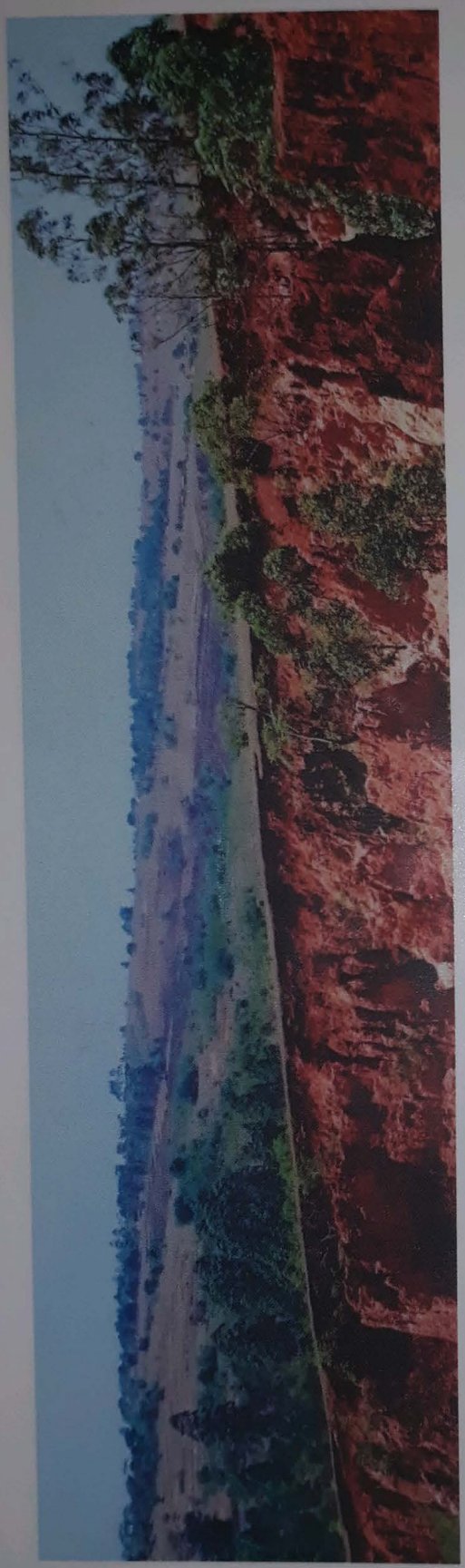


Southern African Geomorphology:

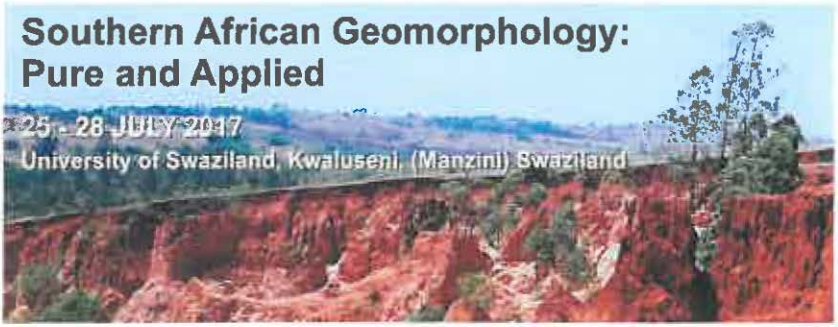
Pure and Applied

25 - 28 July 2017

University of Swaziland,
Kwaluseni, Swaziland

UNIVERSITY OF SWAZILAND

Handbook & Presentation Abstracts



25 July 2017

Welcome all delegates to the SAAG conference: *Southern African Geomorphology: Pure and Applied*, hosted this year by the University of Swaziland.

We are particularly pleased to announce that the conference is being held in conjunction with the Erosion Focus Group of LaRSSA (the Land Rehabilitation Society of Southern Africa), and The Vetiver Network International (TVNI). Both of these organisations bring valuable practical aspects to the solution of landscape and landform problems, in line with the theme of the SAAG conference of *Southern African Geomorphology: Pure and Applied*.

The first conference took place in 1988 in Mthatha, South Africa, and the Association was formally constituted in 1991, with conferences taking place regularly every two years. The organising committee has made some "changes" this year to put SAAG on the (more applied and corporate) "map", and one of the changes was to contract a professional event organiser, Kruger & Associates, who has planned and managed successful conferences since 1982.

This year, the SAAG conference organisers received contributions from a vast array of stakeholders, including government officials and decision-makers, professional practitioners from several sectors in southern Africa and further abroad, as well as astute academics and students from several universities. SAAG has also applied for CPD accreditation. Another new and beneficial addition is to have a fully functional (and maintained) website that makes life much easier for all.

What we are trying to achieve with this conference is to offer stakeholders in Geomorphology (landform process studies) and land rehabilitation the opportunity to share success stories but also failures in southern Africa (and further afield). This conference also allows geomorphological purists to share their cutting-edge research methodologies and results, on which applied geomorphology can, and does, often build. Sharing experiences in this regard will enable government, practitioners, academics and the wider industry to verify current best practice and identify needs for future research. The conference will focus on academic papers on the one hand, while ensuring that sound scientific, practical solutions are presented for the benefit of all stakeholders present.

This conference depends largely on sponsorship, and I would like to thank all those organisations which donated funds to make it possible for this first annual conference to introduce the activities and growing importance of SAAG.

On behalf of the organising committee, it gives me great pleasure to welcome you to the SAAG conference: *Southern African Geomorphology: Pure and Applied.*

Jay le Roux
President: Southern African Association of Geomorphologists (SAAG)

Something about our keynote speaker.....

