the first objective is the catalytic production of methanol with the purpose of converting it to dimethyl ether (DME) for hydrogen storage as the next stage. DME has a high hydrogen storage capacity (26.1 wt.%), making it an excellent choice for future energy systems. It is also appealing due to its non-toxic and non-carcinogenic properties, as well as its potential to replace liquefied petroleum gas (LPG). However, the inherent thermodynamic stability and kinetic inertness of CO₂ pose considerable challenges for its activation and conversion [2]. This project aims to synthesise a series of catalysts that can convert CO₂ to methanol. The catalytic systems are composed of Cu metal supported on a metal oxide such as CeO₂, which can be modified by the addition of elements such as Zn and Zr. It is proposed that the combination of metals will allow for the activation of CO₂ and subsequent conversion to methanol.

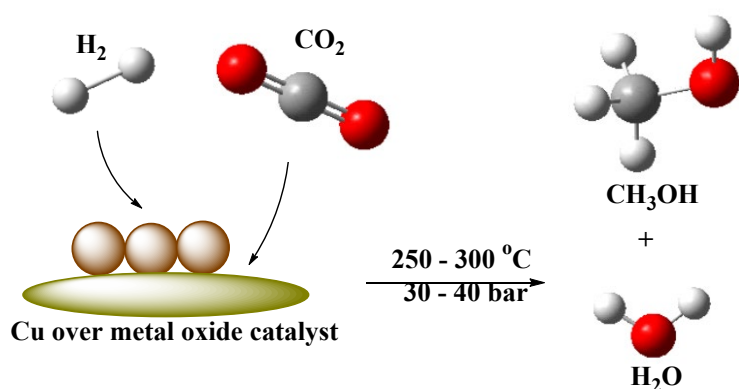


Figure 1: Catalytic conversion of CO₂ to methanol

References

- [1] Sabine, C. L.; Feely, R. A. CARBON DIOXIDE. In *Encyclopedia of Atmospheric Sciences*; Holton, J. R., Ed.; Academic Press: Oxford, **2003**; pp 335–343.
- [2] Catizzone, E.; Freda, C.; Braccio, G.; Frusteri, F.; Bonura, G. Dimethyl Ether as Circular Hydrogen Carrier: Catalytic Aspects of Hydrogenation/Dehydrogenation Steps. *J. Energy Chem.* **2021**, 58, 55–77.

BCC-O-11

Isolation and Characterization of Cannabis-Derived Extracellular Vesicles

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Chronic and non-healing wounds remain a significant global healthcare challenge due to prolonged inflammation, delayed tissue regeneration, and the increasing prevalence of antimicrobial resistance. Extracellular vesicles (EVs) have emerged as promising cell-free therapeutic agents because of their ability to mediate intercellular communication and promote tissue repair. While mammalian-derived EVs have been extensively investigated, plant-derived extracellular vesicles (PDEVs) have recently gained attention as biocompatible, cost-effective, and scalable alternatives. Cannabis is a medicinal plant rich in bioactive phytochemicals, including cannabinoids, terpenes, and flavonoids, which possess well-documented anti-inflammatory, antioxidant, and wound-healing properties. However, limited information is available regarding extracellular vesicles derived from this plant, and their potential therapeutic applications. This study aimed to isolate and characterize cannabis-derived extracellular vesicles (CDEVs) and evaluate their potential for wound healing applications. Cannabis-derived extracellular vesicles were isolated from cannabis plant material using polyethylene glycol (PEG)-based precipitation. Nanoparticle tracking analysis (NTA) revealed particles with a mean diameter of 168.9 ± 21.5 nm, and with an average concentration of 2.9×10^{10} particles/mL, indicating the successful isolation of abundant nanosized vesicles. Transmission electron microscopy (TEM) revealed membrane-bound cup-shaped structures, consistent with the characteristic morphology of extracellular vesicles. Protein quantification using the bicinchoninic acid (BCA) assay demonstrated that the isolated CDEVs contained an average protein concentration of 19.07 ± 2.02 µg/mL, confirming the presence of protein cargo associated with these vesicles. High-performance liquid chromatography coupled with tandem mass spectrometry (HPLC-MS/MS) detected several cannabinoids, including THCV (93.2 ± 39.0 µg/mL), CBG (2610.0 ± 191.6 µg/mL) and CBC (857.5 ± 221.1 µg/mL), demonstrating that bioactive phytocannabinoids were associated with the isolated vesicles. Collectively, these findings confirm the successful isolation and physicochemical characterization of CDEVs and support their potential as novel, naturally occurring nanocarriers. The biological activity of the isolated CDEVs is currently being evaluated using MTS cell proliferation and scratch wound migration assays to determine their cytocompatibility and wound-healing potential.

BCC-O-12

Isolation, characterization and cargo loading of mammalian extracellular vesicles

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Extracellular vesicles (EVs) are small, membrane-bound particles that are released to facilitate intercellular communication. EVs exist in both plant and animal kingdoms to carry bioactive molecules (cargo) to their target tissue [1]. Mammalian-derived EVs can be isolated from a range of biological fluids as well as cell-conditioned media [2]. Mammalian EVs are of interest as potential compound-delivery systems as they can be cargo-loaded to improve their delivery of specific compounds to target cells. EVs are believed to be a better alternative to synthetic nanocarriers since they can protect their cargo, have low immunogenicity and can cross the blood brain barrier. The current study seeks to find EV-based approaches to enhance the delivery of cargo to target cells. EVs were isolated from 3T3-L1 preadipocyte conditioned media using differential centrifugation and characterized using nanoparticle tracking analysis, transmission electron microscopy and the MTS assay. Isolated EVs had a median size of 138.4 nm, displaying the expected oval. Storage studies showed that EVs were stable at 4 °C for at least 10 days, and at room temperature for at least 7-day. MTS assay results indicated that the EVs were not cytotoxic to cells at concentrations ranging from 5×10^6 to 5×10^8 EV/mL. Finally, EV uptake assay results showed that EVs are taken up by 3T3-L1 cells after 22 h incubation. Cargo loading and delivery studies are currently underway. Both characterization studies and uptake assay show that 3T3-L1 EVs can be used as a potential delivery vehicle to deliver cargo.

References

- 1.Subha, D., Harshnii, K., Madhikiruba, K. G., Nandhini, M., & Tamilselvi, K. S. (2023). Plant derived exosome-like Nanovesicles: An updated overview. *Plant Nano Biology*, 3, 100022.
- 2.Shekari, F., Alibhai, F. J., Baharvand, H., Börger, V., Bruno, S., Davies, O., ... & Nieuwland, R. (2023). Cell culture-derived extracellular vesicles: Considerations for reporting cell culturing parameters. *Journal of Extracellular Biology*, 2(10), e115.

ORAL ABSTRACTS

BIOLOGICAL SCIENCES

BS-O-1

Network Pharmacology and Molecular Docking Reveal Multi-Target Anti-Malarial Mechanisms of a Polyherbal Extract from *A. indica*, *P. americana*, and *M. indica*

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Malaria remains a huge burden on the global population and increasing resistance to artemisinin-based combination therapies (ACTs) means that new therapeutic approaches are desperately needed. Herbal medicines with multiple active ingredients containing bioactive phytochemicals are potential multi-target alternatives. In this study, the molecular mechanisms of action of a polyherbal formulation comprising *Azadirachta indica*, *Persea americana* and *Mangifera indica* are explored using the combination of network pharmacology, molecular docking and molecular dynamics simulations.

A phytochemical library was built consisting of 172 compounds and 95 compounds with druglike properties were selected after applying Lipinski's Rule of 5 to SwissADME. GEO (GSE5418) target prediction was performed and the genes associated with malaria were intersected with human targets, which resulted in 549 overlapping human targets. Hub genes STAT3, TNF, IL6, IL-1 β and CASP3 were identified as central nodes in the PPI network analysis. The TNF, TLR, NOD-like receptor, IL-17 and Th17 signalling pathways were also shown to be significantly modulated by GO and KEGG enrichment analyses, pathways known to play an important role in the inflammation and immunopathology associated with malaria.

The molecular docking results revealed good binding affinities for the key lead compounds, with flowerone showing an affinity of -7.6 kcal/mol to IL-1 β and IL-6 (-7.5 kcal/mol), salimuzzalin to STAT3 (-7.0 kcal/mol), quercetin to CASP3 (-7.5 kcal/mol), and ellagic acid to TNF (-5.0 kcal/mol). The stability of the protein-ligand complexes was further validated by subsequent molecular dynamics simulations for 250 ns where the RMSD values were found to be low (0.17–0.41 nm) and the binding free energy calculated using MM-GBSA was favourable, especially for quercetin–CASP3 binding free energy of -23.54 kcal/mol.

This integrative computational study offers strong mechanistic understanding and insights into the multi-target immunomodulatory, anti-inflammatory, and anti-apoptotic effects of the polyherbal extract. The formulation exerts multiple modulations of critical host pathways targeted by severe malaria, making it a rational basis for its traditional use and providing a promising adjunctive host-directed therapy. The results pave the way for further preclinical investigation and illustrate the potential of network pharmacology for modernization of ethnomedicinal knowledge to combat drug-resistant malaria.

Keywords: Network pharmacology, polyherbal antimalarial, molecular docking, molecular dynamics, cytokine signalling.

BS-O-2

Seasonality Influences C, N, and P-Cycling Extracellular Enzyme Activities Under an Extended El-Niño Cycle

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Persistent soil acidification, extreme climatic conditions, and changes in soil physicochemical properties have altered secondary macro- and micronutrient concentrations. However, the responses of carbon (C)-, nitrogen (N)-, and phosphorus (P)-cycling extracellular enzymes (EEAs) and soil bacterial communities to these changes remain poorly understood in sub-escarpment grasslands. This study investigated the effects of long-term ammonium sulphate (AS), phosphate (P), and lime (L) application on soil bacterial communities and associated C-, N-, and P-cycling EEAs across three soil depths during summer and winter at the Ukulinga Grassland Nutrient Experiment (UGNE). β -glucosidase, N-acetyl- β -D-glucosaminidase, and nitrate reductase activities were significantly higher in summer than winter ($p < 0.05$), whereas acid phosphatase activity was significantly higher in winter ($p < 0.05$). Soil organic C (%), N, and zinc (Zn) were identified as the primary drivers of extracellular enzyme activities across increasing AS, P, and L application rates, soil depths, and seasons. Increasing AS, P, and L application rates also primarily structured culturable bacterial community composition, whereas season and soil depth contributed minimally. These findings indicate that seasonal temperature changes regulate hydrolytic and oxidoreductase enzyme activities, while soil physicochemical properties and nutrient concentrations, particularly Zn, drive variation in soil EEAs under long-term nutrient enrichment. Overall, soil physicochemical properties, nutrient availability, and seasonal dynamics play important roles in regulating bacterial-mediated C, N, and P cycling in sub-escarpment grasslands. Understanding these long-term responses is important for forecasting soil bacterial functioning and nutrient cycling under consistent nutrient enrichment and frequent extreme weather events.

BS-O-3

DNA METABARCODING REVEALS SPATIAL PATTERNS OF ZOOPLANKTON BIODIVERSITY ACROSS THE AGULHAS CURRENT

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The strong western boundary Agulhas Current (AC) transports warm tropical waters and biota south-westwards along South Africa's eastern seaboard, where it is instrumental in the dispersal and recruitment of marine species in the pelagic environment. This study contributes to monitoring of zooplankton biodiversity across the AC, as a tool to evaluate ecosystem responses to climate change. Marine zooplankton respond rapidly to shifts in ocean conditions through changes in their phenology, distribution, and community composition, making them effective indicators of ecosystem change. Zooplankton samples were collected with plankton nets towed by the research ship SA Agulhas II at stations along the Agulhas System Climate Array (ASCA) transect during 2023 and 2024. Data on water temperature, current velocity, and depth were used to define distinct inshore, current core, offshore and eddy zones across the AC. DNA was extracted from zooplankton samples and analyzed using metabarcoding, to generate the species composition of individual tow net samples. DNA metabarcoding detected 547 unique zooplankton species across the AC, increasing the taxonomic resolution compared to previous studies that relied on visual methods and morphological analysis. Alpha diversity metrics indicated clear trends in species richness among zones, and multivariate beta diversity showed significant differences in community composition. This study is the first application of DNA metabarcoding to characterise spatial variation in marine zooplankton assemblages across the AC. The results establish an important molecular baseline for future biodiversity monitoring, as a tool to detect ecosystem responses to oceanographic variability and climate change.

BS-O-4

Language Model-Assisted Response Surface Optimization of Napier Grass Saccharification and Co-Fermentation for Efficient Lignocellulosic Bioethanol Production

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This study explored the optimization of Napier grass (*Pennisetum purpureum*) saccharification using an integrated **Generative Artificial Intelligence (AI)** and **Response Surface Methodology (RSM)** framework. The approach employed **Large Language Models (LLMs)** enhanced with **Retrieval-Augmented Generation (RAG)** to predict and narrow the optimal parameter ranges, which were subsequently refined through **statistical modeling** via RSM. The resulting hydrolysate was then utilized for **co-fermentation of bioethanol** using a mixed culture of *Saccharomyces cerevisiae* and *Scheffersomyces stipitis*. Within the hybrid AI-RSM framework, LLM-driven generative modeling was used to synthesize prior knowledge and experimental datasets to propose optimal operating conditions. These AI-derived insights guided the experimental design of the **Box-Behnken RSM model**, which systematically evaluated the effects of **temperature**, **nanoparticle dosage**, and **Tween 80 concentration** on reducing sugar release. Statistical modeling produced a robust quadratic fit ($R^2 = 0.9781$; adjusted $R^2 = 0.9387$). **ANOVA** confirmed that temperature, along with its

quadratic term, exerted the most significant influence ($p < 0.0001$), while Tween 80 and nanoparticles had negligible effects. The optimized conditions—50 °C, 1.5% nanoparticles, and 1.5% Tween 80—yielded a **predicted reducing sugar output of 0.98 g/g**, closely matching the **experimental yield of 0.95 g/g**. Structural characterization validated the process efficiency: **FTIR spectra** revealed intensified cellulose-associated peaks, while **SEM micrographs** showed extensive disruption of the lignocellulosic matrix compared to untreated biomass. Importantly, the **saccharification time was reduced by 50%** (from 72 h to 36 h) without compromising yield, reaching sugar recovery comparable to reported literature values (up to 1.7 g/g). The subsequent **co-fermentation step** efficiently converted both **hexose (C6)** and **pentose (C5)** sugars using a microbial consortium of *Saccharomyces cerevisiae* and *Scheffersomyces stipitis*, leading to the successful production of ethanol. Overall, this work establishes a **Generative AI-assisted optimization framework** that effectively accelerates enzymatic saccharification, sustains high sugar yields, and enhances the economic feasibility of **Napier grass-derived bioethanol**. The study highlights how integrating **computational intelligence with experimental design** can streamline process discovery, reduce experimental costs, and promote scalable, sustainable lignocellulosic biofuel production

Keywords: Napier grass (*Pennisetum purpureum*); Generative Artificial Intelligence (AI); Response Surface Methodology (RSM); Enzymatic saccharification; Co-fermentation; Lignocellulosic bioethanol.

BS-O-5

Microbiological quality of the uMsunduzi River water and genomic analyses of representative *E. coli* isolates

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Access to clean water is a fundamental requirement for public health. Yet rivers in urbanised and peri-urban areas in South Africa often receive untreated sewage, sewer overflow, or agricultural runoff. This study aimed to assess the microbiological quality of the uMsunduzi River in KwaZulu-Natal over four seasons (April 2024 to April 2025), focusing on bacterial indicator organisms, potential pathogens, and antibiotic resistance.

A total of 19 water samples were collected, and selected microbiological parameters such as the aerobic plate count (APC), the most probable number (MPN) for total and faecal coliforms, and *Escherichia coli*, and viable counts for intestinal enterococci were established. In addition, the presence of presumptive *Klebsiella* spp. and *Salmonella* spp. was analysed, along with selected physicochemical parameters (e.g., temperature, pH, chemical oxygen demand (COD)).

The pH of the river water ranged from 6.49 to 7.26, the COD from 10 to 30 mg/L, and the water temperature varied from 14.1°C (winter) to 27.7°C (summer). APC values for river water samples ranged from 3.83 to 4.79 log CFU/mL, total coliforms from 4.04 to 5.54 log MPN/100 mL, and faecal coliforms from 3.23 to 5.11 log MPN/100 mL, while *E. coli* and

intestinal enterococci reached up to 4.69 log MPN/100 mL and 3.8 log CFU/100 mL. Presumptive *Klebsiella* spp. was detected frequently, whereas *Salmonella* spp. was detected only once during winter. Antibiotic susceptibility testing (AST) revealed that about 35% of *E. coli* isolates analysed were antibiotic resistant, including 4 multidrug-resistant candidates.

A total of 19 randomly selected isolates, representing both antibiotic-resistant (12) and susceptible (7) *E. coli*, were further analysed by whole-genome sequencing (WGS). Thus, various *E. coli* sequence types and serotypes were identified, including ST10, ST38, ST73, ST131, and O25:H4, O26:H32, and O86:H18. The largest proportion of isolates represented phylogroup B2, followed by phylogroup B1, and A. Among the 12 antibiotic-resistant *E. coli* isolates, aminoglycoside resistance genes, such as *aph(6)*, encoding aminoglycoside 6-O-phosphotransferase, were most frequently detected, along with genes encoding β -lactam antibiotic inactivating enzymes, such as *bla*CTX-M-15, and *bla*CTX-M-27. Additionally, virulence-related genes such as *fyuA* and *fimH*, associated with the ExPEC pathotype, were detected.

In conclusion, the presence of high microbial loads, faecal indicators, opportunistic pathogens, and MDR *E. coli* isolates carrying ESBL-encoding genes such as *bla*CTX-M, and *bla*OXA were detected, confirming that the uMsunduzi River is unsuitable for domestic and recreational purposes, stressing the need for continuous water quality monitoring, improved wastewater management, and antibiotic resistance surveillance.

BS-O-6

Medicinal Invertebrates Used in African Traditional Medicine: A Systematic Review

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Information on entomotherapy in Africa is fragmented across different countries, resulting in the lack of comprehensive documentation of the diversity of invertebrate species used in traditional medicine. This review systematically searched databases including Google Scholar, Science Direct and Web of Science for articles published from 2000 to 2023 documenting the medicinal use of invertebrates in Africa. The search resulted in 20 eligible articles that listed 117 invertebrate species from 40 orders, as used in traditional medicine to treat 189 symptoms across 19 Sub-Saharan African countries. The Republic of Benin, South Africa, Nigeria, and Burkina Faso were the leading documented users of medicinal invertebrates. Insects were the most used invertebrates, treating over 60% of the identified symptoms, including wounds, arthritis, cough, stomach aches, and fever. Medicinal material was derived from invertebrate body parts such as the whole body, head, and mandibles. Invertebrates were used at different growth stages, including nymphs, larvae, and adults. Medicinal material used includes termites' nest, mole cricket gut contents, tick blood, and honey. This review indicates rich ethnomedicinal uses of invertebrates in Africa. However, there are limited studies on the topic. Therefore, we recommend more research to document the diversity of medicinal invertebrates, expanding into other African regions for a comprehensive database. Additionally, further studies to investigate the impacts of

medicinal invertebrate harvesting, assessing sustainability and conservation. We also call for future studies to isolate the bioactive compounds of these invertebrates to validate their claimed therapeutic use, and to enhance benefit sharing to traditional practitioners.

BS-O-7

Metabolomics Reveals Bacterial–Algal Cross-Feeding Enhances Nutrient Removal and PUFA-Enriched Biomass in Poultry Processing Wastewater

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Poultry processing wastewater (PPWW) is characterised by extreme nitrogen, phosphorus, and organic loads from blood, fats, feathers, and gastrointestinal residues [1]. These properties hinder conventional treatment yet present opportunities for nutrient recovery and biomass valorisation [2]. In this study, a consortium of *Chlorella sorokiniana* G32 and keratinolytic *Kocuria rhizophila* (CKC) was evaluated against their monocultures in sterilised PPWW over 22 d. CKC achieved 85.1 ± 1.2 % total nitrogen, 55.6 ± 1.7 % total phosphorus, and 70.5 ± 0.9 % chemical oxygen demand removal, which substantially exceeded *C. sorokiniana* monoculture (CM) (41.7 %, 50.2 %, 47.1 % respectively). Its biomass yield reached 0.573 ± 0.021 g L⁻¹ (10.4-fold higher than the monoculture) with correspondingly elevated productivity. GC–MS-based metabolomics revealed that *K. rhizophila* mineralises complex PPWW organics by releasing tricarboxylic acid intermediates, amino acids, and indole-3-acetic acid. These metabolites are assimilated by *C. sorokiniana*, driving glycerophospholipid and storage lipid biosynthesis. Coculture biomass exhibited a 7.5-fold increase in total lipid signals, with enrichment of oleic acid (33.2-fold) and nutritionally valuable polyunsaturated fatty acids: eicosapentaenoic acid (5.8-fold), docosahexaenoic acid (6.0-fold), and arachidonic acid (7.0-fold). Multivariate analyses and KEGG enrichment suggest over-representation of the tricarboxylic acid cycle, alanine/aspartate/glutamate metabolism, and glycerophospholipid biosynthesis, with correlation networks linking bacterial metabolites to algal lipid accumulation. A combination of growth-kinetics, physiological, and metabolomic data identifies mutualistic cross-feeding as the mechanistic driver of CKC's superior nutrient removal and biomass productivity. Thus, this empirical data establishes a scalable, locally adapted bioremediation platform that couples high-efficiency PPWW treatment with production of PUFA-enriched microalgal biomass for feed and nutraceutical applications in sub-Saharan Africa.

Keywords: Microalgae–bacteria consortium, Cross-feeding, Metabolomics, Poultry wastewater, Polyunsaturated fatty acids

Reference

1. Ruslinda, Y., Nur, A., Komala, P. S., Leni, L., Regia, R. A., & Mardatillah, R. (2025). Characterization of Wastewater in The University Campus: A Case Study in Universitas Andalas, Indonesia. *Dampak*, 21 (2), 18–26.

2. Gopalakrishnan, K., Wager, Y. Z., & Roostaei, J. (2024). Co-cultivation of microalgae and bacteria for optimal bioenergy feedstock production in wastewater by using response surface methodology. *Scientific Reports*, 14(1), 20703.

BS-O-8

ANTIBIOTIC RESISTANCE SURVEILLANCE ALONG THE MSUNDUZI RIVER: AN INTEGRATED ONE HEALTH APPROACH

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Surface waters are vital freshwater resources that support human well-being, agriculture, livestock production, wildlife, and ecosystem health. However, due to failing wastewater treatment infrastructure, they are increasingly threatened by microbial contamination, including antibiotic-resistant pathogenic bacteria. As microbially polluted rivers serve as environmental reservoirs and transmission pathways for antibiotic-resistant bacteria among humans, animals, and the environment, river water surveillance and monitoring are an essential part of the One Health framework. This study aims to advance river water quality surveillance with a particular focus on antibiotic-resistant WHO-priority pathogens (ESKAPE+E) in the Msunduzi River (Pietermaritzburg, South Africa).

River water samples (typically about 100 L) were collected once per season, starting in March 2026, from three locations along the Msunduzi River within Pietermaritzburg using a solar-powered portable Dead-End Ultrafiltration (DEUF) system. Concentrated backflush water samples were analyzed directly using selective media or following selective enrichment, targeting, for example, extended-spectrum β -lactamase (ESBL)-producing *Enterobacterales* such as *Escherichia coli* and vancomycin-resistant enterococci. Bacterial isolates are characterized by biochemical testing, amplicon-specific PCR, MALDI-TOF MS, and antibiotic susceptibility testing. Selected multidrug-resistant (MDR) bacterial isolates will additionally undergo whole-genome sequencing.

Initial findings indicate differences in the recovery of target antibiotic-resistant bacteria across three sampling sites, while biochemically and PCR-confirmed ESBL *E. coli* and vancomycin-resistant *Enterococcus* spp. highlight the presence of antibiotic-resistant ESKAPE+E representatives in river water samples. The *E. coli* isolates so far categorized as multidrug-resistant (MDR) are ESBL producers and resistant to ampicillin, cephalexin, cefotaxime, tobramycin, and norfloxacin. Similarly, representative *Enterococcus* spp. categorized as MDR, exhibited resistance to vancomycin, ampicillin, imipenem, gentamicin, teicoplanin, and norfloxacin.

These initial findings demonstrate the occurrence of clinically important antibiotic-resistant bacteria in the Msunduzi River and underscore the need for continued river water analyses. The ongoing monitoring will provide an improved understanding of the diversity, antibiotic resistance mechanisms, and dissemination of WHO-priority pathogens within the local river system, strengthening One Health surveillance and informing evidence-based water quality management with a focus on antibiotic resistance in local freshwater ecosystems.

BS-O-9

Water quality and macroinvertebrate responses to land use and climate change in KwaZulu-Natal rivers, South Africa

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Freshwater ecosystems have been vital in supporting human livelihoods since ancient times. Presently, anthropogenic factors exert a global impact on freshwater ecosystems, primarily because of pollution, water abstraction, and the construction of physical barriers in rivers. Achieving clean water and sanitation, tackling climate change and preserving life below water (SDG 6, 13 and 14) remain a significant challenge in African countries, including South Africa, where infrastructure failures, inadequate legislative implementation, and sporadic pollution events have degraded freshwater environments to unacceptable levels.

We are reassessing the biological responses at 52 sites across KwaZulu-Natal, South Africa, that were used in the River Eco-status Monitoring Programme (REMP) to re-evaluate the ecological status and function of KwaZulu-Natal rivers. Our sampling was conducted during a period of above-average rainfall, which led to flooding in 2024-2025. These sites were surveyed during the 2014-2016 drought. We studied macroinvertebrates using the SASS5 technique as one component. We also collected diatoms and 2L water bottles to complement in situ water quality monitoring. We sampled in the low flow and high flow seasons of 2024 and 2025.

These surveys assist in the comprehensive collection of relevant data to understand the impacts of climate and land-use changes, especially when compared with long-standing databases. In our study, by monitoring of biological responses, we aim to contribute valuable data for holistic river management, offering valuable insights into freshwater ecosystems' overall health and functioning with a changing climate and land uses.

BS-O-10

Diversity and Evolutionary Analysis of the Transposable Elements in Chicken *Eimeria* Genomes

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Background: Transposable elements (TEs) are repetitive and mobile DNA sequences known for their ability to change position and abundance within host genomes, making them a key driver of genome plasticity. *Eimeria* parasites cause coccidiosis, leading to significant

losses to poultry farmers. The diversity and evolutionary activities of TEs in *Eimeria* are not well understood.

Methods: We performed de novo TE modeling across 15 *Eimeria* genomes obtained from public databases using RepeatModeler. We conducted automatic and manual curation on the predicted TE models to confirm and improve the quality of the final TE models.

Results: Our analysis produced 80 non-redundant TE models across 15 *Eimeria* genomes, with coverage ranging from 0.31% to 5.70%. We confirmed the presence of LTR/Gypsy elements in all *Eimeria* species. In contrast, LINE elements were present in only four species: *Eimeria maxima*, *Eimeria lata*, *Eimeria nagambie*, and *Eimeria zaria*. Moreover, we discovered evidence of recent TE activity and transposition bursts involving LTRs, LINEs, or both in important species, including *E. acervulina*_2, *E. tenella*, *E. necatrix*, *E. praecox*, *E. lata*, and *E. zaria*. A major outcome of this work was the creation of the curated *Eimeria* TE Database, which offers a standardized framework for TE annotation and serves as a valuable resource for future *Eimeria* TE studies.

Conclusion: The widespread occurrence of LTRs across all *Eimeria* genomes suggests they play a key role in shaping genome structure and evolution, a finding that warrants further investigation.

Keywords: Transposable elements, *Eimeria*, coccidiosis genome plasticity, evolution, LTR/Gypsy.

BS-O-11

BIODIVERSITY REPRESENTATION IN ECOSYSTEM MODELS OF MARINE NURSERY HABITATS.

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Marine nursery habitats support the early life stages of many species by providing essential ecosystem services that promote survival to adulthood. Ecosystem network models are used to study habitat structure and functioning while informing their management and conservation strategies. For these strategies to be effective, models need to accurately represent the biodiversity of the ecosystem. Currently existing models have a mixture of taxonomic and functional group representation of their biodiversity. In an effort to understand the effect of biodiversity representation in nursery habitat food web models (estuaries, mangroves, seagrass beds, kelp systems) on structural and functional ecosystem indicators, we analysed 130 ecosystem network models from literature with different taxonomic and functional group representations.

We classified them as (1) taxonomic or (2) functional group models, or (3) a combination of the former two. The taxonomic and combination models were then converted into functional group models by systematically aggregating the nodes according to feeding guilds, and the network indices recalculated. The total number of nodes and number of links in the ecosystem networks decreased by about half after aggregation, whereas the average biomass per node increased, as expected. Similarly, we expected Total Systems

Throughflow (TST) not to stay the same between the original and aggregated models. However, Average Path Length (APL) denoting the internal activity generated from boundary flows, and Finn's Cycling Index (FCI) showing the percentage cycled in relation to TST, differed significantly. Based on these results, it can be concluded that model type (taxonomic or functional) does not influence overall system activity but does alter internal structure and energy cycling. Ecosystem models should carefully consider node aggregation, as it may affect assessment of ecosystem structure and function, as well as inter-model comparisons.

BS-O-12

Development of a novel disinfectant, *t*Lox-23, to reduce fungal infections in healthcare settings.

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Pathogenic fungi pose an emerging and serious threat to human health, with the WHO listing four fungal pathogens, *Candida albicans*, *Candida auris*, *Cryptococcus neoformans*, and *Aspergillus fumigatus*, as critical priority pathogens. These pathogens have become resistant to front-line antifungal therapies and are associated with increased mortality and morbidity. Immunocompromised, diabetic and older patients in healthcare settings are particularly vulnerable, and in South Africa, candidemia in these patients has a mortality rate of 60%. Preventing *Candida* infections in healthcare settings is challenging because common surface disinfectants, such as quaternary ammonium compounds, are ineffective against fungal pathogens. While hypochlorous acid-based disinfectants are effective, they can damage surfaces, leading to colonisation by other pathogens. Hydrogen peroxide vapour has also been used for fungal decontamination, but it is expensive and time-consuming. We have developed a novel surface disinfectant, *t*Lox-23, to specifically address the gap in antifungal disinfectant formulations. We tested *t*Lox-23 against the non-pathogenic model yeast, *Schizosaccharomyces pombe*, and found that it was at least fourfold as potent as hydrogen peroxide in limiting growth. In *C. albicans*, hydrogen peroxide (2.5-5 mM) could limit the growth of the pathogen for 6 hours. However, a single endpoint measurement at 18 hours revealed that these cells had recovered and resumed growth. By contrast, *t*Lox-23 at these same concentrations produced sustained, non-reversible growth inhibition for 18 hours post-exposure. To elucidate the mode of action of *t*Lox-23, we are using qPCR to assess whether this formulation inhibits the AP-1 and MAPK transcriptional stress-response pathways in *S. pombe*. As these pathways are shared between many fungi, *t*Lox-23 could be a broad-spectrum antifungal agent. This offers a novel strategy for reducing the burden of healthcare-associated infections in high-risk clinical settings.

ORAL ABSTRACTS

COMPUTING, MATHEMATICS, AND STATISTICS

CMS-O-1

ATTENTION-ENHANCED ENSEMBLE DEEP LEARNING MODELS FOR MULTI-CROP DISEASE CLASSIFICATION

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Plant diseases pose a significant threat to agricultural productivity, making early and accurate diagnosis essential for reducing crop losses and supporting sustainable food production. Traditional disease identification methods are often time-consuming, subjective, and dependent on expert knowledge. This study proposes an attention-enhanced deep learning ensemble framework for automated multi-crop disease classification using leaf images from apple, corn (maize), and grape crops. The research evaluates the effectiveness of three pretrained Convolutional Neural Network (CNN) architectures, DenseNet121, MobileNet, and InceptionV3, as standalone classifiers and as components of standard stacked, weighted stacked, and attention-based ensemble models with the incorporation of Low Rank Adaptation (LoRA), which is a Parameter Efficient Fine Tuning (PEFT) technique. The framework further incorporates Local Interpretable Model-agnostic Explanations (LIME) to improve model transparency and interpretability. The experimental evaluation was conducted on a dataset comprising ten disease and healthy leaf categories across the three crop types. Individual CNN models were optimized using five-fold cross-validation before being integrated into progressively more complex ensemble architectures. Performance was assessed using accuracy, precision, recall, F1-score, confusion matrices, disease-level error analysis, learning behavior evaluation, and explainability analysis. Results show that DenseNet121 and MobileNet achieved strong standalone performance, each attaining approximately 99% classification accuracy, while InceptionV3 achieved 97% accuracy. Standard stacked ensembles provided modest improvements, with the DenseNet121-MobileNet ensemble achieving 99.17% accuracy. Weighted ensembles further improved performance, with the DenseNet121-MobileNet-InceptionV3 weighted model achieving 99.46% accuracy and an F1 Score of 99.52%. The highest performance was achieved by the proposed attention-enhanced DenseNet121-MobileNet-InceptionV3 ensemble, which achieved near-perfect classification, effectively eliminating most residual classification errors. Disease-level analysis revealed that attention mechanisms improved discrimination in challenging classes characterized by subtle visual differences, while LIME visualizations confirmed that the model's decisions were based on biologically meaningful symptoms, such as lesions, discoloration patterns, and texture variations. The study demonstrates that attention-enhanced ensemble learning provides a highly accurate, robust, and interpretable solution

for multi-crop plant disease classification. By combining complementary feature representations from multiple CNN architectures with adaptive attention-based feature fusion and explainable AI techniques, the proposed framework outperforms individual models, standard stacking, and weighted ensemble approaches. The findings contribute to the development of reliable intelligent decision-support systems for precision agriculture and practical field-based disease diagnosis.

Keywords: Plant disease classification, Deep Learning (DL), Convolutional Neural Network (CNN), Attention mechanism, Ensemble learning, DenseNet121, MobileNet, InceptionV3, LIME, Precision agriculture, Multi-crop disease diagnosis

CMS-O-2

Value at Risk Estimation Under Global Financial Uncertainty: A Heavy-Tailed Student's t Mixture Autoregressive Approach

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Background: Global financial markets have experienced substantial volatility, uncertainty, and structural changes following major economic and geopolitical shocks, particularly the global COVID-19 pandemic and the Russia–Ukraine conflict. These events have highlighted the need for risk-management robust models capable of capturing volatility clustering, heavy tails, nonlinear dependence, and changes in market regimes. Value-at-Risk (VaR) remains one of the most widely used measures for quantifying financial market risk; however, conventional VaR models may inadequately represent the complex and changing dynamics of financial returns. This study aims to develop and evaluate a robust modelling framework based on the Student's-t mixture autoregressive (StMAR) model for capturing volatility and regime-switching dynamics and improving VaR estimation. The analysis uses daily observations from four internationally relevant financial markets: the FTSE/JSE All-Share Index, the CBOE Volatility Index (VIX), Gold prices, and the USD/ZAR exchange rate.

Methods: The StMAR framework was employed to model nonlinear dependence, regime-specific dynamics, and heavy-tailed behaviour in financial returns. Its performance was compared with Markov regime-switching exponential generalized autoregressive conditional heteroscedasticity (MRS-EGARCH) models. The latter were estimated under Student's-t and skewed Student's-t innovation distributions to account for conditional heavy tails and asymmetry. The competing models were evaluated through in-sample VaR forecasts at multiple risk levels. Their predictive adequacy was assessed using the Dynamic Quantile (DQ) backtesting procedure, with particular emphasis on the ability of each model to adequately capture violations of the VaR threshold.

Results: The StMAR models generally demonstrated superior VaR forecasting performance compared with the MRS-EGARCH alternatives across the four financial markets and most VaR levels. Specifically, StMAR(7,2) provided the strongest performance for FTSE/JSE All-Share Index returns and gold price returns, while StMAR(2,2) performed best for VIX returns

and StMAR(5,2) for USD/ZAR exchange-rate returns. Nevertheless, some MRS-EGARCH specifications also performed competitively at selected VaR levels, notably MRS(2)-EGARCH(1,1) with Student's-t innovations and MRS(3)-EGARCH(1,1) with skewed Student's-t innovations.

Conclusion: The findings demonstrate that the StMAR framework provides a flexible and robust alternative for modelling financial returns characterised by nonlinear dependence, heavy tails, volatility clustering, and regime changes. Its superior VaR performance across most risk levels suggests that explicitly modelling regime-dependent dynamics can improve the measurement and management of financial market risk. The StMAR framework therefore offers a useful alternative for financial institutions, risk analysts, and portfolio managers seeking more reliable risk forecasts in volatile and structurally changing global financial markets.

CMS-O-3

Mathematical models for Tuberculosis

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Tuberculosis (TB) is a major global health crisis, infecting approximately 10 million people every year and causing the death of about 1,5 million, despite being curable. TB is caused by *Mycobacterium tuberculosis* (bacteria) and is transmitted through the air, when an infected individual coughs, sneezes or spits. TB mostly affects the lungs (pulmonary) but can affect other organs (extrapulmonary). Several mathematical models have been developed to describe the transmission dynamics of tuberculosis and evaluate potential control strategies. However, most existing transmission models are deterministic and ignore either stochastic effects or spatial heterogeneity. We intend incorporating both aspects in order to develop a realistic model.

Firstly, we will set up a model with five compartments: susceptible, exposed, infected, treated and recovered, known as an SEITR model. This SEITR model will include the transmission rate (b_n), the progression rate (κ), treatment rates for exposed/latent individuals (ρ) and infected individuals (α), the recovery rate (r), and the TB-mortality rate (σ). To make our model more applicable to real-world situations we will also include a re-infection rate (b_r), a loss of immunity rate (γ), a natural mortality rate (μ), and a recruitment rate (χ).

We will undertake a dynamical systems approach to analyse the SEITR model. In particular, we will determine the fixed points and basic reproduction number, $\mathcal{R}_0$, of the system. We will also discuss the stability of the corresponding disease-free equilibrium and endemic equilibrium. The role of $\mathcal{R}_0$ will be investigated in order to determine its effect on these equilibria. We will also perform a numerical simulation that will include data obtained from the World Health Organisation for ten countries in Southern Africa (Angola, Botswana, Eswatini, Lesotho, Malawi, Mozambique, Namibia, South Africa, Zambia and Zimbabwe).

Thereafter we intend to use this model as a basis for a stochastic model. This model will incorporate random variables into the system of equations to model the fluctuations in

infection rates. For the stochastic differential equations (SDE) we will determine the stochastic reproduction number, $\mathcal{R}_0^S$, and perform a numerical simulation.

Finally, we will extend the SEITR model to include spatial effects. This new model will extend the SEITR model by incorporating matrices in the exposed compartment to account for individuals moving between the ten Southern African countries. We will perform a numerical simulation on the spatial model and then compare the numerical simulations for all three models using Mean Absolute Errors (MAE) and Root Mean Square Errors (RMSE) to determine which model fits the data best.

CMS-O-4

Baseline Vulnerability Phenotypes in Pregnancy and Severe Maternal Outcome Among Women Living with HIV

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Background: Pregnancy baseline vulnerability among women living with HIV may not be captured by a single latent construct. We compared structural social, reproductive-history, and social-reproductive phenotype families at pregnancy onset, examined how maternal age and clinically available physiology changed the retained architectures, and evaluated severe maternal outcome as a validating distal outcome.

Methods: We performed a retrospective pregnancy-based cohort analysis within the multi-country PROMOTE study. Baseline phenotype families were derived using latent class analysis from structural social indicators, reproductive-history indicators, or their combination; age-inclusive analyses were examined separately. A bounded secondary extension added clinically observable pre-birth physiology to the retained structural social and social-reproductive families and used sign-aware viral-load status for the HIV-specific sensitivity analysis. Class enumeration continued until the smallest class first fell below 5% of the cohort. Severe maternal outcome by 42 days postpartum was evaluated with site-clustered overlap-weighted risk ratios in the primary first-pregnancy analysis and an all-pregnancies sensitivity analysis.

Results: Without age, the structural social and social-reproductive families retained 3-class solutions, whereas the reproductive-history family retained a 2-class solution. Adding age left the structural social and reproductive-history solutions at three and two classes, respectively, while repartitioning the social-reproductive family into four classes. In the primary first-pregnancy analysis, high-versus-lower risk ratios were 1.84 (95% CI: 1.04, 3.28) for the social-reproductive phenotype, 1.69 (0.98, 2.91) for the structural social phenotype, and 1.31 (0.89, 1.93) for the reproductive-history phenotype. Fixed-point estimates in the ready-now physiology extension were 2.668 (1.252, 5.686) and 2.527 (1.263, 5.054) for the structural social and social-reproductive branches; the corresponding age-plus-physiology estimates were 1.962 (1.033, 3.728) and 2.447 (1.368, 4.376). Posterior classification-uncertainty estimates were directionally similar. Across 50 audited contrasts, fixed-point and posterior directions agreed for 48; 5 contrasts for posterior intervals excluded 1, compared with 16 cluster-bootstrap intervals.

Conclusions: Pregnancy baseline vulnerability in PROMOTE was not represented by a single interchangeable phenotype. The social-reproductive phenotype provided the clearest severe maternal outcome validation, whereas reproductive history defined a more distinct and less outcome-discriminating baseline dimension. Bounded physiology yielded elevated fixed-point contrasts, but classification uncertainty and support diagnostics constrained their interpretation. Baseline phenotyping identifies clinically relevant heterogeneity, but uncertainty prevents treating the phenotypes as a stand-alone screening tool or intervention rule.

CMS-O-5

A Multi-Station Multivariate LSTM Framework for Short-Term Extreme Rainfall Prediction in KZN, SA

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Extreme rainfall events have become increasingly frequent and destructive in KwaZulu-Natal, posing significant risks to communities, agriculture, infrastructure, and environmental sustainability. The devastating floods experienced in recent years highlight the urgent need for intelligent forecasting systems capable of providing timely warnings to support disaster preparedness and climate resilience. Although deep learning has demonstrated considerable potential for rainfall forecasting, many existing approaches rely on single weather stations and are less effective at detecting rare extreme rainfall events.

This research proposes a **multi-station, multivariate Long Short-Term Memory (LSTM)** framework that simultaneously predicts hourly rainfall intensity and identifies extreme rainfall events using meteorological observations collected from multiple weather stations across KwaZulu-Natal. The proposed dual-output architecture combines rainfall regression and extreme-event classification within a single model while incorporating a weighted learning strategy to address the severe class imbalance associated with rare hazardous rainfall events.

Experimental results demonstrate that the proposed framework effectively captures temporal rainfall dynamics across geographically distributed stations and achieves high recall in detecting extreme rainfall occurrences, making it particularly suitable for early warning applications where minimizing missed hazardous events is critical. The study establishes one of the first reproducible multi-station forecasting baselines for the WEATHER Project and provides the foundation for future integration with Graph Neural Networks (GNNs), Internet of Things (IoT) technologies, and intelligent decision-support systems for climate resilience and disaster risk reduction.

The research contributes to the broader goal of developing Artificial Intelligence-driven early warning systems capable of strengthening community resilience and supporting evidence-based environmental management in vulnerable regions of KwaZulu-Natal.

CMS-O-6

ON THE NUMBER OF 1-NEARLY INDEPENDENT VERTEX SUBSETS

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The number of 1-nearly independent vertex subsets, denoted by $\sigma_1(G)$, is a recently introduced graph invariant that counts the vertex subsets of a graph whose induced subgraphs contain exactly one edge. Unlike the classical Merrifield-Simmons index, the value of $\sigma_1(G)$ depends strongly on the arrangement of edges, making it an interesting invariant for investigating the relationship between graph structure and extremal properties [1].

In this study, we investigate the minimum number of 1-nearly independent vertex subsets among connected diameter-2 graphs. By combining counting arguments with structural graph-theoretic techniques, we establish a sharp lower bound for $\sigma_1(G)$ for diameter-2 graphs of order n . Furthermore, we characterize all graphs attaining equality by proving that

$$\sigma_1(G) \geq 2n - 4,$$

with equality if and only if $G \cong K_{2,n-2}$. The characterization is obtained through an analysis of the structural properties of extremal graphs, showing that every graph attaining the bound has girth and circumference equal to four, leading to the unique extremal graph.

These results provide the first extremal characterization of the invariant $\sigma_1(G)$ for diameter-2 graphs and contribute to a broader understanding of how structural constraints influence the number of 1-nearly independent vertex subsets.

Reference(s)

[1] Z. B. Shoji and E. O. D. Andriantiana. The number of 1-nearly independent vertex subsets. *Quaestiones Mathematicae*, 47(12):2353–2373, 2024

CMS-O-7

Artificial Neural Network and Response Surface Analysis of Heat and Mass Transfer in Cattaneo-Christov Oldroyd-B Flow over a Rotating Stretching Sheet

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The integration of advanced numerical simulation, machine learning, and statistical optimization provides an effective framework for analyzing complex transport phenomena and accelerating engineering design. Motivated by this perspective, the present study develops a unified Spectral Quasi-linearization Method (SQLM)-Artificial Neural Network (ANN)-Response Surface Methodology (RSM) framework to investigate heat and mass transfer characteristics in Cattaneo-Christov Oldroyd-B fluid flow over a rotating stretching sheet. The mathematical model incorporates viscoelastic effects through the Oldroyd-B constitutive relation, rotational influences through Coriolis forces, and finite thermal and concentration propagation via the Cattaneo-Christov heat and mass flux theories. The resulting nonlinear boundary-layer equations are transformed into dimensionless form and solved accurately using SQLM. The influences of the governing parameters on the velocity, temperature, and concentration fields are systematically examined, while the local Nusselt and Sherwood numbers are employed as engineering performance indicators. High-fidelity SQLM data are subsequently utilized to train ANN models based on the Levenberg-Marquardt algorithm for rapid prediction of transport responses.

The developed ANN models demonstrate excellent predictive capability, achieving coefficients of determination of $R^2 = 1.000000$ for both responses, with mean squared errors of the order 10^{-9} . In addition, the RSM-based surrogate models exhibit outstanding agreement with the numerical solutions, yielding $R^2 = 0.9997$ and adjusted $R^2 = 0.9995$. Statistical and sensitivity analyses reveal that the Prandtl number, thermal relaxation parameter, and first Deborah number which corresponds to fluid relaxation, significantly influence the Nusselt number, whereas the Schmidt number, concentration relaxation parameter, and first Deborah number predominantly govern the Sherwood number. The Prandtl and Schmidt numbers are identified as the most influential parameters controlling heat and mass transfer, respectively, while increasing Deborah number suppresses both transport processes within the investigated parameter range. Quantitatively, increasing the rotation parameter from the scale of 0.10 to 2.22 reduces the surface heat transfer rate by approximately 13.92%, whereas increasing from 0.27 to 2.73 decreases the surface mass transfer rate by about 41.73%, highlighting the stronger sensitivity of mass transport to rotational effects.

Overall, the proposed SQLM-ANN-RSM framework provides an accurate, computationally efficient, and robust platform for simulation, prediction, sensitivity assessment, and optimization of complex viscoelastic transport systems, offering valuable guidance for the design and control of advanced thermal-fluid engineering processes.

CMS-O-8

Approximation of the Solutions of Pseudomonotone Equilibrium Problems by Modified Subgradient Extragradient Method with Application

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Achieving strong convergence remains a major challenge iterative methods for equilibrium and optimization problems as numerous existing algorithms converge only weakly. In this

work, we propose a new modified inertial subgradient extragradient method for solving pseudomonotone equilibrium problems in real Hilbert spaces. The proposed method employs a self-adaptive stepsize and does not rely on the prior knowledge of the Lipschitz-type constants of the pseudomonotone bifunctions. Under mild conditions and suitable assumptions on the control parameters, we establish the strong convergence results of the proposed algorithm. We illustrate the applicability of our results to fixed point problems and variational inequality problems. Numerical experiments confirm that our new method offer improved efficiency and performance compared to existing methods in the literature.

In [1], Muu and Oetti considered the equilibrium problem (EP) as a generalization of several problems in nonlinear analysis, and these problems include variational inequalities, Nash-equilibrium problems, fixed point problems, and saddle point problems [4]. The EP has applications in many mathematical models from various fields of applied science and engineering such as economics, physics, image restoration, transportation, and optimization. Let C be a nonempty, convex, and closed subset of a real Hilbert space H , and $g: C \times C \rightarrow R$ be a bifunction such that $g(x, x) = 0$ for all $x \in C$. The EP, as defined by Muu and Oetti [1], is formulated as follows: Find $x^* \in C$ such that $g(x^*, t) \geq 0 \quad \forall t \in C$. Consequently, efficient algorithms for approximating common solutions of EP have attracted considerable attention. Censor et al [2] Halpern-type subgradient extragradient methods are classical approaches for solving EP but generally require monotonicity, Lipschitz continuity, and guarantee only weak convergence (see [2,4]). To accelerate the rate of convergence, Polyak's [3] inertial extrapolation technique has been incorporated into extragradient-type algorithms. Recently, Yang and Liu [4] proposed inertial-type subgradient extragradient method with self-adaptive stepsize for EP but established only weak convergence. Motivated by these challenges, we propose a modified inertial subgradient extragradient method for approximating a common solution of $EP(g, C)$.

Reference

1. L. Muu, W. Oettli, Convergence of an adaptive penalty scheme for finding constrained equilibria,
2. Nonlinear Anal.,18 (1992),
3. L. Muu, W. Oettli, Convergence of an adaptive penalty scheme for finding constrained equilibria,
4. Nonlinear Anal.,18 (1992),
5. L. Muu, W. Oettli, Convergence of an adaptive penalty scheme for finding constrained equilibria,
6. Nonlinear Anal.,18 (1992),
1. L. Muu, and W. Oettli, (1992). Convergence of an adaptive penalty scheme for finding constrained equilibria, Nonlinear Anal., **18**(12), 1159–1166.
2. Y. Censor, A. Gibali, and S. Reich, (2011). The subgradient extragradient method for solving variational inequalities in Hilbert space, J. Optim. Theory Appl.,**14**(8), 318-335.
3. Polyak, Some Methods of Speeding up the Convergence of Iteration Methods, USSR Comput. Math. Phys. **4** (1964), 1–17. [https://doi.org/10.1016/0041-5553\(64\)90137-5](https://doi.org/10.1016/0041-5553(64)90137-5).
4. J. Yang, and H. Liu, (2020). The subgradient extragradient method extended to pseudomonotone equilibrium problems and fixed point problems in Hilbert space. Optimization Letters, **14**(2), 1–14.

5. L. Muu, W. Oettli, Convergence of an adaptive penalty scheme for finding constrained equilibria,
Nonlinear Anal.,18 (1992), 1159–1166
7. L. Muu, W. Oettli, Convergence of an adaptive penalty scheme for finding constrained equilibria,
Nonlinear Anal.,18 (1992), 1159–1166
9. L. Muu, W. Oettli, Convergence of an adaptive penalty scheme for finding constrained equilibria,
Nonlinear Anal.,18 (1992), 1159–1166
10. Nonlinear Anal.,18 (1992), 1159–1166

CMS-O-9

A Relaxed Inertial Subgradient Extragradient Method for Solving Variational Inequality and Multivalued Fixed Point Problems.

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Achieving strong convergence remains a major challenge in iterative methods for variational inequality and fixed point problems, as many existing algorithms converge only weakly. In this work, we propose a modified relaxed inertial subgradient extragradient algorithm for approximating a common solution of quasimonotone variational inequality problems and multivalued demicontractive fixed point problems in real Hilbert spaces. Under mild conditions on the control parameters, we establish the strong convergence of the proposed algorithm. Numerical experiments demonstrate its effectiveness and computational efficiency, with comparative results showing improved convergence behaviour over several existing methods in literature.

Variational inequality problems (VIPs) and fixed point problems (FPPs) are fundamental models with broad applications in optimization, equilibrium theory, image processing, signal processing, and engineering. Let H be a real Hilbert space, C be a nonempty closed convex subset of H , and $A: H \rightarrow H$ be a nonlinear operator. The VIP consists of finding a point $x^* \in C$ such that $\langle Ax^*, x - x^* \rangle \geq 0, \forall x \in C$. Consequently, efficient algorithms for computing common solutions of VIPs and FPPs have attracted considerable attention. Korpelevich's [2] extragradient and subgradient extragradient methods are classical approaches for solving VIPs but generally require monotonicity, Lipschitz continuity, and guarantee only weak convergence (see [1, 4]). To accelerate the rate of convergence, Polyak's [3] inertial extrapolation technique has been incorporated into extragradient-type algorithms. More recently, Shehu *et al.* [5] proposed inertial-typed subgradient extragradient method with self-adaptive stepsize for VIPs but established only weak convergence. Motivated by these challenges, we propose a modified relaxed inertial subgradient extragradient method for approximating a common solution $x^* \in \Omega := VI(A, C) \cap F(T)$, where $VI(A, C)$ and $F(T)$ denote the solution sets of the VIP and multivalued demicontractive FPP, respectively.

References

1. Y. Censor, A. Gibali and S. Reich, The subgradient extragradient method for solving variational inequalities in Hilbert space, *J. Optim. Theory Appl.*, **148** (2011), 318-335.
2. G. M. Korpelevich, The extragradient method for finding saddle points and other problems, *Ekonomikai Matematicheskie Metody*, **12** (1976), 747-756.
3. B. T. Polyak, Some methods of speeding up the convergence of iteration methods, *Politehn. Univ. Buchar. Sci. Bull. Ser. A Appl. Math. Phys.*, **4** (1964), 1-17.
4. S. Reich, D. V. Thong, P. Cholamjiak and L. V. Long, Inertial projection-type methods for solving pseudomonotone variational inequality problems in Hilbert space, *Numer. Algorithms*, **88** (2021), 813-835.
5. Y. Shehu, O. S. Iyiola and S. Reich, A modified inertial subgradient extragradient method for solving variational inequalities, *Optim. Eng.*, **23** (2022), 421-449.

CMS-O-10

On minimal degrees of faithful permutation representation of finite groups

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The minimal faithful permutation representation degree, $m(\mathbf{G})$, is a fundamental invariant in finite group theory that measures the smallest degree of a faithful permutation representation of a finite group $\mathbf{G}$. Determining $m(\mathbf{G})$ remains a challenging problem due to its close connection with optimization problems on subgroup lattices. Although quotient groups are generally expected to have smaller minimal degrees of permutation representation than their parent groups, this is not always the case. Such groups are known as *exceptional groups*, highlighting an important but not yet fully understood relationship between finite groups and their quotients. In this talk, I shall present an investigation of the relationship between the minimal faithful permutation representation degrees of finite groups and their quotient groups, with particular emphasis on exceptional groups and distinguished quotients.

CMS-O-11

Cross-Dataset Cell Segmentation with a Domain-Adaptive ResNet50 Attention U-Net

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Accurate cell segmentation remains difficult under domain shift because microscopy images vary in modality, illumination, cellular density, signal-to-noise ratio, and boundary ambiguity.

This paper presents a domain-adaptive ResNet50 Attention U-Net trained on the NeurIPS 2022 multi-modality cell segmentation benchmark and evaluated without retraining on two Cell Tracking Challenge (CTC) fluorescence datasets. The implementation is not a bare network: it combines modality aware preprocessing, robust percentile normalization, background subtraction, CLAHE, dataset-specific denoising, foreground aware patch sampling, balanced domain sampling, compound segmentation loss, and sliding-window inference with Gaussian blending. On the NeurIPS22 validation split, after some epochs, we obtained Dice scores of 0.8912, IoU of 0.8241, precision of 0.8574, and recall of 0.9516. On the CTC benchmarks, the same model achieved a mean SEG of 0.8478 and OP_CSB of 0.8588 on Fluo-N2DH-GOW, and a mean SEG of 0.6902 and OP_CSB of 0.7224 on Fluo-N2DL-HeLa. The results indicate strong transfer to an unseen fluorescence domain and expose the expected difficulty of crowded HeLa scenes.

CMS-O-12

The acceptance of a quick response code model to enhance South African banknote security

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South Africa faces persistent security threats in its cash management sector, characterised by high incidences of cash in transit (CIT) robberies, automatic teller machine (ATM) bombings, and "express kidnappings" for ransom. While existing dye-staining technology devalues stolen currency, it fails to track illicit yet genuine banknotes, facilitating their reintegration into the formal economy through money laundering. The main outcome of the current study was to develop and evaluate a QR code-based model for real-time tracking and tracing of South African banknotes, with the aim of identifying the factors influencing its acceptance among stakeholders in the cash management sector.

The study followed a sequential exploratory design underpinned by phenomenology and the Technology-Organisation-Environment framework. The first phase used qualitative interviews with 6 senior subject-matter experts from the commercial banking and cash-in-transit sectors to capture practical insights into improving banknote security. The second phase produced a three-tier QR code model consisting of a public layer for verification, a restricted layer for institutional authentication, and a secure layer for real-time forensic tracking, supported by a hybrid blockchain-and-relational-database system.

The final phase of the study was quantitative and underpinned by technology acceptance theory. During this phase of the study, the QR code model was presented to a cohort of 43 industry experts, each with more than 3 years of experience in the commercial banking or

CIT sectors and tasked with managing banknote logistics in South Africa. The sample for this phase of the study consisted of a specialised set of respondents who were able to identify with the inner workings of the QR code model.

The survey results indicated a negative skew, with most responses clustered to the right, as confirmed by a 90% acceptance rate. The study's overall theoretical contribution was to highlight the significance of the technological, organisational, and environmental dimensions in implementing QR code technology. It further extends the evolutionary path of banknote security by proposing a model that scales security processes to the level of institutional and real-time forensic tracking. Complexity emerged as the single most critical factor that influenced the intention to adopt the proposed QR code technology. The study concludes that while the technical benefits of QR-based tracking are widely recognised, actual intention to adopt is driven more by perceptions of ease of implementation and organisational readiness.

ORAL ABSTRACTS

ENGINEERING

ENG-O-1

Experimentation, CFD validation, Machine Learning-Based Surrogate Modeling of Pumping Power Reduction of Non-Newtonian Turbulent Pipe Flow

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Precise prediction of pressure drop of crude oil in pipeline is of paramount significance for establishing an optimal drag reduction, energy minimization and ensuring safe transportation. Pressure drop is directly related to higher pumping power in fluid flow. Traditional turbulence models including Reynolds-average Navier-Stokes (RANS) model impart a critical role in resolving numerous flow problems. However, in complex fluid flow system (i.e., Natural gas blend, Petrol and Crude-oil) in long distance pipeline system their accuracy is limited due to limitations and assumptions to employ turbulence model equations. To overcome them, current study includes Computational Fluid Dynamics (CFD) turbulence model including 2-equation turbulence model, Shear Stress Transport (SST $k-\omega$) and Physics-Informed Neural Network (i.e., Kernel-Activated Network (KAN)) and Machine Learning (ML) based Turbulence reduction model involving drag reducing agent (DRAs) molecular weight (Mw), concentration (ppm) and flow parameters (i.e., pipe length, diameter and roughness). The results indicate that CFD-based validation and AI-ML coupled predictions model with minute concentration of DRAs (25-200 ppm) can reduce the significance pumping power (20-50 watt), provides the significance energy saving

potentials upto 20-30% and increase the flow rate upto 5-10 ($\frac{m^3}{h}$). This research marks a significant advancement potential of drag reduction, pumping power reduction and energy saving in turbulence modeling and showcasing the physics informed SST $k-\omega$ parameters and ML based Algorithm including KAN.

ENG-O-2

Assessing the Sensitivity of Harmonic Distortion and Distribution Transformer Risk to Feeder Impedance in Low-Voltage Networks with Distributed Energy Resources

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The increasing penetration of distributed energy resources (DERs) in low-voltage networks is central to the clean energy transition but introduces coupled challenges in voltage regulation, harmonic distortion, and distribution-transformer operation that impact grid sustainability and asset longevity. This paper isolates feeder impedance as a controlled variable and evaluates whether remote-network power-quality severity and transformer consequence follow the same sensitivity trend. A time-domain model used a factory-matched 200 kVA, 11 kV/420 V Dyn11 transformer with 40% DER connected at remote Node S3. The DER current contained prescribed fifth, seventh, eleventh, and thirteenth harmonics, while the LV feeder resistance and inductance were co-scaled from 0.5 to 2.0 pu. Across the DER-connected sweep, Node S3 line-to-line RMS voltage increased from 420.45 V to 428.95 V, and the voltage-rise magnitude increased from 3.03 V to 11.55 V. Selected-order Node S3 VTHD increased monotonically from 1.104% to 1.395%. Baseline-corrected harmonic transfer impedance also increased at every assessed harmonic, supporting a feeder-impedance-driven voltage-response mechanism. In contrast, transformer loading remained within 14.44–14.52%, total transformer loss within 350.26–350.93 W, hot-spot temperature within 38.229–38.246 °C, and common-baseline relative aging within 0.2863–0.2871. The results demonstrate that feeder weakness can materially increase remote-node voltage and harmonic sensitivity without producing a corresponding increase in transformer thermal severity. Network voltage response and transformer consequence should therefore be assessed as related but non-equivalent engineering domains. By separating power quality management from transformer thermal risk, distribution utilities can avoid premature asset replacement, enabling targeted, resource-efficient investments that support sustainable grid planning and long-term renewable integration (SDG 7 and SDG 9).

ENG-O-3

Simulating Growth and Decay Kinetics of Non-Pathogenic *Escherichia coli* Under Controlled Laboratory Conditions for Application to the Isipingo River

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Microbial contamination remains a major concern in Sub-Saharan urban rivers due to its link with diarrhoeal diseases and public health risks. However, few studies have developed models describing the growth and decay behaviour of *Escherichia coli* (*E. coli*). Using the uMhlangane River in the eThekweni municipality, river water was used to conduct microcosm experiments at average high and low temperatures of 18°C and 28 °C, respectively. Other microcosms had sediment while others didn't, to investigate *E. coli* persistence in a representation of the river bed and the water column for this preliminary experiment.

At 18°C, *E. coli* decayed significantly in sediment-free microcosms ($p = 0.0049$; $T_{90} = 40.1$ days), but showed no significant decay with sediment present ($p = 0.167$). At 28°C, decay was significant in both treatments, though at markedly different rates: sediment-containing microcosms had a T_{90} of 165.5 days ($p = 0.0127$), indicating survival in the river bed for nearly half a year, while sediment-free microcosms had a much shorter T_{90} of 15.5 days ($p = 0.0053$).

This disparity suggests that surface-water testing alone may underestimate *E. coli* persistence and the associated health risk. The sediment's protective effect was evident within just 24 days, highlighting the need for long-term longitudinal studies, such as the ongoing Isipingo River trial, to fully characterise this hazard; a longer-term experiment simulating the Isipingo River under comparable conditions is now underway. These findings show that temperature and sediment influence *E. coli* survival. Sediment prolongs bacterial persistence by providing protection, increasing potential health risks. The results provide baseline information to support improved management of river water used for domestic, recreational, and irrigation purposes in South Africa.

ENG-O-4

LIFE CYCLE COST AND BENEFIT ANALYSIS OF MODERN DRIP IRRIGATION SYSTEMS: A SYSTEMATIC REVIEW

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Water scarcity, increasing energy and input costs, and the need to improve agricultural productivity have necessitated the need to adopt efficient drip irrigation technologies [1]. Modern drip irrigation systems integrate pressure-compensating and low-flow emitters, sensor-based automation, precision fertigation, variable speed pumps and renewable energy technologies to improve resource-use efficiency and productivity. However, their widespread adoption remains constrained by high upfront investment costs and limited understanding of their long-term economic viability [2]. This study evaluates whether the long-term economic and operational benefits of modern drip irrigation systems justify their higher initial investment compared to traditional drip systems.

A systematic literature review of 163 peer-reviewed studies published between 1990 and 2026 was conducted to synthesise the costs and benefits of traditional and modern drip irrigation systems. Sixteen life-cycle cost components were identified and grouped into capital expenditure (CAPEX), operational expenditure (OPEX) and end-of-life costs. Economic evidence, including net present value, benefit-cost ratio, internal rate of return and payback period, was synthesised alongside indicators of water-use efficiency, energy savings, fertilizer-use efficiency, labour requirements and crop productivity. Modern systems consistently require 77-381% higher upfront CAPEX, but generally reduced OPEX by 19-30% through reduced water and energy consumption, labour requirements and maintenance costs while improving resource-use efficiency and agricultural productivity. The review also identified substantial inconsistencies in cost reporting and lack of standardised life-cycle cost methodologies.

Overall, the evidence indicates that the long-term agronomic and economic benefits of modern drip irrigation systems generally outweigh their higher initial costs through lower operating expenses, improved resource-use efficiency, longer system lifespans and shorter payback periods. These findings provide an evidence base for policymakers, financial institutions and farmers to support investment decisions and highlight the importance of adopting a life-cycle perspective rather than relying solely on initial capital costs when evaluating drip irrigation systems.

References

1. Hernández Lagana, M. and P. Mejias Moreno, *AQUASTAT water data snapshot 2025*. 2025, FAO: Rome, Italy. p. 48 p.
2. Ali, A., et al., *Investment profitability and economic efficiency of the drip irrigation system: Evidence from Egypt**. *Irrigation and Drainage*, 2020. **69**(5): p. 1033–1050.

ENG-O-5

VALORISATION OF SANITATION WASTE FOR ALTERNATIVE BUILDING MATERIAL SYNTHESIS

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Approximately 4.2 billion people globally lack access to safe sanitation, leading to significant faecal sludge (FS) risks to public health and the environment. In South Africa, about 2.7 billion people rely on non-sewered sanitation systems. Concurrently, the buildup of inert silt in sewer systems in eThekweni complicates municipal waste management and affects nearby communities. Meanwhile, the construction industry continues to use large amounts of water, virgin clay, and cement, leading to high costs and land degradation. The incorporation of waste valorization in this study addresses these connected challenges. The aim is to explore the use of FS, polymer liners from the LOOWATT sanitation system, and municipal sewer silt from Durban in hybrid fired-clay bricks. The raw materials were characterized by different methods, including elemental analysis (CHN), Thermogravimetric analysis (TGA), X-ray fluorescence (XRF), X-ray diffraction (XRD), heavy metal analysis, and

chemical and biological analysis. The factorial mix approach assessed the replacement of FS (0-15 wt.%), sewer silt (0-20 wt.%), and polymer liners (2 wt.%) to create hybrid bricks, using purely clay bricks as a reference. These bricks are created through mixing, molding, drying, and firing at 950°C. The fired bricks were tested for compressive strength, water absorption, apparent porosity, and firing shrinkage in accordance with SANS 227:2019. Results obtained showed compressive strengths ranging from 14 to 35 MPa, with water absorption in the range of 14% to 17%, indicating better durability. Thermal conductivity decreased by 20% to 30% compared to conventional clay bricks, enhancing insulation. Firing shrinkage remained around 3% to 6 %, preventing structural cracking, while heavy metals were immobilized by USEPA standards. This research aims to create a SANS-compliant building material that minimizes landfill waste, generates local jobs, promotes circular economy principles, and supports Sustainable Development Goals for clean sanitation and sustainable cities.

ENG-O-6

INVESTIGATING THE POTENTIAL TO ACCURATELY MEASURE RIVER FLOW DISCHARGE USING REMOTE SENSING TECHNIQUES

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River discharge is a key parameter for water resource management, flood mitigation, and hydrological monitoring, yet South Africa's traditional river gauging network has declined markedly in operational density since the 1980s [1]. Physical gauging structures, while accurate, are costly to construct and maintain and can be ecologically disruptive. As a result of this, there are several rivers in the country that are not monitored. This creates a need for low-cost, non-intrusive, and scalable supplementary methods of river discharge estimation.

Particle Image Velocimetry (PIV), particularly Large-Scale PIV (LSPIV), offers a promising ex-situ alternative. LSPIV can be used to derive surface flow velocity fields from video imagery. These fields can be converted into volumetric discharge through a "virtual weir" approach combining surface velocity, a velocity coefficient, and channel bathymetry [2]. LSPIV has been used successfully internationally across varied flow conditions and camera platforms, achieving accuracies of approximately $\pm 5\text{--}10\%$ relative to conventional gauging methods [3], at a fraction of the cost of physical gauging weirs or Acoustic Doppler Current Profilers (ADCPs). However, empirical validation of LSPIV-based virtual weirs within a South African context remains absent from the literature.

This MSc study addresses this gap through the design, deployment, and evaluation of a solar powered, remotely accessible LSPIV virtual weir station at a pilot site in the uMngeni Catchment, KwaZulu-Natal. A feasibility assessment was first conducted covering power management, cellular data transfer, data sharing, and camera performance under sun glare and reduced tracer visibility. The proposed system will integrate a fixed outdoor camera, an embedded single-board computer, and a 4G-enabled remote interface for continuous, low-maintenance image capture. Thereafter, the discharge estimates from the

virtual weir will be compared against an independent reference gauge to assess the discharge measurement accuracy and identify sources of error specific to South African rivers. By quantifying the accuracy, cost, and operational feasibility of a low-cost LSPIV-based virtual weir under local conditions, this research aims to support a framework for increasing river gauging density in South Africa at a fraction of the cost of traditional infrastructure.

References

- [1] Johnson, K, Smithers, J, Singh, K and Khushi, N. 2021. Impacts of floods and data availability, data quality and data screening on the estimation of design floods. Water Research Commission.
- [2] Tsubaki, R, Moramarco, T, Manatis, G, Le Coz, J and Muste, M. 2025. Advances in river measurement technologies. *New Waves in Hydrometry* 1 36–59.
- [3] Torres, W, Torres, A, Valencia, E, Pinchao, P, Escobar-Segovia, K and Cando, E. 2024. Experimental validation of a remote sensing method for river velocity measurement using an open-source PIV scheme. *Water* 16 (22): 3177.

ENG-O-7

Experimental Physical Benchmark for Accurate Software Emulation of a Transmission Line: A Foundation for Hardware-in-the-Loop Validation

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Power system flexibility and stability assessment under intermittent renewable energy integration requires transmission line software models that accurately replicate the physical behavior of transmission lines to enable reliable hardware-in-the-loop (HIL) validation. This study utilizes a Lucas-Nülle 300 km three-phase laboratory transmission line represented in software by lumped series, nominal π and distributed-parameter models. The physical benchmark comprises a nominal π -equivalent circuit with per-phase series resistance ($7.2\ \Omega$), inductance (230 mH), inter-phase capacitance ($3 \times 300\ \text{nF}$), phase-to-earth capacitance ($3 \times 1.1\ \mu\text{F}$) and neutral return impedance ($15\ \Omega + j62.83\ \Omega$). The software models were evaluated against measured receiving-end voltages under resistive (100 Ω , 500 Ω and 750 Ω) and inductive loading conditions. The lumped series model demonstrated the highest accuracy while the distributed-parameter model produced unrealistic voltage amplification for this hardware scale. A power-angle ($P-\delta$) relationship incorporating line resistance, neutral grounding through an attenuation factor ($\kappa = 0.828$) and series compensation was also derived. The validated transmission line model was subsequently integrated into a three-bus ring network and assessed using linear load flow, Newton–Raphson with Iwamoto stabilization, Gauss–Seidel and continuation power flow methods. The resulting benchmark provides a physically validated reference for transmission line software modeling in HIL environments, supporting credible quasi-dynamic stability studies

of renewable-dominated power systems while aligning with the model verification principles recommended by NERC and ERCOT.

ENG-O-8

Low-Cost Online Water Quality Monitoring of Water Efficient Sanitation Systems using Soft Sensors

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Water Efficient Sanitation Systems (WESS) provide decentralised wastewater treatment for schools and communities where conventional sewer infrastructure is unavailable. Although these systems are capable of producing high-quality effluent, maintaining consistent treatment performance requires regular monitoring. Routine laboratory analyses are often costly and time consuming, making continuous monitoring of multiple decentralised systems impractical.

This study investigates the development of a low-cost, real-time water quality monitoring platform for WESS by integrating commercially available physical sensors with data-driven soft sensor models. The monitoring system continuously measures turbidity, electrical conductivity, total dissolved solids, pH, oxidation-reduction potential, and temperature to monitor treatment performance throughout the treatment process. These measured parameters are combined with regression-based soft sensor models developed using laboratory reference data to estimate key water quality parameters that cannot be measured directly using low-cost sensors, including chemical oxygen demand (COD), total nitrogen (TN), and phosphate.

The study also considers the practical challenges associated with long-term field deployment, including sensor integration, housing design, power management, sensor interference, Internet of Things (IoT) communication, and overall system reliability under wastewater operating conditions. By combining continuous physical measurements with predictive modelling, the monitoring platform aims to provide near real-time assessment of treatment performance, allowing changes in process operation to be identified without relying solely on routine laboratory analyses.

Current work focuses on laboratory validation of the sensor platform, calibration of individual sensors, and development and evaluation of the soft sensor models using paired laboratory and real-time monitoring datasets. The proposed system provides an affordable and scalable approach for continuous monitoring of decentralised wastewater treatment systems and supports improved operational decision-making for Water Efficient Sanitation Systems.

Developing a Provincial-Scale Transport–Emissions Modelling Architecture for Data-Constrained Regions: A Case Study of KwaZulu-Natal, South Africa

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Transportation networks are a major contributor to environmental degradation, generating significant greenhouse-gas emissions and local air pollutants that pose growing challenges for climate change and public health. However, in many data-constrained developing regions, the assessment of transport-related environmental impacts remains limited by the absence of modelling architectures capable of linking traffic activity, operating conditions and emissions in a spatially explicit manner across transportation networks. Existing approaches are commonly restricted to aggregated fuel-based inventories developed for national reporting under the Intergovernmental Panel on Climate Change (IPCC) and United Nations Framework Convention on Climate Change (UNFCCC) guidelines or to site-specific corridor studies, both of which provide limited support for regional transport planning and environmental mitigation. This study developed a provincial-scale transport-emissions modelling architecture for application in data-constrained regions, using KwaZulu-Natal, South Africa, as a case study. A structured framework was established to evaluate alternative modelling components across five functional levels, namely transport-demand modelling approaches, traffic-assignment platforms, elevation integration techniques, emission estimation models and vehicle-fleet data sources. Candidate configurations were assessed using a weighted multi-criteria evaluation procedure to identify the architecture that best balanced scientific robustness, data availability and implementation feasibility. The highest-ranked architecture integrated the traditional four-step travel-demand model, PTV Visum, Google Maps Elevation API, the Handbook Emission Factors for Road Transport (HBEFA) and Online Vehicle Marketplace vehicle-fleet data. The selected architecture was implemented using a provincial transport model developed for KwaZulu-Natal, where it successfully quantified road-transport emissions in a spatially explicit manner across the provincial road network. The model estimated annual greenhouse-gas emissions of approximately 7.68 Mt CO₂e for the 2019 base year and quantified their spatial distribution across the province, enabling the identification of major emission hotspots together with the relative contributions of municipalities, vehicle classes and air pollutants. Primary validation against an independently developed IPCC Tier-1 fuel-based greenhouse-gas inventory demonstrated reasonable agreement for carbon dioxide (CO₂), methane (CH₄) and nitrous oxide (N₂O), while secondary validation showed that the estimated annual carbon dioxide equivalent (CO₂e) emissions differed by only 5.78% from the published 2019 KwaZulu-Natal transport-sector greenhouse-gas inventory. These findings demonstrate that the proposed architecture provides a robust and transferable framework for provincial-scale road-transport emissions assessment, hotspot identification and evidence-based mitigation planning in data-constrained regions.

Keywords: Transport Emissions; Travel Demand Modelling; HBEFA; PTV Visum

Sustaining waste management gains in informal settlements: Beyond parachute solutions

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Informal settlements located adjacent to rivers are major sources of plastic pollution, and municipal waste services in these areas are often intermittent or absent. A central question is whether externally funded waste management interventions produce change that outlasts the intervention itself, since most evaluations assess performance only while support is still in place. This study analyses the post-termination trajectory of an 18-month municipal and community-based waste intervention in Quarry Road West, an informal settlement in the eThekweni Municipal Area, South Africa, drawing on a household survey of 329 respondents conducted approximately one year after project closure. Waste management practices returned to levels statistically indistinguishable from pre-intervention conditions. This return occurred regardless of a household's participation. Municipal systems absorbed only a part of the service gap. Perceived voice in decision-making was associated with more positive outcomes. Residents identified infrastructure and service provision, rather than education, as their primary need, and informal waste-related livelihoods did not persist once funding ended. These findings follow other similar post-termination trajectories, reflecting a recurring structural pattern in externally funded service interventions. Sustainable outcomes in informal settlements appear to depend less on participation measured by attendance and more on meaningful community influence and institutional transition planning that outlasts external funding.

Significance:

- Externally funded waste management interventions in informal settlements are rarely evaluated after funding ends, leaving their long-term sustainability poorly understood.
- This study provides a rare post-termination evaluation of a community waste intervention in an African informal settlement, showing that gains achieved during implementation were not sustained.
- Meaningful community voice in decision-making, rather than participation measured by attendance, was more strongly associated with lasting behavioural change
- These findings are relevant to municipalities, NGOs, and practitioners designing waste and service-delivery interventions in informal settlements across the Global South.

ENG-O-11

Innovative Application of Nuclear in Isotopic-Pathogen Tracer Study in Peri-Urban Rivers

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Rivers in peri-urban areas of South Africa are under serious pressure from poor sanitation, growing informal settlements, and aging wastewater infrastructure that frequently fails to prevent raw sewage from entering watercourses. In the eThekweni Municipality, this is evident in most rivers, particularly the uMhlangane and uMhlatuzana rivers, where the annual average *E. coli* concentrations recorded for 2025 by eThekweni Water Sanitation (EWS) to be as high as 86,498 and 57,496 CFU/100 mL respectively. These values are far beyond the 0 CFU/100 mL limit set by SANS 241-1:2015 and point to severe ongoing faecal contamination from multiple overlapping sources. Severe rainfall patterns now attributed to eThekweni in the wet season further intensify pathogen influx into and transport within river systems. In order to address this, the municipality has been rolling out Water Efficient Sanitation Systems (WESS) in several catchments, including Low Flush Aquonic units along the uMhlatuzana River, Enviro Loo Clear units along the uMdloti River, and NEWgenerator units within the uMgeni and Ohlanga catchments. However, it is not yet clear whether these systems are actually helping to reduce pathogen loads in the rivers. This study sets out to investigate that question by applying stable water isotope tracing ($\delta^{18}\text{O}$ and $\delta^2\text{H}$) that acts as a major tracer element, as well as physicochemical parameters and climate conditions (such as temperature and rainfall) as consecutive tracer input for the End-Member Mixing Analysis (EMMA) to identify and quantify the contributions of different water sources (groundwater, stormwater, random tributaries, and wastewater treatment works) being discharged into the rivers at downstream monitoring points. Machine learning will be further applied to strengthen the EMMA analyses in terms of source attribution. Phase 1 results from upcoming sampling (July-September 2026) will be analyzed and presented.

Keywords: *E. coli* · End-Member Mixing Analysis · Machine learning · Peri-urban water quality · Stable water isotopes · Water Efficient Sanitation Systems (WESS)

ENG-O-12

A Decision Framework for Sludge Management and Valorization to De-risk Water-Efficient Sanitation Systems

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Water-Efficient Sanitation Systems (WESS) are a relatively new class of decentralized, non-sewered sanitation technology that reduces water demand and infrastructure costs compared with conventional sewer systems. Their long-term viability depends on several factors, including user acceptance, financial sustainability, and mechanical maintenance, but effective sludge management is the most operationally critical: unmanaged accumulation drives high desludging costs, increases system failure risk, and reduces resource-recovery value. This project develops an evidence-based decision framework for sludge management and valorization across four WESS sites, Pholani (Enviroloo), Ekuthuleni, Oakford (Prana), and the Upper and Lower Malacca systems, by integrating sludge characterization, accumulation quantification, settling assessment, risk classification, and techno-economic screening of valorization routes.

A population balance equation model of floc aggregation in unstirred WESS tanks, built from Brownian motion and differential settling, produced a field-deployable diagnostic in which turbidity declines roughly twice as fast as total suspended solids during early aggregation. Physicochemical characterization across the sites has shown wide variability in sludge strength and consistently low pH, while weekly monitoring of sludge blanket height at the Malacca sites is generating tank-specific accumulation rates to guide desludging planning. Together, these results will underpin the risk classification and valorization screening needed to complete the decision framework, giving WESS operators and regulators a structured, evidence-based basis for de-risking decentralized sanitation infrastructure.

ORAL ABSTRACTS

PHYSICS

PHYS-O-1

Preparation of optical Schrodinger cat states using coherent control and their applications

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A control technique in [1] is used to prepare an atom trapped in a Fabry-Perot cavity [2] in a desired state using a sequence of interactions with prepared single photons, which are the controllers. The trapped atom has a lambda configuration i.e. it is a 3-level atom which has 2 ground states and 1 excited state, for example, a Rubidium-87 atom. The prepared atom-cavity system can then be used to generate Schrodinger cat states by reflecting coherent states of light off the prepared atom-cavity system [3]. Entanglement can be generated between different cavity modes, the atoms and the photons. This talk will detail the evolution of the coherent states of light as they move through the atom-cavity system. Applications of the photonic cat states will be discussed.

[1] Konrad, T., Rouillard, A., Kastner, M. and Uys, H., 2021. Robust control of quantum systems by quantum systems. Physical Review A, 104(5), p.052614.

[2] Reiserer A., Kalb N., Rempe G., and Ritter S., A quantum gate between a flying optical photon and a single trapped atom, Nature 508, 2237(2014)

[3] Batin A.Q., Ghosh S., Roy U., and Vitali D., Engineering entangled Schrodinger cat states of separated cavity modes in cavity QED, Phys. Rev. A **110**, 043717

PHYS-O-2

Measurement of the Dark Energy Spectroscopic Instrument (DESI) Galaxy cluster bulk velocity with kinematic Sunyaev-Zeldovich (kSZ) signals from Atacama Cosmology Telescope Polarimeter (ACTPol) Data Release 4

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In this research project, the Dark Energy Spectroscopic Instrument (DESI) galaxy cluster bulk velocity will be measured using kinematic Sunyaev-Zeldovich (kSZ) signals from the Atacama Cosmology Telescope Polarimeter (ACTPol) Data Release 4. The kSZ signal will be detected using 1-point statistics, then developing and applying aperture photometry on the BOSS North and Deep 56 regions of ACTPol DR4. With the extracted kSZ signal, the bulk velocity of the galaxy cluster will be estimated using galaxy cluster positions from the DESI Legacy Imaging Survey Data Release 8.

PHYS-O-3

***BiFeO₃* Multifunctional Thin Films for Energy Storage and Non-Volatile Memory Devices**

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In this work, a *TiN/BiFeO₃* interdigitated capacitor was fabricated on p-type silicon by room-temperature pulsed laser deposition. The capacitor was characterised at 1, 10 and 100 kHz over AC test levels from 20 to 1000 mV by analysing its series capacitance, dissipation factor and series-equivalent resistance. *BiFeO₃* (BFO) is attractive for multifunctional thin-film capacitors because its room-temperature ferroelectric polarization can contribute to electrical energy storage and retain electrically written states, while its semiconducting transport and interface-sensitive conduction provide an additional route to resistive switching. These responses can coexist in a single capacitor architecture, but their interpretation depends strongly on leakage current, electrode interfaces, substrate conduction and electrode geometry. The capacitor exhibited a repeatable frequency-dependent response with comparatively weak dependence on the applied AC test level. The voltage-averaged series capacitance decreased from 13.38 pF at 1 kHz to 11.27 pF at 100 kHz. The lowest mean dissipation factor was 0.0613 at 10 kHz, while the series-equivalent resistance decreased from 1.16 MΩ at 1 kHz to 10.0 kΩ at 100 kHz. Capacitance values obtained using two independent LCR-meter acquisition configurations agreed within 1.3%, and the measured capacitance, dissipation factor and resistance were internally consistent at 10 and 100 kHz. Conformal-mapping analysis yielded apparent lower-side relative permittivities of 46.3, 43.0 and 38.8 at 1, 10 and 100 kHz, respectively. Since the fringing electric field penetrates both the BFO film and the p-type silicon substrate, these values describe the effective terminal response of the complete *TiN/BFO/Si* capacitor rather than the intrinsic permittivity of BFO only. These results establish a validated electrical characterisation baseline for the *TiN/BFO/Si* capacitor, providing the basis for the retention and switching measurements needed to evaluate its suitability for non-volatile memory applications.