Kate Rowntree is an Emeritus Professor in the Department of Geography at Rhodes University, where she has worked since 1986. From leave replacement posts in 1986 and 1987, she worked her way up to full Professor in 2004. Previously, Kate had spent six years in Kenya, lecturing at Kenyatta University, two years at Sunderland Polytechnic in England, and one year at The Queen's University of Belfast. She completed her PhD in sediment modelling through the Department of Civil Engineering at Strathclyde University; her undergraduate and Masters degrees were obtained from the University of Bristol. Physical geography research at Bristol University had a strong emphasis on field data collection, a tradition which she continues to encourage among her own students.

From her research in Kenya, Kate produced a number of papers on soil erosion and rainfall erosivity, but after coming to South Africa she established herself more strongly in the field of fluvial geomorphology. Since the early '90s she and her postgraduate students have been active in promoting geomorphology as a key component of river and catchment management. The WRC in particular has been generous in their support of this research. Collaboration with river ecologists has reinforced the importance of recognizing the response of ecological processes to geomorphological drivers. The negative ecological effects of fine sediment inputs are now widely recognized and Kate's research is contributing to our understanding of the links between sediment processes at the catchment and instream scales. In 2009 the NRF funded a sediment tracing laboratory that has supported this research.

Research is never an individual endeavour and Kate would like to acknowledge her PhD students who have contributed to the advancement of fluvial geomorphology in South Africa. She and Dr Bennie van der Waal continue to work closely together on a catchment rehabilitation project in the Tsitsa, funded by the DEA, advising on rehabilitation plans and supervising research by Masters students.

.....and something about our post-conference course facilitators

Heinz Beckedahl is an Associate Professor of Physical Geography in the Department of Geography Environmental Science and Planning at the University of Swaziland, after retiring from the University of KwaZulu-Natal, where he served for more than 26 years, and where he is still and honorary research associate. His research interest lies in Applied Geomorphology and in geomorphic processes, with a special interest in rehabilitation and the prevention and management of land degradation. Prof Beckedahl is an established researcher with more than 65 publications to his name, including 3 books. He has supervised in excess of 45 Masters and more than 15 PhD students to completion, four of whom were registered at highly respected universities in Germany. He has served (and continues to serve) on several national and international committees relevant to his field of interest.

Roley Nöffke is a director of Hydromulch, South Africa, and a director of The Vetiver Network International with responsibility for South Africa. He is also a Vice President of the International Erosion Control Association with global responsibilities. Roley has a construction company that works in many parts of Africa, in the course of which he introduces vetiver. He has sponsored a number of vetiver workshops, and is currently putting together an important collection of vetiver ecotypes from around the world.

Paul Truong, a director of TVNI (The Vetiver Network International) for Asia and Oceania, has been involved in soil conservation research and extension, including the rehabilitation and reclamation of degraded and salt affected lands in the last 40 years. For the last 30 years he has concentrated on the research, development and application of the Vetiver System (VS) for soil erosion control in general and rehabilitation of degraded lands in Australia in different climates. He has conducted numerous vetiver research projects throughout Queensland, and has used vetiver grass as the main species in several projects. His pioneering work on the hydraulics of vetiver hedges in overland flow provided for the first time a basic understanding on hedge hydraulics needed for the application of the vetiver hedge system in erosion and sediment control on the flood plains of Queensland. His particular interest in environmental protection has led him to his pioneering R&D on the capacity and applicability of VS to treat and to safely dispose polluted wastewater such as sewage effluent, landfill leachate and industrial wastewater. Paul Truong has received three major World Bank Research Awards, one in 1991 for his pioneering research on the salt tolerance of vetiver grass and one in 1993 for its tolerance to low soil pH and aluminium and manganese toxicities. In January 2000 he was awarded the King of Thailand Vetiver Award for his research on the application of VS in environmental protection.

INDEX

2017 SAAG CONFERENCE COMMITTEE

Prof Heinz Beckedahl, UNISWA (Chair)
Dr Jay Le Roux, University of the Free State
Mr Roley Nöffke , Hydromulch
Dr Sizwe Mabaso, UNISWA
Dr Wisdom Dlamini, UNISWA
Mr Ian van Zuydam, UNISWA
Mr Mthobisi Masilela, UNISWA
Prof Paul Sumner University of Pretoria
Ms Glaudin Kruger, Kruger and Associates

CONFERENCE PLANNER Glaudin Kruger Kruger and Associates PO Box 599 Onrusrivier 7201	Tel: 028 316 2905 *or* Mobile 072 320 7015 Fax: 086 606 9983 E-mail: kruger@krugerassociate.com

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ACKNOWLEDGEMENT

The organisers of **SAAG 2017** would like to express their sincere thanks to the authors who have written and will present their papers and posters, and to the organisations which have supported or funded their attendance at the conference.

We owe our sponsors a very special word of thanks for their generous support of the conference.

SOCIAL FUNCTIONS AT SAAG 2017

Tuesday 25 July 2017

Meet and Greet at the New Dining Hall, sponsored by the University of Swaziland - 18:00

Wednesday 26 July 2017

Conference Dinner at Esibayeni Lodge 19:00 – 24:00
Wine will be served at the table - delegates can purchase additional drinks from the bar.

SPONSORS

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Social Enterprise Council of South Africa

University of the Free State

Swaziland National Trust Commission (SNTC)

University of Swaziland

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www.endemicvision.co.za

EndemicVision Environmental Services provides environmental and biodiversity management support and specialist consulting to both developer companies and consulting firms in Southern Africa. Our vision is to improve the reach and quality of environmental and biodiversity management in the arid areas of Southern Africa. With diverse profiles in engineering, ecology and environmental management, we present strong supporting skills and experience in project management, quality control, biophysical closure planning and management, risk management, auditing and natural resource management. We understand the required regulatory tools for developments and the pro-active conservation tools to enhance projects.