Keywords: *BiFeO₃*, Pulsed laser deposition, room temperature, Interdigitated capacitor, Frequency dependent, and P-type silicon substrate.

PHYS-O-4

Wind Resource and Energy Potential Assessment in Ten Nigerian Cities Based on a Modified Bimodal Mixture Weibull Probability Density Function

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The potential for wind resources in Nigeria is spatially heterogeneous and strongly controlled by seasonal circulation, terrain exposure, surface roughness, elevation, and coastal and inland atmospheric forcing. This study assessed wind speed distributions and energy potential in Bauchi, Calabar, Ilorin, Jos, Kaduna, Kano, Maiduguri, Nsukka, Owerri, and Uyo using the Modified Bimodal Mixture Weibull probability density function. Twenty-one years of average monthly wind speed data measured at 10 m above ground level were obtained, cleaned for missing values, negative and non-numeric entries, and fitted independently for each site. The model couples two Weibull components via a logistic transition function, allowing a smooth representation of low and high-speed regimes, skewness, bimodality, and energy-relevant upper and tail behaviour. Parameters were estimated using maximum likelihood, while model adequacy was evaluated using AIC, BIC, RMSE, the Chi-square test, the Kolmogorov-Smirnov test, and Monte Carlo validation. Results revealed substantial inter-site variability. Calabar recorded the highest mean wind speed of 5.8906 m/s, followed by Kaduna, Maiduguri, Uyo, and Kano, whereas Jos had the weakest mean speed of 3.3269 m/s. The fitted model reproduced empirical PDF and CDF structures with generally low RMSE and K-S values. Kaduna showed the strongest fit. Energy estimates projected Kaduna as the leading site, with an annual energy density of 1218.0897 kWh m⁻² yr⁻¹ and wind power density of 139.3836 W/m², followed by Calabar, Maiduguri, and Uyo. The findings indicate that the Modified Bimodal Mixture Weibull PDF provides a reliable framework for city-level wind resource classification and renewable energy planning in Nigeria.

Keywords: Modified Bimodal Mixture Weibull, wind resource assessment, wind power density, annual energy density, probability density function, Monte Carlo validation, Nigerian wind regime.

PHYS-O-5

DEVELOPMENT OF A REMOTE, SELF-SUSTAINING, LOW-COST, LOW-POWER GNSS RTK BASE STATION FOR CORS APPLICATIONS

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The expansion of Continuously Operating Reference Station (CORS) networks in South Africa is limited by the high cost of geodetic-grade infrastructure, resulting in sparse coverage from networks such as TrigNet and reduced capability for centimeter-level Real-Time Kinematic (RTK) positioning and ionospheric monitoring in many regions. This study presents the design, development, and evaluation of two low-cost, low-power GNSS base station prototypes for autonomous deployment in remote environments, currently deployed at the South African National Space Agency (SANSA) in Hermanus. The first prototype is built around a u-blox ZED-F9P receiver integrated with a Raspberry Pi 4, while the second uses a SparkFun GNSS Flex pHAT incorporating a Septentrio mosaic-X5 receiver integrated with a Raspberry Pi 5. Both systems are powered by a solar energy subsystem consisting of a 100 W solar panel, an MPPT charge controller, and a lithium iron phosphate battery, with the remaining hardware architecture common to both prototypes. The ZED-F9P-based station streams RTCM 3.3 MSM7 observations in real time to the SANSA NtripCaster via a 4G LTE connection while simultaneously logging hourly UBX binary observation files, which are converted into RINEX files. The mosaic-X5-based station records raw Septentrio Binary Format (SBF) observations, which are subsequently converted into Ionospheric Scintillation Monitoring Receiver (ISMR) products to support ionospheric and space weather monitoring. Performance is evaluated through co-location testing with a scientific-grade GNSS receiver, demonstrating that the low-cost stations produce observations of sufficient quality for RTK positioning, ionospheric Total Electron Content (TEC) estimation, and scintillation monitoring. The results demonstrate that the proposed systems provide a practical, scalable, and cost-effective approach to increasing CORS network density while supporting GNSS-based space weather monitoring across southern Africa.

Keywords: GNSS, RTK, CORS, TrigNet, NTRIP, ZED-F9P, ionospheric monitoring, TEC, RINEX, RTCM, low-cost, autonomous deployment, SANSA

PHYS-O-6

Variational Quantum Eigensolver and The Measurement Test Algorithm

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Future quantum computers can solve problems that are currently bottlenecks for classical computers; such computations can be found in fields such as cryptography, optimisation, and materials science [1]. Quantum computers also promise to revolutionise the fields of quantum computational chemistry [2,3] and materials design by simulating complex quantum systems with a level of accuracy that is not feasible with classical means [4].

Our presentation will introduce the principles of the Variational Quantum Eigensolver (VQE) algorithm for quantum chemistry (Electronic Structure Problem) and demonstrate its application to molecular systems, such as hydrogen (H_2) and lithium hydride (LiH) [5]. All quantum computations will be executed by backends or simulators, which are configured by and managed using the Qiskit framework. In addition to computing molecular ground state energies, this work implements the **Measurement Test algorithm** proposed by **Prof. T. Konrad and Dr A.G. Tene** to evaluate the quality of variational trial wavefunctions [6]. The

algorithm allows an assessment of how close the optimised trial wave state approximates the true molecular ground state, therefore validating the VQE results beyond the standard norm of energy convergence.

References:

- [1] Feynman, R.P., 2018. Simulating physics with computers. *Feynman and computation*, 22, pp.133-153.
- [2] Aspuru-Guzik, A., Dutoi, A.D., Love, P.J. and Head-Gordon, M., 2005. Simulated quantum computation of molecular energies. *Science*, 309(5741), pp.1704-1707.
- [3] Cao, Y., Romero, J., Olson, J.P., Degroote, M., Johnson, P.D., Kieferová, M., Kivlichan, I.D., Menke, T., Peropadre, B., Sawaya, N.P. and Sim, S., 2019. Quantum chemistry in the age of quantum computing. *Chemical reviews*, 119(19), pp.10856-10915.
- [4] Alexeev, Y., Amsler, M., Barroca, M.A., Bassini, S., Battelle, T., Camps, D., Casanova, D., Choi, Y.J., Chong, F.T., Chung, C. and Codella, C., 2024. Quantum-centric supercomputing for materials science: A perspective on challenges and future directions. *Future Generation Computer Systems*, 160, pp.666-710.
- [5] Tilly, J., Chen, H., Cao, S., Picozzi, D., Setia, K., Li, Y., Grant, E., Wossnig, L., Rungger, I., Booth, G.H. and Tennyson, J., 2022. The variational quantum eigensolver: a review of methods and best practices. *Physics Reports*, 986, pp.1-128.
- [6] Tene, A.G. and Konrad, T., 2026. Solving a Linear System of Equations on a Quantum Computer by Measurement. *arXiv preprint arXiv:2604.26098*.

PHYS-O-7

Detection of Kinematic Sunyaev Zel'dovich Signals Using the Pairwise Momentum Estimator

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The kinematic Sunyaev-Zel'dovich (kSZ) effect comes from the Doppler shift of Cosmic Microwave Background (CMB) photons scattered by moving galaxy clusters. It offers a strong way to study the large-scale velocity field and test cosmological models. In this thesis, we aim to detect the kSZ signal by using the pairwise momentum estimator on data from the Atacama Cosmology Telescope Polarimeter (ACTPol). This method improves the weak kSZ signal by measuring the average momentum between pairs of galaxy clusters. This allows us to extract information about their peculiar velocities. We combine high-resolution CMB temperature maps from ACTPol with external DES Legacy Survey cluster catalogs for extra kSZ signals.

PHYS-O-8

Variational Monte Carlo and the Quantum-Enhanced Metropolis-Hastings Algorithm

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Variational Monte Carlo (VMC) is a widely used stochastic technique for estimating the ground-state properties of quantum systems. Its performance, however, is fundamentally limited by the efficiency of the classical Metropolis-Hastings (MH) sampling algorithm. As quantum computing continues to mature, hybrid quantum-classical approaches provide new opportunities to improve Monte Carlo sampling strategies.

In this work, we investigate a hybrid quantum-enhanced Metropolis-Hastings algorithm within the single-thread Monte Carlo framework for ground-state energy estimation. Using a three-level Hamiltonian as a proof-of-concept model, we compare a classical implementation with a quantum-enhanced acceptance procedure based on quantum phase estimation and quantum circuit representations of the Metropolis algorithm. Both methods are evaluated under identical simulation conditions to assess convergence behaviour, estimator precision, and computational performance.

The quantum-enhanced approach consistently demonstrates faster convergence towards the exact ground-state energy and reduced statistical uncertainty compared with the classical algorithm. For the test Hamiltonian, the hybrid implementation achieves the same level of numerical accuracy in fewer Monte Carlo steps while producing a more precise energy estimate after extended sampling. Although all simulations were performed on classical hardware, the proposed framework illustrates how quantum resources may improve Monte Carlo sampling in future fault-tolerant quantum computers.

These results demonstrate the potential of hybrid quantum-classical algorithms to enhance stochastic simulation methods and provide a foundation for extending quantum-enhanced Monte Carlo techniques to larger many-body systems and more realistic Hamiltonians.

PHYS-O-9

Effect of Nickel Substitution on Magnesium Ferrite Nanoparticles and Their Application in Spinach Cultivation

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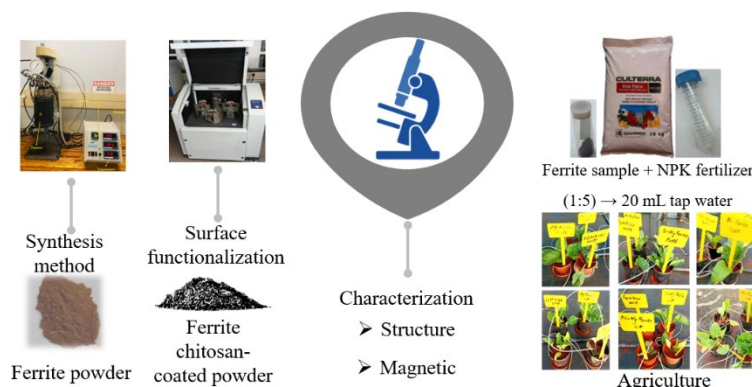
Supervised by Dr Wendy Mdalose and Dr Jerry Dlamini

This study examines the structural, morphological, and magnetic properties of nickel-substituted magnesium ferrite nanoparticles. The nanoparticles were synthesised via the

glycol-thermal method and coated with biocompatible chitosan via ball milling. Characterisation techniques, including X-ray diffraction (XRD), Fourier transform infrared (FTIR) spectroscopy, high-resolution transmission electron microscopy (HRTEM), and vibrating sample magnetometry (VSM), were employed. XRD confirmed single-phase spinel structures, with decreasing crystallite sizes (11.4–8.60 nm) and lattice parameters (8.38–8.33 Å) as Ni content increased. A fluctuation in crystallite size was observed in the coated nanoparticles, ranging from 5.90 to 10.7 nm. FTIR supported the spinel-structure findings and revealed the characteristic chitosan peaks. TEM revealed semi-spherical particles with varying degrees of agglomeration, and the coated materials were well dispersed, confirming nanoscale dimensions. However, the coated materials showed a significant decrease in saturation magnetisation, ranging from 1.1 to 2.9, indicating paramagnetic behaviour. SEM revealed a rough surface for the as-prepared materials and smoother surfaces after coating, and EDX confirmed the elemental composition. Magnetic analysis showed a mixture of ferrimagnetic and paramagnetic behaviour, with the saturation magnetisation increasing from 45.74 to 70.39 emu/g.

The early growth response of spinach seedlings was assessed using magnesium ferrite (MF), a mixed 0.5(Ni–Mg) ferrite (NMF), and nickel ferrite (NF), applied at 0.5 g per 2.5 g of fertiliser. MF treatment pair revealed (chlorophyll content of about 21.1%, LAI with a range between 0.596–0.929), the NF treatment pair inhibited it (chlorophyll content of about 46.7%, LAI 0.587–0.982), and the NMF treatment pair produced intermediate effects (chlorophyll content of about 87.8%, LAI 1.08–0.910). Overall, the MF showed promising crop growth, and the NMF treatment pair provided partial recovery and balance properties. These findings highlight the potential of these materials for agricultural applications.

Graphical Abstract: This research evaluates the potential of ferrite nanoparticles and their chitosan-treated counterparts to enhance crop growth. Emphasis is placed on synthesis and coating methods in tuning the structural and magnetic behaviour.



PHYS-O-10

ASSESSMENT OF WIND RESOURCES AND ENERGY POTENTIAL IN BISHO, EASTERN CAPE PROVINCE, SOUTH AFRICA, USING A BIMODAL WEIBULL PROBABILITY DENSITY FUNCTION

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Reliable characterization of inland wind regimes is essential for decentralized energy planning in South Africa's Eastern Cape Province, where electricity access and supply reliability remain uneven. Conventional single-Weibull models inadequately represent heterogeneous wind regimes that arise from temporal variation. This study assessed the wind resource and energy potential of Bisho using a bimodal mixture Weibull probability density function. Thirty years of wind speed data (1996 to 2025), measured by the South African Weather Service at 10 m above ground level, were analyzed at 08:00, 14:00, and 20:00. Model parameters were estimated by maximum likelihood estimation using the bound-constrained L-BFGS-B algorithm. Model performance was evaluated using root mean square error, chi-square, Kolmogorov-Smirnov statistics, Akaike and Bayesian information criteria, log-likelihood, and Monte Carlo validation with 1,000 replications. Mean wind speeds were 4.2054, 5.6161, and 4.5711 m/s at 08:00, 14:00, and 20:00, respectively. The corresponding mean wind power densities were 49.228, 114.57, and 61.945 W/m², while annual energy densities were 431.23, 1003.7, and 542.64 kWh/m²/year. The highest resource occurred at 14:00, demonstrating pronounced time-of-day dependence in Bisho's wind regime. The results indicate moderate wind energy potential, with stronger suitability for stand-alone, decentralized, and hybrid renewable energy systems than for large utility-scale generation. The bimodal mixture Weibull PDF, therefore, provides a useful basis for representing temporal wind heterogeneity and supporting local energy planning.

Keywords: Bimodal mixture Weibull, Bisho, Decentralized energy, Wind energy potential, Wind resource assessment

FLASH ABSTRACTS

AGRICULTURAL, EARTH AND ENVIRONMENTAL SCIENCES

AEES-F-1

Integrating Climate Change Modelling with Land Use/Land Cover Assessments to Support Estuary Management in Subtropical KwaZulu-Natal, South Africa

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Estuaries are among the world's most productive ecosystems, providing essential ecological services including biodiversity conservation, flood regulation, carbon sequestration, fisheries support and shoreline protection. Along the KwaZulu-Natal (KZN) coastline, these ecosystems are increasingly threatened by sea-level rise, altered river runoff and expanding anthropogenic land use. Although hydrodynamic climate models can project future flooding and sea-level rise scenarios, translating these outputs into practical management actions remains a significant challenge. Consequently, there is a critical need to bridge the gap between climate science and policy by identifying where climate impacts will occur, which ecosystems and communities are most vulnerable, and what ecosystem-based adaptation responses are required.

This research develops an integrated framework that combines existing high-resolution hydrodynamic climate simulations with Planet scope-derived land use/land cover (LULC) mapping to evaluate the potential climate-driven changes in estuary-associated landscapes across 72 subtropical systems in KwaZulu-Natal. Hydrodynamic simulations produced using Delft3D WAVE and FLOW models under IPCC climate scenarios provide projections of inundation extent, flood duration and water-level dynamics. These outputs are integrated with LULC classification and digitized habitat datasets within estuarine functional zones to quantify potential habitat degradation, loss and gain, identify vulnerable ecosystems in present-day, mid-century and late-century risk zones and assess implications for biodiversity and ecosystem service provision. Representative estuaries, including uThukela, iLovu and uMuziwezinto, provide transferable approaches for application to data-poor systems.

Preliminary analyses indicate that projected sea-level rise and increased flooding will substantially alter estuarine habitats, particularly mangrove and saltmarsh ecosystems, with contrasting responses between urbanized and less-developed estuaries. By integrating climate projections with spatial habitat assessments, this research provides decision-support products that move beyond hazard mapping to identify priority locations for conservation, restoration and ecosystem-based adaptation.

AEES-F-3

Integrating Remote Sensing and Citizen Science for Inland Water Quality Monitoring: A Systematic Literature Review and Bibliometric Analysis

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Inland water quality monitoring is critical for environmental management and public health; however, conventional in situ monitoring approaches are often constrained by high operational costs, labor-intensive field campaigns, and limited spatial and temporal coverage. Remote sensing (RS) and citizen science (CS) have emerged as complementary, cost-effective, and scalable alternatives. Despite their individual strengths, their combined application for long-term inland water quality monitoring remains limited and insufficiently explored, particularly in the Global South, where financial, institutional, and technical constraints continue to hinder comprehensive monitoring programmes.

To address this gap, this study combines a systematic literature review with a bibliometric analysis to examine the evolution, characteristics, and integration of RS and CS for inland water quality monitoring. A total of 81 peer-reviewed publications retrieved from the Scopus and Web of Science databases were analysed using VOSviewer and Biblioshiny (Bibliometrix) to evaluate publication trends, geographic distribution, collaboration networks, influential authors, keyword co-occurrence, and thematic clusters.

The findings demonstrate a substantial growth in research output over the past decade, reflecting growing international interest in both monitoring approaches. However, bibliometric network analyses reveal that RS and CS continue to evolve largely as independent research domains, with limited methodological integration. Furthermore, the review highlights that the literature is geographically dominated by studies from the Global North, highlighting a significant research gap within Africa and other resource-constrained regions.

AEES-F-4

Empowering Smallholder Farmers: Leveraging South African Weather Services Seasonal Climate Information for Climate Adaptation and Enhanced Food Security in Kwazulu-Natal

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This planned study investigates how seasonal climate forecasts from the South African Weather Services (SAWS) can support smallholder farmers in KwaZulu-Natal to better adapt

to climate variability and extreme weather. Employing a mixed-methods approach, surveys, interviews, and focus groups with farmers, extension officers, and climate service providers, the research aims to assess farmers' access to, understanding of, and use of seasonal climate information in agricultural decision-making. Preliminary insights anticipate challenges in accessibility, relevance, and interpretation of forecasts, alongside limited awareness and localized advisory support. The study seeks to identify ways to enhance the climate services value chain through targeted training, participatory dissemination, and stronger collaboration between SAWS, agricultural actors, and communities to improve resilience, food security, and sustainable farming outcomes.

AEES-F-5

Assessing Sustainable Intensification Options for Maize Across Diverse Farm Types in central Malawi

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Smallholder farming systems in Sub-Saharan Africa are highly heterogeneous in terms of resource endowment and livelihood objectives, posing challenges for the design of effective agricultural interventions. In this study we characterize farm system diversity in Mtunthama Extension Planning Area, Kasungu District, Malawi, and evaluate the suitability of sustainable intensification innovations across farm types. Data were collected through focus group discussions and household surveys involving 43 farming households. Principal Component Analysis was used to construct a farm typology, while innovation suitability was assessed using a multi-criteria decision analysis framework.

The analysis identified four distinct farm types reflecting differences in resource endowment and production orientation: High Resource-Endowed farms (HRE), Moderately resource-endowed farms with Mixed crop-livestock orientation (MCL), Diversified Cropping systems (MDV), and Resource-Constrained Maize-dominated farms (RCM). The multi-criteria assessment revealed substantial variation in suitability across types. Conservation agriculture recorded the highest overall score (0.68), followed by intercropping (0.54), while strip cropping showed the lowest (0.25). MDV achieved the highest overall innovation score (0.66), whereas MCL and RCM showed limited uptake.

These findings demonstrate that sustainable intensification effectiveness is shaped not only by resource endowment, but by distinct trade-offs between productivity, income, and sustainability. In particular, the decoupling of maize yield and household income suggests that intensification pathways are context-specific. The framework presented here provides a useful approach for identifying which practice combinations are most appropriate under different structural conditions, offering a practical basis for designing adaptive intervention strategies.

Keywords: context-specific interventions; farm diversity; Malawi; climate resilience; Typology

AEES-F-6

Circular Economy Approaches for Resource Recovery from Drinking Water Treatment Residues: A Scoping Review

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Rapid population growth and urbanisation are driving unprecedented increases in global water demand, placing significant pressure on freshwater resources. To meet the growing demand for potable water, municipalities and water service providers abstract water from rivers, dams, lakes, and groundwater sources. [1]. Conventional drinking water treatment processes, particularly coagulation and flocculation, generate large volumes of water treatment residues (WTRs), which are often disposed of in landfills despite containing valuable mineral constituents that can be recovered [2].

This scoping review mapped the current state of knowledge on circular economy applications for WTRs and identified emerging opportunities and research gaps. A systematic literature search was conducted using the Web of Science and Scopus databases[3]. Of the 1,401 records identified, 491 duplicates were removed, and 534 studies were excluded during title and abstract screening based on predefined eligibility criteria.

The review found that most circular economy applications of WTRs focus on reusing dewatered (solid) residues in construction materials, pollutant adsorption, biochar production, biofilters, constructed wetlands, and soil improvement. In contrast, the reuse of liquid WTRs remains largely unexplored, with only a few studies investigating their potential for irrigation. These findings highlight important research opportunities to advance sustainable WTR management and strengthen circular economy implementation in the water sector.

1. Boretti, A. and L. Rosa, *Reassessing the projections of the world water development report*. NPJ Clean Water, 2019. **2**(1): p. 15.
2. Nguyen, M.D., et al., *Beneficial reuse of water treatment sludge in the context of circular economy*. Environmental Technology & Innovation, 2022. **28**: p. 102651.
3. Musazura, W. and A.O. Odindo, *Characterisation of selected human excreta-derived fertilisers for agricultural use: A scoping review*. Journal of Cleaner Production, 2022. **339**: p. 130516.

AEES-F-7

Seafloor mapping and geophysical characterization of the central Agulhas Slide on the Southern Cape Margin.

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This study couples high-resolution multibeam bathymetry, sub-bottom profiler lines, and 2D seismic reflection data with sediment coring and core-based geotechnical CT analysis to produce a seismic-stratigraphic and geomorphological framework across the headscarp, continental shelf, and upper slope of the Central Agulhas Slide. The Agulhas Slide, situated off southeastern South Africa, is one of the world's largest submarine landslides and exerts a major influence on slope morphology, subsurface fluid migration, and benthic ecosystem development [1],[2]. Previous work on the Kingklip Ridge, a structural high within the Port Elizabeth (PE) Corals Marine Protected Area (MPA), used integrated ground-truthing (Dredge, ROV) to show that faults and glide planes form vertically connected fluid pathways that focus methane-rich fluids to the seabed, producing pockmarks, fluid pipes and authigenic carbonate buildups [1]. Building on these observations, the present work expands the study area across the headscarp, shelf and upper slope to develop seismic stratigraphy and a geomorphological framework that maps scarps, glide planes and mass transport deposits, characterizes weak layers and structural controls through core-based geotechnical CT analyses and quantifies fluid migration links to slope instability and seep development. The combined dataset will constrain failure staging, inform hazard assessments and test the role of structurally controlled fluid flow in mega-slide initiation and emplacement.

References

1. Dingle, R. V., The anatomy of a large submarine slump on a sheared continental margin (southeast Africa), J. Geol. Soc. London, 134, 293-310, 1977
2. Mzolo, B., 2016. Phosphogenesis on the outer shelf and upper slope, offshore Port Elizabeth. BSc Hons Thesis, University of KwaZulu-Natal, 38pp

AEES-F-8

Comparative and Integrated Remote Sensing: Using Multispectral UAV and Satellite Based Imagery to Assess the Distribution and Risk of Invasive Alien Riparian Vegetation

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Riparian ecosystems provide essential ecosystem goods and services including water quality improvement, essential reeds, riverbank stabilisation, flood attenuation, groundwater recharge, and biodiversity conservation. Despite their ecological importance, these ecosystems remain difficult to delineate and monitor because of their narrow spatial extent, as they are often combined with surrounding ecosystems such as wetlands, rivers and floodplains with dynamic characteristics, and the absence of comprehensive Geographic Information System (GIS)-based datasets. In South Africa, riparian zones are among the most heavily invaded environmentally sensitive areas by invasive alien plants, which reduce water availability, alter ecosystem functioning, and threaten biodiversity.

Advances in remote sensing provide opportunities to improve the monitoring and management of riparian zones; however, the comparative performance and integration of Unmanned Aerial Vehicle (UAV)-based multispectral imagery and satellite imagery for identifying, mapping, and monitoring invasive alien riparian vegetation remain insufficiently investigated. This study aims to compare and integrate UAV multispectral and satellite-based remote sensing techniques to identify/detect and map riparian vegetation, classify invasive woody alien plant species, and identify areas at risk of invasion by non-native species. The study will be conducted within the Upper Mkhomazi Catchment, KwaZulu-Natal, South Africa, focusing on selected riparian reaches representative of the catchment's environmental conditions. Vegetation indices, image classification techniques, and predictive spatial modelling will be employed to evaluate vegetation condition and invasion patterns across the catchment. The findings are expected to improve the accuracy of riparian vegetation mapping, support evidence-based invasive species management, and provide a transferable monitoring framework for catchment management and conservation planning.

AEES-F-9

A Bottom-Up Approach to Mapping Water-Energy-Food Nexus Interactions Towards Sustainable and Resilient Agrifood Systems in Socio-Ecologically Vulnerable Context

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Agrifood systems are increasingly challenged by climate change, environmental degradation, and socio-economic pressures that threaten food security and rural livelihoods. KwaZulu-Natal is particularly exposed to climate-related shocks, including severe floods and droughts, alongside persistent social and economic vulnerabilities. Building sustainable and resilient agrifood systems in such contexts requires more than technically designed solutions; it demands pathways that reflect the lived realities, priorities, and capacities of local communities. Yet, research and decision-making surrounding interconnected water, energy, food, and land resources are predominantly undertaken through top-down frameworks, with limited integration of local experience and knowledge. To address this gap, this study uses Swayimane, a socio-ecologically vulnerable rural community in KwaZulu-Natal, as a case study to map water-energy-food (WEF) nexus interactions from the bottom up. Aligned with SDGs 2, 6, 7, and 13, the study employs Community-Based Systems Mapping and Group Model Building to engage local stakeholders as active knowledge holders. The process will enable participants to identify critical interdependencies across water availability, energy access, crop and livestock production, food security, and environmental health, which will be conceptualized through Causal Loop Diagrams (CLDs) to capture underlying feedback mechanisms. This participatory approach creates space for local and Indigenous knowledge to complement scientific knowledge and identify context-specific challenges, trade-offs, and opportunities that may be overlooked by top-down approaches. The resulting causal structures will be analysed to identify potential leverage points and provide a foundation for stakeholder-informed transition pathways. By centering communities in systems mapping and pathway

development, this study seeks to contribute to more inclusive approaches to strengthening climate resilience, food security, and the sustainability of agrifood systems in vulnerable rural contexts.

AEES-F-10

A REVIEW OF DIAGNOSTIC PERFORMANCE OF INDIGENOUS SOIL INDICATORS FOR RAPID SOIL ASSESSMENT IN SMALLHOLDER FARMING SYSTEMS

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Smallholder farmers commonly use indigenous indicators to assess soil conditions and guide land management decisions. These field-based observations are particularly important where access to laboratory soil analysis is limited. Despite the increased recognition of soil indigenous knowledge as a legitimate and complementary knowledge system, uncertainty remains regarding the diagnostic performance of individual soil indicators and their consistency across contrasting environments. This review synthesizes current evidence on the use and performance of indigenous soil indicators in smallholder farming systems. Unfortunately, limited attention has been given to evaluating the diagnostic performance of individual indigenous indicators or their consistency across contrasting environmental conditions. These knowledge gaps provide the scientific rationale for the proposed MSc research, which aims to identify indicators for rapid, low-cost soil assessment in smallholder farming systems. Such evidence has the potential to contribute to the development of evidence-based rapid soil assessment approaches that integrate indigenous knowledge with scientific soil assessment to support sustainable soil management in smallholder farming systems.

KEY WORDS: Indigenous Knowledge; indigenous soil fertility indicators; Smallholder Farming; Diagnostic performance.

AEES-F-11

Optimizing vinegar marination and wood smoking for safe and consumer acceptable rabbit biltong production in KwaZulu-Natal, South Africa

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Background: Rabbit meat is a sustainable, underutilized protein source with potential to improve food and nutrition security in South Africa. However, rabbit meat is highly perishable and value-addition through processing is needed to extend shelf-life and increase marketability. Biltong, a traditional dried meat product, presents an opportunity for rabbit meat utilization. Traditional preservation methods such as vinegar marination and wood

smoking can improve safety and sensory attributes, but there is limited scientific data on their application in rabbit biltong.

Problem statement: The lack of validated processing protocols and safety data for rabbit biltong limits its adoption by small-scale producers. Therefore, there is a need to investigate an approach that combines vinegar marination and wood smoking to ensure microbiological safety and consumer acceptability.

Aim: To determine the effect of vinegar marination and wood smoking on the microbiological, physicochemical, and sensory properties of rabbit biltong during storage.

Objectives:

1. To evaluate the effect of vinegar marination and wood smoking on the microbiological safety and shelf-life of rabbit biltong during storage.
2. To determine the effect of vinegar marination and wood smoking on the physicochemical properties including pH, water activity, moisture content, texture, and color of rabbit biltong during storage.
3. To assess the effect of vinegar marination and wood smoking on the sensory and consumer acceptability of rabbit biltong.

Methodology: Rabbit meat will be marinated in 0%, 1%, 2%, and 3% vinegar treatments. Each treatment will be divided into smoked and non-smoked groups. Wood smoking will be conducted at <30°C for 6 – 8 hours using hardwood. All samples will be dried and stored. Microbiological and physicochemical analyses will be conducted at 0, 7, 14, 21, and 28 days. Sensory evaluations will be conducted at 0, 14, and 28 days. Data will be analyzed using two-way ANOVA.

Expected outcomes and significance: This study will generate data on optimal vinegar levels and the role of wood smoking in improving the safety, quality, and shelf-life of rabbit biltong. The findings will provide evidence-based processing guidelines for small-scale producers and support the utilization of rabbit meat as a sustainable protein source aligned with food security.

Keywords: Rabbit meat, biltong, vinegar, wood smoking, shelf-life, food safety

AEES-F-12

COMPREHENSIVE CHARACTERIZATION OF JUNCAO GRASS (*Cenchrus fungigraminus*) BIOCHAR: CHEMICAL, STRUCTURAL AND SURFACE PROPERTIES

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Juncao (*Cenchrus fungigraminus*) is a rapidly growing, high-biomass, perennial grass that thrives in marginal soils with low inputs, making it an appropriate renewable feedstock for biochar production. This study examined the chemical properties of biochar derived from Juncao grass at 350 and 550 °C pyrolysis temperatures. The feedstock and biochar were

analysed for pH, selected elemental composition and surface properties. Total carbon (C) and nitrogen (N) were higher in biochar (>60% C and >1% N) compared to feedstock (45.5% C and 0.86%). The higher pyrolysis temperature increased fixed C, micro- and macronutrient concentrations, and pH, while volatile matter decreased. The FTIR spectra indicated the disappearance of O–H, C–H, and C=O functional groups and an increase in aromaticity with pyrolysis temperature, whereas scanning electron microscopy (SEM) validated the transformation from dense plant tissue to a more porous biochar structure, particularly at 550 °C. However, the BET surface area remained relatively low at 4.66 and 5.54 m² g⁻¹ for 350 and 550 °C pyrolysis temperatures, respectively. The findings indicate that Juncao grass biochar exhibits increased C, alkalinity, mineral content, and structural porosity as pyrolysis temperature increases, indicating the potential of Juncao biochar for C sequestration.

Keywords: Biochar, elemental composition pyrolysis temperature, and Juncao grass

AEES-F-13

Consumer And Retailer Perceptions Towards Broiler, Indigenous, And Crossbred Chicken Meat in the uMgungundlovu District, KwaZulu-Natal, South Africa

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Consumer perceptions play a fundamental role in determining the acceptance and market success of livestock products. Increasing concerns regarding food safety, animal welfare, environmental sustainability, and the use of growth promoters have contributed to growing consumer interest in poultry products produced under more natural production systems. Crossbreeding indigenous chickens with commercial broilers has emerged as a potential strategy to improve productivity while retaining desirable meat quality characteristics associated with indigenous chickens. However, limited information exists regarding consumer and retailer perceptions towards crossbred chicken meat in South Africa. This study forms part of a broader investigation evaluating the meat quality, carcass characteristics, and consumer acceptance of broiler, indigenous, and crossbred chickens. This study investigated consumer and retailer perceptions towards broiler, indigenous, and crossbred chicken meat in the uMgungundlovu District of KwaZulu-Natal, South Africa. A structured questionnaire was administered to 200 respondents comprising 150 consumers and 50 retailers selected using convenience sampling. Data were analysed using descriptive statistics to determine respondent characteristics, meat consumption patterns, purchasing behaviour, and perceptions towards the three chicken breeds. Most of the respondents indicated previous consumption of indigenous chicken meat and expressed a willingness to purchase indigenous or crossbred chicken meat if commercially available. Consumers associated indigenous and crossbred chicken meat with superior flavour, perceived health benefits, and the absence of growth promoters, while supermarkets remained the primary source of poultry meat purchases. Retailers also recognised potential market opportunities for crossbred chicken meat, although concerns regarding product availability and consumer awareness were identified as potential barriers to market adoption. The findings suggest that crossbred chicken meat has considerable market potential among consumers seeking healthier and more sustainable poultry products. These results provide valuable information for poultry producers, retailers, and policymakers

interested in promoting climate-smart and livelihood opportunities in resource-poor communities.

AEES-F-14

Evaluating the Impact of Milk Replacer Supplementation and Calf Starter Feed Physical Form and Crude Protein Content on Feed Intake and Growth Performance in Female Holstein Friesian Calves: Two Separate Trials

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Optimising preweaning calf nutrition is essential for improving growth performance, feed efficiency, and long-term productivity in dairy production systems. In South Africa, many commercial farms rely on restricted milk feeding programmes, and the use of milk replacers and starter feed modifications remains inconsistent despite evidence that early-life nutrition strongly influences calf development. This study evaluated two nutritional interventions aimed at improving the growth performance of Holstein-Friesian heifer calves during the preweaning period under commercial dairy conditions in KwaZulu-Natal, South Africa.

Two trials were conducted over an eight-week period using a total of thirty newborn Holstein-Friesian calves per trial. In Trial 1, calves were randomly allocated to three liquid feeding treatments consisting of whole milk only, whole milk supplemented with milk replacer for 28 days, and whole milk supplemented with milk replacer for 56 days. Calves were monitored weekly for body weight changes, average daily gain, starter feed intake, and feed conversion ratio. In Trial 2, calves were allocated to four starter feed treatments in a 2 × 2 factorial design comparing physical form (meal versus pellet) and crude protein concentration (18% versus 21%). Growth performance, feed intake, and feed efficiency were assessed over the same eight-week preweaning period. Data were analysed using the General Linear Model procedure of SAS.

Results from Trial 1 indicated that milk replacer supplementation significantly improved calf growth performance. Calves supplemented with milk replacer for 56 days achieved the highest final body weights, while calves fed whole milk only recorded the lowest. Although starter feed intake increased progressively with age in all treatments, calves receiving milk replacer consumed less concentrate overall. Feed conversion efficiency improved with milk replacer supplementation, with the lowest cumulative feed conversion ratio recorded in calves supplemented for 56 days.

In Trial 2, neither crude protein level nor starter physical form significantly affected average daily gain or feed intake. However, calves fed pelleted starter diets, particularly at 21% crude protein, showed numerically improved feed conversion ratios compared with meal-based diets, suggesting better feed utilisation.

Overall, the study demonstrated that liquid feeding strategy had a greater influence on calf performance than moderate adjustments in starter crude protein content or feed form. Extending milk replacer supplementation improved growth consistency and feed efficiency during the preweaning period. Pelleted starter diets showed potential benefits for feed

utilisation, although further research with larger sample sizes is recommended to confirm these effects and assess long-term productivity outcomes.

Keywords: calf nutrition, crude protein, feed conversion ratio, growth performance, Holstein-Friesian calves, milk replacer, pellet starter, preweaning period, starter feed form, whole milk

AEES-F-15

The Use of Endophytic Strains of *Trichoderma* to Prevent Pre- and Post-harvest Diseases of Avocado Caused by *Pseudocercospora*, *Colletotrichum* and *Lasiodiplodia*.

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Avocado (*Persea Americana*) is grown and in high demand internationally due to the growing demand for the fruit itself and its products (Sneh Punia Bangar a et al., 2022). However, avocado production is affected by several diseases, some of which are pre- and post-harvest caused by fungal pathogens. Avocado Black Spot is caused by a fungal pathogen known as *Pseudocercospora purpurea* and is still considered the most crucial pre-harvest disease in South Africa (Darvas, 1979). In South Africa, this pathogen can cause up to 69% losses in untreated orchards (Darvas, 1987). This pathogen is considered one of the most important pre-harvest diseases of avocado at Westfalia Estate. Anthracnose is considered one of the most significant pre- and post-harvest diseases of avocado. The primary causal agent for Anthracnose in all avocado-producing countries is *Colletotrichum gloeosporioides*. Stem End Rot is the second most significant post-harvest disease after anthracnose, and is the most significant in dry-producing areas (Prusky, 2009). This disease is caused by several pathogens, mainly from the [Botryosphaeriaceae](#) family, such as *Colletotrichum gloeosporioides*; *Alternaria altanata* (Hartill, 2002), and the newly rising pathogen *Lasiodiplodia* (Coutinho, 2017). Several previous studies aimed to find a suitable control method that is also environmentally friendly.

Biological control is an ongoing practice that has proven effective and has relied on trial and error for more than 100 years (DeBach, 1964; DeBach, 1991). Biological control can either be direct or indirect when it comes to inhibiting a pathogen causing a disease by another organism(s) (Cook, 1983). The useful organism is referred to as a biocontrol agent (BCA) (Jensen, 2016, Tronsmo, 2020). The aim of the study is to isolate and screen *Trichoderma spp.* as a biocontrol agent (BCA) to control pre- and post-harvest diseases of avocado such as Anthracnose; Stem-end rot and Leaf spot disease.

Leaf samples were collected from several farms around Pietermaritzburg for *Trichoderma* isolation. 75 *Trichoderma* isolates were successfully obtained from avocado leaves, and 60 of them were screened against the three latter pathogens in vitro using a dual-culture test. The 10 best-performing *Trichoderma* strains were selected for in vivo screening. The 10 best strains underwent endophytic screening in a greenhouse trial using avocado seedlings. Only 8 *Trichoderma* strains were found to be endophytic. The strains have yet to undergo the final in vivo screening, a fruit trial conducted under laboratory conditions. The avocado fruits will be inoculated with the endophytic *Trichoderma* strain and subsequently inoculated with the three latter pathogens individually after 7 days. The data will be

collected, and based on the results, it will be concluded whether the endophytic strains of *Trichoderma* are effective biocontrol agents against the latter pathogens.

AEES-F-16

GROUNDWATER SALINITY EVOLUTION USING PHREEQC GEOCHEMICAL MODELLING IN THE FRACTURED BASEMENT AQUIFER OF THE HOUT RIVER CATCHMENT, LIMPOPO PROVINCE, SOUTH AFRICA

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Groundwater salinisation is a global problem, resulting from natural processes including mineral dissolution, ion exchange and anthropogenic activities, such as irrigation return flows, industrial waste, and land-use changes. Similarly, groundwater quality and sustainable water use in the semi-arid Hout River Catchment of Limpopo Province, South Africa, is a notable concern due to increasing groundwater salinity. The processes controlling geochemical evolution and salinity along the groundwater flow path are poorly understood. This study therefore applies PHREEQC geochemical inverse modelling to 36 water samples collected during April-May 2024 and August 2025, including saturation-index and inverse modelling, together with Piper classification to investigate mineral-water interactions and the hydrochemical evolution of groundwater in the catchment. The results of the PHREEQC modelling showed a gradual geochemical evolution of groundwater along the flow path in the Hout River Catchment, as evidenced by changes in hydrochemical facies, mineral saturation indices, and water-rock interactions. The Piper plot demonstrated a transition from mainly fresh Ca-HCO_3 groundwater in the upper catchment to more evolved Na-HCO_3 water types in the lower catchment. Groundwater in Zones 3 and 4, especially HGWB16, HGWB24, HGWB29, HGWB30, HGWB32 and HGWB34, indicated elevated TDS and positive saturation indices for calcite, aragonite and dolomite, implying supersaturation relative to these carbonate minerals and a potential for carbonate precipitation. The change from predominantly undersaturated conditions in the upper catchment to carbonate supersaturation downstream reflects progressive changes in groundwater-mineral equilibrium. Inverse modelling further suggests that the changes in groundwater chemistry are the result of mineral dissolution and ion-exchange reactions. The combined Piper, saturation-index and inverse-modelling results indicated overall progressive hydrochemical evolution and increasing salinity from the upper recharge areas to the lower catchment.

Keywords: Groundwater geochemical evolution; water-rock interaction; PHREEQC modelling; saturation index analysis; inverse geochemical modelling. format.

LIVING ALONGSIDE KRUGER NATIONAL PARK: A COMPARATIVE STUDY OF CONSERVATION PERCEPTIONS AND HUMAN WILDLIFE CONFLICT IN MATSULU AND PHALAUBENI

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Human-Wildlife Conflict (HWC) has intensified globally, particularly in communities adjacent to protected areas, where conservation objectives often intersect with local livelihood needs. HWCs are not merely incidental; rather, they are structurally created by environmental decline and historical political marginalisation, which facilitate functional overlap between human activity and wildlife habitats. Drawing on political ecology and sustainable livelihoods frameworks, this study comparatively investigated perceptions of HWC among local communities in Phalaubeni (Limpopo) and Matsulu (Mpumalanga), both of which are adjacent to the Kruger National Park (KNP) in South Africa. Simple random sampling and purposive sampling techniques were adopted for quantitative and qualitative data collection, respectively. An explanatory sequential mixed-methods approach was employed, integrating quantitative household surveys (n=200) with qualitative semi-structured interviews, using SPSS and NVivo. The results indicated that both communities (Matsulu and Phalaubeni) experienced HWC in the form of crop depredation, livestock predation, property damage and human casualties, although these impacts were driven by different socio-environmental factors. The qualitative results from the focus group discussions indicated that the HWCs in Phalaubeni and Matsulu are driven by unemployment, cultural beliefs, unequal access to resources, and weak institutional and government responses. Further, environmental drivers included seasonal food scarcity, limited resources within the park, wildlife migration and spatial factors such as land use and proximity to protected areas. Despite these challenges, the respondents' attitudes towards protected areas in Phalaubeni were more positive (69%) than in Matsulu (27%), showing a highly statistically significant relationship ($p < 0.001$). Furthermore, the findings showed that most members in both areas are interested in supporting conservation initiatives, wildlife, and social institutions. Key informant interviews indicated that local authorities acknowledged existing gaps and described their involvement in communities through forums, collaboration with NGOs, and other initiatives. In conclusion, HWC in communities adjacent to KNP is driven by socio-economic vulnerability, environmental pressures, and limited institutional support. The researchers recommend that community members consider planting unpalatable crops to deter wildlife from communities and engage in other income-generating activities to reduce severe impacts during wildlife incursions. Addressing these challenges will require responsible stakeholders to implement policies that are area-dependent to better serve affected and vulnerable groups and to leverage positive community attitudes to support human-wildlife coexistence.

Keywords: human-wildlife conflict; Kruger National Park; political ecology; Sustainable livelihoods; community perceptions

An exploratory study on consumer behaviour regarding food waste in Msunduzi & uMngeni Municipalities: Implications for household food security

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South Africa incurs an annual loss of R61.5 billion, representing 2.1% of its Gross Domestic Product (GDP), attributable to food waste primarily driven by consumer behaviour [1, 10]. This equates to the disposal of one-third (10 million tonnes) of the food produced for consumption within the country [9]. At the household level, the nation faces challenges with food insecurity, while simultaneously millions of tons of food are wasted, representing a significant missed opportunity to improve food security. Most studies argue that poor meal planning, over purchasing, high income level, and improper storage are the main factors resulting in food waste [7, 8, 12]. The majority of households in developed countries are likely to waste more food than households in developing countries [3, 6, 11]. Previous research has explored the impact of food waste on food security and the environment, as well as its detrimental effect on governmental efforts to mitigate food insecurity [2, 4, 5].

However, there is a notable paucity of research focusing on consumer behaviour related to food waste. Consequently, this study aims to identify consumption patterns within households and examine the influence of these behaviours on food waste. Additionally, the study aims to analyse the effects of behaviour towards food waste on household food security. The research will be conducted in Msunduzi & uMngeni Local Municipalities, employing a mixed methods approach. The sample size of the study is expected to be 196 participants, calculated using the Yamane formula with 8% error. The 8% is used to reduce the sample size since the period for the collection of data is very short, with only a few days. Furthermore, ethnographic analysis will be utilized to comprehend consumer behaviours, while descriptive statistics, factor analysis, and thematic analysis will be applied to analyse both internal and external consumer behaviours.

The descriptive statistics will be employed to provide a brief overview of households' purchase quantity and percentage of consumed specific food groups, while the factor analysis will be used to identify major consumer behaviours and uncover hidden patterns and relationships thereof. The thematic analysis seeks to link factors to the study area's culture and social setting. The logistic regression will determine whether a household is food secure or insecure as a result of food waste patterns. Therefore, the effects of consumer behaviour towards food waste will be analysed by Multiple regression analysis and Thematic analysis.

Therefore, this research aims to contribute to the existing body of knowledge by spelling out key consumer behaviours in these two areas that lead to food waste and examining how policymakers address these behaviours. Additionally, this study aims to address the geographic gap by providing empirical data on household food waste.

Keywords: Food waste, consumer behaviour, household food security, attitudes

References

1. AgriSA, 2024. *South Africa's Food Waste Crisis: Inspiring Collective Action for a Sustainable Tomorrow*. [online] AgriSA™. Available at: <https://agrisa.org.za/agrisa-disaster-relief-foundation/south-africas-food-waste-crisis-inspiring-collective-action-for-a-sustainable-tomorrow/>.
2. Aktas, E., Sahin, H., Topaloglu, Z., Oledinma, A., Huda, A.K.S., Irani, Z., Sharif, A.M., Van't Wout, T. and Kamrava, M., 2018. A consumer behavioural approach to food waste. *Journal of Enterprise Information Management*, 31(5), pp.658-673.
3. Baykoca, B. and Yilmaz, S., 2025. Understanding food loss patterns across developed and developing countries using a GDP, growth rate, and health expenditure-based typology. *Scientific Reports*, 15(1), p.27597.
4. Carvalho, R., Lucas, M.R. and Marta-Costa, A., 2025. Food Waste Reduction: A Systematic Literature Review on Integrating Policies, Consumer Behavior, and Innovation. *Sustainability*, 17(7), p.3236.
5. Haque, A., Karunasena, G.G. and Pearson, D., 2022. Household food waste and pathways to responsible consumer behaviour: evidence from Australia. *British Food Journal*, 124(11), pp.3783-3802.
6. Heng, Y. and House, L., 2022. Consumers' perceptions and behavior toward food waste across countries. *International Food and Agribusiness Management Review*, 25(2), pp.197-210.
7. Karunasena, G.G., Ananda, J. and Pearson, D., 2021. Generational differences in food management skills and their impact on food waste in households. *Resources, Conservation and Recycling*, 175, p.105890.
8. Lisciani, S., Camilli, E. and Marconi, S., 2024. Enhancing food and nutrition literacy: A key strategy for reducing food waste and improving diet quality. *Sustainability*, 16(5), p.1726.
9. Mmereki, D., David Jr, V.E. and Wreh Brownell, A.H., 2024. The management and prevention of food losses and waste in low-and middle-income countries: A mini-review in the Africa region. *Waste Management & Research*, 42(4), pp.287-307.
10. Nahman, Anton, and Willem de Lange. "Costs of food waste along the value chain: Evidence from South Africa." *Waste management* 33, no. 11 (2013): 2493-2500.
11. Paraschivu, M., Cotuna, O., Matei, G. and Sărățeanu, V., 2022. Are food waste and food loss a real threat for food security?.
12. Tomaszewska, M., Bilska, B. and Kotożyn-Krajewska, D., 2022. The influence of selected food safety practices of consumers on food waste due to its spoilage. *International journal of environmental research and public health*, 19(13), p.8144.

AEES-F-20

The Feasibility of ML For Optimising Non-Yielding Pillars In Hard-Rock Bord-And-Pillar Designs In Underground Mines

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In a Volatile, Uncertain, Complex, and Ambiguous (VUCA) mining environment, optimizing non-yielding pillar design in hard-rock bord-and-pillar mining remains a significant rock engineering challenge. Conventional pillar design approaches, which rely primarily on empirical formulations and engineering judgment, often lack the flexibility required to accommodate complex geological variability and changing operational conditions. This study investigates the feasibility of integrating Machine Learning (ML) techniques with established South African pillar design methodologies to improve design accuracy, safety, and extraction efficiency.

A hybrid modelling framework is proposed that combines traditional pillar strength equations with supervised ML algorithms, including XGBoost, Support Vector Machines (SVM), and Ridge Regression, to predict pillar strength and Factor of Safety (FoS) under varying geotechnical conditions. The study evaluates the capability of these models to replicate and enhance engineering design decisions, optimize bord-and-pillar layouts, and generalize across different mining scenarios. Model performance is assessed using standard regression metrics, including Root Mean Square Error (RMSE), coefficient of determination (R^2), and comparative accuracy against conventional empirical methods.

The results suggested that ML models outperformed traditional approaches, reducing RMSE by approximately 20–35% and achieving R^2 values greater than 0.85, compared to typical baseline values of 0.60–0.70. Furthermore, the hybrid framework improves FoS prediction accuracy by 15–25% and optimizes pillar layouts to increase extraction ratios by 5–12% without compromising stability. The findings support the development of intelligent, data-driven rock engineering systems, providing a pathway toward safer, more efficient, and adaptive hard-rock bord-and-pillar mining operations.

Keywords: *Non-yielding pillars; Bord-and-pillar mining; ML; Pillar design optimisation; Factor of Safety; Geotechnical modelling*

AEES-F-21

ENHANCING DROUGHT TOLERANCE IN POTATOES BY EXOGENOUS APPLICATION OF MORINGA LEAF EXTRACT FROM AQUEOUS-BASED METHODS

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Drought is one of the most limiting abiotic factors in agriculture, affecting potato productivity. While the foliar application of natural, growth-enhancing substances is well-reported to reduce the adverse effects of drought stress in plants. This study, therefore, evaluated the efficacy of foliar application of moringa leaf extracts (MLEs) obtained through cold water (CW-MLE) or hot water (HW-MLE) extraction. Following treatment application, three drought stress levels were maintained, i.e., 100, 75, and 50% field capacity (FD), characterized as well-watered, moderate, and severe drought stress. One week after

drought stress imposition, plants were sprayed with CW-MLE 5 g moringa leaf powder (MLP) + 450 ml distilled water (DW) or HW-MLE (5 g MLP + 450 ml DW) or water spray until runoff. Plants irrigated to 100% FD and sprayed with water were used as controls. The crop was evaluated for growth, yield, physiological, and biochemical parameters. Drought stress significantly affected growth parameters, leaf chlorophyll index, relative water content, yield, antioxidant activity, and ascorbic acid concentration. However, HW-MLE alleviated the drought stress more than other treatments, as it increased growth parameters, total leaf chlorophyll concentrations, relative water content, and yield. Under severe and moderate drought stress, CW-MLE increased antioxidant activity and ascorbic acid concentration, superior to other treatments. Foliar-applied MLEs can, therefore, be used to mitigate the negative effects of drought stress on potato, although with each extraction method, some compounds were not fully extractable. Hence, future research should investigate the optimal water temperature for extracting growth-enhancing compounds from MLP.

Keywords: Biostimulants, drought stress, food and nutrition security, phytonutrients, plant morphology

AEES-F-22

UAS-Based Hyperspectral and LiDAR Observations for Cross-Scale Ecohydrological Monitoring in the Northern Drakensberg Strategic Water Source Area

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Strategic Water Source Areas (SWSAs) supply a disproportionate share of downstream freshwater, yet remain difficult to monitor. In-situ measurements offer high accuracy but limited spatial coverage, while satellite observations provide broad geographic coverage but are constrained by coarse resolutions, cloud contamination, and topographic distortion across steep, heterogeneous terrain. Unmanned Aerial Systems (UAS) offer an intermediate scale capable of bridging this gap, yet their potential for integrated, multi-sensor ecohydrological monitoring in SWSAs remains insufficiently understood. To address this knowledge gap, a PRISMA-guided systematic review of 118 peer-reviewed, quantitative studies (2010–2024) evaluated the integration, validation, and scaling of multispectral, hyperspectral, Light Detection and Ranging (LiDAR), and thermal infrared sensing for ecohydrological monitoring in high-altitude mountainous SWSAs. The review revealed a pronounced sensor imbalance, with multispectral and LiDAR studies dominating while hyperspectral applications remain critically underrepresented. Soil moisture and evapotranspiration emerged as the most frequently monitored variables, yet no eligible South African studies were identified, exposing a national research gap despite the country's globally significant mountain catchments. Building on these findings, this research develops an uncertainty-aware, cross-scale observation framework integrating UAS-derived hyperspectral and LiDAR measurements with in-situ and satellite data to resolve evapotranspiration dynamics in the Northern Drakensberg. Central to this work is a Rutherford Appleton Laboratory (RAL) Space UAS-based hyperspectral imaging (HSI) payload, designed for the DJI Matrice 300/350/400 platforms. The system pairs dual visible (450–625 nm) and near-infrared (650–950 nm) hyperspectral cameras with a two-axis gimbal, a downwelling spectrometer, and a newly developed Python-based control

interface, enabling calibrated, radiometrically consistent capture across spectrally complex terrain. Deployment follows a rigorous protocol incorporating ground control points, reflectance-calibrated tiles, and saturation checks to ensure data integrity under variable illumination. A recent campaign with the Science and Technology Facilities Council (STFC) RAL Space and the South African Environmental Observation Network (SAEON) delivered hands-on operator training, establishing independent, in-country capacity to deploy the system, and validated its capability for high-spatial and high-spectral-resolution catchment monitoring relevant to evapotranspiration dynamics. Together, the review and fieldwork establish a transferable methodology for reconciling multi-sensor observations across scales, addressing an underserved gap in African ecohydrological remote sensing.

Keywords: evapotranspiration; LiDAR–hyperspectral fusion; scale mismatch; strategic water source areas; systematic review

AEES-F-23

WHOSE CONSERVATION? RE- WRITING HISTORY WITH ARCHIVES, INDIGENOUS KNOWLEDGE, AND COMMUNITY STORIES

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Mainstream conservation history is often told as a story of wilderness saved from residents who originally rightfully owned the land before colonization. My presentation is more on the angle "Whose conservation?" Drawing on a dialogue between three often-separated sources

1. The archives that were mainly established during the colonial era.
2. Indigenous knowledge systems.
3. Living community oral histories.

My study shows that the above sources, when placed together, challenge the myth of "empty wilderness" and show conservation landscapes as places of lived history, memory, and ongoing evolution of better conservation practices and systems. It also acknowledges that conservation has evolved, contributing to the preservation of the natural resources we have today.

Through case studies from the Hluhluwe iMfolozi Park in KwaZulu-Natal, South Africa, I show how archival records — maps, correspondence on conservation systems, and eviction scenes — reveal not an empty wilderness but a managed landscape by indigenous people using indigenous systems. My presentation argues that to understand conservation fairly, we must go beyond the archival data. By combining archival data, indigenous knowledge, and community life stories, we can add to, rewrite, and reconstruct a post-apartheid history written by indigenous people born and bred in the area, bringing another version of the

written history of communities and their interactions with the surrounding environment and protected areas.

In the presentation, I offer not just a critique of fortress conservation, but a framework for a plural, justice-centered conservation future. One where history is co-authored, where archives are decolonized, and where the question shifts from "how do we protect nature from people?" to "how do we rewrite and restore the relationships between people and nature that have always protected both?"

Keywords: Conservation History, Decolonial Conservation, Communities, Indigenous Knowledge Systems, Oral History, Environmental Justice, Political Ecology, Archives, South Africa.

FLASH ABSTRACTS

BIOCHEMISTRY AND CHEMISTRY

BCC-F-1

SYNTHESIS AND CHARACTERISATION OF NOVEL ACYLTHIOUREAS AND THEIR S-ALKYLATED ANALOGUES FOR PROSPECTIVE IN SILICO AND IN VIVO BIOLOGICAL EVALUATIONS.

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Thiourea derivatives and their S-alkylated congeners represent privileged scaffolds in medicinal chemistry, displaying a broad spectrum of therapeutic potentials. This work describes the systematic synthesis and structural characterisation of a novel library of N-(pyridin-2-ylcarbamoithiyl) benzamides and their corresponding S-alkylated analogues (N-((Benzylthio)(pyridin-2-ylamino)methylene)benzamides). The target acylthioureas were successfully synthesised via the reaction of unsubstituted and substituted benzoyl chlorides (Benzoyl chloride, 4-Methylbenzoyl chloride, 4-tert-Butylbenzoyl chloride, 4-Methoxybenzoyl chloride, 4-Nitrobenzoyl chloride (solid), 4-Cyanobenzoyl chloride (solid), 4-(Trifluoromethyl)benzoyl chloride, 4-Chlorobenzoyl chloride, 4-Fluorobenzoyl chloride, 4-(Chloromethyl)benzoyl chloride, 2,4-Dichlorobenzoyl chloride, 2,6-Dichlorobenzoyl chloride, 2,4-Difluorobenzoyl chloride) with potassium thiocyanate, to obtain corresponding acyl isothiocyanates, followed by in-situ nucleophilic addition of 2-Amino pyridine. Subsequent regioselective S-alkylation of these N-(pyridin-2-ylcarbamoithiyl)benzamide intermediates was achieved using structurally diverse benzyl bromides under mild basic conditions to yield the respective S-benzyl derivatives.

The structural elucidation of the synthesised compounds is carried out using comprehensive spectroscopic techniques, including Fourier-transform infrared spectroscopy (FT-IR), nuclear

magnetic resonance spectroscopy ^1H and ^{13}C NMR), and mass spectrometry (MS). To explore the therapeutic viability of these novel matrices, future directions will focus on evaluating their antimicrobial profiles. This will encompass comprehensive *in silico* molecular docking and ADMET simulations to map target interactions, alongside parallel *in vivo* biological screenings to establish concrete structure-activity relationships (SAR).

Keywords: Acylthioureas, S-Alkylation, Benzoyl chlorides, Benzyl bromides, *In silico* docking, *In vivo* studies.

BCC-F-2

MONITORING CONTAMINANTS OF EMERGING CONCERN IN WASTEWATER USING GAS CHROMATOGRAPHY-MASS SPECTROMETRY

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Contaminants of emerging concern (CECs) are a broad range of largely unregulated substances that have the potential to adversely impact ecological and physiological health. The concern of the trace-level presence of CECs in reclaimed and portable water is a rising global phenomenon, attributed to the overwhelming evidence of CECs potential peril to humans and the environmental. In under-developed and developing countries, the presence of CECs can be expected to surpass the suggested limits due to substandard infrastructure, adopted treatment systems, and unique water characteristics. Therefore, this study proposes the development of a multi-residual gas chromatography-mass spectrometry (GC-MS) method for the monitoring of 12 CECs (pharmaceuticals, personal care products, pesticides, stimulants and hormones) in wastewater in order to assess the efficacy of local treatment systems. Derivatization via silylation was optimized to expand the chromatographic characteristics of the target analytes, improve separation and sensitivity. The method demonstrates successful chromatographic separation, linearity between a broad concentration range ($0.01 - 5.0 \text{ mg L}^{-1}$) and R^2 values (0.99). Overall, this study demonstrates the use of derivatization for the sensitive multi-residue GC-MS detection of CECs, and its potential for the monitoring of CECs in local treatment systems.

BCC-F-3

Synthesis of N^ΛO-donor Mg(II) and Zn(II) complexes as catalysts for the production and depolymerization of PLAs

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The widespread use of petroleum-derived plastics has contributed significantly to environmental pollution. This has driven the development of bio-based polymers from renewable resources, offering a sustainable alternative that reduces plastic waste and supports a circular economy through chemical recycling. One such biopolymer is poly(lactide) (PLA), which is biodegradable and biocompatible, and is derived from renewable resources, making it a sustainable alternative to the petroleum-based polymers. Herein, we report the synthesis of Zn(II) and Mg(II) complexes bearing N[∧]O-donor (amino)pyridine and (imino)phenol Schiff base ligands. Structural characterization of the complexes using NMR and spectroscopic techniques, elemental analyses, and X-ray crystallography assisted in elucidating the identity of the complexes. All the complexes exhibited high catalytic activity for the ring-opening polymerization of *rac*-lactide to PLA, and both Mg(II) and Zn(II) complexes efficiently catalyzed the depolymerization of PLA into the green solvent methyl lactate (Fig. 1). Among the synthesized complexes, the mononuclear Zn(II) complex exhibited the highest catalytic activity, highlighting the critical role of catalyst structure in regulating catalytic performance.

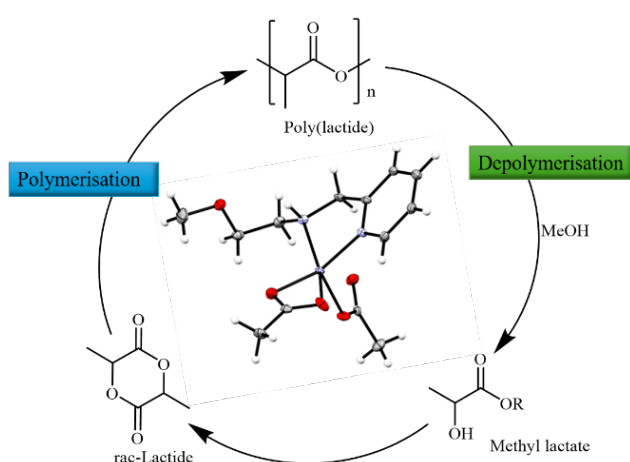


Figure 1: Production and degradation of poly(lactide).

[1] F. Santulli, D. Pappalardo, M. Lamberti. ACS Sustainable Chemistry & Engineering 2023, **11**, 15699-15709.

[2] S. Guzman-Puyol, J. J. Benítez and J. A. Heredia-Guerrero, 2021. **14**(1), p.22.

BCC-F-4

Development of 1,2,3-Triazole-Based Bioisosteric Scaffolds for C-Terminal and Histidine Modification of Antimicrobial Peptides via Solid-Phase Peptide Synthesis

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Antimicrobial peptides (AMPs) are promising therapeutic candidates for combating antimicrobial resistance; however, their clinical translation is often limited by poor metabolic stability. In this work, we report the design and synthesis of a novel acid-labile 1,2,3-triazole methylamine linker for solid-phase peptide synthesis (SPPS) that enables the introduction of a 1,2,3-triazole motif as a C-terminal bioisostere of glycynamide. The linker was prepared from MBH-Br resin through azide substitution followed by copper(I)-catalyzed azide-alkyne cycloaddition (CuAAC), affording an $\text{NH}_2\text{-CH}_2\text{-1,2,3-triazole}$ scaffold fully compatible with conventional Fmoc/tBu SPPS. Acid cleavage studies confirmed efficient peptide release, with complete cleavage achieved following extended trifluoroacetic acid treatment. The developed strategy was subsequently applied to the synthesis of triazole-containing amino acid derivatives and peptide analogs.

The bioisosteric properties of the triazole scaffold were investigated using Orn-CAM11 antimicrobial peptide analogs incorporating different C-terminal residues. Biological evaluation against representative Gram-positive and Gram-negative bacteria demonstrated that the Orn-CAM11 triazole analog retained antibacterial activity comparable to its glycynamide counterpart, particularly against *Escherichia coli* and *Pseudomonas aeruginosa*, while preserving the activity profile of the parent peptide. Conversely, replacing the C-terminal residue with charged or aromatic amino acids resulted in marked changes in antimicrobial potency. In addition, replacement of the histidine imidazole side chain with a 1,2,3-triazole moiety in the peptide NrTP6 maintained or improved antibacterial activity.

Overall, these results establish the 1,2,3-triazole scaffold as an effective bioisostere for both C-terminal amides and histidine side chains in AMPs. This approach expands the toolbox for peptide modification and offers a promising strategy for developing metabolically stable antimicrobial peptides without compromising biological activity.

BCC-F-5

PRELIMINARY EVALUATION OF ISOLEUCINE, LYSINE AND SERINE ON GLUCOSE HANDLING IN EX VIVO AND DIABETIC RAT MODELS

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The global burden of type 2 diabetes mellitus (T2DM) is consistently increasing despite the scientific advances in managing the endocrine disorder. The most recent international diabetic federation (IDF) report noted that over 90% of the population living with diabetes are T2DM. In the quest to manage this disorder, improving peripheral glucose utilisation and intestinal glucose handling is important. This study evaluated the preliminary antidiabetic potential of pure compounds of isoleucine, lysine and serine using *ex vivo* and *in vivo* experimental models.

In the *ex vivo* model, Sprague-Dawley rat psoas muscle and jejunum were isolated and used to assess glucose uptake and absorption, respectively. For the *in vivo* study, rats were divided into 12 groups of 7 rats each. This included normal control, diabetic control,

metformin-treated control, low and high-dose treatment, and toxicity treatment groups for isoleucine, lysine and serine. T2DM was induced by fructose administration and a 40 mg/kg streptozotocin injection. Random blood glucose and weight were documented weekly, feed and water intake were monitored daily, and an oral glucose tolerance test (OGTT) was conducted in the last week of the experiment.

In the *ex vivo* study, glucose uptake showed varying levels of activity, with the highest uptake observed for serine at 400 µg/mL. In the isolated jejunum, glucose absorption was reduced in tissues treated with sample solutions compared with the normal response, suggesting possible regulation of intestinal glucose transport. In the *in vivo* model, diabetic control rats maintained elevated blood glucose and weight loss after induction and throughout the experimental period, whereas treated groups showed improved blood glucose and weight over the treatment period. Serine and lysine at high doses showed a comparatively lower glucose level at week 8 than the diabetic control and were closer to the metformin-treated group. The OGTT also indicated improved glucose clearance in the treated groups compared with the diabetic control. Toxicity groups maintained glucose levels within the normal control range.

These preliminary findings suggest that isoleucine, lysine, and serine may influence glucose handling by affecting muscle glucose uptake and intestinal glucose absorption. Serine at high dose demonstrated the most consistent trend toward improved glycemic control. Further assessment is ongoing to determine the effects of these compounds on major organs and to elucidate the possible mechanism of action.

BCC-F-6

GREENER SYNTHESIS OF N-ACYL HYDRAZONES OF ISONIAZID IN DEEP EUTECTIC SOLVENT

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Developing efficient, green, and environmentally benign methodologies for the synthesis of broadly applicable chemical scaffolds remains a key challenge in synthetic chemistry. Conventional processes often rely on toxic catalysts and hazardous solvents, posing significant environmental and health risks, particularly in the chemical and pharmaceutical industries. In this study, a sustainable and eco-friendly method was developed for the synthesis of N-acyl hydrazone analogues via the condensation of isoniazid with various substituted benzaldehydes. A deep eutectic solvent (ZnCl₂/urea) was employed, serving a dual role as both solvent and catalyst. This methodology enabled the synthesis of target compounds within 2–6 minutes, eliminating the need for extensive purification procedures. The protocol is operationally simple and offers several advantages, including short reaction times, good to excellent yields, scalability, and catalyst recyclability and reusability. Green chemistry metrics further confirmed the environmental compatibility of this method. Moreover, Density Functional Theory (DFT) calculations were used to predict the Frontier Molecular Orbitals (FMOs) and global reactivity parameters of the synthesised compounds, providing insights into their electronic properties.

DEVELOPMENT OF SUSTAINABLE MAGNETIC MOLECULARLY IMPRINTED *LIPPIA JAVANICA* FOR THE SELECTIVE REMOVAL OF PHARMACEUTICALS FROM WASTEWATER: ADSORPTION KINETICS & ISOTHERMS

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The prevalence of pharmaceuticals in wastewater has become an environmental crisis due to widespread application and incomplete metabolism. When consumed, about 90% of these drugs are excreted as metabolites or parent compounds via urine and faeces and are transported to wastewater treatment plants (WWTPs). The removal of these emerging contaminants remains challenging as conventional WWTPs struggle to remove these persistent pollutants, leading to their discharge into surface water, which threatens aquatic ecosystems and promotes antibiotic resistance through environmental and food chain exposure. Their persistence in aquatic environments highlights the need for sustainable and highly selective adsorbents to remove them from wastewater. This study investigates the application of magnetized *Lippia javanica* on its own and with a molecularly imprinted polymer incorporated as sustainable adsorbents for the selective extraction of pharmaceuticals from wastewater using dispersive micro-solid phase extraction (D- μ SPE). Magnetized *Lippia javanica* was synthesized by incorporating iron oxide nanoparticles onto the plant biomass, while magnetic molecularly imprinted *Lippia javanica* was prepared by coating the magnetized bioadsorbent with a molecularly imprinted polymer to introduce selective recognition sites. The adsorbents were characterized with FTIR to determine the functional groups present and those that govern the interactions between adsorbent and analyte, SEM for surface morphology, XRD to determine the formation of the magnetite nanoparticles, BET for surface area and pore volume, and TGA for thermal activity of the adsorbents. The extraction method was optimized by evaluating parameters including sample pH, sample volume, extraction time, and initial concentration to maximize extraction efficiency. Liquid chromatography mass spectrometry (LC-MS) was used for the quantification of the extracted analytes. Adsorption models, such as kinetics, isotherms, and thermodynamics, were used to determine the adsorption nature and mechanism of analyte and adsorbent interactions. Selectivity and regeneration were conducted to assess their affinity for the target analytes in the presence of competing compounds and their reusability over multiple extraction cycles. The findings provided valuable insight into the role of molecular imprinting in improving the performance of plant-based magnetic adsorbents while contributing to the development of efficient, reusable, and environmentally sustainable materials for the removal of pharmaceuticals in wastewater.

References

- [1]Chisvert, A., Cárdenas, S. and Lucena, R., 2019. Dispersive micro-solid phase extraction. *TrAC Trends in Analytical Chemistry*, 112, pp.226-233.
- [2]Kunene, P.N. and Mahlambi, P.N., 2026. Simultaneous Removal of Copper, Lead, and Zinc From Water Using a Novel Magnetized *Lippia javanica* Biosorbent. *Nano Select*, 7(2), p.e70081.

BCC-F-8

EUCALYPTUS GUNNII ESSENTIAL OIL: AN ECOFRIENDLY AND COST-EFFECTIVE ADSORBENT FOR SULFONAMIDES REMOVAL IN WASTEWATER

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Sulfonamides (SAs) are antibiotics for treating human and animal bacterial infections. The high consumption and improper disposal of these antibiotics have made them common in aquatic environments [1]. Conventional wastewater treatment processes cannot eliminate SAs [2]. Thus, this work aims to explore for the first time the essential oil of *E. gunnii* as a green, inexpensive, and sustainable adsorbent for removing SAs in wastewater. Before adsorption studies, Fourier Transform Infrared (FTIR) spectroscopy, Gas Chromatography Mass Spectrometry (GC/MS), and Transmission Electron Microscopy (TEM) were performed for the characterisation of the essential oils. FTIR allows for identifying functional groups such as O-H, C=C, and C-H, which can bind to sulfonamide antibiotics. GC-MS identified 1,8-cineole as the dominant compound, whose chemical structure enables adsorption. TEM for *E. gunnii* showed that the surface area had rod-like shapes, enhancing the adsorption capacity. Prime factors affecting adsorbent capacity were evaluated: initial concentration of the analyte, pH, contact time, and volume of the adsorbent. The relative recoveries of selected antibiotics were 89% and above for *E. gunnii*. Adsorption kinetics were found to obey the pseudo-second order. Adsorption isotherms fit the Langmuir model. This study shows that essential oils of *E. gunnii* can be successfully employed as inexpensive, eco-friendly and cost-effective adsorbents for removing SAs from wastewater.

[1] Ovung, A.; Bhattacharyya, J. Sulfonamide drugs: structure, antibacterial property, toxicity, and biophysical interactions. *Biophys Rev* 2021, 13 (2), 259-272.

[2] Zhu, G.; Sun, Q.; Wang, C.; Yang, Z.; Xue, Q. Removal of Sulfamethoxazole, Sulfathiazole and Sulfamethazine in their Mixed Solution by UV/H(2)O(2) Process. *Int J Environ Res Public Health* 2019, 16 (10).

BCC-F-9

USE OF COPPER-BASED CATALYSTS FOR THE DIRECT FORMATION OF DIMETHYL ETHER (DME) FROM CO₂

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The rise in atmospheric CO₂ concentrations is a key driver of global warming and climate change. This highlights the urgent need to develop technologies that reduce CO₂ emissions by converting CO₂ into value-added chemicals and fuels. In this study, we investigate the use of copper-based catalysts for the direct synthesis of dimethyl ether (DME) via CO₂ hydrogenation, offering a viable route for carbon utilisation and cleaner energy generation. DME's clean combustion properties and potential use as a hydrogen carrier make it an appealing alternative fuel. The production of highly active and selective catalysts for direct DME synthesis remains challenging, especially in balancing methanol synthesis and dehydration activities within a single catalytic system, despite major advances in CO₂ hydrogenation. This study addresses this gap by assessing the impact of catalyst promoters and supports on the performance of Cu-based catalysts.

BCC-F-10

EDIBLE *Ulva fasciata* ATTENUATES FRUCTOSE-INDUCED METABOLIC DYSFUNCTIONS AND RESTORES SERUM AND ADIPOSE METABOLITES IN RATS

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High dietary sugar intake is a major contributor to obesity and metabolic dysfunction, highlighting the need for functional foods that can improve metabolic health. Edible seaweeds are increasingly recognized for their bioactive properties and therapeutic potential. Our previous published *in vitro* and *ex vivo* studies demonstrated that *Ulva fasciata* possesses antioxidant activity, inhibits carbohydrate- and lipid-digesting enzymes, limits intestinal glucose absorption, enhances muscle glucose uptake, and protects adipose tissue against oxidative injury. Building on these findings, the present study investigated whether these beneficial effects translate to a rat model of fructose-induced metabolic dysfunction or not. Male Wistar rats were allocated to a normal control, fructose-fed control, orlistat-treated, and low- and high-dose *U. fasciata* treatment groups. Metabolic health was evaluated through adiposity indices, glucose tolerance, serum insulin, biochemical markers, visceral adipose tissue weights, and adipose redox status. In addition, targeted LC-MS metabolomics was performed to quantify key carbohydrate-, polyol-, energy-, and amino acid-related metabolites in serum and adipose tissue using authentic standards. Chronic fructose consumption induced obesity-associated metabolic dysfunctions, characterized by increased adiposity, impaired glucose tolerance and insulin regulation, dyslipidemia, biochemical stress, compromised adipose antioxidant defense, and widespread metabolic alterations. Additionally, fructose-fed rats exhibited elevated glucose, fructose, sorbitol, glycerol, pyruvate, citrate, and alanine concentrations, together with reduced glycine levels in serum and adipose tissue. Treatment with *U. fasciata* attenuated these disturbances, with the high-dose group producing the most consistent improvements in terms of adiposity, insulin resistance, serum biochemistry, adipose redox balance, and metabolite profiles. Elevated carbohydrate-, polyol-, and energy-related metabolites were fully restored, while glycine concentrations were restored towards normal levels. To the best of our knowledge, this is the first study to demonstrate the *in vivo* metabolic and metabolomic effects of edible *Ulva fasciata* in a fructose-fed rat model with metabolic

dysfunctions. These findings provide evidence that *U. fasciata* ameliorates fructose-induced metabolic dysfunction while normalizing tissue-specific metabolic disturbances, supporting its potential as a functional food for ameliorating metabolic dysfunctions.

Keywords: Obesity, Metabolic dysfunctions, Insulin resistance, *Ulva fasciata*, Rats

BCC-F-11

Development and testing of bismuth-based photocatalysts supported on biochar for water treatment

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Freshwater resources are facing increasing pressure from population growth, rapid urbanisation, climate change, and declining water quality. In South Africa, where water scarcity is already a major concern, safeguarding existing water resources has become equally as important as securing new supplies. Among the factors contributing to deteriorating water quality is the continuous discharge of emerging contaminants, particularly pharmaceutical residues, into aquatic environments. Conventional wastewater treatment processes were not designed to completely remove these compounds, allowing them to persist in wastewater effluents and surface waters. Pharmaceuticals such as carbamazepine and ibuprofen are of particular concern because of their widespread consumption, resistance to biodegradation, and potential adverse effects on aquatic ecosystems even at low concentrations. Heterogeneous photocatalysis has emerged as a promising advanced oxidation technology process for the degradation of persistent organic pollutants. However, the efficiency of many photocatalysts is restricted by rapid electron-hole recombination and limited adsorption capacity. Bismuth-based semiconductors, including bismuth vanadate (BiVO_4), bismuth tungstate (Bi_2WO_6), and bismuth oxycarbonate ($\text{Bi}_2\text{O}_2\text{CO}_3$), have demonstrated considerable potential under visible-light irradiation but require further improvement to maximise their photocatalytic efficiency, which motivates the development of composite systems with suitable support materials. This study proposes using biochar derived from *Lessertia frutescens* (Cancer bush), an indigenous Southern African medicinal plant, as a support material for these photocatalysts. The porous carbon structure and surface functionality of the biochar are expected to enhance pollutant adsorption while facilitating charge transfer between support and semiconductor. The photocatalysts and their biochar-supported composites will be synthesised and characterised using complementary physicochemical techniques before being evaluated for the degradation of carbamazepine and ibuprofen under simulated solar irradiation. By systematically comparing three biochar-supported bismuth photocatalysts prepared under comparable conditions, this study aims to identify the most effective composite system and demonstrate the potential of locally sourced biochar as a sustainable material for visible-light-driven wastewater treatment.

Exploration of *Artemisia afra* leaves as bio-adsorbents for effective removal of pharmaceutical contaminants from wastewater: Kinetics, isotherms and thermodynamics

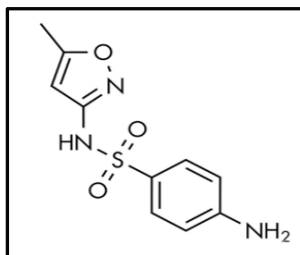
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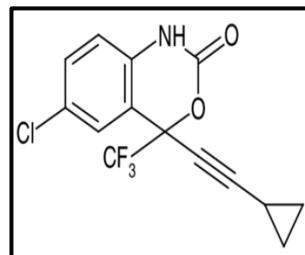
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Sulfamethaxazole



Efavirenz

Antibiotic and antiviral drug contamination in water is currently an urgent, global crisis, that necessitate effective, yet affordable water remediation strategies. This study therefore, explored a novel batch adsorption process incorporated with raw, glycine and sodium bicarbonate modified *Artemisia afra* leaves as bio-adsorbents to decontaminate dolutegravir and trimethoprim from wastewater. Fourier Transform Infrared spectroscopy demonstrated that both acidic and basic treatment was successfully performed as the alteration of surface functional groups of the biomaterial was observed. Scanning Electron Microscope images revealed that both the treatments resulted to comparatively enhanced surface porosity and surface irregularity which improved sorption efficiency compared to unmodified *Artemisia afra* leaves. Energy Dispersive X-Ray Spectroscopy of all assessed bio-adsorbents revealed a high elemental composition by weight of only carbon and oxygen. Thus, implying to the presence of reactive functional groups (carbonyl, hydroxyl, carbonyl) for effective adsorption interaction with pharmaceuticals. The adsorption process was carried out on a 10 mL spiked wastewater in the presence of the bio-adsorbent, and agitated in an orbital shaker followed by filtration and analysis by LC-MS. The percentage removal was 45.96-70.01 % for raw, 59.61-82.22 % for sodium bicarbonate and 54.51-77.78 % for glycine modified *Artemisia afra*, respectively. This further indicated that modification treatment was more effective on the surface material. This novel method therefore demonstrated to be an efficient, cost effective and eco-friendly alternative for the simultaneous removal of multi classes of pharmaceutical contaminants from wastewaters.

Keywords: Antiretroviral drugs, antibiotics, batch adsorption, removal efficiency, *Artemisia afra* leaves

BCC-F-13

DEVELOPMENT OF AN ULTRASENSITIVE ELECTROCHEMICAL SENSOR WITH MAGNETICALLY AMPLIFIED MOLECULAR RECOGNITION FOR THE DETECTION OF AN ANTIRETROVIRAL DRUG IN RIVER WATER

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The presence of antiretroviral drugs (ARVDs) in aquatic ecosystems poses a major environmental risk and public health concerns due to their potential for bioaccumulation, antimicrobial resistance, potential ecotoxicity and chronic toxicity in non-target organisms. Among these, abacavir sulphate requires urgent monitoring at trace levels in water bodies like rivers. In this study, an ultrasensitive electrochemical sensor with magnetic properties and molecular recognition abilities was developed, where a carbon paste electrode (CPE) was modified with a molecularly imprinted polymer (MIP) integrated with iron oxide nanoparticles (Fe_3O_4 -NPs). The magnetic Fe_3O_4 -NPs were used to enhance the electroactive surface area, while the MIP provided highly selective molecular recognition sites. The sensor's performance was characterised using physicochemical techniques and electrochemically evaluated using cyclic voltammetry (CV) and differential pulse voltammetry (DPV). Under optimised experimental conditions, the MIP- Fe_3O_4 /CPE sensor exhibited a wide linear response with excellent sensitivity in terms of a low limit of detection (LOD) and quantification (LOQ) of 6.5 nM and 19.8 nM, respectively. The sensor demonstrated good reproducibility with low relative standard deviations (RSD < 5%). The sensor showed practical applicability and accuracy with excellent percentage recoveries of spiked river water samples with a range of 98.6 to 99.4% and low relative standard deviations (RSD < 5%). This MIP- Fe_3O_4 /CPE sensor offers a robust, rapid, cost-effective, and highly sensitive tool for monitoring ARV contaminants in environmental water bodies, providing an important solution for water quality risks associated with pharmaceutical pollution in aquatic environments.

BCC-F-14

A Safety-Catch Resin for Solid-Phase Peptide Synthesis (SPPS). Avoiding the use of Trifluoroacetic Acid (TFA) for the Cleavage*

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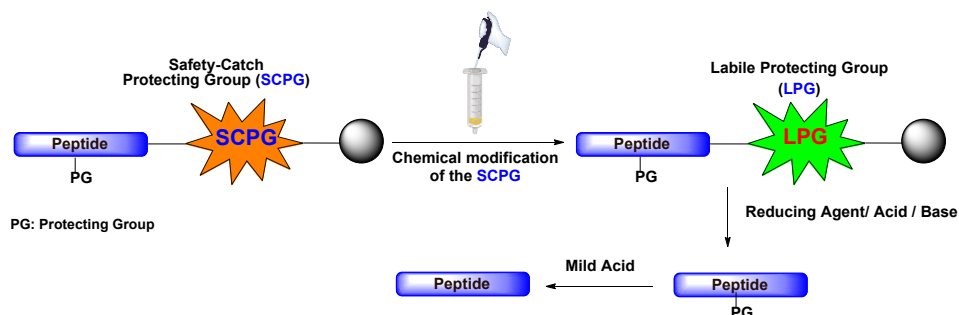
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A safety-catch protecting group is a group that remains stable under the standard reaction conditions, and after chemical modification can be removed under mild conditions. This principle has been applied to the development of a new resin for solid-phase peptide synthesis (SPPS). Thus, the resin forms a bond with the first amino acid of the sequence which

is stable throughout fluorenylmethoxycarbonyl (Fmoc) SPPS conditions: coupling of protected Fmoc-amino acids and removal of the Fmoc group. But, at the end of the synthesis the resin is modified and then the peptide was able to be cleaved in very mild conditions avoiding the use of trifluoroacetic acid (TFA). TFA is a polyfluoroalkyl substance (PFAS), which are a group of chemicals that are increasingly scrutinized by regulatory authorities and likely to face future usage restrictions. These compounds degrade very slowly in the environment and pose significant risks to both human health and ecosystems.