Mrs Lauren Sweidan
Esri South Africa, PO Box 652, Halfway House, Midrand 1685, South Africa
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Esri South Africa is the sole distributor for the Esri ArcGIS product range in Southern Africa and is committed to making a difference in the corporate world and wider community. Our extensive range of spatial solutions enables us to service users ranging from the government sector to private organisations.

ArcGIS brings together maps, apps, data, and people to make smarter decisions and enable innovation in your organization or community.

Understanding the interdependency of the earth's ecosystems and human impact on the environment requires a great deal of information and analytical capacity. Doing something about it requires insight and collaboration. Esri ArcGIS technology allows you to do both. Esri supports all industries whose work touches environmental management. Government agencies, private businesses, and environmental organizations use Esri ArcGIS to turn science into action that meets the Earth's major challenges.

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hydromulch
Planting the Seed of Environmental Success

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Hydromulch offers a comprehensive range of integrated, turn-key solutions to address almost any environmental rehabilitation, re-vegetation and landscape bio-engineering project. Services include vegetation establishment & maintenance, erosion control, soil sampling & analysis, Vetiver grass, industrial waste services and suppliers of Finn hydroseeding and GyroTrac bush clearing equipment.

The Vetiver Network International
Proven & green environmental solutions

The Vetiver Network International, www.vetiver.org
Patron: Her Royal Highness Princess Maha Chakri Sirindhorn of Thailand

The Vetiver Network International (TVNI) promotes the worldwide use of the Vetiver System (VS) for a sustainable environment particularly in relation to land and water. The Network is a true interaction of individuals, groups, communities, entrepreneurs, and social organizations working together. The "networking" interaction is all voluntary - no managers and no remuneration!

IECA

Vision and Mission of IECA, www.ieca.org

The International Erosion Control Association (IECA) is a non-profit organization devoted to serving as the premier global resource for the prevention, control and mitigation of erosion and sediment related problems and associated pollution or degradation of land and water. IECA is one of the world's oldest and largest professional associations, devoted to the science and technical solutions to erosion and sediment control problems. To sustain its mission, IECA's primary focus is to provide education and professional development opportunities on the latest science, technologies, and practical solutions to address erosion and sediment control issues, storm water management and water quality.

Region One consists of North America, South America and Europe. All other countries fall under Region Two. Southern Africa is closely aligned with Australasia.

MACCAFERRI
AFRICA

Ms Michelle Neermal
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For nearly 40 years Maccaferri has provided innovative solutions to the construction, geotechnical and mining industries. Renowned as the world leader in gabion retaining structures, it has diversified significantly over the past 20 years and now offers engineered solutions, including reinforced solid structures, coastal protection, soil stabilisation, landfills, natural hazard mitigation and river control works.

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MTN Swaziland is a partnership between MTN and Swaziland Post and Telecommunications Corporation (SPTC) and has been operating commercially since July 1998. The company also sponsors the Entrepreneur of the Year Award and the King Cup Golf event, and now supports the biennial conference of the Southern African Association of Geomorphologists, being held at the University of Swaziland from the 25th to the 28th July, 2017. MTN Swaziland makes regular donations to social welfare.

We have responded to the challenge of universal connectivity by pursuing a strategy of broad geographic and population coverage through enhanced network infrastructure, catering for our low-income market segments through the introduction of low-denomination recharge vouchers and per-second billing in some markets, thereby further reducing economic barriers to communication access. We are creating a customer-centric culture within our organisation by training, developing, growing and rewarding our employees.

Beneath our economic headlines lie the social and development impact that will help us sustain longterm value for all our stakeholders. We are constantly learning where we can make the most pertinent impact. Overall, we are encouraged that we have met most of our sustainability objectives. We are creating a strong platform from which to monitor and measure our impact going forward and aim to create an integrated and interlinking stakeholder value as we progress.

Ms Mary Gillett-de Klerk
National Coordinator of SECOSA (Social Enterprise Council of South Africa);
Coordinating Secretary of ASEN (African Social Entrepreneurs Network)
291 Long Avenue, Randburg 2194, Johannesburg, Gauteng
Tel: +27 82 395 1268 Email: marylyn22@gmail.com Website: www.secosa.org.za

The "Canyons" of UNESCO Kruger 2 Canyons Biosphere Reserve. A Critical Watershed of extreme hydrological and geological value. A collective vision, supported by Lulumisa, Motapo Wa Africa and Rotary. Driven by the communities representing the formal protected areas, to the conjoining communal wilderness spaces', that entwines them all. A mission to forge Innovative partnerships and collective brilliance between sectors, committed to unlocking a regions vast natural assets, while building for the promotion of social justice and protection of vulnerable landscapes. The unleashing of potential towards a rapidly advancing green and just economy, with improved adaptive capacity and resilience to the many challenges associated to poverty and climate change. In collaboration, challenges become opportunity and new spaces are engaged with connectivity.

Mr Thulani Methula
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The **Swaziland National Trust Commission (SNTC)** is the parastatal organisation responsible for the conservation of nature and the cultural heritage of the Kingdom of Swaziland as mandated, by the SNTC Act of 1972 which was amended in 1973.

It is important for the country to provide a platform or mechanisms that will promote nature conservation and sustainable utilisation of resources. To achieve this, among other things, the government of Swaziland through the Swaziland National Trust Commission has put together role players or stakeholders to drive a project on biodiversity conservation known as: **"Strengthening the National Protected Areas Systems of Swaziland" (SNPAS)**. The aim of the project is effectively to expand, manage and develop Swaziland's protected area network through the landscape approach. This approach promotes a conservation framework that allows for the management of a mosaic of land use activities including protection, restoration, production, and subsistence use in order to deliver ecological, economic and social benefits. It involves working both within and beyond the boundaries of protected areas. The SNPAS Project facilitated for the development of national land cover and vegetation type maps for four-time steps 1990, 2000, 2010 and 2015. These datasets were used to inform the recently completed biodiversity assessments.

Dr Jay le Roux
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Tel: +27 401 3570, Email: lerouxj@ufs.ac.za, Website: https://www.ufs.ac.za/

Vision - A university recognised across the world for excellence in academic achievement and in human reconciliation.
Mission - The university will pursue this vision through its mission:

- Setting the highest standards for undergraduate and postgraduate education.
- Recruiting the best and most diverse students and professors into the university.
- Advancing excellence in the scholarship of research, teaching, and public service.
- Demonstrating in everyday practice the value of human togetherness and solidarity across social and historical divides.
- Advancing social justice by creating multiple opportunities for disadvantaged students to access the university.
- Promoting innovation, distinctiveness and leadership in both academic and human pursuits.
- Establishing transparent opportunities for lifelong learning for academic and support staff.

Values - The following five core values represent deeply-held commitments that inform every policy and steer every action. These values underpin both the Academic Project and the Human Project of this university.

- Superior Scholarship
- Human Embrace
- Institutional Distinctiveness
- Emergent Leadership
- Public Service

UNIVERSITY OF
SWAZILAND

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MISSION

To be responsive to national and international needs through excellence in teaching and learning, research and innovation, entrepreneurship, and community engagement for sustainable development.

CORE VALUES

- Autonomy
- Integrity
- Professionalism
- Transparency
- Accountability
- Innovation
- Quality
- Relevance
- Differentiation
- Diversity

SAAG 2017 CONFERENCE PROGRAMME

TUESDAY, 25 JULY 2017

18:00 -	**Meet and Greet cocktails** in the New Wing dining hall, and preconference registration. **Welcome** by the Vice Chancellor, *Prof CM Magagula;* the Dean of the Faculty of Science and Engineering, *Prof JM Thwala*, and the Head of the Department of Geography, Environmental Science and Planning, *Dr M Mlipha*.

CONFERENCE DAY ONE - WEDNESDAY, 26 JULY 2017

07:00 - 08:45	**Registration and coffee/tea IDE Lecture Theatre**
Venue	**Opening Session - IDE Lecture Theatre**
08:45 – 08:55	**Welcome:** *Prof Heinz Beckedahl, SAAG conference chair, University of Swaziland*
08:55 – 09:15	**Opening**: Ministry of Tourism and Environmental Affairs, Swaziland
09:15 – 10:00	**Keynote address**: Geomorphology and ecosystem protection: putting geomorphology into environmental flow assessment - *Prof Kate Rowntree, Rhodes University, South Africa*
10:00 – 10:30	**Morning coffee/tea**
Venue	**IDE Lecture Theatre**
10:30 – 12:00	• Biennial General Meeting of SAAG • Discussion: The Erosion Focus Group
12:00 – 12:30	**Session 1: Poster Session**
	Understanding the relationships between land cover dynamics and soil erosion in former homeland of Limpopo, South Africa: A remote sensing perspective – *Dr Timothy Dube and Messrs Sibanda Mbulisi, Khoboso Seutloali and Cletah Shoko, University of Limpopo, South Africa* Wetland Geomorphology: Erosion processes shaping the Magnolia Dell Park - *Ms Renee Grundling, Mr Arnold Kotze, Ms Petra Gort, Mr Hippocrates Bogiages and Mr Michael Loubser, University of Pretoria, South Africa* Soil erosion prevention is better than cure in South Africa's only large river network without a dam – *Dr Jay le Roux, University of the Free State, South Africa* Geomorphology of the granite caves of Gobholo, Swaziland - *Mr Mthobisi Masilela and Prof Heinz Beckedahl, University of Swaziland, and Prof Paul Sumner, University of Pretoria, South Africa* Gully erosion rates in the Tsitsa River Catchment, Eastern Cape Province – *Mr Lefa Morake, University of the Free State, South Africa*