In this presentation, the nature of the Safety-Catch Protecting Group and the conditions used to cleave the peptide from the resin will be discussed using several model peptides.

*Patent pending

BCC-F-15

Synthesis And Biological Evaluation of Ru(II) Complexes Containing Chelating 1,2,3-Triazole-Based Ligands as Potential New Antitubercular and Antiretroviral Agents

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Tuberculosis (TB) remains the leading cause of death among people living with human immunodeficiency virus (HIV), with TB-HIV co-infection posing a major global health challenge, particularly in low- and middle-income countries[1, 2]. The prolonged treatment regimens, drug-drug interactions, toxicity, and increasing resistance associated with current therapies highlight the need for new agents capable of targeting both diseases[3-5]. In this study, eight pyridyl-functionalised 1,2,3-triazole ligands (**L1-L8**) and their mononuclear ruthenium(II) complexes of the types $[\text{RuCl}(\text{p-cymene})(\text{L})]\text{PF}_6$ (**C1-C8**) and $[\text{RuCl}_2(\text{DMSO})_2(\text{L})]$ (**C9-C16**) were synthesised, characterised, and their activity against HIV-1 and *Mycobacterium tuberculosis* (*Mtb*) was investigated. All the compounds were spectroscopically characterised. The structures of **C7**, **C10** and **C14** were confirmed by single-crystal X-ray diffraction analysis. The p-cymene-based ruthenium complex **C8** is the most active compound against *Mtb* H37Rv strain, with a MIC90 value of 15.6 $\mu\text{g/mL}$; but, it was eight times less active than ethambutol (1.95 $\mu\text{g/mL}$). Furthermore, biological investigations showed that compound **L2** ($\text{IC}_{50} = 0.1042 \mu\text{g/mL}$, selectivity index [SI] = 4798) and the DMSO-based complex **C12** ($\text{IC}_{50} = 0.9366 \mu\text{g/mL}$) exhibited potent HIV-1 activity

with low cytotoxicity. Consequently, these two compounds are promising candidates for further optimisation as potential anti-HIV therapeutics.

Keywords: pyridyl-1,2,3-triazoles, click chemistry, Ru(II) complexes, anti-TB, anti-HIV-1

References

- [1] S. Akwafuo, T. Abah and J. Oppong, *Journal of Infectious Diseases and Epidemiology*, 2020, **6**, 143.
- [2] N. H. Gama, A. Y. F. Elkhadir, B. G. Gordhan, B. D. Kana, J. Darkwa and D. Meyer, *BioMetals*, 2016, **29**, 637-650.
- [3] N. Pooranagangadevi and C. Padmapriyadarsini, *Frontiers in Tropical Diseases*, 2022, **3**, 834013.
- [4] M. K. Gebremariam, G. A. Bjune and J. C. Frich, *BMC Public Health*, 2010, **10**, 651.
- [5] M. R. O'Donnell, A. Wolf, L. Werner, C. R. Horsburgh and N. Padayatchi, *Journal of Acquired Immune Deficiency Syndromes*, 2014, **67**, 22-29.

BCC-F-16

Stability DNA Binding Affinity and Cytotoxic Properties of Oxovanadium (IV) Phenanthroline Complexes

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Transition metal complexes have attracted considerable interest in medicinal chemistry because of their diverse structural, electronic and biological properties, making them promising candidates for the development of new therapeutic agents [1, 2]. Oxovanadium (IV) complexes have demonstrated potential anticancer activity and are being investigated as alternatives to conventional metal-based drugs [1]. Schiff base ligands are versatile coordinating agents that can readily form stable complexes with transition metal ions through their donor atoms, while modifications to their substituents provide a means of tuning the electronic, steric and biological properties of the resulting complexes [2, 3]. DNA is an important molecular target in drug design, and interactions between metal complexes and DNA can provide valuable insight into their potential mechanisms of cytotoxic activity [3]. This study aims to synthesise and characterise novel oxovanadium (IV) Schiff base complexes and to investigate the influence of ligand substituents on their stability, DNA binding affinity and binding mode, as well as their structure activity relationships and potential cytotoxic properties. The complexes $[\text{VO}(\text{ONO-X})(\text{PHEN})]$ and $[\text{VO}(\text{ONN-X})(\text{PHEN})]\text{PF}_6$, where PHEN = 1,10-phenanthroline will be synthesised using tridentate ONO-X and ONN-X Schiff base ligands. The ONO-X ligands will be derived from salicylaldehyde and 4-substituted 2-aminophenols, while the ONN-X ligands will be prepared from 1-methyl-2-imidazolecarboxaldehyde and 4-substituted 2-aminophenols. The substituents investigated will include the electron-withdrawing bromine (Br) group and the electron-donating methoxy (OCH_3) and tert-butyl $[\text{C}(\text{CH}_3)_3]$ groups. The synthesised ligands and complexes will

be characterised using elemental analysis, UV-Visible, FT-IR spectroscopy, mass spectrometry and, where possible, single-crystal X-ray crystallography. The ligands and complexes will additionally be characterised using NMR and EPR spectroscopy, respectively. DNA-binding interactions will be evaluated using UV-Visible absorption titration and fluorescence emission spectroscopy, with thermal denaturation studies employed to further elucidate the binding mode. Comparative analysis of the electron-donating and electron-withdrawing substituents will be used to assess the relative contributions of electronic and steric effects to complex solution stability, DNA binding affinity and binding mode. This study seeks to establish relationships between ligand structure, physicochemical properties, DNA interactions and biological activity, thereby providing insight into the factors governing the potential of oxovanadium (IV) Schiff base complexes as cytotoxic agents and supporting the rational design of more effective metal-based therapeutic compounds.

1. X. Li, X. Fu, X. Pu, S. Ju, Y. Zhao, C. Zhang, J. Wang, Q. Zhu, L. Qiu and Y. Bai, *Chemistry – An Asian Journal*, **2026**, 21, no. 1, e70552.
2. I. Boucekine, K. Ouari, M. Merzougui, W. Benabid, and D. Hannachi, *J. Mol. Struc.*, **2024**, 1309, 138121.
3. I. Sindhu¹, A. Singh, A. Chauhan and N. Patel, *Discover Chemistry*, **2026**, 3, 71.

BCC-F-17

SYNTHESIS AND CHARACTERIZATION OF A SERIES OF FUNCTIONALIZED QUINOXALINE SILVER (I) COMPLEXES

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Quinoxaline and its derivatives have attracted significant scientific interest due to their wide range of biological activities and therapeutic potential. The rise of antimicrobial resistance (AMR), largely driven by the misuse of existing antimicrobial agents, highlights the urgent need for novel and more effective compounds. Quinoxaline-based compounds have been reported to exhibit strong antimicrobial properties[1], while silver complexes are well known for their broad-spectrum antimicrobial, antifungal, antiparasitic, and anti-inflammatory activities, as well as their emerging potential in anticancer therapy[2]. The integration of silver with quinoxaline ligands offers a promising approach to enhance biological efficacy through synergistic effects.

In this study, 2,3-diphenyl;2,3-di(2-thienyl) and 2,3-dimethyl quinoxaline and its derivatives, including 6-methyl- and 6,7-dimethyl-substituted analogues, were synthesized via a condensation reaction between benzil; 2,2'-thienil; diacetyl and the corresponding 1,2-diamines. The resulting ligands were reacted with silver(I) nitrate in ethanol to form the respective silver(I)-quinoxaline complexes. The ligands and their metal complexes were characterized using spectroscopic and analytical techniques, including FT-IR, UV-Visible, ¹H and ¹³C NMR spectroscopy, melting point determination, and mass spectrometry. These

studies confirmed the successful formation of the target ligands and their corresponding Ag(I) complexes

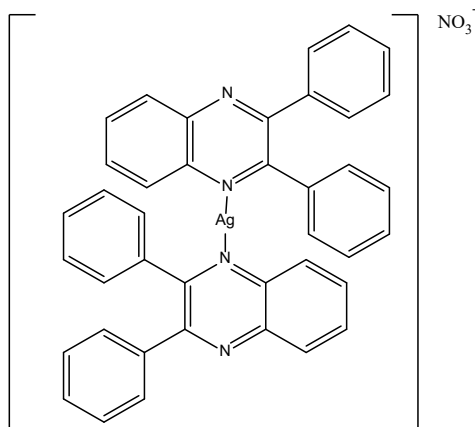


Figure 1: Structure of the complex, $[Ag(2,3\text{-diphenylquinoxaline})_2]NO_3$

[1] Pereira, J.A., *et al.*, Quinoxaline, its derivatives and applications: A State of the Art review, *Eur. J. Med. Chem.*, **2015**, 97, 664-672. European Journal of Medicinal Chemistry, 2015. **97**, 664-672.

[2] Medici, S., *et al.*, Silver coordination compounds: A new horizon in medicine, *Coord. Chem. Rev.*, **2016**, 327, 349-359.

BCC-F-18

COBALT(II) PHTHALOCYANINES APPENDED WITH SCHIFF BASE ION-EXCHANGERS OR CHELATORS FOR THE ELECTROCHEMICAL DETECTION AND QUANTIFICATION OF TRACES OF MERCURY(II) AND LEAD(II) IN WASTEWATER.

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The release of industrial and domestic waste, including emissions laden with nonessential, and therefore toxic, heavy metal elements (HMEs), has harmed the environment, particularly aquatic ecosystems. The synthesis, fabrication, and evaluations of the two new modified glassy carbon electrode dry-casted with cobalt(II) phthalocyanines (CoPcs) appended with Schiff base ion-exchangers (CoPc-sulfonyl) or chelators (CoPc-Py-Carboxyl, Py = pyridine) to enhance sensitivity for the quantitative analysis of lead(II) and mercury(II) ions are discussed. Under optimised conditions, the Differential Pulse Anodic Sweep Voltammetry (DPASV) responses of the CoPc-Py-carboxyl- and CoPc-Sulfonyl-GCE electrodes showed linear correlations within the $[Pb(II)]$ ranges 1 – 120 μM with an estimated LOD of 49.2 nM, and 0.5 – 130 μM with an LOD of 128.6 nM, respectively. Similarly, DPASV current responses were correlated with $[Hg(II)]$ within the ranges 5–100 μM (LOD 43.7 nM) for CoPc-Py-Carboxyl and 1 – 90 μM (LOD 42.5 nM) for CoPc-Sulfonyl. The two modifiers showed

good recoveries of 74-96% for the analyte in spiked Msunduzi river water samples. The synthesised CoPcs could detect Pb(II) below the WHO permissible Limit, making them viable electrochemical sensors for the toxic metal ion in environmental samples.

BCC-F-19

Synergistic Antioxidant and Cytotoxic Effects of Selenium-Coated Zinc Ferrites In Vitro

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The dual effects of trace elements, such as Zn and Se, in oxidative stress open many avenues for exploring their behaviour at the nanoscale as potential diagnostic tools or treatments for disorders. The ability of Zn and Se to act as both antioxidants and pro-oxidants has been extensively studied individually; however, few studies have examined their synergistic capabilities. Surface modifications of zinc ferrite (ZnFe_2O_4) with selenium (Se) were investigated to assess their synergistic effect on antioxidant activity and cytotoxicity in vitro for biomedical applications. The inherent capability of ZnFe_2O_4 to adsorb Se from aqueous solution was exploited to form a Se coating. The ZnFe_2O_4 were coated with two different concentrations of Se, 5% and 10%. The NPs were characterised using XRD and FTIR. TEM, SEM, EDX, NTA. Both TEM and NTA observed a size increase with increasing Se^0 concentration. In the TEM, a size increase from 8,8 nm to 10,9 nm, whilst the NTA visualised an increase from 109 nm to 140 nm. The XRD confirmed the synthesis of cubic spinel ZnFe_2O_4 , while the FTIR also served as confirmation of ZnFe_2O_4 , noting slight shifts in the spectra due to the Se^0 coating on the surface. The NPs were assessed for their antioxidant activity and cytotoxicity using the DPPH and MTT assays. The 10% $\text{ZnFe}_2\text{O}_4@\text{Se}$ sample displayed the highest cytotoxicity and antioxidant activity. The statistical analysis indicated significant differences between NPs. The results obtained suggest a potential application of 10% $\text{ZnFe}_2\text{O}_4@\text{Se}$ in cancer treatment, such as hyperthermia, due to its magnetic targeting and cytotoxic effects. The 5% $\text{ZnFe}_2\text{O}_4@\text{Se}$ displayed the least cytotoxicity, thus opening up avenues for future optimisation with polymer coatings and ligands for gene and drug delivery.

BCC-F-20

Structural Characterisation and Epithelial Cell Uptake of *Gardnerella vaginalis* Extracellular Vesicles Reveal Their Potential Role in Bacterial Vaginosis Pathogenesis

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Background: *Gardnerella vaginalis* is a key contributor to bacterial vaginosis (BV), a common vaginal dysbiosis among women of reproductive age that is associated with adverse reproductive health outcomes and increased susceptibility to human immunodeficiency virus (HIV) infection. Extracellular vesicles (EVs) are emerging mediators of host-pathogen interactions, but their production dynamics and interactions with host cells remain poorly understood. This study characterised EVs produced by *G. vaginalis* during bacterial growth and investigated their uptake by epithelial cells.

Methods: EVs were isolated from two *G. vaginalis* strains collected at multiple bacterial growth time points (6-144 h) using sequential centrifugation, filtration, and polyethylene glycol precipitation. Vesicle concentration and size distribution were determined by nanoparticle tracking analysis, morphology was confirmed by transmission electron microscopy, and cellular uptake was assessed in HepG2 cells using confocal laser scanning microscopy.

Results: Both strains produced structurally intact EVs throughout bacterial growth, with particle concentrations increasing progressively across all growth phases. ATCC 14018 produced a higher EV yield, reaching approximately 1.2×10^{11} particles/mL at 120 h, whereas ATCC 49145 reached approximately 8×10^{10} particles/mL at 144 h. In contrast, EVs from ATCC 49145 were larger (167-183 nm) than those from ATCC 14018 (153-172 nm). Transmission electron microscopy confirmed the characteristic spherical, cup-shaped morphology of EVs from both strains, while culture medium controls contained no vesicle-like structures. Confocal laser scanning microscopy demonstrated successful uptake of fluorescently labelled EVs by HepG2 cells after 24 h.

Conclusions: *G. vaginalis* strains exhibit distinct extracellular vesicle production profiles, differing in vesicle yield and size while maintaining the characteristic morphology of bacterial EVs. The efficient uptake of these vesicles by epithelial cells supports their potential role in host-pathogen interactions during bacterial vaginosis. These findings provide a foundation for future studies investigating the molecular cargo and biological functions of strain-specific EVs in bacterial vaginosis pathogenesis.

Keywords: *Gardnerella vaginalis*; bacterial vaginosis; extracellular vesicles; epithelial cells; confocal laser scanning microscopy; nanoparticle tracking analysis; transmission electron microscopy.

BCC-F-21

Optimisation and validation of an HPLC-PDA method for the quantification of contaminants of emerging concern – An investigation of seven selected pharmaceuticals

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Pharmaceuticals are increasingly recognised as contaminants of emerging concern due to their continuous release into aquatic environments and incomplete removal by conventional wastewater treatment processes. Reliable monitoring of these compounds requires sensitive, accurate and reproducible analytical methods, particularly in laboratories without access to mass spectrometric detection. This study developed,

validated and applied a high-performance liquid chromatography with photodiode array detection (HPLC-PDA) method for the quantification of seven pharmaceuticals: lamivudine (LAM), sulfamethoxazole (SMX), acetaminophen (ACT), albendazole (ALB), norethisterone (NOR), diclofenac (DIC) and efavirenz (EFZ). Chromatographic conditions were optimised and the method validated over a concentration range of 2-10 mg L⁻¹. Excellent linearity ($R^2 > 0.99$), limits of detection of 0.22-0.42 mg L⁻¹, limits of quantification of 0.67-1.26 mg L⁻¹, recoveries of 82-102% and relative standard deviations below 6% confirmed the method's sensitivity, accuracy and precision. The validated method was subsequently applied to wastewater samples collected in triplicate from the KwaMashu Wastewater Treatment Plant, KwaZulu-Natal, South Africa, following solid-phase extraction and quantification using the standard addition method to minimise matrix effects. All target pharmaceuticals were detected throughout the treatment process, with removal efficiencies varying considerably among compounds. Sulfamethoxazole (99.6%), acetaminophen (91.4%) and albendazole (89.0%) showed high removal efficiencies, while lamivudine (61.5%) and efavirenz (66.1%) exhibited moderate removal. In contrast, norethisterone showed poor removal (18.1%), whereas diclofenac exhibited negative removal (-23.2%), suggesting transformation or deconjugation processes during treatment. This study also reports the first detection of norethisterone in South African wastewater. Overall, the findings demonstrate that pharmaceutical removal is highly compound dependent, highlight the limitations of conventional activated sludge systems for eliminating persistent pharmaceuticals, and establish a robust HPLC-PDA method for pharmaceutical monitoring in resource-limited settings.

BCC-F-22

BIOACTIVE PLANT EXTRACT-MODIFIED NANOCHITIN FOR THE REMOVAL OF MICROBIAL CONTAMINANTS FROM IRRIGATION WATER

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The increasing global demand for freshwater driven by urbanization, industrialization, population growth, and climate change has led to widespread use of reclaimed wastewater for irrigation purposes. Despite its benefits, including the provision of essential nutrients that can enhance crop growth and reduce fertilizer requirements, wastewater reuse presents significant microbiological challenges as it introduces pathogenic microorganisms and antibiotic-resistant microbes into agricultural environments [1]. Once the pathogens are introduced to irrigation systems, they can persist in water and cause infection when they come in contact with plant tissues or other natural opening resulting in disease outbreaks. Conventional water treatment technologies, including chlorination, ozonation, and filtration are effective in reducing microbial contamination but are often associated with high operational costs, energy demands, and formation of harmful by-products [2]. There is a growing need for sustainable, cost-effective, and environmentally friendly water purification method, capable of efficiently removing microbial contaminants from irrigation water and improving its quality for safe use. This study investigated the development of surface-modified nanochitin as a sustainable material for reducing

microbial contamination in water. This is due to the abundance, biodegradability, biocompatibility, low toxicity, and inherent antimicrobial properties of chitin, which makes it a sustainable, and cost-effective material. While plant-derived bioactive compounds were incorporated to enhance the materials ability. Chitin nanomaterials were synthesized through acid hydrolysis, then modified using *Eucalyptus* plant extract. The Fourier-transform infrared spectroscopy analysis confirmed the incorporation of plant extract by enhancing the characteristic C-H and C-O-C vibrations. Powder X-ray diffraction confirmed the α -chitin polymorph, with increased crystallinity after hydrolysis, Brunauer-Emmett-Teller analysis indicated changes in surface characteristics following functionalization, while Transmission Electron Microscopy revealed rod-like nanocrystals.

[1] Christou, A., Beretsou, V. G., Iakovides, I. C., Karaolia, P., Michael, C., Benmarhnia, T., Chefetz, B., Donner, E., Gawlik, B. M., & Lee, Y. (2024). Sustainable wastewater reuse for agriculture. *Nature Reviews Earth & Environment*, 5(7), 504–521.

[2] Partyka, M. L., & Bond, R. F. (2022). Wastewater reuse for irrigation of produce: A review of research, regulations, and risks. *Science of the total environment*, 828, 154385.

BCC-F-23

An Investigation into the Presence of Organic Chemical Pollutants in the Reuse Water Plant at an uMngeni-uThukela Water Wastewater Treatment Plant.

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Water reuse has become an essential approach for mitigating water scarcity and promoting sustainable water resource management. Treated wastewater, often referred to as reuse water, is increasingly considered for agricultural irrigation, industrial operations, and even potable applications in some regions. The use of treated wastewater presents an environmentally sustainable and practical alternative [1]. While conventional treatment processes efficiently remove many contaminants, concern persists regarding residual pollutants (organic micropollutants such as pharmaceuticals, pesticides, and polychlorinated biphenyls (PCBs)) that may remain after treatment [2]. Since Umgeni-uThukela Water does not routinely test for organic micropollutants, the quality and safety of reuse water with respect to pharmaceutical and pesticide contamination remain uncertain. This study focuses on the development and validation of analytical methods for detecting and quantifying selected organic pollutants in reuse water. This will enable future monitoring of contaminants in reuse water. An LC-MS and a GC-MS method were developed to monitor pharmaceuticals and pesticides/PCBs respectively. The GC-MS method was successfully validated according to ICH guidelines. The validated GC-MS method exhibited excellent linearity ($R^2 = 0.994 - 0.997$), satisfactory recoveries (70–119%), acceptable precision ($RSD \leq 14.7\%$), and suitable detection limits for all target analytes. Once the LC-MS method has undergone validation, the methods will be applied to real reuse water samples from a local treatment facility. Additionally, pollutant levels in relation to physicochemical parameters will be assessed, providing baseline data to guide future monitoring and enhance understanding of pollutant behaviour in treated wastewater.

- [1] K.K. Kesari, R. Soni, Q.M.S. Jamal, *et al.* Wastewater Treatment and Reuse: A Review of Its Applications and Health Implications. *Water Air Soil Pollut*, 2021, **232**, 208
- [2] A. Gogoi, P. Mazumder, V. K. Tyagi, G. G. Tushara Chaminda, A. K., And M. Kumar, *Groundw. Sustain. Dev.*, 2018, **6**, 169-180
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FLASH ABSTRACTS

BIOLOGICAL SCIENCES

BS-F-1

Health Workers' Perspectives and Diagnostic Practices in Malaria Case Identification Among Pregnant Women in Primary Health Settings in Oyo State, Nigeria.

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Malaria in pregnancy (MIP) is a major public health challenge, carrying substantial risks for mothers and unborn children, leading to negative birth outcomes. Sub-Saharan Africa and Northeast Asia are the region's most significantly impacted by malaria. There is a need for accurate diagnosis, care, and management of malaria in pregnant women to combat this disease in these regions.

The aim of this study is to explore health care workers' perspectives on malaria case identification and management in pregnant women, focusing on their clinical understanding, diagnostic practices, interprofessional collaboration, and referral systems.

This study employed a qualitative research design, collecting data from primary health centers in Oyo State through semi-structured one on one in-depth interviews with 13 health care professionals, comprising six community health workers, two nurses, three laboratory officers, and two medical officers. The data were analysed thematically to identify key patterns and insights related to malaria diagnosis and management. NVivo software was used to code and thematically analyse the transcripts.

The study shows strong collaboration among community health workers, nurses, doctors, and laboratory officers, which reinforces communication and the proper treatment of pregnant women. The coordination is hierarchical, role-dependent, and unequal, with organized cooperation and team-based care among the cadre. The study also highlighted the gaps in the flow of communications, feedback processes, referrals, and mutual understanding of the protocols.

Key words: Community Health Workers, Malaria in Pregnancy, Primary Health Center, Qualitative Analysis.

BS-F-2

Antimicrobial and Anti-Quorum Sensing Screening of Endophytic Bacteria Isolated from *Kigelia africana*

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The rapid escalation of antimicrobial resistance (AMR) demands alternative therapeutic options, including anti-virulence strategies that disrupt bacterial communication without imposing severe selective survival pressure. This study conducted a primary phenotypic and functional screening of 97 endophytic bacterial isolates recovered from the leaves of the medicinal plant *Kigelia africana*. Morphological and Gram-staining characterization revealed a collection of 50 Gram-positive (51.5%) and 47 Gram-negative (48.5%) bacteria, showing five distinct pigmentation types dominated by cream (47.42%) and yellow (22.68%) colonies, with a heavy predominance of bacillary morphotypes (96–100%). Primary antimicrobial screening using modified cross-streak assays against six clinical reference pathogens revealed highly selective antagonistic activity. Among Gram-positive targets, vancomycin-resistant *Enterococcus faecalis* ATCC 51299 was the most susceptible, with 10.31% and 12.37% of isolates displaying highly active and strong inhibition, respectively. *Acinetobacter baumannii* ATCC 19606 was the most susceptible Gram-negative pathogen, with 5.15% of isolates causing total growth inhibition. Primary screening for quorum sensing inhibition (QSI) using live-colony overlay assays identified significant anti-virulence potential. Specifically, 26.80% of isolates inhibited short-chain acyl-homoserine lactone (AHL)-associated signaling in *Chromobacterium subtsugae* 017, 18.56% disrupted long-chain AHL communication in *Chromobacterium violaceum* ATCC 12472, and 19.59% targeted AI-2-associated signaling in *Vibrio campbellii* BB120. Twelve isolates exhibited dual-system AHL inhibition, while three isolates simultaneously interfered with both AHL and AI-2 pathways. Nearly full-length 16S rRNA gene sequencing identified selected bioactive isolates (such as broad-spectrum strain 206 and multi-system QSI strain 91) belonging to five genera across the phyla Pseudomonadota and Bacillota: *Achromobacter*, *Atlantibacter*, *Pandoraea*, *Pseudomonas*, and *Bacillus*. These findings underscore the functional diversity of *K. africana*-associated endophytes as a valuable repository for targeted antimicrobial and anti-virulence agent discovery.

Keywords: *Kigelia africana*; bacterial endophytes; antimicrobial screening; quorum sensing inhibition; 16S rRNA sequencing.

BS-F-3

Integrated *in vitro* and *in silico* evaluation of food preservation and hypoglycemic potentials of *Megaphrynium macrostachyum*

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Indigenous food-wrapping plants are widely used in many West African communities for food packaging and preservation; however, scientific evidence for their biological properties remains limited. This study investigated the *in vitro* food preservative and hypoglycaemic potential of leaf extract fraction *Megaphrynium macrostachyum*. The bioactive components of the active fractions were identified using Gas Chromatography-Mass Spectrometry (GC-MS), and their potential hypoglycaemic and food-preservation properties were assessed using *in silico* molecular modelling approaches. All the *in vitro* assays were done using standard methods and the molecular docking was performed against microbial and diabetic-related protein targets (PDB IDs: 4ZA5, 5MMN, 1HNY, 5NN8 and 5YK7) to know the interaction of selected bioactive compounds. The dichloromethane fraction demonstrated the highest antimicrobial activity against the tested food-borne pathogens. The n-hexane fraction showed the most promising hypoglycaemic activity, significantly compared with the positive control (Acarbose). Molecular docking analysis identified Oxacycloheptadec-8-en-2-one, (8Z) as the most promising ligand, exhibiting strong binding affinities of -10.6, -7.5, -6.9, -6.2 and -7.0 kcal/g, respectively, with the aforementioned proteins. The 4ZA5 target showed the strongest ligand interaction overall, with a binding energy of -10.6 kcal/g. These findings provide scientific evidence supporting the traditional application of *M. macrostachyum* as a food wrapping leaf and demonstrate its potential application as a source of antimicrobial and hypoglycaemic agents for lead drug development. However, future studies should focus on the isolation and characterization of the active compound, molecular dynamic simulations, toxicity assessment and *in vivo* validation to establish their safety, efficacy and potential application in food preservation and pharmaceutical development.

BS-F-4

INTEGRATED *IN VITRO* AND *IN SILICO* EVALUATION OF BIOACTIVE METABOLITES FROM ENDOPHYTIC *BACILLUS* AND *PSEUDOMONAS* SPECIES

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The increasing prevalence of antimicrobial resistance, together with the adverse effects associated with some synthetic therapeutic agents, has intensified the search for effective

and biocompatible bioactive compounds from natural sources. This study investigated the antibacterial, anti-biofilm, quorum sensing inhibition, antioxidant and anticancer activities of crude extracts obtained from endophytic *Bacillus* and *Pseudomonas* species isolated from *Kigelia africana*. Bacterial extracts were produced by fermentation in medium Mannitol, followed by solvent extraction. Gas chromatography–mass spectrometry (GC-MS) and Fourier-transform infrared spectroscopy (FTIR) were used to putatively identify extract constituents and their associated functional groups. Antibacterial activity was evaluated using broth microdilution assays, while anti-biofilm activity was assessed using initial adhesion inhibition and mature biofilm disruption assays. The Gram-negative quorum sensing inhibition activity was assessed using *Chromobacterium* species as biosensors. Antioxidant activity was determined using DPPH and ABTS radical scavenging assays. Anticancer activity against DU-145 prostate and MCF-7 breast cancer cells was evaluated using the MTT assay. Network pharmacology and molecular docking were used to investigate potential anticancer targets enriched signalling pathways and predicted compound–protein interactions.

The extracts contained constituents associated with several functional groups, including alkanes, alcohols, amines and aromatic compounds. Extract KA-M12 exhibited antibacterial activity against all six indicator bacteria with MICs ranging from 2.5 to 5 mg/ml. At 1600 µg/ml, the KA-M12 extract inhibited biofilm formation by methicillin-resistant *Staphylococcus aureus* ATCC 43300 by 62.33±2.97%, whereas extract KA-M5 disrupted mature biofilm of *Acinetobacter baumannii* ATCC 19606 by 53.73±1.67%. KA-M3 and KA-M5 exhibited quorum-sensing inhibition activity of 50.46±2.09% and 55.77±0.83%, respectively, at 1600 µg/ml. KA-M7 exhibited the highest antioxidant activity, reaching 58.00±0.51% at 1600 µg/ml. KA-M5 and KA-M12 inhibited DU-145 prostate and MCF-7 breast cancer cell viability with % inhibition ranging from 63.9% to 99.3% at 1600 µg/ml. KA-M12 demonstrated the greatest apparent selectivity and a selectivity index of 2.84 against both MCF-7 and DU-145 cell lines. Protein-protein interaction network analysis using the maximal clique centrality algorithm identified EGFR, CDK1, TOP2A and TYMS as prominent breast-cancer-associated hub targets, whereas MMP9, MMP2 and KDR were prominent in the prostate cancer network. KEGG enrichment analysis identified pathways associated with cancer progression and therapeutic response, including prostate cancer, endocrine resistance, bladder cancer and relaxin signalling. Putatively annotated 1,1'-(4-methyl-1,3-phenylene)bis[3-(5-benzyl-1,3,4-thiadiazol-2-yl)urea] in extract KA-M12 showed predicted binding energies of –10.2, –12.6, –10.0 and –9.5 kcal/mol for EGFR, CDK1, MMP9 and KDR, respectively. These findings indicate that endophytic *Bacillus* and *Pseudomonas* species associated with *K. africana* represent potential sources of metabolites with antibacterial, anti-virulence, antioxidant and anticancer activities. However, bioassay-guided fractionation, structural confirmation of the active metabolites and mechanistic validation of the predicted molecular targets are required before their therapeutic potential can be established.

BS-F-6

SMOKE-DERIVED COMPOUNDS REVEAL NEW MANAGEMENT OPPORTUNITIES FOR INVASIVE CROFTON WEED

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Mexican weed *Ageratina adenophora* (Crofton weed; Asteraceae) is among the most damaging invasive plants threatening South African rangelands, where it reduces grazing capacity and displaces indigenous vegetation. Biological control has not been successful and invasion continues because persistent soil seed bank remains largely unmanaged. Since the discovery over five decades ago that Crofton weed seeds require light for germination, numerous environmental and chemical factors have been investigated to overcome this requirement, yet none has convincingly substituted for light. This study investigated whether smoke-derived compounds could expose vulnerabilities in the recruitment biology of Crofton weed and provide a foundation for soil seed bank management.

Seeds were exposed to smoke-water (SW) and its isolated compounds KAR₁, KAR₂, KAR₃ and trimethylbutenolide (TMB) under temperature, light and salinity regimes. Germination was optimal at alternating day/night temperatures of 25/20 °C, whereas higher temperatures were thermoinhibitory. Germination was strongly light-dependent (partial $\eta^2 = 0.901$), with only 3% of control seeds germinating in complete darkness compared with more than 50% following a 5-h pulse of white light. SW compounds increased dark germination to a maximum of 23%, but this response was driven almost entirely by KAR₂ (60%). Surprisingly, KAR₂ was ineffective following far-red light exposure, demonstrating that darkness and far-red light represent physiologically distinct inhibitory states. These findings suggest that KARs do not simply replace the light requirement, as universally acknowledged. Because vegetation canopies absorb red light while enriching far-red wavelengths, KAR₂ is likely to be most effective where buried seeds remain in darkness rather than beneath dense vegetation. The challenge is no longer simply overcoming the constraints imposed by seed burial, but understanding how surrounding vegetation regulates responsiveness to smoke germination cues through changes in light quality.

Germination was completely inhibited by 150 mM NaCl. Simultaneous application of NaCl+SW compounds restored germination to approximately 35%, although seedlings were abnormal and poorly developed. These findings suggest that soil salinity may temporarily suppress recruitment, whereas rainfall or irrigation that leaches salts from the soil could create favourable conditions for germination and invasion. The ability of these SW compounds to alleviate salt-induced inhibition could potentially be exploited after heavy rainfall, when salts have been leached from the soil, to stimulate a synchronized flush of seedling emergence. Farmers and pastoralists could then survey invaded areas and physically remove the young seedlings, reducing replenishment of the soil seed bank and halting further invasion.

The results suggest a relatively inexpensive and environmentally-friendly solution to managing rangelands invaded by Crofton weed infestations. Future studies must investigate other stress factors which might influence germination performance of these cues such as soil pH, drought and microplastics.

BS-F-7

PLANT-ARTHROPOD INTERACTIONS ACROSS RIPARIAN AND ADJACENT UPLAND HABITATS ALONG THE UMNGENI RIVER: IMPLICATIONS FOR ECOSYSTEM FUNCTIONING

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Riparian habitats are highly heterogeneous and disturbance-driven, creating strong ecological filters that shape vegetation functional composition and arthropod functional diversity differently from adjacent upland areas. Linking vegetation and arthropod community variation across riparian and upland habitats is essential for understanding how these cascade to arthropod-mediated ecosystem services. This study examined how variation in vegetation diversity and functional composition influences spider assemblage and diversity across riparian and adjacent upland habitats along the uMngeni River at Umgenipoort Research Centre, Hilton College Nature Reserve and Fountainhill Estate. At each site, sampling was conducted at four points spaced approximately 300 m apart along the river, with each point comprising a riparian sample at the river edge (0 m) and an adjacent upland sample located 300 m from the river. Plant species rooted within 1 m² quadrats placed at the start and end of paired 30 m transects spaced 10 m apart were recorded and their abundance estimated using percentage cover, while spiders were collected along the same transects using pitfall traps. Diversity indices and multivariate analyses were used to assess community patterns. Riparian habitats supported higher plant diversity and greater forb representation than upland habitats, despite substantial invasive plant cover. Spider community composition varied across habitats; however, PERMANOVA indicated no significant difference ($p = 0.80$). Redundancy analysis revealed weak, marginally non-significant associations between vegetation functional composition and spider assemblages ($p = 0.0667$), suggesting that vegetation structure contributes to, but does not strongly determine, arthropod community patterns. Relationships between vegetation abundance and spider abundance and richness further indicated context-dependent responses rather than uniform habitat effects. These findings suggest that vegetation functional composition may indirectly mediate spider functional responses across riparian–upland gradients, with potential implications for arthropod-mediated regulating ecosystem services such as biological pest control, although these effects appear to be moderated by spatial heterogeneity and environmental gradients.

BS-F-8

Genetic Diversity of Heat Shock Proteins (HSPs) in South African Nguni Cattle Populations

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Climate change is threatening the sustainability of livestock production systems by causing heat stress in livestock. Indigenous cattle breeds such as the Nguni are valued for their adaptability and natural thermotolerant abilities in changing climates. This study investigates the genetic diversity of selected heat shock protein gene families (HSP70 and HSP90) in Nguni cattle, by focusing on single-nucleotide polymorphisms (SNPs) and their potential role in thermotolerance. By combining molecular genetics with population-level diversity analyses, this study aims to identify the SNPs contributing to thermotolerance.

DNA sequencing and statistical analyses of genetic variation were used to assess inter- and intra-population diversity within selected HSP genes. These findings will ultimately contribute to the conservation and sustainable breeding of indigenous cattle. Additionally, they align with national goals for sustainable agriculture and food security as per South Africa's Bioeconomy Strategy by promoting the use of locally adapted genetic resources in response to global environmental challenges.

BS-F-9

Corn Resistant Starch Restores Glucose Homeostasis by Modulating the Gut–Pancreas–Metabolism Axis

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Resistant starch has emerged as a promising functional food owing to its ability to modulate the gut microbiota and improve metabolic health. However, the integrated mechanisms linking gut microbial modulation to pancreatic metabolism and systemic glucose homeostasis remain incompletely understood. This study investigated the effects of corn resistant starch (CRS) on the gut–pancreas–metabolism axis in a fructose–streptozotocin-induced rat model of type 2 diabetes (T2D). Male Sprague–Dawley rats with T2D were orally administered CRS at doses of 150 or 300 mg/kg body weight, five days per week for five weeks. Body weight and fasting blood glucose were monitored weekly, while oral glucose tolerance was assessed during the final week of intervention. Faecal samples were also collected. Following euthanasia, blood, pancreas, and colon were harvested for biochemical, metabolomic, and morphological analyses. CRS significantly reduced blood glucose levels and improved glucose tolerance. It enhanced glycolysis and Krebs cycle activity in both the pancreas and colon, while suppressing gluconeogenesis and the polyol pathway. CRS also restored glutathione-dependent antioxidant defence, improved energy metabolism, increased glyoxalase-1 activity, and attenuated inflammatory responses by inhibition of 5- and 12/15-lipoxygenase activities. Metabolomic analysis demonstrated improved pancreatic and colonic lipid metabolism and associated metabolic pathways. Faecal metabolomics revealed increased levels of beneficial microbial metabolites, particularly short-chain fatty acids. Furthermore, full-length 16S rRNA gene sequencing revealed enrichment of beneficial lactic acid bacteria with a concomitant reduction in the abundance of *Romboutsia ilealis*. Morphological analysis further demonstrated preservation of pancreatic architecture and improved β -cell population. These results

demonstrate that CRS restores the gut–pancreas–metabolism axis through coordinated modulation of gut microbial composition, microbial metabolite production, pancreatic and colonic metabolic modulation, and tissue integrity. This integrated response suppresses hyperglycaemia, oxidative stress, inflammation, dysregulated lipid metabolism, and gut dysbiosis, highlighting CRS as a potential dietary strategy for improving metabolic homeostasis and mitigating the progression of T2D.

BS-F-10

Antibiotic resistance profiling of *Staphylococcus* spp. and *Salmonella* spp. from three locations along the Msunduzi River

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River water plays an important role in human life and is used in South Africa for domestic purposes, irrigation, and recreation. However, bacterial contamination of domestically used river water is a major cause of waterborne illnesses.

The aim of the study was to analyze river water samples collected from three locations along the Msunduzi River in the city of Pietermaritzburg for the presence of antibiotic-resistant bacteria, specifically targeting *Salmonella* spp. and *Staphylococcus* spp. In addition, the presence of *Vibrio* spp. in water samples was examined. Seasonal sample collection started in March 2026. One hundred liters of river water were collected on-site using a solar-powered portable pump and filtration system. After sampling, the filters were backflushed with 1L of 0.1% buffered peptone water amended with 0.05% Tween 80. The isolation of antibiotic-resistant *Staphylococcus* spp. was done via pre-enrichment (Tryptone Soy Broth supplemented with salt, aztreonam, and cefoxitin), followed by using Baird Parker agar. The isolation of presumptive *Salmonella* spp. employed Rappaport Vassiliadis broth enrichment followed by the use of Xylose Lysine Deoxycholate agar. *Staphylococcus* spp. and *Salmonella* spp. were confirmed by biochemical tests and amplicon-specific polymerase chain reaction. For the isolation of potential *Vibrio* spp., pre-enrichment in alkaline saline peptone water was followed by inoculation onto Thiosulfate-Citrate-Bile-salts-Sucrose agar. Representative isolates will additionally be characterized by MALDI-TOF MS.

Initial results confirmed the presence of antibiotic-resistant *Staphylococcus* spp. in collected Msunduzi River water samples, including isolates exhibiting resistance against the β -lactam antibiotic oxacillin, against fluoroquinolones (e.g., ciprofloxacin), or macrolides (e.g., erythromycin).

However, based on antibiotic susceptibility testing, the *Salmonella* spp. isolates obtained so far were susceptible to the tested antibiotics.

Interestingly, several presumptive *Vibrio* spp. isolates exhibited resistance towards macrolides (e.g., erythromycin), tetracycline, or the fluoroquinolone ciprofloxacin, awaiting confirmation.

While work is ongoing, these initial results highlight the presence of known bacterial pathogens - including antibiotic-resistant strains - in the Msunduzi River water that could negatively affect human and animal health upon exposure.

BS-F-11

AUTHENTICATION OF WILDLIFE MEAT AND MEAT PRODUCT LABELLING FROM SELECTED COMMERCIAL WILDLIFE OUTLETS IN DURBAN, KWAZULU-NATAL PROVINCE, SOUTH AFRICA

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Wild animal meat is highly consumed in southern African countries, including South Africa. It is normally obtained either through farming, ranching, or hunting. It has been reported that the consumption of ostrich and wild ungulates, also known as game, is a healthy alternative to other domestic meat products. The purpose of this study was to authenticate wildlife meat and meat product labelling from products purchased from different selected commercial wildlife outlets by identifying the animal species provided on the product labelling using universal mitochondrial-vertebrate primers. A total of 56 packaged wildlife meat and meat product samples from Ostrich, Warthog, Venison, Wildebeest, Bushpig, Kudu, Buffalo, Impala, and Springbok were purchased from randomly selected supermarkets, online vendors, and local butcher outlets in Durban, KwaZulu-Natal. All products were received in a fresh/frozen state and, upon arrival, were catalogued and stored in a freezer at -20°C. Meat samples were then subjected to DNA extraction, PCR analysis, and positive amplicons were sent for sequencing. The sequences were subject to the nucleotide Basic Local Alignment Search Tool (BLAST) to confirm the animal species provided on the product labelling, and the other declared and/or undeclared animal species present in the meat products. The results showed that 70% contained other meat species not declared on the product label. Contamination was more prevalent in biltong (87,5%), while steak products had the lowest contamination (20%). This was not surprising, as the intensive processing involved in processed products may have contributed to the observed high mislabelling percentage in these products compared to unprocessed meat products. However, it was not clear whether the observed mislabelling was intentional for financial gains or unintentional due to incorrect handling and utilisation of shared equipment during processing. Results further showed that meat labelling regulations are not always followed by some outlets in Durban, KwaZulu-Natal; consequently, consumers' rights are violated.