	Aeolian processes and sediment flux on sub-Antarctic Marion Island - *Mr Abuyiselwe Nguna and Prof Werner Nel, University of Fort Hare, and Dr David Hedding, UNISA, South Africa* The effect of beneficial microbes on plant and soil health - *Ms Dine Pretorius, University of the Free State, South Africa* Assessing the influence of valley setting and specific stream power on river form and processes in mountainous, semi-arid catchments, Eastern Cape, South Africa – *Ms Siviwe Sekese, University of the Western Cape, South Africa* Gully development and land use change in the Tsitsa River Catchment, Eastern Cape Province - *Ms Lebogang Senokoane and Dr Jay le Roux, University of the Free State, South Africa* Mapping and monitoring the spatio-temporal variations of land degradation using multispectral remote sensing data. A case study of Sekhukhune District – *Mr Terrence Sepuru and Dr Timothy Dube, University of Limpopo, South Africa* The effect of rainfall events on gullies in the Tsitsa River Catchment – *Mr Johannes Theunissen, University of the Free State, South Africa*	
12:30 – 14:00	**Lunch – New wing dining hall**	
Venue	**IDE Lecture Theatre**	**IDE Seminar Room**
Session	**Session 2: Swazi geomorphology**	**Session 3: Geomorphological techno-junkies**
14:00 – 14:20	An overview of the environmental geology and geomorphology of Swaziland – *Prof Heinz Beckedahl and Prof Thomas Schlüter, University of Swaziland*	Implementation of 10-Be and 26-Al AMS at iThemba LABS and first measurements for an erosion study – *Dr Stephan Winkler and Messrs Vela Mbele and Simon Mullins, iThembaLabs, and Messrs Tebogo Makhubela, Jan Kramers, Sibusiso Konyana and Rivoningo Khosa, University of Johannesburg, South Africa*
14:20 – 14:40	Landsat-derived land cover maps and change analysis for Swaziland - *Dr Sizwe Mabaso and Prof Heinz Beckedahl, University of Swaziland, and Mr Thulani Methula, UNDP, Swaziland*	Cosmogenic nuclide surface exposure dating: pitfalls and challenges for isolated fieldwork - *Ms Elizabeth Rudolph, University of the Free State, Dr David Hedding, UNISA, and Prof Werner Nel, University of Fort Hare, South Africa*
14:40 – 15:00	Geomorphological heterogeneity and biodiversity in Swaziland – *Dr Wisdom Dlamini, University of Swaziland*	A bibliometric study of the role of artificial intelligence in geomorphology – *Mr Barend van der Merwe, University of Pretoria, South Africa*
15:00 – 15:20	Geoheritage and geoconservation as a tourism potential in Swaziland - *Prof Thomas Schlüter, University of Swaziland and Prof Andreas Schumann, Makerer University, Uganda*	Unmanned aerial vehicles (UAVs): applications for geomorphological research and use in South Africa – *Prof David Hedding, University of South Africa*
15:20 – 15:40	Swaziland landscape-based management planning assessment – *Messrs Gcina Dlamini and Thulani Methula, UNDP, Swaziland and Dr Sizwe Mabaso, University of Swaziland*	A review of equipment and operator protocols for rock temperature studies – *Mr Michael Loubser, University of Pretoria, South Africa*
15:40 – 16:00	**Afternoon coffee/tea**	

Venue	IDE Lecture Theatre	IDE Seminar Room
Session	**Session 4: Geomorphological "greenies" (bio-geomorphology) using plants to achieve geomorphic (landscape) objectives**	**Session 5: Geomorphological "secret" agents (behind soil movement)**
16:00 – 16:20	Slopes stability improvement with Vetiver System technology - *Dr Paul Truong, The Vetiver Network International; Mr Aloisio Pereira and Ms Paula Leao Pereira, Deflor Bioengenharia, and Mr Daniel Londono, Veticon Consulting, Australia*	An assessment of global rainfall erosivity – *Prof Werner Nel, University of Fort Hare, South Africa*
16:20 – 16:40	Vertical soil traps and Vetiver System for slope protection – *Mr Leonel Castro, Vetiver Inc, Guatemala*	Southern African dust sources – *Dr Frank Eckardt, University of Cape Town, South Africa and Jonathan E Murray, Imperial College London, United Kingdom*
16:40 – 17:00	Earthworks and selected plants used to restore marginal agricultural land - *Ms Alexandra Kruger, Permaculture Education Africa, South Africa*	Short-term and high-frequency diurnal frost observations for Vesleskarvet, Antarctica – *Ms Christel Hansen, Ms Nicola Wilmot and Dr Ian Meiklejohn, Rhodes University, South Africa*
19:00 – 24:00	**Networking and Dinner at Esibayeni Lodge**	

CONFERENCE DAY TWO - THURSDAY, 27 JULY 2017

Venue	IDE Lecture Theatre	IDE Seminar Room
Session	**Session 6: Geomorphology matters**	**Session 7: Fluvial geomorphology – crucial research on a crucially limited resource**
08:30 – 08:50	Assessing geomorphologic disturbances of a wetland ecosystem by wildlife and tourism activities. A case study of Dete Vlei in Hwange district, Zimbabwe – *Dr Thomas Marambanyika, Midlands State University, Zimbabwe*	Landuse change and sedimentation on water reservoir in Upper Runde sub-catchment, Zimbabwe – *Dr Winmore Kusena, Midlands State University, Zimbabwe*
08:50 – 09:10	The role of Working for Land in addressing the triple challenges of poverty, unemployment and skills development – *Ms Mahuma Ramashala, Department of the Environment, South Africa*	Geomorphological sensitivity examined in a recently degraded river: integrating connectivity and Panarchy to understand change – *Dr Rebecca Powell, Prof Kate Rowntree and Prof Fred Ellery, Rhodes University, South Africa*
09:10 – 09:30	Geomorphology applied: typing river ecosystems and mapping river condition, National Biodiversity Assessment (NBA) 2018 – *Dr Lindie Smith-Adao, Ms Chantel Petersen, Ms Heidi van Deventer, CSIR, and Ms Jeanne Nel, South Africa*	The efficiency, effectiveness and precision of a locally appropriate approach to suspended sediment monitoring in the Upper Tsitsa River Catchment – *Mrs Laura Bannatyne, Prof Kate Rowntree and Dr Benjamin van der Waal, Rhodes University, South Africa*
09:30 – 09:50	Perceptions on land degradation in South Africa: a national overview – *Mr Lehman Lindeque, UNDP; Prof Heinz Beckedahl, UNISWA, Swaziland; Dr Graham von Maltitz, CSIR and Mr Francois Koegelenberg, Mpumalanga DARD, South Africa*	The link between the physical river habitat template, aquatic ecology and water quality – *Ms Chantel Petersen, Dr Nebo Jovanovic, Dr PJ Oberholster, CSIR, and Dr Michael Grenfell, UWC, South Africa*