BS-F-12

MICROSCOPIC ANALYSIS AND PHYTOCHEMICAL COMPOSITION OF *Cryptopcaria woodii* ENGL. (LAURACEAE)

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Medicinal plants have been utilized by generations to treat different ailments, informed by indigenous knowledge systems and cultural practices passed down. These plants encompass many different phytochemical constituents that underpin their medicinal characteristics, thereby accounting for continued use in the treatment of complex diseases. *Cryptocarya woodii* is a South African indigenous medicinal plant that belongs to Lauraceae, a family famous for numerous medicinal species, a variety of phytochemical classes and essential oils. *Cryptocarya woodii* is believed to exhibit magical and medicinal properties, it is also recorded to treat diarrhoea, although there is limited research on phytochemical composition of this species, even though it belongs to a family and a genus of well-studied phytochemical composition and pharmacological properties. Preliminary studies revealed anti-inflammatory activity in *C. woodii*, however, the secondary metabolites responsible for these medicinal properties remain unknown. Secondary metabolites such as α -pyrones, goniotalamin and cryptofoline have been revealed in crushed *C. woodii* leaves, however, a comprehensive investigation of the secondary metabolites present in this species and their localization is still required. *C. woodii* has shown potential therapeutic properties and has been used by communities to treat different ailments, although a gap for a comprehensive study on its phytochemical constituents, localization and microscopic morphology and ultrastructure still exist. Limitation of the microscopic, phytochemical composition and biological activity research inhibits developments on the pharmacological studies and ways of improving sustainable utilization of this species. The aim of the study is to investigate the microscopic features, histochemistry and phytochemical composition of *C. woodii*. The leaves and stem of *C. woodii* were selected for this study. A stereomicroscope was used to view the general surface morphology, and the detailed surface micromorphology under Scanning Electron Microscope, and Transmission Electron Microscope for the ultrastructure. Different histochemical stains will be used to localize secondary metabolites under light microscope; qualitative phytochemical tests will be performed on *C. woodii* plant extracts to detect the presence of secondary metabolites. Preliminary stereomicroscopy and scanning electron microscopic observations revealed the presence of non-glandular trichomes along the midrib of the leaves. Higher trichome density was observed on the abaxial of emergent leaves compared to younger and mature leaves. TEM, histochemical and phytochemical analyses are currently ongoing and will report on the secondary metabolites present and their localization on the plant tissues of this species. The significance of this study is to provide a comprehensive investigation on the secondary metabolites present, the localization of these compounds and pharmacological activities they exhibit, specifically for this species. This will contribute to the scientific knowledge of the genus, inform drug discovery and contribute to the conservation of South African indigenous species.

BS-F-13

The effects of fortifying maize meal and sorghum porridges with mopane worms and gyanisa caterpillars on colour quality and nutritional composition

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Malnutrition, including both protein-energy malnutrition (PEM) and micronutrient deficiencies, remains a significant global public health issue. It is prevalent in low- and middle-income countries, including South Africa. Vulnerable groups, such as infants, young children, and pregnant and lactating women, are disproportionately affected, and the effects of malnutrition may be further exacerbated by infections. In South Africa, high rates of poverty, income inequality, and unemployment are primary drivers of malnutrition. The FAO has proposed edible insects as an alternative and potentially cost-effective nutrient-rich food source for addressing protein and micronutrient deficiencies among vulnerable populations. Their high-quality protein and essential amino acids content contribute to their nutritional value. This study therefore investigated the effects of incorporating mopane worm and *gynanisa* caterpillar meal on the colour and nutritional composition of maize meal and sorghum porridges. These porridges were prepared using a standardised cooking method and supplemented with mopane worm and *gynanisa* caterpillar meal at 5% and 10% (w/w), as well as an insect meal combination at 5% and 10% (w/w). The colour and nutritional composition of the control and insect-fortified porridges were determined using the standard analytical methods. Lightness was affected by the type of insect, the inclusion level of insects, and the type of porridge. Among the three insect types, mopane worm fortification resulted in the greatest decrease in lightness, indicating a darker porridge. Similarly, 10% fortification level resulted in the highest decrease in lightness compared with the 5% fortification level. Regarding porridge type, maize meal porridge showed the greatest decrease in lightness compared to sorghum porridge. The highest decrease in lightness was reported in maize meal porridge supplemented with 10% mopane worm meal compared to sorghum porridge fortified with 5% mopane worm meal. The protein content was significantly affected by insect type as the highest protein content was recorded in mopane worm meal fortification. The protein content increased with fortification level; hence, the highest protein content was recorded in maize meal porridge supplemented with 10% mopane worm meal. In contrast, the protein content for sorghum porridge decreased with insect fortification level; sorghum porridge supplemented with 5% *gynanisa* caterpillar meal had the highest protein content. The highest zinc content was recorded in maize meal porridge fortified with 10% *gynanisa* caterpillar meal and 10% insect meal combination, while the highest iron content was recorded in sorghum porridge supplemented with 10% mopane worm. The essential amino acid lysine content increased with an increase in insect fortification level. sorghum porridge supplemented with 10% *gynanisa* caterpillar meal had the highest lysine content. These findings demonstrate the potential of mopane worm and *gynanisa* caterpillar meals to improve the nutritional value of maize meal and sorghum porridges and contribute to addressing protein and micronutrient deficiencies in South Africa. However, further product optimisation is required to minimise the darkening of the fortified maize-meal porridge and improve its potential consumer acceptability.

Keywords: nutritional composition, malnutrition, edible insects, porridge, colour

BS-F-14

Can selected *Pseudomonadota* strains exhibiting β -lactamase activity cross-protect susceptible bacterial strains against β -lactam antibiotics?

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β -Lactam antibiotics are widely used chemotherapeutic agents to treat bacterial infections. Due to such extensive use, bacterial resistance to these compounds is frequently reported globally. The lowered or absent therapeutic efficacy of β -lactam antibiotics due to bacterial resistance negatively affects public health, as treatment of bacterial infections may fail. A common resistance mechanism employed by Gram-negative bacteria is the use of antibiotic inactivation enzymes, β -lactamases.

This study aimed to determine whether representative bacterial strains exhibiting phenotypic resistance to β -lactam antibiotics employ β -lactamase activity as a means of resistance. Furthermore, the ability of selected strains (including environmental isolates) exhibiting β -lactamase activity to cross-protect bacterial strains that are susceptible to β -lactam antibiotics was determined.

β -Lactam-antibiotic-susceptible reference strains such as *Escherichia coli* ATCC 25922 and *Salmonella* Enteritidis ATCC 13076, and β -lactamase-producing reference strains (e.g., *Enterobacter hormaechei* subsp. *steigerwaltii* ATCC BAA-1143), and selected environmental isolates (e.g., MDR *Enterobacterales*) were analysed. The presence of β -lactamase activity was verified qualitatively using intact cells and quantitatively using crude extracts and a chromogenic cephalosporin. While β -lactamase-negative control strains did not hydrolyze the β -lactam ring, tested environmental isolates exhibiting phenotypic resistance to β -lactam antibiotics showed high specific β -lactamase activity toward the chromogenic cephalosporin.

Furthermore, strains exhibiting elevated β -lactamase activity were able to cross-protect susceptible strains, such as *Escherichia coli* ATCC 29222 and *Salmonella* Enteritidis ATCC 13076, against β -lactam antibiotics such as ampicillin, cefotaxime, and cephalothin.

BS-F-15

PHYTOREMEDIATION POTENTIAL OF *VIGNA UNGUICULATA* AND *VIGNA RADIATA* IN HEAVY METAL-CONTAMINATED URBAN SOILS

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This study evaluated the potential of cowpea (*Vigna unguiculata*) and mung bean (*Vigna radiata*) to reduce metal toxicity and improve soil fertility in heavy metal-contaminated soils collected from vehicle scrap yards in Isipingo, South Africa. Changes in soil nutrient concentrations, extracellular enzyme activities, soil microbial composition, and plant tissue nutrient and metal accumulation were assessed before and after legume cultivation. Cowpea significantly altered soil chemical properties, reducing K and Mn while increasing pH and exchange acidity relative to pre-planting soils. In contrast, mung bean reduced K and increased exchange acidity but had no significant overall effect on multivariate soil nutrient composition. Activities of acid phosphatase, alkaline phosphatase, and β -glucosidase varied significantly over time, with temporal patterns differing between sites. Plant tissue composition differed between the two legumes and varied by site. Cowpea accumulated higher concentrations of P and Zn, whereas mung bean accumulated higher Mg, Cr, Ni, and Sr. Legume cultivation shifted bacterial communities from predominantly metal-resistant taxa to bacteria associated with plant growth promotion, nitrogen fixation, and phosphorus solubilisation. Cowpea favoured *Pseudomonas*, *Pseudoxanthomonas*, and *Acinetobacter*, whereas mung bean retained a higher abundance of metal-resistant and biodegrading taxa, including *Cupriavidus*, *Enterobacter*, *Pseudoxanthomonas*, and *Sphingopyxis*. Overall, both legumes demonstrated potential for phytoremediation of heavy metal-contaminated urban soils, with cowpea showing greater capacity to improve soil biological and chemical properties.

Keywords: Phytoremediation, *Vigna unguiculata*, *Vigna radiata*, enzyme activities, heavy metal-contaminated soils, soil microbes

BS-F-16

Post-Stress recovery in fission yeast (*Schizosaccharomyces pombe*) following oxidative stress

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Reactive oxygen species (ROS), such as hydrogen peroxide, act as essential signalling molecules at low concentrations but cause oxidative damage to lipids, proteins, and DNA at high concentrations. This dual role is tightly regulated by dose-dependent signalling and antioxidant systems. Dysregulation of ROS levels is strongly implicated in a wide range of human diseases, including Alzheimer's disease, cancer, and diabetes, where impaired redox homeostasis contributes to cellular dysfunction. Despite extensive research into how cells respond to oxidative stress, comparatively little is known about how cells recover once a stressor has been detoxified, and whether incomplete recovery itself contributes to disease progression. This study investigates post-stress recovery in the fission yeast *Schizosaccharomyces pombe*, a model organism whose antioxidant systems and stress-signalling pathways, including the Sty1 MAPK pathway, are highly conserved in humans. Cells will be exposed to controlled, dose-dependent concentrations of H₂O₂, and recovery will be tracked by monitoring key antioxidant components (Tpx1, glutathione, catalase, and superoxide dismutase) and associated transcription factors (Pap1, Atf1, Prr1).

To establish the experimental parameters, preliminary growth curve experiments were conducted to determine the doses of H₂O₂ that induce growth arrest without causing widespread cell death. Based on these data, concentrations of 0.5 mM and 1.0 mM were selected. Subsequent colony-forming unit (CFU) and LIVE/DEAD (Invitrogen) assays verified that cells exposed to these concentrations remain metabolically active, entering a state of temporary growth arrest prior to recovery. Furthermore, Pierce quantitative external peroxide assay kits were utilised to determine the rate of H₂O₂ detoxification and to ascertain the onset of recovery across these populations. Interestingly, these assays revealed that the initial dose of stress dictates both the rate of detoxification and the timing of the recovery phase. Characterising the dynamics, thresholds, and trade-offs that define successful post-stress recovery may therefore illuminate disease mechanisms linked to oxidative stress, ultimately contributing to future therapeutic strategies and biomarkers for restoring redox homeostasis.

BS-F-17

Honeydew-mediated multitrophic interactions in fruit agroecosystems: Ecological implications for integrated pest management: A narrative review

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Honeydew, a carbohydrate-rich excretion produced by phloem-feeding hemipterans, is a key ecological resource that shapes multitrophic interactions in fruit crop agroecosystems. In perennial fruit systems such as citrus, mango, avocado, cocoa, and grapevine, honeydew-producing pests, including aphids, mealybugs, whiteflies, psyllids, and soft scales, influence interactions among plants, herbivores, ants, parasitoids, predators, and microbial communities, with important consequences for pest regulation and crop productivity. Despite its ecological significance, current knowledge remains fragmented, particularly in African fruit agroecosystems, where empirical evidence is limited. This review synthesises global evidence on honeydew-mediated interactions in fruit agroecosystems, using African fruit production systems as a focal case study to address their marked underrepresentation in the literature, assess the transferability of existing ecological knowledge, and identify priorities for future research and regionally appropriate integrated pest management (IPM) strategies. Honeydew can enhance biological control by providing a readily available carbohydrate resource that increases the longevity, fecundity, and foraging efficiency of parasitoids and other natural enemies. Conversely, it promotes ant-hemipteran mutualisms, whereby ants protect honeydew-producing pests from natural enemies, often reducing parasitism and increasing pest persistence. This dual role creates a central ecological paradox, whereby honeydew can simultaneously strengthen and undermine biological control. Honeydew also facilitates the development of sooty mould, which can impair photosynthesis, reduce fruit quality, and contribute to economic losses. The outcomes of honeydew-mediated interactions are highly context-dependent and influenced by ant identity, hemipteran traits, host plant characteristics, habitat complexity, environmental conditions, and management practices. Emerging evidence indicates that honeydew-mediated interactions operate within complex ecological networks, generating

non-linear and sometimes contrasting effects on pest suppression. Integrating honeydew ecology into IPM frameworks offers a promising pathway towards more sustainable pest management, but greater research attention is needed in understudied fruit agroecosystems, particularly in Africa, to support locally adapted management strategies.

Keywords: *Honeydew-mediated interactions, Multitrophic interactions, Biological control, Integrated pest management (IPM), Fruit agroecosystems, Phloem-feeding Hemiptera, Ant-hemipteran mutualisms, Parasitoid wasps*

BS-F-18

BASELINE ASSESSMENT OF ENVIRONMENTAL DETERMINANTS OF VIABLE DIARRHOEAGENIC PATHOGENS IN ISIPINGO RIVER, KWAZULU-NATAL

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Urban river systems are increasingly affected by anthropogenic activities, including wastewater and industrial discharges, informal settlements and stormwater runoff, resulting in deteriorating water quality and increased risks of waterborne diseases. The Isipingo River in KwaZulu-Natal, South Africa, is exposed to multiple pollution sources that may facilitate the persistence and transport of diarrhoeagenic pathogens, posing risks to public health and aquatic ecosystems. This study investigates environmental determinants associated with pathogen occurrence and establishes baseline data for spatial microbial risk mapping. Surface water samples were collected from six sample sites, where physicochemical parameters, including dissolved oxygen (DO), temperature, pH, electrical conductivity (EC) and total dissolved solids (TDS), were measured in triplicate. Environmental DNA (eDNA) was extracted from membrane-filtered water samples and assessed using NanoDrop spectrophotometry and agarose gel electrophoresis. Eighteen samples were analysed across six sites. Water temperature ranged between (20.3–22.8°C) and pH (6.74–7.61) remained within South African water quality guideline limits, whereas DO concentrations were consistently low (0.73–1.30 mg/L), indicating possible organic pollution and elevated microbial oxygen demand. Electrical conductivity ranged from 516 to 10 803 $\mu\text{S}/\text{cm}$, while TDS ranged from 264 to 5 313 mg/L, with the highest values recorded at downstream sites affected by multiple pollution sources. eDNA concentrations varied between 26.2 and 91.4 ng/ μL , suggesting increased microbial loading at impacted locations. These baseline findings demonstrate spatial variability in water quality and conditions favourable for pathogen persistence. Ongoing molecular analyses using quantitative polymerase chain reaction (qPCR) and propidium monoazide (PMA) will distinguish total and viable bacterial pathogens; viral and protozoan pathogen concentration and associated virulence genes for pathogenicity. Future work will integrate molecular, physicochemical and environmental data using statistical modelling and GIS to identify contamination hotspots, environmental drivers and seasonal risk patterns to support evidence-based water quality management strategies and public health protection in urban river catchments.

Distribution of the Common Starling (*Sturnus vulgaris*), Common Myna (*Acridotheres tristis*), and Rose-ringed Parakeet (*Psittacula krameri*) in KwaZulu-Natal, South Africa, over ten years

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Invasive alien bird species pose a significant threat to biodiversity, ecosystem functioning, and agricultural productivity through competition with native species, habitat modification, and disease transmission. Understanding their occurrence and spatial distribution is essential for monitoring invasion dynamics and informing management strategies. This study investigated the spatial and temporal occurrence of three invasive bird species, the Common Myna (*Acridotheres tristis*), Common Starling (*Sturnus vulgaris*), and Rose-ringed Parakeet (*Psittacula krameri*), across KwaZulu-Natal, South Africa, using BirdLasser occurrence records collected between 2015 and 2025. Spatial analyses were conducted using ArcGIS Pro and Python to map species occurrences, assess spatial autocorrelation using Moran's I, quantify annual observation counts, and examine associations with land cover and elevation. Differences in observation counts among species were evaluated using one-way analysis of variance (ANOVA).

The Common Myna had the widest spatial distribution across KwaZulu-Natal and was primarily associated with formal residential areas with low vegetation or grass. In contrast, the Common Starling was concentrated mainly around Pietermaritzburg and occurred predominantly in natural grasslands, while the Rose-ringed Parakeet was mostly restricted to the Durban metropolitan area and surrounding urban landscapes. Moran's I analysis indicated significant positive spatial autocorrelation for the Common Myna, whereas the Common Starling and Rose-ringed Parakeet displayed random spatial patterns. Annual observation counts varied throughout the study period, with Common Myna and Common Starling observations generally increasing until approximately 2020 before fluctuating in subsequent years, while Rose-ringed Parakeet observations showed a gradual increase toward the end of the study period. Observation counts differed significantly among species, with the Common Myna consistently recording the highest number of observations.

These findings demonstrate distinct occurrence patterns, spatial distributions, habitat associations, and elevational preferences among invasive bird species in KwaZulu-Natal. The study highlights the value of long-term citizen-science data for monitoring invasive species distributions and provides baseline information to support future monitoring, management, and conservation planning within the province.

***In Silico* Design of a Multi-Epitope Therapeutic Vaccine Targeting HPV-35 E6 and E7 Oncoproteins for African Populations**

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Background: High-risk human papillomaviruses (HR-HPVs) are established aetiological agents of head, neck, and anogenital cancers, with a rising burden in Africa. Current prophylactic vaccines do not protect against several HR-HPV types, including HPV35, 51, 56, and 59, which are disproportionately prevalent in African populations [1]. The viral E6 and E7 oncoproteins are promising targets for therapeutic vaccine development, as they are central to HPV-driven oncogenesis and represent meaningful targets for cell-mediated immunity. HPV35, with increasing prevalence in Africa [2], was selected for vaccine design.

Methods: Multiple sequence alignments were performed to assess site-specific entropy and genetic variability of HPV35 oncoproteins from African isolates. An *in silico* multi-epitope vaccine (MEV) was designed using predicted B-cell, cytotoxic T lymphocyte (CTL) and helper T lymphocyte (HTL) epitopes derived from E6 and E7 consensus sequences. Epitopes were selected based on strong allele binding (i.e. ≤ 2 percentile rank), good antigenicity (>0.5), non-allergenicity and non-toxicity. Three-dimensional structure modelling, population coverage prediction, immune simulations, molecular docking and *in silico* cloning were performed to characterise the computational MEV candidate and evaluate its potential efficacy.

Results: Immunoinformatics analyses predicted the vaccine to be antigenic, non-allergenic, and water-soluble, with the potential to induce strong immune responses, including cytotoxic T lymphocyte activation and memory cell formation. Predicted population coverage was highest for North Africa (72.81%), while Central Africa was the lowest (47.24%). *In silico* cloning into the pUC19 and pYES2 vectors showed the potential for gene propagation in *E. coli*, and subsequent expression in *S. cerevisiae*, as is the norm with current HPV vaccines [3].

Conclusions: In conclusion, this study presents a computationally designed MEV candidate targeting HPV35, highlighting its potential to address region-specific gaps in HPV-related cancer prevention in Africa.

1 Nyide, B., Thomas, M., Banks, L., Mkhize, P. P. & Matume, N. D. Genetic Diversity of Selected High-Risk HPV Types Prevalent in Africa and Not Covered by Current Vaccines: A Pooled Sequence Data Analysis. *International Journal of Molecular Sciences* **26**, 11056 (2025).

2 Murahwa, A. T., Dzobo, M., Mahenge, A., Rantshabeng, P. & Dube Mandishora, R. S. The Burden of HPV35 in African Cervical Pathologies: Prevalence, Contributing Factors, and Vaccine Prospects. *Reviews in Medical Virology* **36**, e70129 (2026).

3 Cheng, L., Wang, Y. & Du, J. Human papillomavirus vaccines: an updated review. *Vaccines-Basel* **8**, 391 (2020).

INSECT PESTS DAMAGING THE BAOBAB FRUITS AND THEIR SOCIO-ECONOMIC IMPACTS ON LOCAL COMMUNITIES IN THE VHEMBE AREA.

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African baobab fruit is an indigenous food and source of income for thousands of local people in the rural African communities [1]. There are over 9,000 unemployed women in Southern Africa who depend on collecting and selling baobab fruit to locally based processing companies, which further process it into fruit pulp used as a nutritious food ingredient and oil used in the cosmetics industry [1]. These products are sold locally and internationally and this commercialization is a natural way to reduce poverty in rural communities [1]. However, the quality of these fruits is degraded by insect pests that invade the fruits while still developing on the tree, causing internal and external damage [2,3]. Additionally, the harvesters sort the fruits by external damage or cracks before selling, and fruits with external damage are discarded, resulting in food loss [3,4]. Fruits with internal damage pass through the sorting stage and into the processing stage, where processors detect the damage, resulting in food and income losses [4]. The specific insects damaging the fruits, the extent of damage, and the socioeconomic impact are unknown. This study will employ two approaches: a field survey and a socioeconomic survey in Limpopo province (Vhembe area). One hundred and twenty (120) trees will be selected to collect 10-15 baobab fruits fallen on the ground, to assess the external and internal damage, and the severity of the damage will be graded using a severity scale. Insects found inside will be counted, categorized by feeding mechanisms, and identified to the species level. Questionnaires will be used to assess the perceptions of local harvesters and processing companies regarding insect damage, the quantity of fruit lost during the sorting and processing stages, and how this is affecting them economically. Identifying insect pests damaging these valuable fruits will help directly by protecting the livelihoods of people depending on these fruits, by safeguarding their income, and preventing food and income loss.

1. Venter, S.M. and Witkowski, E.T., 2013. Fruits of our labour: contribution of commercial baobab (*Adansonia digitata* L.) fruit harvesting to the livelihoods of marginalized people in northern Venda, South Africa. *Agroforestry Systems*, 87(1), pp.159-172.
2. Cossam, F.G., Dzanja, J.K., Kamwana, B., Olumeh, D.E. and Mithöfer, D., 2023. Determinants of postharvest losses along the baobab value chain in Malawi. *Frontiers in Sustainable Food Systems*, 7, p.1119107.
3. Jäckering, L., Fischer, S. and Kehlenbeck, K., 2019. A value chain analysis of baobab (*Adansonia digitata* L.) products in Eastern and Coastal Kenya. *Journal of Agriculture and Rural development in the Tropics and Subtropics (JARTS)*, 120(1), pp.91-104.
4. Lukasik, P. and Johnson, T., 2007. Arthropod communities and succession in baobab, *Adansonia rubrostipa*, fruits in a dry deciduous forest in Kirindy Forest Reserve, Madagascar. *s. African Entomology*, 15(1), pp.214-220.

Effect of adding edible insects on the nutritional and physical properties of fermented sorghum mageu

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Food and nutrition insecurity contribute to malnutrition in Africa, where many low-income communities rely on carbohydrate-rich cereal foods that provide inadequate protein and essential micronutrients. Sorghum is a drought-tolerant cereal suitable for climate-resilient food production; however, it is limited in protein, minerals such as zinc and iron and essential amino acids, particularly lysine. Edible insects are nutrient rich and may improve the nutritional quality of sorghum-based foods while maintaining their affordability. This study investigated the effect of adding mopane worm and termite meal on the nutritional composition and physical properties of sorghum mageu. Sorghum mageu were prepared using standard methods and the sorghum meal was partially substituted by 5% or 10% (w/w) edible insect meals. The nutritional composition, colour and viscosity of the mageu samples, including the control (100 sorghum mageu), were assessed and uncooked edible insects and sorghum were analysed using standard methods. One Way ANOVA was used to determine the effect of insect meal and edible insect fortification level on the nutritional composition and physical characteristics of sorghum mageu. There were no significant differences ($p > 0.05$) in protein fat, moisture and fibre content of sorghum mageu fortified with edible insects. However, protein increased from 5.51% in the control to 7.70% and 7.56% in the 10% mopane worm and termite formulations, respectively. Ash significantly increased from 0.76% to 1.11% and the highest increase was observed in 10% termite fortified mageu. Iron decrease with mopane worm fortification but increased in 10% termite fortified mageu to 32.67 mg/kg while zinc increased from 4.67 mg/kg in the control mageu to 10.33 mg/kg in termite fortified mageu. Lysine increased from 0.21% to 0.46% and 0.44% following 10% mopane worm and termite fortification, respectively. The viscosity ranged from 364.7 to 14 345 cP with 10% termite fortified mageu showing the highest apparent viscosity with the thickest consistency at 14 345 cP. Increasing mopane worm fortification reduced redness and increased yellowness whereas increasing termite fortification reduced redness, yellowness and lightness from 46.85 to 44.17. Overall, termite fortified mageu was darker than the control and mopane worm formulation and produced the highest total colour differences. The findings indicate that insect fortification improved protein, mineral and essential amino acids but produced darker, thicker mageu which could influence consumer acceptance, highlighting the need for sensory evaluation. However, integrating drought-resilient sorghum with nutrient-rich edible insects may offer a suitable approach for affordable fermented foods while improving the nutritional quality and food security in vulnerable communities.

Key words: Sorghum mageu; edible insects; fermentation; nutritional quality; food security

BS-F-23

ISOLATION AND CHARACTERIZATION OF A LYTIC PHAGE AS A POTENTIAL BIOCONTROL AGENT FOR *KLEBSIELLA QUASIPNEUMONIAE*

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The environmental spread of antibiotic-resistant pathogenic bacteria has become a global health concern. Freshwater bodies polluted with ESKAPE pathogens, such as *Klebsiella pneumoniae*, pose a serious hazard to human health. Chlorination, a conventional method used in wastewater treatment plants, requires high chemical dosages to curb antibiotic-resistant bacteria, resulting in adverse environmental impacts. This led to the search for environmentally friendly, effective alternative strategies to mitigate the presence of undesirable bacteria, such as members of the so-called ESKAPE group, in wastewater.

This research reports on the isolation and characterization of a new lytic bacteriophage, using Msunduzi River water as inoculum and *Klebsiella pneumoniae* ATCC700603 (now *K. quasipneumoniae*) as the bacterial host. A lytic phage was isolated using spot tests and the double-layer technique, demonstrating high capacity to lyse its bacterial host. The purified phage produced clear plaques after 24 hours. Transmission electron microscopy revealed a head-and-tail morphology, with virus heads of about 65 nm and tails of about 130 nm. Host range characterization showed that the phage has a narrow host range, reducing the likelihood of off-target effects on beneficial bacteria.

The phage remained stable across mesophilic pH values (pH 5-9) and up to 50 °C, highlighting its applicability under ambient conditions. Moreover, biofilm inhibition assays using crystal violet staining confirmed that the phage effectively inhibited biofilm formation of its bacterial host on plastic surfaces. Its ability to destroy mature biofilms is currently under investigation.

Biofilm formation is an important factor in bacterial survival and resistance, and the ability to inhibit its formation indicates the phage isolate's potential to control biofilm-associated contamination in wastewater treatment and freshwater storage systems.

Collectively, these findings indicate the potential of phage-based biocontrol approaches as eco-friendly, sustainable strategies to replace chemical disinfectants for controlling antibiotic-resistant pathogenic bacteria in aqueous environments.

BS-F-24

Isolation and preliminary characterization of lytic phages infecting *Enterococcus faecium* and an ESBL-producing multidrug-resistant *Escherichia coli*

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Enterococcus faecium and extended-spectrum β -lactamase (ESBL) producing pathogenic *E. coli* are known to cause healthcare-associated infections, with antibiotic-resistant strains representing a particular public health concern. If released into receiving water bodies via wastewater treatment plant effluent or raw sewage, they might put people at risk using such water for domestic, recreational, or irrigation purposes. However, lytic bacteriophages are a promising, environmentally friendly alternative to the traditional chlorination treatment.

Therefore, lytic phages were isolated from wastewater using *Enterococcus faecium* ATCC 36657 and an extraintestinal pathogenic *Escherichia coli* (ExPEC) strain of sequence type 131 as hosts, employing spot testing and double-layer assays to determine the appearance and size of plaques formed by selected phage isolates. The morphology and size of purified bacteriophages were analyzed using Transmission Electron Microscopy (TEM). Furthermore, host range, physicochemical stability, and inhibition of biofilm formation were assessed.

Two lytic phages were isolated from wastewater samples after enrichment using the above *E. faecium* and *E. coli* strains as hosts. Both phages produced a clear zone of lysis after incubation in the presence of their respective hosts for 24 hours at 37 °C, with average plaque sizes of about 1.2 mm (*E. coli*) and 2.5 mm (*E. faecium*) established. TEM revealed that both bacteriophages exhibited a head and tail morphology, indicating that these phage isolates belong to the class *Caudoviricetes*. Both phages had a hexagonal head of about 40 nm (*E. faecium*) and 50 nm (*E. coli*) and a tail of about 100 nm (*E. coli*) and 38 nm (*E. faecium*).

Active phages were recovered after exposure of up to 2 hours in SM-buffer to temperatures between 4 and 60 °C. The two phage isolates adsorbed efficiently, displayed a short latent period, and caused a visible decrease in optical density of the host culture due to their lytic activity. The two bacteriophage isolates were highly specific to their host strains and efficiently lysed host cells at high phage titers. Furthermore, they effectively inhibited the formation of host biofilms on a hydrophobic surface.

While further characterization of these lytic bacteriophages is ongoing, their ability to eliminate ESKAPE+E pathogens, including a multidrug-resistant strain, is promising.

BS-F-25

EVALUATING THE EFFICACY, COST-EFFECTIVENESS, AND ADOPTION POTENTIAL OF BIOPESTICIDES AGAINST THE YELLOW SUGARCANE APHID *SIPHA FLAVA*

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The yellow sugarcane aphid, *Sipha flava* (Hemiptera: Aphididae), has emerged as a significant pest of sugarcane in South Africa, causing substantial reductions in crop productivity through sap feeding, chlorosis, and stunted plant growth. Current management strategies rely predominantly on synthetic insecticides; however, their continued use raises concerns regarding insecticide resistance, environmental contamination, and adverse effects on beneficial organisms. Biopesticides derived from microbial and botanical sources offer a promising sustainable alternative, yet their adoption remains constrained by inconsistent field performance, economic uncertainty, and limited grower awareness. This study aims to evaluate the biological efficacy, economic viability, and adoption potential of selected biopesticides for the management of *S. flava*. Laboratory bioassays, glasshouse experiments, and field trials will compare the microbial biopesticides *Beauveria bassiana*, *Metarhizium anisopliae*, and *Trichoderma* spp., and the botanical biopesticides neem oil (*Azadirachta indica*), pyrethrum extract, *Lantana camara* extract, and *Lippia javanica* extract with the chemical insecticides buprofezin and cyantraniliprole, including selected synergistic combinations of buprofezin with fungal biopesticides. Treatments will be assessed for aphid mortality, lethal time (LT₅₀), reproductive suppression, feeding damage, and crop yield. Economic analyses will determine treatment cost-effectiveness using benefit-cost ratio assessments, while a socio-economic survey of sugarcane growers in KwaZulu-Natal and Mpumalanga will investigate knowledge, perceptions, and factors influencing the adoption of biopesticides. Biological, economic, and social datasets will be integrated to develop practical recommendations for sustainable aphid management within integrated pest management programmes. The study is expected to identify effective and economically viable biopesticide options, provide evidence-based strategies to promote their adoption, reduce reliance on synthetic insecticides, mitigate the development of resistance, and contribute to environmentally sustainable sugarcane production in South Africa. These findings will support the transition towards resilient crop protection systems and inform policy and extension initiatives aimed at increasing the uptake of biologically based pest management technologies.

BS-F-26

METAGENOMIC ANALYSIS OF THE GUT MICROBIOME STRUCTURE AND FUNCTION IN THE MOPANE WORM (*GONIMBRASIA BELINA*)

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Mopane worm (*Gonimbrasia belina*) is an edible insect of cultural and economic significance in southern Africa. Despite its significance, its gut microbial community had not previously been studied at a molecular level. This study presents the first comprehensive metagenomics characterization of the *G. belina* gut microbiome. A total of 31 adult mopane worm gut samples were sequenced using MGI DNBSEQ-G400. The data were examined through taxonomic classification and functional annotation using COG, KEGG, and GO systems. Ten bacterial phyla were detected in each sample, with Pseudomonadota (33.87%), Actinomycetota (6.31%), and Bacillota (5.55%) being more dominant. Five genera, *Streptomyces*, *Streptococcus*, *Xanthomonas*, *Bacillus*, and

Clostridium were consistently identified in all 31 samples, while *Streptomyces* sp. T12 was the only species detected in every sample.

Functional analyses revealed active involvement of these microbial communities in metabolic pathways, secondary metabolite biosynthesis, mobile genetic elements, and nitrogen compound metabolism. The gut microbiome of *G. belina* remains similar and functionally active in all samples, which may contribute to the insect's nutritional value as a source of protein. The constant presence of *Streptomyces* sp. T12 and its associated biosynthetic gene clusters further indicate that the gut could serve as a source for novel bioactive compounds. These results help in understanding the microbes in *G. belina* and support using it as a safe, sustainable, and high-protein food.

Keywords: *Gonimbrasia belina*; shotgun metagenomics; COG; KEGG; Gene Ontology; taxonomic profiling.

BS-F-27

Investigating the Effects of Different Fire Regimes on Plant-Collembola Interactions in South African Mesic Grasslands

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Collembola (springtails) are abundant soil-dwelling arthropods that play an important role in maintaining soil ecosystem functioning. However, little is known about how different fire regimes influence Collembola communities in South African mesic grasslands. This study investigates how fire frequency and season influence vegetation structure and composition, and how these changes affect Collembola community composition and functional diversity.

The study was conducted at Ukulinga Research Farm, where contrasting fire regimes have been maintained for approximately 75 years. The study focused on control (no fire), annual, biennial and triennial treatments from the winter and spring burn regimes. Collembola were extracted from soil samples using Berlese-Tullgren funnels and classified according to morphological traits, while vegetation structure, litter characteristics and soil properties were quantified within each treatment.

Preliminary analyses indicate clear differences in Collembola abundance among fire treatments. Collembola were absent from the long-term fire-excluded control plots but occurred across all burnt treatments. Among the burnt treatments, abundance generally increased with decreasing fire frequency, with differences observed between spring- and winter-burned plots. Differences in vegetation, litter and soil characteristics coincided with these patterns, and preliminary observations suggest that functional composition also differs among fire regimes.

These preliminary findings suggest that fire influences Collembola communities through changes in the habitat they occupy, rather than through fire alone. Exploring these

FLASH ABSTRACTS

COMPUTING, MATHEMATICS, PHYSICS AND STATISTICS

CMPS-F-1

SOLUTION PROCESSABLE THIN FILM ORGANIC SOLAR CELL AS ALTERNATIVE SOURCE OF RENEWABLE ENERGY

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The growing demand for clean, affordable, and sustainable energy has increased interest in thin-film organic solar cells (TFOSCs) as alternatives to conventional silicon-based photovoltaic technologies. TFOSCs offer several advantages, including low-cost fabrication, lightweight construction, mechanical flexibility, and compatibility with large-area solution processing. Despite these benefits, their commercial adoption remains limited by challenges such as low power conversion efficiency, inadequate light absorption, inefficient charge transport, and poor long-term stability. To address these limitations, this research proposes the incorporation of quantum dots and plasmonic noble metal nanoparticles into TFOSC architectures. Quantum dots possess tunable optical properties and broad light absorption capabilities, while plasmonic nanoparticles enhance light harvesting through localized surface plasmon resonance effects. By combining these nanomaterials within the solar cell structure, the study seeks to improve photon absorption, exciton generation, charge separation, and charge transport, ultimately leading to enhanced photovoltaic performance. The expected outcome is the development of more efficient, stable, and commercially viable organic solar cells. Such advancements could accelerate the deployment of flexible and lightweight photovoltaic technologies in applications such as wearable electronics, portable power systems, and building-integrated photovoltaics, thereby contributing to the global transition toward sustainable and renewable energy solutions

CMPS-F-2

Robust Emotion Recognition Through Generative Adversarial Audio Enhancement and Multi-Branch Deep Learning Models

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Speech emotion recognition (SER) has become a technology in affective computing, human-computer interaction, mental health surveillance, and smart voice assistants. Lately, deep learning approaches—convolutional, recurrent, and adversarial neural networks—have made significant advancements in SER accuracy. Nonetheless, applying SER in scenarios continues to be difficult because of noise disruption, inadequate feature extraction, and confusion between acoustic similar emotions. This analysis explores an end-to-end learning workflow integrating: First stage preprocessing of the RAVDESS emotional speech dataset, second stage improved MFCC-centered feature extraction, third stage audio denoising via GAN employing a U-Net generator, and fourth stage a CNN-LSTM combined model for ultimate emotion recognition. We assess this integrated framework against studies emphasizing parallels with leading SER techniques, outlining performance patterns reported in the literature, and suggesting paths for future investigations. Results show that integrating denoising GANs into the SER pipeline significantly improves robustness and accuracy under noisy conditions. The hybrid model achieves 98.86% accuracy on the RAVDESS dataset. This work provides both a comprehensive review and a practical implementation roadmap for next-generation emotion recognition models.

Keywords: Speech Emotion Recognition; Hybrid CNN--BiLSTM2; GAN; MFCCs.

CMPS-F-3

A Simplified Architecture for Practical Plug-and-Play Quantum Key Distribution

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Quantum key distribution (QKD) allows distant parties Alice (sender) and Bob (receiver) to remotely share secret keys via the laws of quantum physics [1]. Plug-and-Play (PnP) QKD has gained considerable attention for its ability to ensure a provably secure communication, particularly characterised by the precise controls of quantum signals and long-term operational stability. However, a conventional PnP QKD systems has some limitations on miniaturization because of the inclusion of a bulky storage line (SL). In addition, the secure key rate is relatively low since signal pulses from Bob's system are transmitted only at dedicated time slots to overcome backscattering [2]. In this work, we propose a

method to resolve back scattering via simplified semi-conductor optical amplifier (SOA)-assisted architecture that offers a promising alternative to the storage line-based plug-and-play QKD systems while preserving the security and robustness required for quantum communication.

References

- [1] Gisin, N., Ribordy, G., Tittel, W., & Zbinden, H. (2002). Quantum cryptography. *Reviews of modern physics*, 74(1), 145.
- [2] Ko, H., Lim, K., Oh, J., & Rhee, J. K. K. (2016). Informatic analysis for hidden pulse attack exploiting spectral characteristics of optics in plug-and-play quantum key distribution system. *Quantum Information Processing*, 15(10), 4265-4282.

CMPS-F-4

MERGHERS TIER 3: Diffuse Radio Emission in High-Redshift Clusters

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Diffuse synchrotron emission in galaxy clusters, commonly observed as radio halos and relics, provides important information about turbulence, magnetic fields, and particle acceleration in the intracluster medium (Brunetti & Jones 2014). While diffuse radio emission has been extensively studied in nearby galaxy clusters, recent studies have increasingly explored these sources at higher redshifts (Di Gennaro et al. 2021; Sikhosana et al. 2025; Phuravhathu et al. 2025). At high redshifts, the detection of radio halos and relics becomes increasingly challenging due to enhanced inverse Compton energy losses of cosmic-ray electrons and cosmological surface-brightness dimming.

Studying radio halos and relics in this high-redshift regime will allow us to investigate the evolution of diffuse radio emission across cosmic time and provide further constraints on the physical mechanisms responsible for its formation. In this study, we investigate six samples of high-redshift galaxy clusters at $z \geq 0.8$ using MeerKAT Exploration of Relics, Giant Halos, and Extragalactic Radio Sources (MERGHERS) Tier 3 observations. I will present the initial data analysis and characterisation of the diffuse emission.

CMPS-F-5

On Maximal Frames with Property P

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Focusing on **almost compact and S -closed frames**, we define a maximal frames with property P by embedding a given frame L as a subframe of $S_c(L)$ (a frame whose elements are sublocales of L that are joins of closed ones) via embedding $a \rightarrow o(a)$ that sends every element of L to the open sublocale that it determines. We show that every maximal almost compact frame is submaximal and we characterize these maximal frames with property P .

REFERENCES

- [1] Dube, T., *Maximal Lindelöf Locales*. Applied Categorical Structures **27**, no. 6 (2019): 687-702.
- [2] Cele L.S, and Mthethwa S.S., *Localic view of almost compact frames and some notes on S -closed frames*. In progress.

CMPS-F-6

Extreme Value Forecasting of Financial Losses Under Discrete Time Hawkes Excitation

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When financial markets crash, severe losses rarely strike alone. They tend to arrive in bursts, with one shock triggering the next. Predicting risk therefore means answering two questions at the same time: how severe could tomorrow's worst loss be, and how much does today's market turmoil raise the odds of another extreme event happening soon? This study builds a single forecasting framework designed to answer both.

The approach separates a financial shock into two natural parts. The first asks how severe a loss can be once the market has entered dangerous territory, using a branch of mathematics built specifically for rare events (*Extreme Value Theory*) rather than ordinary day-to-day movements. The second asks how likely another shock is to follow, capturing the way recent stress and market-wide turbulence make further losses more probable before the tension gradually fades (*Hawkes Process*). A bridging step links these two parts so that they speak to one another, producing a single, transparent measure of next-day risk.

Tested on years of daily data across a broad panel of listed companies, each part of the framework performs convincingly on its own: the model reliably describes how large extreme losses tend to be, and it captures the tell-tale clustering of when they strike. A refined version further stabilises these estimates, making the predictions more dependable without erasing the real differences between individual companies, and setting the stage for the harder task of bringing the two together.

The deepest scientific question emerges precisely where the two halves meet. Each component can be sharp and well behaved on its own, yet the central challenge of this work is the act of fusing them into a single, trustworthy measure of next-day risk, a recombination far subtler than the sum of its parts. It is here that the research lives: at the

frontier where the timing of danger and the depth of danger must be reconciled into one coherent forecast. This is the study's contribution, the recognition that extreme financial risk is not a single phenomenon to be captured, but a dynamic interplay between *when* an extreme loss arrives and *how far* it reaches, and that mastering their union is the true scientific prize.

CMPS-F-7

Displacement-Aware Multi-Fuel Dynamics in Dynamic Bilevel Carbon Policy Optimisation

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This study extends the dynamic carbon emission model (DBOP), in which a government leader sets nonlinear, time-escalating tax and subsidy instruments, and profit-maximising producers respond by choosing a production mix across high-, medium-, and low-carbon-emission (HCE, MCE, LCE) sources. Their model proves a finite-horizon phase-out of HCE production and characterises the resulting monotonic transition dynamics, but does so under an implicit assumption that the three production streams respond independently to policy — nothing in the follower's problem lets a reduction in one fuel's output reappear as an increase in another's. This paper relaxes that assumption. We introduce cross-fuel displacement elasticities and a waterbed constraint that couple HCE, MCE and LCE production under a fixed emissions cap, decompose the follower's response into substitution and output effects, disaggregate production by sector, and formalise a subsidy-leakage mechanism linking domestic incentives to market integration. We further extend the original Adaptive Genetic Algorithm into a multi-objective, displacement-aware variant that traces the Pareto frontier for emissions.

CMPS-F-8

FIDELITY-BASED READOUT OF QUANTUM OPTIMIZATION SOLUTIONS

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Quantum optimization algorithms often encode their solutions in the amplitudes of a quantum state. Although such algorithms may efficiently prepare a solution state, extracting sufficient classical information from that state remains a major challenge. This work proposes a fidelity-based approach for reading out quantum optimization solutions. After the optimization algorithm prepares the unknown solution state, a parameterized trial state is trained to approximate it. Their fidelity is evaluated by measurements on a quantum computer and maximizing it identifies the parameterized state with the greatest overlap

with the quantum solution. The approach avoids full quantum-state tomography and requires no ancillary qubit or controlled-SWAP operation. Numerical experiments demonstrate its ability to recover quantum solution states with high fidelity. The algorithm can be applied to solve linear systems of equations with more than 1000 variables. This framework therefore offers a practical bridge between quantum optimization and the extraction of usable solution information, addressing one of the key bottlenecks in quantum algorithm implementation.

CMPS-F-9

A Mathematical Framework for Stability Analysis and Control Strategies of a Hepatitis C Virus (HCV) Model with Immune Response

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Hepatitis C virus (HCV) infection remains a significant global public health challenge, although effective antiviral therapies are available. This study presents a comprehensive mathematical framework for investigating interactions between the Hepatitis C virus (HCV) and the host immune system during infection. We develop a system of nonlinear ordinary differential equations that captures the complex interactions among hepatocytes, HCV, immune cells, and specific cytokines. The well-posedness of the model is established to ensure that it is mathematically consistent and biologically meaningful. We derive the basic reproduction number, R_0 , and establish conditions for the stability of the disease-free and endemic equilibria. Sensitivity analysis and numerical simulations under different immune response scenarios highlight the important roles of T-helper cells and Interleukin-2 (IL-2) in controlling HCV infection. Building upon this biological framework, antiviral treatment strategies are incorporated into the model through an optimal control approach. The objective is to minimize the viral load while reducing treatment side effects. The proposed treatment strategies achieve effective viral suppression, shorten the treatment duration, and minimize overall side effects.

CMPS-F-11

DEEP LEARNING MODELS FOR EARLY TUBERCULOSIS DIAGNOSIS USING X-RAY IMAGES FOR ANALYSIS

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Tuberculosis (TB) is one of the leading fatal diseases globally [1], even though it is curable [1]. TB also has high incidence, with Africa forming a shocking incidence of 24% as of year

2024[2]. Radiography has been used to diagnose TB which is known to identify TB abnormalities even before a patient displays any clinical symptoms, especially following the high number of missed cases by traditional testing methods that rely on biological samples (sputum) such as TBNAAT tests which can miss over 20% TB cases [3], due to low bacterial load among other reasons. TBNAAT tests also require two further tests which in South Africa means an additional annual cost of R13,649,824[4]. This delays diagnosis and consequently, treatment initiation. Another factor that perpetuates this delay is the scarcity of certified Radiologists [5], especially in under-resourced regions, who can interpret radiographs (x-ray images) accurately and fast to enhance early TB diagnosis which has been proven to speed up treatment initiation, reduce TB related mortality, and assist in TB spread management, consequently improving survival chances [6]. This work developed seven Artificial Intelligent models by implementing Deep Learning frameworks namely ResNet101, XceptionNet, VGG19, DenseNet169, MobileNet and Multi-Scale Vision Transformers (MViT) to detect TB through classification, as well as UNet for segmentation of areas of interest, all of which are known to perform exceptionally well in learning hierarchies and spatial features on visual data such as images [7]. The implementation was guided by responsible AI (RAI) and Explainable AI (XAI) principles to strengthen performance, findings, and the ethicality of results [8] and to promote a positive attitude towards AI among health worker. The model was deployed through a web application which a user can upload an x-ray image and get a prediction of TB positive or negative. The web app also displays the uploaded x-ray images showing heatmaps on areas that the model uses to make a decision or prediction or classification to explain how much each of those areas contributed to the final classification prediction which enforce transparency, safety and accountability and understandability to human beings. This was achieved through the utilization of Grad-Cam and Shapley Additive Explanations (SHAP). To eliminate bias, and achieve model robustness, the model(s) were trained on datasets of x-ray images publicly available and ethically collected, representing various ages, different genders and races. Cohen's Kappa was used for the evaluation of results to ensure that the model is not simply guessing but rather making informed decisions beyond chance [9], along with ISO and IEEE evaluation metrics for AI models such as ROC, F1 score, recall, accuracy and precision [10]. This study introduces a new metric called the Trapezoidal method which was used to measure model reliability and dependability. The MViT outperformed all models in both datasets with an average accuracy of 99.9% and showed high reliability with a trapezoidal area of 0.003.

REFERENCES

[1] Delia Goletti, et,al, 2025. [2] Yohhei Hamada, et al 2024. [3] Wei-Chang Huang, et al, 2022..... [4] Ayanda Shabalala, et al, 2024 [5] Kleanthis Konstantinidis, 2024..... [6] Eui Jin Hwang, et al2024 [7] Md Khairul Islam, et al 2024[8] Stephanie Baker et al 2023. [9] Gerald Rau, et al 2021.....[10] Naeem Ullah, et al2024

CMPS-F-12

Using Difference Imaging with a Deep Learning CNN to Classify Smoke Plumes

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Forest fire camera networks watch large areas of forest for smoke, but smoke is not the only thing that appears to move between consecutive images. Leaves move, cameras shake, clouds drift and cast moving reflections on the ground, cars pass, and dust rises where a car travels along a dusty road. Every alert carries a cost: fire management is requested each time smoke shows, and attending to every false positive would inconvenience both the operator and the fire department. A missed fire, however, is extremely costly, so reducing false negatives is the priority. Most research addresses this by filtering images with respect to colour to separate smoke from the background [1].

This study uses difference imaging to get the best out of the dataset before feeding it to a convolutional neural network. Four consecutive images of the same scene, taken four seconds apart, are reduced to one cumulative difference image in which dark parts symbolise no movement and bright pixels show movement. Since smoke is constantly moving and diffusing and never returns to its initial position, unlike leaves and trees which displace around a fixed point, this representation makes smoke stand out. Two versions were compared: M1, where frames are reduced to brightness before differencing, and M2, where differencing is carried out in the red, green and blue channels, retaining colour cues. The two pipelines are otherwise identical, so the only difference between them is the number of channels.

Images were supplied by EnviroVision Solutions from pan-tilt-zoom cameras mounted on fire towers at fixed geographical positions. After duplicates were removed by comparing SHA-256 hashes of the raw image bytes, and the classes were balanced, the dataset comprised 21 312 frames forming 5 328 groups of four, or 2 664 groups per class. Groups were never split across sets, and 267 groups per class were held out for testing. Three-fold stratified cross-validation was used, and the decision threshold was selected on validation data and applied once to the held-out set.

Cross-validation accuracy was 0.8512 ± 0.0101 for M1 and 0.8723 ± 0.0050 for M2. On the held-out test set M2 outperformed M1 on every metric, with accuracy of 0.8708 against 0.8446, recall of 0.9213 against 0.8876, and an AUC of 0.9473 against 0.9210. False negatives fell from 30 to 21, a reduction of 30 % in missed fires. Colour differencing therefore improves on grayscale, which can be attributed to the additional channels carrying information that a single intensity-centred channel discard.

[1] Z. Han, Y. Tian, C. Zheng, and F. Zhao, "Forest fire smoke detection based on multiple colour spaces deep feature fusion," *Forests*, vol. 15, no. 4, p. 689, 2024.

CMPS-F-13

Anisotropic compact star in regularized 4D Einstein-Gauss-Bonnet gravity with non-minimal coupling

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We present a closed-form exact solution for an anisotropic compact star in regularized four-dimensional Einstein–Gauss–Bonnet gravity with a non-minimal scalar–Gauss–Bonnet coupling $\xi(\phi)G$. Adopting the Finch–Skea metric ansatz and an exponential dilaton-type coupling $\xi(\phi) = \xi_0 e^{-\kappa\mu\phi}$, we integrate the full system of modified field equations analytically via a Buchdahl coordinate transformation, obtaining the scalar field, energy density, and anisotropic pressures in exact form. The solution possesses a central singularity inherited from the ansatz; away from the core, however, the model defines a physically well-behaved stellar shell in which all standard viability criteria are satisfied: the null, weak, and strong energy conditions hold, sound speeds are subluminal in both the radial and tangential directions, Herrera’s cracking condition and the adiabatic stability bound $\Gamma > 4/3$ are met, and the Buchdahl compactness limit is respected. The interior is matched to a Boulware–Deser-type exterior in the $D \rightarrow 4$ limit. Mass–radius curves constructed from the model show that increasing the effective Gauss–Bonnet coupling β raises both the maximum supportable mass and the stellar radius: for moderate coupling the maximum mass exceeds $2 M_\odot$ with radii in the range 10–13 km, comfortably accommodating the observed masses of PSR J0740+6620 ($2.08 M_\odot$), PSR J0348+0432 ($2.01 M_\odot$), and PSR J1614–2230 ($1.97 M_\odot$). The Einstein gravity limit is recovered when the coupling is switched off. These results demonstrate that regularized scalar–Gauss–Bonnet gravity admits exact stellar models whose predictions are consistent with current pulsar observations.

CMPS-F-14

Southern African HIV/AIDS Dynamics Analysis Integrating Statistical and Mathematical Modelling

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HIV is a fatal infectious disease spread mainly by sexual transmission recently; that is highly prevalent in endemic areas of the world. A simple subset of an epidemic population model for HIV-AIDS can be split into the following: Susceptible, HIV-Infected and AIDS-infected, (SIA). We propose and use a nonlinear mathematical model to analyse the dynamics of HIV transmission in a population. The equilibrium points for the model are computed where the stability of the disease-free equilibrium is governed by the basic reproductive number. PRCC technique is utilized to investigate the sensitivity analysis of the model. Numerical simulations are computed to analyse the qualitative behaviour of the model compartments, using MATLAB ode45 solver. Optimal control analysis is introduced where the optimal problem is formulated using Pontryagin’s Maximum Principle. The simulations were carried out using the forward-backward sweep method, allowing us to determine the impact of the control strategies on each of the model compartments, particularly the infectious class. The influence of a single control and the combination of both is investigated. The comparison of the two strategies in eliminating the reproductive number is done by simulation of contour plots. It is found that the use of more than one control is the most optimal when compared to the use of a single control.

CMPS-F-15

Deep Learning Framework for Fine-Grained and Hubble-Informed Hierarchical Galaxy Classification

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With the increasing scale of modern astronomical surveys, automated galaxy morphology classification has become an important application of deep learning. This study investigates fine-grained galaxy classification using the complete, naturally imbalanced ten-class Galaxy10 DECaLS dataset. EfficientNet-B4 and Swin-Tiny are evaluated under a common experimental protocol, with each architecture implemented in both flat and Hubble-informed hierarchical configurations.

The hierarchical models introduce an auxiliary coarse morphological output while retaining direct prediction of the original ten classes. Astronomy-aware geometric, photometric and noise-based augmentation is applied alongside an adaptive Fourier phase augmentation method designed to perturb selected frequency components while preserving important morphological structure. Class weighting is used to address dataset imbalance, while performance is assessed using top-1 and top-3 accuracy, macro-averaged metrics and class-level confusion analysis. Preliminary EfficientNet-B4 experiments achieve approximately 86% ten-class accuracy and over 98% top-3 accuracy, with the greatest remaining difficulty concentrated in heterogeneous or morphologically similar classes, particularly Disturbed, Unbarred Tight Spiral and Unbarred Loose Spiral galaxies.

The completed study will evaluate whether hierarchical supervision, transformer-based representations and frequency-domain augmentation improve fine-grained recognition under a controlled training framework.

CMPS-F-16

NORMAL LATTICES, RELATED STRUCTURES, AND THEIR APPLICATIONS

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Normal lattices, introduced by Cornish (1972), extend the notion of normality in topology to lattice theory by employing closed sets. This research investigates the structure and properties of normal lattices, their connections to other lattice classes, and their potential applications in mathematics, particularly frame theory. Building on foundational work by Stone (1938), Birkhoff (1940), and Grätzer & Schmidt (1957), the study explores how normal

lattices can be characterized through prime ideals, congruence relations, and lattice operations.

CMPS-F-17

Optimizing African-Centric and Global LLMs for Code-Switched STEM Education: A Comparative Evaluation Under Resource-Constrained Hardware Simulations

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High-resource language models frequently fall short in the South African educational context, where there is a critical need for localized architectures that are scientifically accurate, linguistically fluent, and computationally accessible within the severe infrastructure constraints of public-school environments. This study evaluates the comparative performance of InkubaLM-0.4B (a small African-centric language model developed by Lelapa AI) against the globally optimized Llama 3.2:3B architecture under a uniform 4-bit QLoRA optimization constraint. This evaluation isolates how architectural resilience and specialized tokenization influence bilingual STEM reasoning across 1200 total test inference cycles. The accuracy-efficiency frontier is modelled within simulated 4GB and 8GB VRAM envelopes, enforced through OS-level throttling to mirror the legacy infrastructure profiles of South African public-school laboratories. An automated knowledge distillation pipeline curates ZuSTEM, a custom-curated and CAPS-aligned synthetic dataset of isiZulu-English code-switched instruction-response pairs distilled from public DBE curriculum documents. Concurrently, a customized G-Eval LLM-as-a-Judge framework provides structured, rubric-based evaluation of each output. Parametric inferential analysis utilizing independent samples t-tests will assess whether the African-centric architecture mitigates cross-lingual hallucinations and maintains semantic consistency during bilingual code-switching at a statistically significant threshold. This work challenges the conventional paradigm that effective bilingual intelligent tutoring systems must rely on substantial computational resources or cloud dependencies. By eliminating these overheads, this study establishes a rigorous low-cost technical blueprint for inclusive AI-assisted STEM pedagogy in resource-constrained South African classrooms.

CMPS-F-18

ON THE STUDY OF VARIATIONAL QUANTUM ALGORITHMS (VQAs) FOR SOLVING LINEAR SYSTEMS

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A quantum computer as a device and quantum computing as a field is the brainchild of Richard Feynman. It all began when he realized that quantum systems cannot be efficiently

simulated on a classical computer [1], he later realized that a device that would pull such a feat would have to be quantum in nature - hence the idea of a quantum computer was born. The physics community began to take notice of his proposition and then started developing quantum algorithms that would run on such devices once we have them. To name a few of these algorithms that have been developed, we have the famous Shor algorithm [2] for factoring integers into primes and the Grover algorithm [3] for unstructured database searching. These algorithms are designed to run on fault-tolerant quantum devices - we have not built one yet.

Then there is what we call Variational Quantum Algorithms (VQAs). VQAs are quantum algorithms designed to run on NISQ (Noisy Intermediate-Scale Quantum) devices. These are state-of-the-art quantum computers with imprecise gates and measurements (noise). There have been many VQAs that have been developed to solve different kinds of problems, the first of its kind is the so-called Variational Quantum Eigensolver (VQE) [4], which was first used to simulate the ground energy of helium hydride (HeH^+) molecule. Here we introduce and study the Variational Quantum Linear Solver (VQLS) [5]- a quantum algorithm for solving linear systems $Ax = b$, whose inspiration has been drawn from the VQE itself. We break down the algorithm component by component, we demonstrate how it works by solving actual linear systems and explore its limitations. We then further introduce a newly proposed VQA, the Measurement Test [6] - which is also an algorithm to solve linear systems. We study the Measurement Test and compare it with the VQLS.

1.Feynman, Richard P. "Simulating physics with computers." In Feynman and computation, pp. 133-153. cRc Press, 2018.

2.Wong, Hiu Yung. "Shor's algorithm." In Introduction to Quantum Computing: From a Layperson to a Programmer in 30 Steps, pp. 289-298. Cham: Springer International Publishing, 2023.

3.Stoudenmire, E. M., and Xavier Waintal. "Grover's algorithm offers no quantum advantage." arXiv preprint arXiv:2303.11317 (2023).

4.Peruzzo, Alberto, Jarrod McClean, Peter Shadbolt, Man-Hong Yung, Xiao-Qi Zhou, Peter J. Love, Alán Aspuru-Guzik, and Jeremy L. O'brien. "A variational eigenvale solver on a photonic quantum processor." Nature communications 5, no. 1 (2014): 4213.

[5] Bravo-Prieto, Carlos, Ryan LaRose, Marco Cerezo, Yigit Subasi, Lukasz Cincio, and Patrick J. Coles. "Variational quantum linear solver." Quantum 7 (2023): 1188.

[6] Giresse Tene, A. and Konrad, T., 2026. Solving a Linear System of Equations on a Quantum Computer by Measurement. arXiv e-prints, pp.arXiv-2604.

CMPS-F-19

CLASSIFICATION OF HEMATOXYLIN AND EOSIN STAINED BREAST CANCER HISTOLOGY MICROSCOPY IMAGES USING DEEP LEARNING

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Breast cancer remains a leading cause of mortality among women worldwide, with early and accurate diagnosis through medical imaging critical for improving patient outcomes. While deep learning has demonstrated significant potential for automating breast cancer image classification, widespread clinical adoption is impeded by persistent challenges including fragmented knowledge, limited labelled data, and the hierarchical nature of disease progression that conventional Euclidean methods fail to adequately represent. This study presents a systematic scoping review and a novel geometric deep learning framework to address these challenges. The scoping review, following PRISMA guidelines on articles (2020–2025), identifies critical gaps: a 70.2% concentration of research output in Asia with Africa underrepresented, a predominant focus on binary over multi-class classification, a paradigm shift from CNNs to Vision Transformers, and a scarcity of large, diverse benchmarked datasets. To address these gaps, the Adaptive Hyperbolic Vision Transformer (AH-ViT) is proposed, introducing three innovations: (1) learnable hyperbolic curvature that adaptively shapes geometric space to represent the hierarchical taxonomy of breast cancer progression, departing from prior fixed-curvature approaches; (2) integration of a frozen Vision Transformer backbone with curvature-aware projection and hyperbolic prototype matching within an episodic meta-learning paradigm; and (3) stability-regularised optimisation with stain normalisation to mitigate domain shift from staining variability. Evaluated on the ICIAR2018 BACH dataset under a 4-way, 5-shot protocol, AH-ViT achieves 81% accuracy, outperforming the standard Vision Transformer baseline (79%), while the variant without few-shot learning achieves 88% accuracy, establishing a new state-of-the-art benchmark for transfer learning in multi-class breast cancer image classification. Per-class metrics demonstrate consistent and balanced performance across all histological subtypes, with precision, recall, and F1-scores ranging from 80% to 91%. This research contributes a comprehensive scoping review mapping the current landscape of breast cancer image classification and the application of adaptive hyperbolic geometry with learnable curvature for few-shot histopathology classification, establishing a new paradigm for resource-efficient computational pathology.

CMPS-F-20

A New Two-Inertial Two-Subgradient Extragradient Algorithm for Approximating Solutions of Variational Inequality and Fixed Point Problems in Real Hilbert Spaces

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Variational inequality and fixed point problems provide a unifying framework for equilibrium, optimization, and nonlinear analysis arising in signal processing, image restoration, economics, and machine learning. A central open question posed by Censor *et al.* [3] concerns the convergence of the two-subgradient extragradient method (TSEGM), which replaces costly feasible-set projections with cheaper half-space projections. Existing answers guarantee only weak convergence under restrictive conditions, and strongly

convergent, linesearch-free algorithms handling both problems simultaneously remain limited.

Our study introduces a New Two-Inertial Two-Subgradient Extragradient Method (TITSEGM) for approximating a common solution of monotone variational inequality and fixed point problems for demicontractive mappings in real Hilbert spaces. Unlike existing single-inertial schemes, TITSEGM combines a two-step inertial extrapolation with a self-adaptive, non-monotonic stepsize rule requiring no prior knowledge of the Lipschitz constants of the cost operator or the Gâteaux differential of the constraint function, and dispenses entirely with linesearch procedures. Under mild assumptions, we establish strong convergence of the generated sequence to the minimum-norm common solution.

Numerical experiments in finite-dimensional Euclidean space and the infinite-dimensional sequence space ℓ_2 validate the theory. Against four state-of-the-art methods [1, 2, 4, 5], TITSEGM consistently converges faster, with fewer iterations and lower CPU time, extending several existing inertial extragradient, viscosity approximation, and projection-type algorithms.

Keywords: *Variational inequality; Fixed point problem; Two-inertial extragradient method; Self-adaptive stepsize; Strong convergence; Real Hilbert spaces.*

References

- [1] T.O. Alakoya and O.T. Mewomo, Strong convergent inertial two-subgradient extragradient method for finding minimum-norm solutions of variational inequality, *Netw. Spat. Econ.*, (2024), **24**(4):25-45.
- [2] Y. Cao and K. Guo, On the convergence of inertial two-subgradient extragradient method for solving variational inequality problems, *Optimization*, (2020), **69**(6):1237–1253.
- [3] Y. Censor, A. Gibali and S. Reich, Extensions of Korpelevich's extragradient method for the variational inequality problem in Euclidean space, *Optimization*, (2012), **61**(9):1119–1132.
- [4] B. Ma and W. Wang, Self-adaptive subgradient extragradient-type methods for solving variational inequalities, *J. Inequal. Appl.*, (2022), **2020**:54.
- [5] H. ur Rehman, Z-Y. Peng and J-C. Yao, Approximate Subgradient Extragradient Methods for Solving Variational Inequality Problems: Convergence Analysis and Applications in Signal and Image Processing, *Commun. Nonlinear Sci. Numer. Simul.*, (2025), 152, doi:<https://doi.org/10.1016/j.cnsns.2025.109211>

CMPS-F-23

EXPLORING THE DIVERSITY OF MATHEMATICAL MODELS OF DIABETES MELLITUS

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This study investigates the diversity of mathematical models used to study diabetes mellitus in recent years. A systematic literature search was conducted to identify relevant research articles, which were subsequently collected, organised, and classified according to the mathematical modelling approaches employed.

Preliminary findings indicate that ordinary differential equation (ODE) models remain the predominant modelling approach. However, a broad range of alternative techniques have also been identified. These include fractional-order calculus (FOC), system dynamics modelling (SDM), machine learning, hybrid models, quantitative systems physiology (QSP), and age-structured population models. The models address diverse aspects of diabetes, including glucose–insulin regulation, hormone dynamics, disease progression, treatment interventions, and population-level risk factors.

These findings demonstrate the increasing diversity of mathematical modelling approaches used to investigate diabetes mellitus and provide a foundation for future comparative analysis of their applications, strengths, and limitations.

CMPS-F-24

Evaluating growth trajectories in HIV-exposed uninfected children using a calibrated simulated HIV-unexposed comparator population

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Background: HIV-exposed uninfected (HEU) children often show poorer linear growth than HIV-unexposed uninfected (HUU) children, but real-world HUU comparators are frequently unavailable. Simulation-based counterfactuals offer an alternative, yet their plausibility requires rigorous evaluation.

Methods: We simulated a HUU reference population using published growth parameters calibrated to local characteristics from a HEU cohort across four African countries. Latent class growth mixture models were fitted for height-for-age (HAZ) and weight-for-age (WAZ) z-scores from 0 to 60 months in both the observed HEU cohort and the simulated HUU population. Country effects on class membership were compared using multinomial logistic regression.

Results: Entropy values were modest (0.52-0.67). In the simulated HUU population, South Africa (OR 1.86, 95% CI 1.17–2.95) and Zimbabwe (OR 1.45, 95% CI 1.04-2.03) showed higher odds of favourable HAZ class membership than Malawi. In the HEU cohort, these countries showed lower odds of the most unfavourable HAZ class (South Africa: OR 0.13, 95% CI 0.07-0.24; Zimbabwe: OR 0.17, 95% CI 0.10-0.27). Strong positive correlations were observed between HEU and HUU high-growth trajectories ($r = 0.96$ for WAZ). WAZ country effects were absent in the simulated population but emerged in the HEU cohort (South Africa Class 2 OR 5.14, 95% CI 2.07-12.74).

Conclusion: A calibrated simulated HUU population provides a plausible counterfactual. HIV exposure modifies geographic growth patterns in complex ways, supporting simulation-based approaches when real comparators are unavailable.

Keywords: HIV-exposed uninfected (HEU); counterfactual simulation; growth trajectories; latent class growth mixture model; height-for-age z-score; weight-for-age z-score; country effects; sub-Saharan Africa

FLASH ABSTRACTS

ENGINEERING

ENG-F-1

STRUCTURAL EFFECTIVENESS OF ROLLED STEEL BRIDGE GIRDERS SUBJECT TO PITTING CORROSION: A PERFORMANCE-BASED APPROACH

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Pitting corrosion poses a significant threat to the integrity and performance of steel structures, potentially leading to progressive collapse if left unaddressed. This research investigates the impact of pitting corrosion on the structural effectiveness of rolled steel bridge girders under service conditions. We adopt a performance-based approach that integrates *Finite Element Analysis* (FEA) and an *Artificial Neural Network* (ANN) to evaluate structural degradation with respect to plastic strain.

Pitting corrosion profiles, modelled according to *American Society for Testing and Materials* (ASTM)-G46 21 specifications and equation for rate of corrosion, are used to simulate various levels of corrosion over time. The mechanical performance of the girder is assessed based on its stress-strain behavior. Our results demonstrate a substantial reduction in load-bearing capacity, particularly in areas of high corrosion intensity, which significantly compromises the overall stability of the structure [1 -3]. We also discuss potential mitigation strategies aimed at improving the resilience of this critical structural element.

This research provides valuable insights into the long-term durability of rolled steel bridge girders subjected to pitting corrosion during their service life which in turn enables structural engineers to create an optimized design to enhance structural safety and longevity.

Keywords: Pitting Corrosion, Rolled Steel bridge girder, Finite Element Analysis (FEA), Machine Learning, Artificial Neural Network (ANN), Structural Integrity, ASTM G46 21, Performance-Based Design

Reference

- [1] Janse van Rensburg, D. T., Cornish, L. A., & Van der Merwe, J. (2019). Corrosion map of South Africa's macro atmosphere. *South African Journal of Science*, 115(7-8), 1-8.
- [2] Melchers, R. E. (2018). A review of trends for corrosion loss and pit depth in longer-term exposures. *Corrosion and Materials Degradation*, 1(1), 42-58.
- [3] ASTM International. (2021). *Standard Guide for Examination and Evaluation of Pitting Corrosion (ASTM G46-21)*. ASTM International. <https://doi.org/10.1520/G0046-21>.

ENG-F-2

A Fog-Centric Deep Learning Trust Management Architecture for Industrial IoT Networks

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Industrial Internet of Things (IIoT) systems are increasingly organised around layered Edge-Fog-Cloud (EFC) architectures, in which distributed, resource-constrained devices exchange data continuously to support real-time industrial control. This distribution of intelligence across heterogeneous nodes expands the attack surface beyond what identity-based security mechanisms alone can address. Trust Management Systems (TMSs) have therefore emerged as a behavioural complement, continuously evaluating node trustworthiness rather than only verifying identity. Deep Learning (DL) offers superior detection fidelity for the complex, nonlinear attack patterns present in IIoT traffic, but its computational density conflicts with the strict latency and memory budgets of Edge devices, while Cloud-based inference introduces stochastic delays incompatible with deterministic industrial control loops.

This MSc research addresses this through the Edge-Fog Trust Management Architecture (EF-TMA), which relocates DL-based trust inference to the Fog layer. A lightweight stacked Long Short-Term Memory (LSTM) model derives a continuous trust score from nine header-derived, flow-aggregated features, using stateless sliding-window inference to bound computational cost independently of network scale. Asynchronous, one-step-delayed policy enforcement decouples inference from packet forwarding, preserving line-rate data-plane performance.

EF-TMA was trained and evaluated on the CIC-IoT-2023 benchmark and deployed via ONNX Runtime within an ns-3 network simulation. Offline evaluation achieved an F1-score of 0.9996 and ROC-AUC of 0.9999, while the ONNX-optimised model achieved a mean inference latency of 0.049 ms and a 302 kB memory footprint, with inference cost confirmed to scale independently of node count up to 200 simulated Edge nodes. Full-system simulation, using purpose-built benign and malicious traffic generators calibrated against CIC-IoT-2023, confirmed robust detection under Denial-of-Service and Mirai botnet scenarios while

maintaining a benign false-positive rate of 0.07%. This work has been accepted for publication in the Journal of Sensor and Actuator Networks (MDPI, Q1).

Building on this simulation-validated design, current work extends EF-TMA toward physical validation through a hardware testbed comprising Raspberry Pi Fog nodes, with multiple ESP-32 and Raspberry Pi IIoT Edge devices. This testbed will assess whether the latency, memory, and detection characteristics established through simulation are preserved under real hardware and network conditions, addressing a gap between model-level evaluation and practical Fog-tier deployment that is common in the trust management literature.

Together, the simulation-based architecture and the ongoing hardware validation reflect the current progress of this MSc research toward a viable, deployable approach to continuous, DL-based trust evaluation for latency- and resource-constrained IIoT networks.

ENG-F-3

AN INTEGRATED FRAMEWORK FOR THE DEVELOPMENT OF SUSTAINABLE ASPHALT MIXTURES INCORPORATING WASTE GLASS AND HYBRID SYNTHETIC FIBRES

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The pursuit of sustainable pavement infrastructure has intensified efforts to incorporate recycled materials into asphalt mixtures without compromising engineering performance. Waste glass and hybrid synthetic fibres are among the effective substitute options identified, showing great promise to enhance mechanical properties and sustainability and to help achieve circular economy aims. Yet, research at this point is divided, with material characterisation, material selection, mixture design, mixture performance evaluation, mixture optimisation, mixture durability evaluation, and sustainability evaluation examined as separate topics. An integrated design approach for Sustainable Asphalt Mixes that incorporates waste glass and hybrid synthetic fibres is presented in this paper. A Boolean search was formulated to retrieve relevant literature on sustainability, waste glass, fibres and asphalt mixture performance. The identified literature was subsequently screened and assessed for its quality to determine the scope for future analysis to complete framework design. The synthesised evidence was used to identify research trends, methodological gaps, and the interrelationships among the key stages of asphalt mixture development. The developed framework comprised six interrelated sub-processes: material selection, characterisation of physicochemical and microstructural properties, design of asphalt mixtures, performance assessment at the laboratory scale, multi-objective optimisation, and evaluation of life-cycle sustainability. By consolidating the six processes into a single engineering flow, the developed framework provided useful operational guidance to researchers and practitioners for designing asphalt mixtures that resist adverse conditions, conserve natural resources, and maintain ecological balance, while simultaneously guiding follow-up research and implementation.

Keywords: Sustainable asphalt mixtures; recycled glass waste; hybrid synthetic fibres; integrated framework; circular economy.

ENG-F-4

DEVELOPMENT OF A SOLAR HEAT EXCHANGER FOR MAIZE WITH COMBINE STORAGE UNIT FOR SMALLHOLDER FARMERS IN SUB-SAHARAN AFRICA.

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Farmers in Sub-Saharan Africa faced challenges in accessing affordable, energy-efficient, and technically reliable drying systems to reduce maize moisture to a safe storage level of 13% while maintaining grain quality during successive storage under small-scale farming conditions. Maize had the highest recorded post-harvest losses, at about 18%-36% each year. High moisture content after harvest increases the risk of deterioration due to microbial decomposition, which can lead to aflatoxin contamination. Inefficient maize drying and storage practices could increase the risk of post-harvest losses, increase energy consumption for conventional maize drying, and lead to food insecurity by reducing the quality and quantity of maize available for consumption. The development of a solar heat exchanger and its integration into a maize comb dryer-storage system would meet farmers' needs by reducing moisture content to a safe level for storage while maintaining maize quality and colour. An experimental approach using natural and forced ventilation was used to evaluate solar collectors. The proposed research aims to design a solar heat exchanger integrated with a whole-maize-cob dryer and storage to enhance drying efficiency and reduce post-harvest losses for farmers. The current study consists of a literature review and an experimental design on the solar dryer performance. The experiment will establish the effects of airflow mode and operating conditions on the dryer's performance. The following parameters will be evaluated: temperature, relative humidity, thermal and drying efficiencies, moisture reduction, and mass loss of the maize cobs.

ENG-F-5

Generating electricity from ocean currents with underwater kites

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As of 2020, 63.3% of the world's global electricity production comes from fossil fuels, with coal and natural gas accounting for 36.7% and 23.5%, respectively. This means that only 36.7% of the world's electricity is produced from low-carbon emission sources, otherwise known as renewable energy sources. The current dilemma associated with fossil fuels and natural gasses is the harmful by-products produced when they are burnt. These are detrimental

towards the global population's physical health as well as being the greatest contributor towards global warming through the production of greenhouse gasses. The Organisation of Petroleum Exporting Countries (OPEC) is a group of 12 countries, which combined account for approximately 40 percent of the world's total oil production as well as holds most of the world's oil reserves. This creates a monopoly over these finite resources which can result in incredible price fluctuations for dependent countries (Shahzad, 2015). For developing countries these issues can become detrimental to the growth of the economy and as such, alternative avenues of energy generation should be investigated. An emerging method of renewable energy technology has been recently investigated by Minesto with tethered undersea kites or "hydro-kites". Our research investigates the practicality of designing, testing and building these hydro-kites for the Agulhas ocean current. Currently we have developed a small-scale testing method that allows us to simulate our proposed design in the UKZN Howard College swimming pool. We'll be using the results of these practical tests to inform and refine our numerical model to better estimate the energy generation potential of these underwater kites.

ENG-F-6

GREEN PROCESS DESIGN – A STRATEGY FOR ELIMINATION OF HAZARDOUS CHEMICALS IN CHEMICAL SYNTHESIS

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Process optimisation is a typical task for a chemical engineer, and the overall goal of this Master project is the optimisation of the production of 5-hydroxyfurfural (HMF). HMF is a platform chemical produced from carbohydrates. Prior research has shown that the reaction of fructose results in high yields, even under mild conditions. Glucose and sucrose, which are of much higher relevance in the biorefinery context, are much more challenging to convert to HMF [1].

As a consequence of the environmental impact of chemical production, sustainability is now an axis on which informed environmental stakeholders' decisions, policies and frameworks revolve around. While typical technical aspects, such as yield, still play a role in reaction optimisation, in this study, the overall sustainability performance of the solvents and catalysts needed to be assessed to identify optimum reaction conditions for a truly sustainable future process. Three pillars of sustainability namely: social, environmental and economical were explored in the evaluation of solvent and catalyst alternatives to facilitate decision making [2].

For this purpose, a scoping literature review was conducted, focussing on the conversion of either glucose or sucrose to HMF. After selection of suitable indicators for the three aspects of sustainability, relevant data for all solvents and catalysts used was sourced and normalised numerical values assigned to each dimension's indicator based on the intrinsic properties of each chemical as specified by the Globally Harmonised System (GHS) hazard statements [3].

Thereafter, a dimension index was calculated as an average of its indicator-normalised values which was subsequently used to obtain a Sustainability Performance Score (SPS) for each chemical evaluated relative to the respective Integrated Weighting Factor (IWF) assigned to each dimension. A traffic light colours ranking system, in accordance to a specified range, was implemented to rank chemicals according to their SPS. This presentation provides insights into the methodology, which is widely applicable to similar optimisation tasks, and lends itself ideally to the production of a meaningful and critical literature review.

References

1. Aranha, D.J. and P.R. Gogate, *A Review on Green and Efficient Synthesis of 5-Hydroxymethylfurfural (HMF) and 2,5-Furandicarboxylic Acid (FDCA) from Sustainable Biomass*. *Industrial & Engineering Chemistry Research*, 2023. **62**(7): p. 3053–3078.
2. OECD, *Current Landscape of Alternatives Assessment Practice: A Meta-Review*, in *Series on Risk Management of Chemicals*. 2013: Paris.
3. Egger, G., et al., *Sustainability Assessment during Early Stage Chemical Process Design: Comparing Two Different Methods of Synthesizing Noroxymorphone*. *ACS Sustainable Chemistry & Engineering*, 2024. **12**.

ENG-F-7

VULNERABILITY ASSESSMENT FRAMEWORK FOR CLIMATE-RESILIENT ROAD NETWORKS IN KWAZULU-NATAL

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South Africa's road infrastructure is increasingly vulnerable to the impacts of climate change, with KwaZulu-Natal (KZN) experiencing heightened exposure to extreme weather events, including intensified rainfall, flooding, severe storms and temperature-related impacts. These climate-driven hazards pose significant risks to the functionality, safety and long-term performance of the provinces road network, resulting in increased maintenance demands, infrastructure deterioration, mobility disruptions and socio-economic consequences. As climate variability continues to influence infrastructure performance, a growing need has developed for a systematic approach to assess vulnerabilities and support climate-resilient decision-making across the road infrastructure's lifecycle.

This research aims to develop a climate vulnerability assessment framework for the road network of KZN, enabling the identification, prioritisation and management of climate-related risks across the province. The study integrates historical and projected climate data with road infrastructure characteristics to evaluate the exposure and sensitivity of road assets to changing climatic conditions. Key climate stressors, including rainfall intensity, temperature variations and flooding frequency, will be assessed to determine the influence on infrastructure vulnerability. The framework will incorporate risk-based assessment methodologies to establish the relationships between climate hazards, infrastructure sensitivity and adaptive capacity within different regions of KZN.

The research will contribute towards improving climate resilience within the provincial road network by providing a structured approach for identifying vulnerable infrastructure and informing adaptation strategies. The outcomes will support the integration of climate considerations into road planning, design, maintenance and asset management practices – ultimately contributing to safer, more reliable and sustainable transportation systems throughout KZN.

Keywords: climate resilience, road infrastructure, vulnerability.

ENG-F-8

VALORISATION OF SOUTH AFRICAN PGM TAILINGS THROUGH CARBON SEQUESTRATION AND SYNTHESIS OF ALKALI-ACTIVATED MATERIALS

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Approximately 80 million tonnes of PGM tailings are generated from the Bushveld Igneous Complex in South Africa. These tailings are dominated by crystalline silicate phases such as orthopyroxene and plagioclase, which exhibit limited dissolution kinetics and pose a unique scientific and engineering challenge for the development of effective utilization strategies. PGM tailings from SA have the potential to sequester 93,700 tonnes of CO₂ per year via the accelerated carbonation route, while their aluminosilicate phases make them potential feedstocks for alkali-activation. Simultaneously, reducing CO₂ emissions associated with cement production has increased interest in alternative cementitious materials derived from industrial residues. This study seeks to explore a dual-stage valorization route that integrates high-pressure mineral carbonation with hydrothermal alkali activation to transform PGM tailings into low-carbon geopolymer cement.

In the first step, raw tailings will undergo carbonation under high-pressure (130-170 bar) and high-temperature (165-215 °C) conditions, using NaHCO₃ as the carbonation medium. A Response Surface Methodology utilizing a Central Composite Design will be employed to evaluate the effects of operating variables on carbonation performance.

Thereafter, raw tailings will undergo hydrothermal alkali activation at moderate temperatures (150-200 °C) using low concentrations of NaOH (3.5-5 M), blended with sodium silicate to control the silicate modulus. The activated tailings raw will be blended with coal fly ash to form geocement, which will then be used to synthesize geopolymer pastes. Once optimal geopolymerisation conditions have been determined, carbonated tailings will be used for geopolymerisation to investigate whether prior carbonation influences geopolymer formation and mechanical performance. To improve process economy and ensure circularity, the commercial sodium silicate alkali activator will subsequently be replaced by sodium silicate synthesized from waste glass via low-temperature hydrothermal dissolution (150-200 °C) of post-consumer waste glass powder.

The primary anticipated outcome from the study is a comprehensive, validated valorization pathway for low-reactivity PGM tailings via carbon sequestration and alkali activation. It is

expected that the proposed process will yield a net reduction in the binder's carbon footprint, while the use of waste glass is expected to improve process economics. The study is expected to contribute to understanding the interactions between mineral carbonation and alkali activation in crystalline PGM tailings.

ENG-F-9

A DISTRIBUTED WORKLOAD AND RESOURCE ALLOCATION SCHEME FOR PAVEMENT DEFECT DETECTION

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High-quality road infrastructure is essential for economic development, mobility, and public safety. In KwaZulu-Natal (KZN), pavement surface defects are widespread due to aging infrastructure and high traffic volumes. Traditional manual detection methods currently in use are labour-intensive and suffer from slow reporting cycles, which significantly delays maintenance intervention.

Automated computer vision systems offer an alternative, but the high volume and velocity of visual data have substantial computational and storage demands. This ongoing research focuses on resource orchestration within a multi-tier Internet of Things (IoT) environment. In this work, a resource allocation scheme is developed that partitions defect detection inference tasks across the edge-fog-cloud continuum. This involves managing the computational, storage, and communication resources for pre-trained deep learning models.