09:50 – 10:30	**Morning coffee/tea**
Venue	**IDE Lecture Theatre**
Session	**Session 8: Soil erosion and rehabilitation in theory and practice**
10:30 – 10:50	Application of Vetiver System technology for stream bank and coastal dike stabilisation in Vietnam - *Dr Paul Truong, The Vetiver Network International, Australia, and Messrs Van Tran and Man Tran, Vietnam Vetiver Network*
10:50 – 11:10	Rehabilitation of soil erosion in Southern Africa: The good, the bad and the ugly – *Prof Heinz Beckedahl, University of Swaziland*
11:10 – 11:30	Integrating sustainable land management into catchment management strategies – *Mr Albert van Zyl, Terrasim cc, and Dr James Cullis, Aurecon, South Africa*
11:30 – 11:50	Scale: A critical success factor in rehabilitation - the Langtou River case study – *Mr Charl de Villiers, Charl de Villiers Environmental Consulting, and Dr Liz Day, Freshwater Consulting Group, South Africa*
11:50 – 12:10	Manipulating the geomorphology of wetlands in minimising the impacts of erosion: a southern African wetland rehabilitation case study – *Dr Piet-Louis Grundling, Centre for Environmental Management, University of the Free State*
12:10 – 12:30	Principles for developing a catchment rehabilitation strategy: the case of the NLEIP in the Tsitsa catchment, South Africa - *Dr Benjamin van der Waal and Prof Kate Rowntree, Rhodes University, and Mr Japie Buckle, DEA, South Africa*
12:30 – 13:30	**Lunch**
Session	**Session 9: Geomorphological mapping and modelling: soil erosion and wetlands**
13:30 – 13:50	Comparing wetland probability maps for the Kruger National Park, South Africa – *Dr Althea Grundling, Agricultural Research Commission; Mr NB Collins, UFS; Mr HM van den Berg, IRIS International, and Dr P-L Grundling, DEA, South Africa*
13:50 – 14:10	Wetland probability map for Swaziland – *Mr Jason le Roux, University of Pretoria; Dr Anthea Grundling, ARC; Dr N Collins, CEM UFS, and Mr JDF Kotze, ARC, South Africa*
14:10 – 14:30	Integrating erosion modelling into mine rehabilitation design – *Mr Albert van Zyl, Terrasim cc, and Philip Barnard, Golder Associates Africa (Pty) Ltd, South Africa*
14:30 – 14:50	The application of the SWAT model to identify key sediment sources in the Inxu Catchment, South Africa – *Ms Namso Nyamela, Prof Kate Rowntree, Prof Benjamin van der Waal, Rhodes University and Dr JJ le Roux, University of the Free State, South Africa*
14:50 – 15:10	A review of soil erosion and its environmental and socio-economic impacts in Swaziland – *Mr Sikhumbuzo Maseko, Ministry of Agriculture - Land Use Planning and Development Department, Swaziland*
15:10 – 15:30	**Afternoon coffee/tea**
Session	**Session 10: Geomorphological teaching in southern African Universities**
15:30 – 17:00	*Presentations and discussion*
Optional trip to Gobholo caves; Evening free - Dinner for delegates' own account	

CONFERENCE DAY THREE - FRIDAY 28 JULY 2017

Practical course in the use of bio-engineering and Vetiver grass (*Chrysopogon zizanioides*) jointly organised by the Erosion Focus Group of the Land Rehabilitation Society of Southern Africa (LaRSSA) and the Vetiver Network International (TVNI)

Venue	IDE Seminar Room	
08:00 - 08:30	**Registration and coffee/tea**	Secretariat
Time	**Item**	**Facilitator**
08:00 - 08:15	**Opening, welcome and outline of the Workshop**	*Heinz Beckedahl*
08:15 - 09:00	**Slide show on the use of vetiver grass for phytoremediation applications**	*Paul Truong and Leonel Castro*
09:00 - 09:20	**Understanding erosion processes – the key to successful rehabilitation work**	*Heinz Beckedahl*
09:20 - 10:45	**Introduction and overview for soil erosion process based rehabilitation using bio-engineering practices and vetiver grass** • Shaping and trimming of donga and gully side slopes including practical use of A-Frame for setting out contour lines. • Placing and installation of bio-engineering systems (sand bags, rock berms, silt fences and bio-jute erosion control netting). • General overview and introduction to the use of Vetiver grass for soil erosion applications.	*Roley Nöffke*
10:45 – 11:00	**Mid-morning tea and coffee break**	

POSTCONFERENCE TOUR		
Depart: 11:00 **Return: 13:00**	Bus departs from Kwaluseni for field trips to: • The Elangeni erosion site • The Ezulwini sewerage works to view environmental work stabilising side slopes using vetiver grass planted some 13 years ago.	**Facilitators:** *Heinz Beckedahl, Paul Truong and Roley Nöffke*

Delegates depart

INDEX TO ORAL PRESENTATIONS

INDEX TO ORAL PRESENTATIONS

INDEX TO POSTERS PRESENTATIONS

THE EFFICIENCY, EFFECTIVENESS AND PRECISION OF A LOCALLY APPROPRIATE APPROACH TO SUSPENDED SEDIMENT MONITORING IN THE UPPER TSITSA RIVER CATCHMENT

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ABSTRACT

Directly-measured suspended sediment data were required to support the prioritisation of community-based land rehabilitation initiatives in rural communal areas in the highly degraded and gullied Tsitsa River catchment in the Eastern Cape Province of South Africa, and to determine the relative contributions of sub-catchments to suspended sediment yield at the site of the proposed Ntabelanga Dam. Existing modelled data were unverified and at odds with the results of studies based on dam sedimentation rates. In response, a catchment-wide suspended sediment sampling programme was developed whereby locally resident citizen technicians were engaged to collect suspended sediment samples at sub-daily timestep at eleven sites on the Tsitsa River and its tributaries. Within a framework of twice-daily "baseline" sampling, emphasis was placed on more intensive sampling of observed high flow events, which are known to transport the bulk of suspended sediment over any given time period. Low-tech, high-volume laboratory processes were developed to analyse the resulting several thousand samples for turbidity and suspended sediment concentration, with the aim of providing high resolution, sub-catchment scale suspended sediment flux and yield data using basic equipment and facilities. The efficiency, effectiveness, and precision of the resulting sampling and analysis method were assessed at four selected sampling sites through a series of flow events that occurred in the catchment between December 2015 and June 2016. The degree to which citizen technicians had sampled available flow and suspended sediment concentration peaks was used as an indicator of sampling efficiency and effectiveness. Precision was assessed in terms of the similarity of the turbidity and suspended sediment concentration data which resulted from the analysis of "triple" (or repeat) samples collected in rapid succession once per week by each citizen technician.

The results indicate that citizen technicians sampled a range of flood discharges despite gaps occurring at night and during thunderstorms when sampling was prohibited for safety reasons. Whilst personal problems negatively affected sampling frequency in some cases and led to some important floods being missed, the use of trained stand-ins for planned absences provided data continuity. One advantage of the citizen technician approach compared to the installation of sophisticated instruments was exemplified when the fixed acoustic suspended sediment concentration probe which was intended to provide benchmark data was destroyed by lightning shortly after installation. This led to a total loss of monitoring capacity for the remainder of the season, compared with the relatively short periods of data loss when citizen technicians did not sample according to their schedule.

Keywords: Tsitsa River; Citizen technician; Suspended sediment; Flood sampling; Open Data Kit; Catchment restoration management

Laura Bannatyne is a Masters candidate in the Geography Department at Rhodes University. Supervised by Prof Kate Rowntree and advised by Dr Bennie van de Waal, she has developed a flood-focused, citizen technician-based approach to direct suspended sediment sampling in the tributaries and main stem of the upper Tsitsa River, upstream of the proposed Ntabelanga Dam site.

REHABILITATION OF SOIL EROSION IN SOUTHERN AFRICA: THE GOOD, THE BAD AND THE UGLY

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ABSTRACT

This paper considers a range of case studies focussing on the rehabilitation of different forms (or types) of soil erosion in the region. This study shows that there appears to be no uniformity in the rehabilitation techniques applied, even with similar form of erosion. The work shows that, given the spectrum of rehabilitation techniques used, there is an almost equal spectrum ranging from success to outright failure to rehabilitate.

The lesson to be gained from this is that it is not sufficient to understand the causality of the particular form of erosion, but rather, the work highlights the need for a common approach of agreed upon Best Practice protocols. This philosophy is all the more important in light of the current debates in the region concerning Land Degradation Neutrality (LDN) – the argument driven by the UNCCD that countries should set respective values of LDN appropriate to their needs. Part of the philosophy of attaining the limits of neutrality agreed upon is to ensure that current and future land use practices do not increase the level of erosion and, where possible, already eroded sites should be rehabilitated. Underlying these arguments then, is the assumption that the rehabilitation and preventative techniques used are, in fact, successful.

Keywords: Soil erosion; rehabilitation; best practice protocols; Land degradation neutrality

Heinz Beckedahl is on the professorial staff of the Department of Geography, Environmental Science and Planning at the University of Swaziland, after retiring from UKZN in June 2016. His special interest is in geomorphic process studies, specifically in the prevention of land degradation and the rehabilitation of eroded land. To date he has more than 65 publications to his name.

AN OVERVIEW OF THE ENVIRONMENTAL GEOLOGY AND GEOMORPHOLOGY OF SWAZILAND

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ABSTRACT

Although Swaziland is one of the smallest African countries (covering an area of only some 17,36 km2), in geological terms it is one of the oldest and most diverse, which in turn has a direct bearing on its complex geomorphology. The geological formations in the west, north and central parts of the country are largely dominated by rocks of Archean age (ranging from some 3,6 to 2,5 Ga), and to a lesser extent of Proterozoic age (2,5 – 0,45 Ga), whereas in the east these rock types are overlain and replaced by sediments and volcanics of the Karoo Supergroup (about 300 – 160 Ma), with more recent valley infills of Quaternary age (roughly 10 Ma through to 0,01 Ma). Physiographically the country consists of four roughly longitudinal regions, from the highveld in the west, through the middleveld along the central axis of the country, with the lowveld east of this. The highlands of the Lubombo mountains form the eastern boundary of the country. There are no rock outcrops of Cretaceous and Pre-Pleistocene age recorded in Swaziland.

The long geological history and absence of a Pleistocene glaciation (at least in this region of southern Africa), has resulted in several relict and exhumed landscapes. These, together with the granitoid regions in the west and centre of the country offer an ideal open-air laboratory to revisit many of the classical theories of geomorphology, from tors and bornhardts, including the Sibebe Rock bornhardt (a national landmark & reputedly the largest bornhardt recorded), through to the Tricart-type structural landscapes in the Ngwenya Region, or the Büdel-type landforms with deep weathering found in the Zombodze region. Also of interest is that, while there are no limestones or dolomites in thee country, some of the ganitoid rock displays well developed pseudo-karst features and are home to the Gobholo caves – a granite cave system greater than 1,8 km in extent and showing both scree cave and flowstone phenomena.