While conventional two-tier edge-cloud models are common, they are frequently hindered by high latency and excessive bandwidth consumption when processing high-resolution visual data. The introduction of a fog layer closer to the transport network allows the system to aggregate and filter data closer to the source, reducing the load on centralized cloud servers and accommodating vehicular mobility through Vehicle-to-Infrastructure (V2I) communication. Current investigative efforts focus on analysing computational workloads and data generation rates to define the optimal resource allocation scheme. This involves designing strategies that balance the strict trade-offs between latency, network bandwidth and local system resources.

This research aligns with the South African Department of Transport (DoT) Strategic Plan for 2025-2030, which mandates robust data analytics for infrastructure management. By prioritizing the intelligent allocation of resources over traditional centralised processing, the research aims to deliver a scalable, data-driven solution for road surface monitoring in KZN.

Design and Performance Analysis of a Self-Pressurising Nitrous Oxide/Hydrocarbon Propulsion System for Small Satellite Applications

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This research addresses a critical topic for the University of KwaZulu-Natal's (UKZN) Aerospace Systems Research Institute (ASRI), aligning with ASRI's efforts to utilise 'green' propellant alternatives to the current industry standards. A 22 N bi-propellant in-space thruster is to be designed and computationally modelled. In-space propulsion systems are small rocket motors fixed to the satellite itself. To support the mission objective, thrusters are used to manoeuvre the satellite to the correct orbit or orientation as required [1]. Hydrazines (a family of monopropellants) have been the major chemical propellant choice for satellites due to their heritage, good performance, and long-term stability. Despite the advantages, there has been a significant shift away from hydrazines due to their toxicity [2]. The toxic nature of hydrazines imposes high costs in manufacturing, handling, storage, and transport. There is also growing awareness of the full lifecycle of materials and propellants, highlighting the dangers of disposing of these toxic propellants [3]. The specified oxidiser used in this study is nitrous oxide. Nitrous oxide offers many inherent advantages for small satellites. It is colourless, non-toxic, non-corrosive, stable and comparatively unreactive at ordinary temperatures. It is also self-pressurising, which simplifies the required design of the propellant supply system on the satellite [4]. An optimal light hydrocarbon fuel is to be selected to pair with nitrous oxide. Following the literature review, four fuel candidates have been selected, namely, propylene, propane, ethane, and ethylene. These candidates were selected based on their existing demonstrated compatibility in nitrous oxide systems and self-pressurising capabilities. Computational models of the propulsion system's constituent elements, such as its propellant tanks, plumbing, injector, and regeneratively cooled thruster, are being developed to gain a systems-level understanding of its operation. The entire thruster system must be flight-weight and compact to meet ASRI's required specifications. To date, models of propellant tank pressure decay during operation have been developed and validated against experimental data from existing literature. The pressure envelope is a crucial parameter for self-pressurizing propellants, and the pressure decay during operation is a complex, transient physical phenomenon that had to be captured to be used as inputs to system-level computational models. The propellant tank simulations show that feed pressures remain close to saturation pressures for 40-50% of the operating time before the pressure decays parabolically. The immediate next steps involve building system-level computational models and conducting parametric studies to characterise the performance envelope of each propellant combination for direct comparison.

References

- [1] D. Turner, R. Howie, and P. Bland, "The Development of a Next-Generation Latticed Resistojet Thruster for CubeSats.," *Aerospace (MDPI Publishing)*, vol. 11, no. 9, 2024.
- [2] S. Carlotti and F. Maggi, "Evaluating new liquid storable bipropellants: Safety and performance assessments," *Aerospace*, vol. 9, no. 10, p. 561, 2022.

[3] A. Okninski *et al.*, "Development of Green Bipropellant Thrusters and Engines Using 98% Hydrogen Peroxide as Oxidizer," *Aerospace*, vol. 12, no. 10, p. 879, 2025.

[4] V. Zakirov, M. Sweeting, T. Lawrence, and J. Sellers, "Nitrous oxide as a rocket propellant," *Acta Astronaut.*, vol. 48, no. 5–12, pp. 353–362, 2001.

ENG-F-11

LOOWATT(KALOOLA) SLUDGE CHARACTERIZATION AND TECHNO-ECONOMIC ANALYSIS FOR CIRCULAR ECONOMY APPLICATION

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Proper management of sanitation waste is essential to ensure public health, protect the environment and promote sustainable development. However, the infrastructure required for effective sanitation management is costly to assemble and maintain, particularly in developing nations where water and sanitation systems are inadequate. Resource recovery from sanitation systems presents a sustainable solution, enabling the extraction of water, energy, and nutrients from waste streams. The LOOWATT (Kaloola) waterless toilet system, introduced in Durban, South Africa, offers a promising sanitation solution for areas where water availability is limited and conventional sewer systems are not available. Its use of sealed liners to capture and store human waste reduces odour and limits direct human exposure to pathogens, making it a distinctive non-sewered sanitation technology. However, despite these advantages, the safe treatment and resource recovery of the collected faecal sludge and plastic liner remain unresolved. This study therefore investigated treatment and valorisation pathways for these waste streams within a circular economy framework. Critical parameters that were subject to laboratory analysis included Chemical Oxygen Demand (COD), pH, nutrient content (NPK), microbial content, moisture content, total and volatile solids, ash content, viscosity, calorific value and electrical conductivity. The results indicated sludge with high moisture content (~88%), moderate organic load and nutrient levels for resource recovery. Using structured decision-making tools, such as RAG (red, amber, green) analysis, a scoring system, and a decision matrix, anaerobic digestion emerged as the most viable valorisation option for the sludge. A techno-economic assessment confirmed that anaerobic digestion is energy-positive, but the current sludge generation rate (around 100-150 kg/day) limits immediate profitability. Furthermore, integrating municipal organic waste co-digestion, gate-fee revenue, and digestate valorisation closes the financial gap, proving promising for long-term commercial viability.

ENG-F-12

Abnormal Human Activity Recognition from Video Surveillance using Deep Learning

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The rapid deployment of surveillance cameras in urban environments demands robust, automated systems for the real-time detection of abnormal activities to ensure public safety. Traditional manual monitoring is inherently labor-intensive and highly prone to human error, particularly in crowded scenes. While existing deep learning models offer promising solutions, they frequently overfit due to excessive architectural complexity and the limited scale of available datasets, severely hindering generalization. Furthermore, multi-class video classification naturally demands significant computational resources, highlighting an urgent need for smaller, highly efficient models. Consequently, we propose an optimized lightweight ConvLSTM architecture that effectively captures spatio-temporal features while aggressively filtering static background noise. Our customized ConvLSTM model achieved state-of-the-art efficiency and performance, with precision, recall, F1-score, and accuracy averaging 96.15%, 97.72%, 97.43%, and 97.37%, respectively, across the Abnormal Activities and AIRTlab Violence Detection datasets. By drastically reducing parameter count without sacrificing accuracy, this research demonstrates that highly optimized spatiotemporal networks are extremely viable, paving the way for scalable, real-time anomaly detection on resource-constrained edge devices.

Keywords: Abnormal Activity Recognition, ConvLSTM, Violence Detection, Video Surveillance, Lightweight Deep Learning, Edge Computing.

ENG-F-13

Polymer-Impregnated Platinum Slag-Metakaolin Mortar for Sustainable Construction Applications

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The construction industry faces challenges in curbing resource depletion, carbon emissions, and waste generation from building and industrial activities. The preparation of mortar through conventional processes using natural sand and Portland cement (PC) produces considerable amounts of carbon dioxide. In South Africa, the increasing mining activity has resulted in large stockpiles of platinum slag waste (PSW). Previous studies have explored PSW, metakaolin (MK), and polymer impregnation individually; however, no published study has

examined the combined use of these three materials in a single mortar mix. This study aims to provide a comprehensive overview of the current research on the development of polymer-impregnated PSW-MK mortar. In this study, natural fine aggregates and PC are replaced with PSW and MK, respectively, at replacement levels up to 30% at 5% increments. The hardened mortar will be oven-dried prior to impregnation with a styrene-methyl methacrylate monomer mixture to enhance the density and strength of the interfacial transition zone. The research methodology encompasses material characterisation, mortar preparation, fresh-state and rheological testing, mechanical and durability assessments, microstructural analysis, finite element modelling with ABAQUS, and Life Cycle Assessment with SimaPro. The findings of this study are expected to provide novel insights into the synergistic effects of platinum slag, metakaolin, and polymer impregnation. These insights are anticipated to contribute to advancing the circular economy, conserving natural resources, reducing the carbon footprint, and promoting the utilisation of indigenous resources for the development of sustainable mortars.

Keywords: Platinum slag, Metakaolin, Polymer-impregnated mortar, Waste valorisation, Sustainable construction

ENG-F-14

PROCESS DEVELOPMENT AND TECHNO-ECONOMIC EVALUATION OF ZERO-LIQUID DISCHARGE AND BRINE VALORISATION FOR DESALINATION IN KWAZULU-NATAL IN GREEN HYDROGEN PROCESSING APPLICATIONS

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Green hydrogen (GH) production requires a reliable supply of high-quality water for electrolysis. To prevent further strain on freshwater resources, it is desirable to utilize non-potable water sources such as industrial and municipal wastewater, saline and brackish water, acid mine drainage, and seawater. Coastal regions such as KwaZulu-Natal (KZN) have abundant access to seawater, which can be desalinated to produce water suitable for electrolysis. However, highly concentrated brine forms as a by-product and requires careful management to prevent adverse impacts to aquatic ecosystems and public health [1]. Zero-liquid discharge (ZLD) processes have potential to transform desalination from a waste-generating process into a circular resource recovery system. ZLD technologies are widely implemented in industry to maximize the recovery of water, minerals and valuable salts. However, there is limited research evaluating their technical and economic integration for desalination brine management within the GH value chain.

This study aims to evaluate ZLD technologies for the treatment and valorization of desalination brine, and assess the technical and economic feasibility of integrating ZLD into the green hydrogen production value chain in the KZN region. The research will (i) review existing ZLD technologies and brine valorization opportunities; (ii) characterize brine generated by the pilot green hydrogen unit at the Thermodynamics Research Unit (TRU); (iii) develop and simulate a conceptual ZLD process for water and salt recovery; (iv) validate the

proposed process experimentally; and (v) conduct a preliminary techno-economic evaluation for large-scale implementation in the KZN region.

This study involves a literature review, experimental investigation, process modeling, and preliminary techno-economic evaluation. A literature review has been conducted to assess desalination, brine management and valorization opportunities, and ZLD technologies. Brine from the GH pilot plant will be characterized and used to develop a process simulation model, which will be optimized to maximize water recovery and minimize energy consumption. The model will then be validated based on experimental data and refined to improve its accuracy. Finally, a techno-economic assessment will be completed to evaluate the costs, energy requirements, water recovery efficiency, resource recovery potential and scalability.

This research will provide a framework for sustainable desalination brine management and demonstrate the potential of ZLD technologies to improve the long-term viability of GH production in coastal regions such as KZN.

[1] Panagopoulos, A. and Michailidis, P. (2025) Membrane technologies for sustainable wastewater treatment: Advances, challenges, and applications in zero liquid discharge (ZLD) and minimal liquid discharge (MLD) systems, *Membranes*, 15(2), 64.

ENG-F-15

GAB PAIRING IN AN UPLINK PD-NOMA NETWORK

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Power Domain-Non-Orthogonal Multiple Access (PD-NOMA) technology has brought about the intricacy of users clustering on frequency slots. Clustering, therefore, becomes a critical perspective when assigning resources in a PD-NOMA network for throughput and efficiency.

The complications that arise from the clustering of users in PD-NOMA has led to the development of techniques, that aim to improve the user rates with regard to the skewedness of users' channel gains in a single cell. This research advances a user pairing method called Genetic-Ant Bowley (GAB) Pairing on an uplink PD-NOMA network. It further explores a hybrid of the Genetic algorithm and Ant Colony Optimization to maximize the users' rates during pairing.

The results are simulated using an uplink transmit power of 1W, noise level of -174dBm and are further compared with three other existing techniques. They imply that the GAB pairing method is better than the other techniques described, due to its adaptability to user channel gains spread in the single cell. The proposed GAB pairing technique achieves the highest sum rates and the second best fairness and is therefore recommended.

Index Terms—Genetic, Ant Colony, Channel Gain, Bowley, PD-NOMA.

ENG-F-16

SIMULATION-BASED APPROACH TECHNO-ECONOMIC ANALYSIS OF GREEN HYDROGEN FROM NON-PORTABLE WATER SOURCES

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Green hydrogen is considered a key element towards decarbonization, with domestic production forecast at 0.5 Mt annually by 2030. Currently, green hydrogen accounts for only 1% of global annual hydrogen production, a relatively low share, primarily due to higher production costs. Electrolyser technology implementation is constrained by intermittent availability of renewable energy, future hydrogen prices and water availability. This study develops a model and simulation for an integrated green hydrogen process that includes non-potable water pretreatment and purification, a renewable energy source, and a green hydrogen integrated system. The model will compute overall water consumption, electrolyser efficiency, specific energy consumption, hydrogen production, energy losses, installed capacity, and potential waste-valorisation streams. Individual unit processes will be modelled using Aspen Custom Modeler V14, while the simulation will be conducted using Aspen Plus V14.

A comprehensive economic evaluation will be conducted, encompassing capital, water, maintenance, electricity, and component replacement costs, as well as revenue streams. Key performance indicators will include levelised cost of hydrogen, net present value, payback period and internal rate of return. Both technical and economic evaluations will be conducted on seawater and effluent from wastewater treatment works around the eThekweni green hydrogen corridor.

Ultimately, sensitivity analysis will be conducted by varying parameters such as electrolyser capacity, renewable energy capacity, and electrolyser availability to optimise the system, maximise production output, and minimise cost. The resulting framing work will provide a decision-support tool for prospective investors to design integrated green hydrogen processes, including technical and economic assessments that can be adapted to various water sources.

ENG-F-17

LITERATURE REVIEW: SOLAR PHOTOVOLTAIC (PV) RENEWABLE ENERGY SOLUTIONS FOR IRRIGATED SUGARCANE PRODUCTION

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Irrigated sugarcane production in South Africa has been challenged by rising electricity costs, unreliable grid supply, and the need for sustainable energy solutions, making solar photovoltaic (PV) systems an attractive alternative for powering irrigation systems. A literature review was conducted to evaluate irrigation energy requirements, associated PV technologies, alternative system configurations, grid integration options, and techno-economic assessment methods for solar systems.

The literature indicates that while solar PV can significantly reduce energy costs and improve energy security, its technical and economic performance depends on complex interactions between irrigation demand, solar resource availability, irrigation system choice, storage requirements and farm-specific operating conditions [1]. This leads to an array of design options which can confuse farmers and hinder adoption, which is further confounded by limited guidance for farmers on selecting the most feasible option. The studies indicate that the suitability and economic performance of PV irrigation systems vary substantially with system configuration, particularly in relation to PV sizing, battery storage, grid dependence, and irrigation load profiles. The literature demonstrates that there is no single PV configuration that is consistently optimal across different irrigation conditions, highlighting the need for a systematic comparison of alternative configurations based on their technical performance, energy supply, and economic viability.

Consequently, this project aims to develop and validate a techno-economic decision support framework for evaluating and selecting suitable solar PV configurations for irrigation systems. The methodology will include the literature review, industry engagement, engineering design, modelling, and economic analyses to assess and compare alternative PV configurations and energy-efficient technologies under different irrigation scenarios. The study will examine how alternative PV configurations, including grid-tied, battery-integrated, and/or off-grid supported systems, perform in meeting irrigation energy requirements under different operating scenarios, while also assessing the implications of applicable grid-integration and tariff structures, such as energy wheeling, or banking, where relevant.

Reference

[1] - Barnard, S, Grové, B, van der Stoep, I and Moyo, R. 2022. Technical and Financial Feasibility of Alternative Renewable Energy Sources and Technologies in Irrigated Agriculture.

ENG-F-18

SYSTEM INTEGRATION FOR A DESKTOP SELECTIVE LASER SINTERING ADDITIVE MANUFACTURING PRINTER

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Manufacturing is increasingly shaped by the demand for faster innovation, greater design freedom, and highly customized products pressures that traditional fabrication methods struggle to accommodate. In response, additive manufacturing has emerged as a key enabling technology, offering the ability to produce complex geometries directly from digital

models while minimizing material waste and development time. Its growing importance is driven by advances in computational design, improved material performance, and declining system costs, which together have propelled its widespread adoption across industries such as aerospace, healthcare, and consumer product development. This momentum has accelerated a shift from large, centralized industrial machines toward compact, desktop additive manufacturing devices, expanding access to advanced fabrication capabilities within laboratories, small enterprises, and educational environments.

Additive manufacturing technologies can be broadly categorized into several classes, including fused deposition modelling (FDM), stereolithography (SLA), selective laser sintering (SLS), binder jetting, and material jetting, each defined by distinct material states and energy sources. Among these, selective laser sintering is notable for its ability to produce structurally robust, support-free polymer components, though it remains challenging to implement at reduced scale.

This dissertation, titled System Integration for a Desktop Selective Laser Sintering Additive Manufacturing Printer, examines the systematic integration of the core subsystems of an SLS 3D printer such as laser delivery, powder handling, motion control, and thermal management into a unified and operational desktop-scale prototype.

Keywords: Additive Manufacturing, Selective Laser Sintering (SLS), Computer Aided Design (CAD), System Integration.

ENG-F-19

Catalytic Hydrogenation–Dehydrogenation of a Liquid Organic Hydrogen Carrier Using a Triarylborane Catalyst under Crude Hydrogen

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Hydrogen is a clean, high-energy-density carrier central to a low-carbon hydrogen economy, but its low volumetric density under ambient conditions makes conventional storage routes, high-pressure compression, and cryogenic liquefaction energy-intensive and costly [1]. Liquid organic hydrogen carriers (LOHCs) offer a chemical alternative, binding hydrogen in a stable, transportable liquid via reversible catalytic hydrogenation and dehydrogenation, thereby making them compatible with existing liquid-fuel infrastructure [2].

Industrial LOHC hydrogenation relies almost entirely on supported platinum-group-metal (PGM) catalysts, which are readily poisoned by CO, CO₂, and CH₄ present in “crude” hydrogen from gasification or reforming, thereby necessitating costly upstream purification before storage can begin [2]. Main-group triarylborane catalysts, acting through a frustrated Lewis pair (FLP) mechanism, tolerate these contaminants, but reported performance remains limited: the literature reports a maximum hydrogenation yield of only 32% under crude, contaminated H₂, at pressures no higher than 12atm [3], far below the 150atm typical of industrial hydrogenation and the yields achieved under pure H₂.

This project investigates the absorption of hydrogen into a quinaldine (2-methylquinoline)/triarylborane system at a few megapascals and moderate temperatures, and its desorption at 150–200 °C, using a high-pressure static equilibrium cell operating up to 20 MPa, well beyond the 12atm ceiling of prior crude-gas studies [3]. Online vapor-phase sampling via a ROLSI™ capillary micro-sampler coupled to GC-TCD resolves the gas phase component-by-component, revealing how each species in the crude mixture, H₂, CO, CO₂, and CH₄, individually reacts with the catalyst. These measurements are combined with thermodynamic modelling of the phase and reaction behaviour to identify catalyst/additive and solvent combinations, and the temperature, pressure, and composition conditions, that optimize stable hydrogen storage from unpurified industrial gas streams.

References

- [1] F. Dawood, M. Anda, and G. M. Shafiullah, "Hydrogen production for energy: An overview," *Int. J. Hydrogen Energy*, vol. 45, no. 7, pp. 3847–3869, Feb. 2020, doi: 10.1016/J.IJHYDENE.2019.12.059.
- [2] H. Jorschick, M. Vogl, P. Preuster, A. Bösmann, and P. Wasserscheid, "Hydrogenation of liquid organic hydrogen carrier systems using multicomponent gas mixtures," *Int. J. Hydrogen Energy*, vol. 44, no. 59, pp. 31172–31182, Nov. 2019, doi: 10.1016/j.ijhydene.2019.10.018.
- [3] T. Hashimoto, T. Asada, S. Ogoshi, and Y. Hoshimoto, "Main group catalysis for H₂ purification based on liquid organic hydrogen carriers," *Sci. Adv.*, vol. 8, no. 43, Oct. 2022, doi: 10.1126/SCIADV.ADE0189.

ENG-F-20

Machine Learning Prediction Of The Larson–Skold Corrosion Index From Water Quality Parameters

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Accurate prediction of water corrosivity is essential for protecting water distribution infrastructure and supporting effective water quality management. The Larson–Skold Index (LSI), a widely used indicator of corrosion potential, is traditionally determined from multiple laboratory analyses, which may be costly, time-consuming, and susceptible to incomplete datasets. This study investigated the application of machine learning to predict the Larson–Skold Index using eleven routinely measured physicochemical water quality variables collected from monitoring sites across KwaZulu-Natal, South Africa. Random Forest Regression (RF) and Support Vector Regression (SVR) models were developed and evaluated using balanced grouped train-test validation and Group K fold cross-validation to ensure that monitoring sites in the testing dataset remained independent of those used for model training.

The Support Vector Regression (SVR) model achieved the highest predictive performance, with an R² of 0.9672, an RMSE of 0.1180, and an MAE of 0.0482, outperforming the Random

Forest (RF) model, which achieved an R^2 of 0.9216, an RMSE of 0.1825, and an MAE of 0.0935. Beyond model development, the study systematically evaluated all 2,047 possible combinations of the eleven measured water quality variables to identify the minimum parameter sets capable of maintaining reliable prediction accuracy, thereby providing practical guidance for reducing analytical costs while preserving model performance. Model robustness was further assessed by simulating progressive data loss from 0% to 50% in 5% increments, allowing the resilience of both machine learning models to be evaluated under realistic scenarios involving incomplete water quality datasets. The robustness analysis demonstrated that both models maintained strong predictive performance despite missing data. At 10% simulated data loss, the RF model achieved an R^2 of 0.8668, while the SVR model achieved an R^2 of 0.9194, indicating that both approaches remain effective even when water quality datasets are partially incomplete.

The results demonstrate that machine learning provides an accurate and robust approach for predicting the Larson–Skold Index while reducing reliance on complete laboratory datasets. The proposed framework offers a practical decision-support tool for corrosion risk assessment, optimisation of water quality monitoring programmes, and improved infrastructure management, particularly where analytical resources or complete water quality measurements are limited.

ENG-F-21

VARIABLE SPEED LIMIT PERFORMANCE AT LANE DROPS UNDER VARYING TRAFFIC COMPOSITION, SPEED COMPLIANCE, AND TRAFFIC VOLUME

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Freeway lane-drop bottlenecks are prone to congestion, unstable traffic flow, and increased vehicle interactions due to the required merging manoeuvres to move into the fewer available lanes. Variable Speed Limits (VSL) have been widely investigated as a traffic management strategy to improve traffic flow and safety at freeway bottlenecks. However, the effectiveness of VSL is influenced by prevailing traffic conditions and driver compliance with speed limits. Previous studies have examined traffic volumes, heavy-vehicle composition, and driver speed compliance, but these factors are often evaluated separately or with one or more held constant. Consequently, there are limited field-informed studies on how combinations of these factors jointly influence the operational and surrogate safety performance of VSL at permanent freeway lane-drop bottlenecks.

This study aims to evaluate the combined effects of heavy-vehicle percentage, driver speed compliance, and traffic volume on VSL performance at selected lane-drop bottlenecks on the N2 freeway in South Africa. Traffic conditions will be characterised using traffic-count data, vehicle-classification data, vehicle-speed data, travel-time data, driver-survey responses, and available crash information. The data analysis will examine traffic flow, vehicle composition, speed behaviour, and bottleneck performance.

Field-informed microscopic simulation models will be developed and calibrated in PTV VISSIM to reproduce traffic operations at the selected bottlenecks. The models will evaluate variations in traffic volume, heavy-vehicle percentage, and driver speed compliance under VSL and no-VSL conditions. Operational performance will be assessed using travel time, average speed, throughput, and speed variation. Simulated vehicle trajectories will support surrogate safety assessment using conflict frequency and type. Formal interaction analysis will be used to determine whether the influence of one factor varies according to the levels of the other factors. The study is expected to provide a field-informed basis for identifying the traffic and behavioural conditions under which VSL is most likely to improve traffic flow and safety at freeway lane-drop bottlenecks.

ENG-F-22

Development of a Software Prototype for Water Leak Detection Using GIS and Satellite Imagery

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Water pipeline leaks pose a critical threat to municipal water security, accounting for an average of 47.4% of national non-revenue water losses across South Africa. However, conventional leak detection methods often fail to catch early-stage leaks in remote and rural pipelines due to hardware constraints and the difficulties of monitoring geographically isolated networks. This study presents the ongoing development of a software prototype that integrates Geographic Information Systems (GIS) and satellite imagery for remote sensing of water leaks. The functionality of this developmental prototype relies on cloud-based processing in Google Earth Engine (GEE), which is accessed via its API to retrieve multi-sensor satellite datasets: Sentinel-1, Sentinel-2, and Landsat. The software prototype's algorithm is being developed to compute vegetation and water indices. It will use statistical and machine learning methods to detect index anomalies caused by pipeline leaks, with the results scheduled to be validated in upcoming field assessments. This research aims to reduce the delay time in pipeline network leak detection in remote, difficult-to-access locations, enabling utilities to be proactive in maintenance workflows. Prototype development can transform water management into remote infrastructure monitoring and reduce water losses. The software prototype algorithm will compute vegetation and water indices and apply statistical and machine learning methods, such as a Conventional Neural Network, to detect pipeline-induced anomalies. While field assessments are scheduled for upcoming validation, initial framework testing demonstrates the viability of cloud-based multi-sensor integration. This research aims to reduce delay times in pipeline network leak detection within remote and difficult-to-access locations, enabling utilities to adopt proactive maintenance workflows.

ENG-F-24

Performance Evaluation of Pavement's Seal Course Using Nanomaterial and Sasobit REDUX

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Chip seal and Cape seal are among the various surface treatments used in South Africa and across the globe as a cost-effective pavement maintenance strategy. A chip seal is constructed by spreading an asphalt binder onto the pavement surface, which is followed by the application of aggregate, then compacted to achieve the desired embedment. Cape seals are vital surface treatments providing smooth and convenient surfaces for road users. Cape seals are constructed by filling the voids in the chip seal with slurry or microsurfacing. Extended pavement's service life and water-proof surface are key benefits of these seals. However, an unmodified binder often underperformed, particularly during the winter, resulting in cracking and aggregate-binder adhesion failure in seals.

The aim of this investigation is to advance the construction and performance of chip and Cape seals during the winter period using Sasobit Redux (SR) and nano-modified bitumen emulsion (NME). SR is a synthetic wax, produced using the Fischer-Tropsch process, and it is widely used in warm mix asphalt. In this study, SR is used as an additive for the tack coat in the chip seal while the Cape seal is made with NME slurry mix. Preliminary results shows that SR reduces the binder grade at dosage exceeding 1.2% by mass of the binder while NME slurry seal provides an improved performance and hydrophobic impact on the slurry seal compared to conventional slurry mix. The expected outcomes promise enhanced performance of seals at low temperatures and ensure hydrophobic seals, thereby contributing to sustainable solutions to prevalent challenges in the pavement sector. Additionally, the insight from this study will contribute to the best practices and methodology in chip and Cape seal construction during the winter.

Keywords: Surface treatment, Cape seal, Sasobit Redux, hydrophobic, chip seal, nano-modified bitumen emulsion

ENG-F-25

AN AIoT SMART WATER METERING AMI COMPUTING FRAMEWORK

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Water utilities increasingly require advanced metering infrastructure (AMI) to support timely anomaly detection, efficient data management, and scalable analytics. Conventional cloud-centred smart-metering systems transmit large volumes of raw data to remote servers,

which can increase communication overhead, delay operational response, and underutilize computing resources available closer to the meters. This research proposes an Artificial Intelligence of Things (AIoT) computing framework for smart water-metering AMI that distributes sensing, processing, analytics, and model management tasks across heterogeneous edge, fog, and cloud resources.

The framework maps the Home Area Network, Neighbourhood Area Network, Wide Area Network, and Head-End System into a hierarchical edge-fog-cloud architecture. Eight interdependent tasks are formally characterized: data acquisition, data processing, edge anomaly detection, regional event correlation, hydraulic condition assessment, predictive fault analytics, consumption and billing analytics, and model training or retraining. Their precedence relationship is represented as a directed workflow, while task requirements and node capabilities are described using common resource dimensions, including computation, latency, deadline, energy, and data capacity. This enables each task to be allocated to a feasible node rather than assigning all processing to a predetermined layer.

The dependency-aware optimization model is developed to determine task placement and computational offloading across available nodes. Binary allocation and dependency-mapping variables represent the selected processing locations and communication paths. The objective balances task-resource compatibility, end-to-end latency, processing cost, transmission costs, and energy consumption, subject to single-placement, resource capacity, deadline, energy budget, and data-handling constraints. Node availability is accounted for via an offloading factor, allowing the allocation to adapt when edge or fog resources are constrained or unavailable.

The proposed framework will be evaluated through prototype-based testing and realistic simulation against cloud-only and edge-only processing strategies. Performance will be assessed using latency, communication volume, energy and resource utilization, task-deadline compliance, and anomaly-response measures. The study is expected to provide a structured and scalable method for coordinating distributed intelligence in smart water-metering systems, supporting faster leak, burst, tamper, and hydraulic-event responses while reducing unnecessary upstream communication. Its principal contribution is a unified computing and task-allocation model that links AMI operational workflows to the heterogeneous resources of edge-fog-cloud infrastructure without requiring the redesign of existing sensing technologies, communication protocols, or machine-learning algorithms.

ENG-F-26

Fry Drying of Faecal Sludge for Briquette Production

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In South Africa, current sludge treatment methods such as landfilling and incineration are inefficient, expensive, and pose significant environmental and public health concerns. This research investigates fry-drying as a rapid thermal treatment method for sludge valorisation and biofuel production. By using waste oil as the heating medium, fry-drying enables rapid

moisture removal, complete pathogen inactivation, and a significant increase in calorific value transforming waste sludge into energy-dense briquettes. Unlike conventional drying methods, fry-drying achieves these outcomes within minutes, integrating sludge treatment and biofuel production while reducing dependence on fossil fuels. Faecal sludge samples were collected from Edendale, Msunduzi Municipality, KwaZulu-Natal. Samples were pre-treated and weighed for the fry-drying process. The methodology includes characterization and optimization of the fry-drying process, incorporating kinetic analysis. Experiments were conducted at 150°C, 170°C, and 180°C with an average sample size of 80–84g results revealed an immediate decrease in moisture content from approximately 80% to below 1% within 5 minutes across all three temperatures, corresponding to a significant increase in calorific value reaching 20.00-25 MJ/kg a 46.89% increase from the dried sludge. Water activity dropped from 1 to an average of 0.71–0.74, indicating complete removal of free water, leaving only bound water. At this water activity level, microbial and pathogen growth is unlikely. These results are attributed to hydrophobic interactions between waste oil and water within the sludge, where elevated temperatures promote rapid steam generation and evaporation, with the resulting pressure gradient facilitating oil absorption. The applied temperatures were sufficient for complete pathogen inactivation, demonstrating the method's suitability for treating high-moisture sludge in significantly shorter timeframes than conventional approaches. In this context, fry-drying emerges as a promising thermal treatment option, capable of producing energy-rich solid fuels while addressing key challenges in sludge disposal and environmental impact

ENG-F-27

Evaluation of Accelerated Ageing and Pollution Performance of High Voltage Polymeric Insulators

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Outdoor high-voltage insulators are crucial components of electrical power systems that ensure reliable operation of the transmission and distribution networks. They serve two primary functions: providing mechanical support and electrically isolating conductors from supporting structures [1]. While in-service, polymeric insulators are constantly exposed to pollution, moisture and electrical stress that can reduce surface hydrophobicity, increase leakage current and initiate dry-band arcing, tracking, erosion and flashover [1].

South Africa has historically relied on natural ageing and pollution testing at Koeberg Insulator Test Station (KIPTS). However, KIPTS is currently not operational, and its future reinstatement remains unclear [2]. This has created a need for a representative and repeatable artificial ageing and pollution testing of insulators.

In this study, the artificial pollution test methods outlined in CIGRE TB 555 and the tracking-wheel test specified in IEC/TR 62730 is being investigated. The CIGRE TB 555 modified solid-layer method is used to assess the pollution flashover and withstand voltage under controlled contamination and wetting conditions [3]. The tracking-wheel test exposes the polymeric insulators to repeated cycles of dipping in a saline solution, drip-off, electrical energisation,

and cooling to evaluate their resistance to tracking and erosion under accelerated ageing conditions [4]. This study will therefore assess whether the CIGRE TB 555 pollution-testing method and the IEC/TR 62730 tracking-wheel test provide a suitable artificial test for evaluating the pollution and ageing performance of high-voltage polymeric insulators.

References

- [1] T. Nazir, A. Khalid, S. Akram, P. Mishra, I. Kabir, G. Yeoh, and T. Phung, "Electrical tracking, erosion and flammability resistance of high voltage outdoor composite insulation: Research, innovation and future outlook," *Materials Science and Engineering R Reports*, vol. 156, p. 100757, 10 2023
- [2] Eskom, "Interim Insulation Pollution Performance and Aging Requirements in Place of KIPTS," Eskom, Tech. Rep. 240-170000774, Oct.2022, Controlled Disclosure. Approved 24 October 2022;
- [3] CIGRE Working Group C4.303, Artificial Pollution Test for Polymer Insulators: Results of Round Robin Test, Technical Brochure 555, 2013.
- [4] IEC/TR 62730:2012, HV polymeric insulators for indoor and outdoor use - Tracking and erosion testing by wheel test and 5 000 h test.

ENG-F-28

ENHANCING REACTIVE ABSORPTION OF LIQUID ORGANIC HYDROGEN CARRIERS USING ADDITIVES FOR IMPROVED HYDROGEN STORAGE

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Hydrogen is widely recognized as a promising clean energy carrier capable of supporting the transition towards low-carbon energy systems [1]. However, its large-scale storage and transportation remain significant challenges due to its low volumetric energy density and the tightly controlled conditions required for conventional storage methods[2]. Liquid Organic Hydrogen Carriers (LOHCs) provide a safe and efficient alternative by enabling the reversible storage of hydrogen under relatively mild operating conditions using existing liquid fuel infrastructure[3]. Despite these advantages, the hydrogenation performance of many LOHC systems is often limited by slow reaction kinetics and mass transfer constraints, while the long-term stability of hydrogenated LOHCs remains insufficiently understood[2].

This study investigates the use of additives to enhance the reactive absorption behavior of representative heterocyclic LOHC compounds. The research aims to evaluate how additives influence hydrogen uptake under controlled temperature and pressure conditions, identify additive and LOHC combinations that improve reactive absorption and assess the stability of the resulting hydrogenated LOHCs. Experimental measurements will be conducted using a high-pressure equilibrium cell to determine hydrogen absorption behavior over a range of operating conditions. The hydrogenated products will subsequently undergo three stability test which are; storage stability, hydrogenation – dehydrogenation cycling stability, and

thermal stability tests to determine their ability to retain hydrogen storage performance under practical operating conditions.

The outcomes of this study are expected to provide insight into the role of additives in enhancing reactive absorption while establishing the stability and durability of hydrogenated LOHC systems. This work will contribute to the development of more efficient, robust, and practically deployable LOHC technologies for sustainable hydrogen storage and transportation.

ENG-F-29

PRODUCTION OF SUGARCANE BAGASSE PARTICLE BOARDS WITH A LIGNIN BINDER.

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The sugarcane bagasse (SCB) produced in South Africa's sugar industry provides an opportunity for its valorisation, pivoting away from energy generation towards chemicals and materials. Studies show that particle boards can be made from SCB within industrial standards. However, the use of synthetic resin binders such as urea formaldehyde (UF) and phenol formaldehyde (PF) continue to pose environmental threats through emission of volatile organic compounds (VOC), health complications with prolonged exposure [1] as well as difficulty in waste handling. This study aims to substitute resin binders with a renewable binder (lignin), extracted from steam exploded SCB by solvent extraction for the production of particle boards. Bench line results for which this work can be compared have already been produced in the SARChI Research Chair for Sugarcane Biorefining [2], the research gap is in optimizing SCB pretreatment to break the lignocellulosic structure, enhance bonding strength and increase water absorption. A systematic investigation will be conducted, exploring bagasse pretreatment with different organic acids, the effect of temperature and time. Compositional analysis of the resulting biomass will be conducted and correlated to the properties of particle boards produced with a lignin binder. Physical and mechanical tests will be investigated on the produced particle boards to check for compliance with industrial standards [3]. These will include thickness swelling, water absorption, density, modulus of elasticity, modulus of rupture and tensile strength. A future large-scale process based on sugarcane-derived biomass and binder promises short and long-term socio-economic benefits for the South African industry, hence contributing to South Africa's sustainable development initiatives for renewable resources and waste management.

References

1. Derrick, M., *A review of particleboard development and performance using non-toxic and biodegradable adhesives*. International Journal of Engineering Trends and Technology, 2024: p. 1–2.
2. Govender, K., *The production of resin -free particleboards from sugarcane bagasse*, in *Master of Science in Engineering, Chemical Engineering*. 2024, University of KwaZulu-Natal, Howard College' Durban: College of Agriculture, Engineering and Science.

3. Standards, SABS-SANS 6011, *Cutting and marking of test specimens of particle boards*. 2009, South African Bureau of Standards: Pretoria, South Africa.

ENG-F-30

Development of an Integrated Protocol for Sustainable Ultrapure Water Production from Non-Potable Water Sources for Green Hydrogen Production in KwaZulu-Natal

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Green hydrogen (GH) is widely recognised as a key technology for decarbonising energy systems and supporting the global transition to renewable energy. However, the sustainable production of GH requires a reliable supply of ultrapure water (UPW), presenting a major challenge in water-scarce countries such as South Africa. KwaZulu-Natal (KZN), identified as a strategic region within the eThekweni Regional Hydrogen Strategy, possesses abundant non-potable water resources, including treated municipal wastewater and seawater, which offer significant potential for sustainable GH production. Despite the maturity of desalination and water purification technologies, limited research has investigated the suitability of these water sources for producing electrolysis-grade UPW under local conditions.

This research aims to develop an integrated protocol for water source selection, treatment, and waste management for GH production in the KZN Green Hydrogen Corridor. The study will evaluate the effects of seawater, treated municipal wastewater, and blended water (seawater and wastewater) on pre-treatment requirements, reverse osmosis (RO) performance, and the conductivity, microorganism content and total dissolved solids (TDS) of the resulting UPW. Particular emphasis will be placed on optimising pre-treatment processes to minimise membrane fouling, concentration polarisation, scaling, and energy consumption while maximising water recovery.

The proposed treatment train consists of pre-treatment, reverse osmosis, ultraviolet oxidation, ion-exchange polishing, ultrafiltration and degasification to achieve electrolysis-grade water. Sustainable waste management will be investigated through zero liquid discharge (ZLD) strategies to minimise environmental impacts while recovering water and valuable salts from desalination brine. Experimental work will incorporate systematic sampling of selected water sources throughout seasonal variations, supported by statistical quality control and Design of Experiments (DOE) using Response Surface Methodology (RSM) to optimise process performance.

The study is expected to produce a scientifically validated and locally applicable protocol for sustainable UPW production from non-potable water sources for green hydrogen generation. The outcomes will support the implementation of the KZN Green Hydrogen Strategy by reducing reliance on potable water, improving treatment efficiency, reducing environmental impacts, and contributing to the development of an integrated, circular green hydrogen economy in South Africa.

ENG-F-31

Evaluating the Cracking Resistance and Environmental Impact of Glass Waste- and Glass Fiber-Incorporated Asphalt Mixtures.

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The accumulation of glass waste poses significant environmental challenges while the road sector seeks sustainable alternatives to conventional pavement materials. This study investigates the incorporation of glass waste and glass fiber into asphalt mixtures to improve cracking resistance while promoting circular economy principles. The research aims to experimentally evaluate the fracture performance of glass waste- and glass fiber-incorporated asphalt mixtures using the Semi-Circular Bending (SCB) test and to assess the associated environmental and economic implications through cradle-to-gate Life Cycle Assessment (LCA) and cost analysis. Asphalt mixtures with varying proportions of glass waste at a range (5, 1, 15, and 20%) of total weight of mix as a replacement for mixture aggregates and proportions of glass fiber at a range (0.1, 0.2, 0.3, and 0.4%) of total weight of mix as a filler replacement, and locally sourced virgin aggregate materials will be prepared using the Superpave Gyratory Compactor (SGC) volumetric mix methodology in accordance with the AASHTO M323 and evaluated for fracture energy, fracture toughness, and flexibility index. The environmental assessment will compare conventional asphalt production with glass waste and glass fiber-incorporated asphalt mixtures, while the economic analysis will examine potential cost savings associated with reduced raw material consumption and waste diversion. It is anticipated that the incorporation of glass waste and glass fiber will enhance the cracking resistance while reducing the environmental impacts and supporting sustainable pavement construction. The findings are expected to contribute to the development of more durable and environmentally responsible asphalt pavement technologies.

ENG-F-32

BIAS AWARE SENTIMENT ANALYSIS OF GENDERED LANGUAGE FOR FAIR NATURAL LANGUAGE PROCESSING SYSTEMS

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As Artificial Intelligence (AI) systems increasingly influence real-world decision-making, ensuring that Responsible AI (RAI) principles such as fairness, transparency, and accountability are upheld has become a critical priority. In Natural Language Processing (NLP), sentiment analysis models are widely deployed across domains such as customer feedback, healthcare, finance, social media monitoring, law enforcement, and public

policy. However, these models frequently inherit and amplify systemic gender biases present in training corpora, producing disparate sentiment predictions for text that is semantically identical but differs only in gendered language.

This study systematically investigates the extent of gender bias in baseline sentiment analysis systems by identifying the linguistic and model-level factors that contribute to biased outcomes. To address these disparities while preserving predictive performance, the study develops and evaluates a bias-aware sentiment analysis framework incorporating targeted bias mitigation techniques. Model performance is assessed using both conventional predictive performance metrics and gender-specific fairness metrics to evaluate the effectiveness of the proposed approaches.

The findings contribute to the development of equitable, robust, and trustworthy sentiment analysis systems that align with the principles of RAI and support their deployment in high-impact real-world applications.