The drainage of the country generally mirrors the geological and landscape complexity of the region. The major river systems originate outside the borders of the country and discharge through the eastern border into either South Africa (the Lusuthu and Komathi rivers) or into Mocambique (the Mbuluzi River). Some elements of the drainage network have been superimposed onto the exhumed landscapes, while in other ares the drainage has been impeded, resulting in significant wetland systems. The drainage is further complicated by at least four hot spring systems, the best known being in the Ezulwini Valley, where it forms a major tourist attraction (the 'Cuddle Puddle'). The drainage divides have been interpreted as representing axes of epeirogenic uplifts that correlate with spreading regimes in the oceanic ridges surrounding southern Africa, suggesting an origin from stresses related to plate motion. Successive uplift along these axes are thought to have initiated cyclic episodes of denudation.

The mountainous Highveld of Swaziland is characterized by steep slopes with an average gradient of 17%. Due to heavy erosion in the past, the hilly areas are now dominated by rock outcrops and stony ground, while colluvial and alluvial deposits dominate the valleys. The land has been inhabited for a long time (potentially > 43 Ka), implying that vegetation is a consequence of earlier land use patterns including long-term grazing and fire.

The landscape diversity creates many challenges but also creates opportunities, as the different zones react differently to environmental change, hence creating buffers. In the context of applied geomorphology, this offers a range of possibilities to analyse and understand the landscape but, most especially, to use the understanding of process geomorphology to underpin effective, sustainable environmental solutions to landscape management issues.

Keywords: Archaean geology; relict and exhumed landscapes; granitoid landscapes; colluvial and alluvial deposits; sustainable landscape management.

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VERTICAL SOIL TRAPS AND VETIVER SYSTEM FOR SLOPE STABILIZATION

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ABSTRACT

Human developments around the world often destabilize slopes. These slopes need to be stabilized by reducing the slope steepness. In many circumstances, however, this is not an option due to several reasons. Slopes must be stabilized by means of creative and economic solutions. This paper describe a successful solution for a convenient, cost-benefit, slope stabilization project. Vetiver System with an innovative solution and Vertical Soil Traps were combined to achieve slope stabilization and erosion control. Beside slope stabilization and erosion control, the system promoted deposition of sediments behind the vertical wall. When the total wall capacity was reached a flat bed was formed by sediments. This area promoted a faster grow of the Vetiver row placed close to this bed. Vertical walls (0.6 m tall) were placed across the slope. The separation distance varied according to several different variables. In this case study the walls were placed 6 m apart and the Vetiver rows were placed 1 m apart. The wall was made of a woven geotextile. The wall was set up with wooden logs that were thick enough to support the amount of load brought by the sediments and its content of water. During a complete rainy season (six months) the system trapped as much as 0.5 m^3 of sediments per linear meter of trapping system. Each linear meter covered 6 m^2 which means that a 0.08 m thick layer eroded from surface.

Keywords: Vertical soil trap; Woven geotextile: Polypropylene geotextile.

Leonel Castro is the founder of Vetiver Tec and Bio Ingenieria Corporation in Guatemala. He has worked with environment restoration programmes for the mining industry, roads and energy projects (hydroelectric mainly). Leonel is the author of many creative and innovative, convenient solutions for erosion control and sediments. He is active member of TVNI Vetiver.org and IECA (International Erosion Control Association) and has presented many papers around the world.

SCALE: A CRITICAL SUCCESS FACTOR IN REHABILITATION - THE LANGTOU RIVER CASE STUDY

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ABSTRACT

Scale is one of the most important factors to consider when designing interventions in support of river rehabilitation. The success of such initiatives is diminished if planners fail to accurately comprehend the scales at which the drivers of ecosystem change function in space and time, remedies need to be crafted, and governance in support of rehabilitation must be organised. This paper reflects the experience of its authors in developing a strategic management plan for the Langtou River, a severely destabilised foothill river in the Southern Folded Mountains ecoregion of the Western Cape. We reflect on the 'problem of fit' as manifested during the Langtou planning process and explore some of its wider ramifications for river rehabilitation. The 'problem of fit' deals with the incompatibility between ecosystems and institutional arrangements created to manage human activities affecting these systems. The case study underscores why a catchment-scale approach is preferred when formulating a river rehabilitation strategy. It shows how an initial environmental assessment incorrectly explained largescale channel degradation in terms of localised, reach-specific disturbances whereas these had originated from catchment-scale changes to ecosystem drivers. These respective perspectives on the spatial and functional scales at which impacts originated also yielded distinctly different rehabilitation objectives and practises, one appropriate, the other not. The causes of ecosystem instability included loss of flood and sediment retention capacity in damaged wetlands in the catchment, unsuitable alien clearance practices and causeways and bridges with insufficient flood conveyance capacity. Notwithstanding official approval of the plan in December 2014, a statutory 'champion' has yet to come forward to co-ordinate and drive its implementation. Prioritised interventions include wetland rehabilitation, improving the design of bridges and causeways, removing in-channel berms and alien clearance. This would require a multi-agency strategy, co-ordinated by an entity such as the Breede-Gouritz Catchment Management Agency. However, operationalisation the Langtou River plan has been hamstrung by the absence of a devolved, catchment-based and representative body to put it to effect. This represents a serious functional mismatch between a degraded but ecologically important agricultural resource and institutional arrangements to promote its rehabilitation.

Keywords: River rehabilitation, catchment approach, problem of fit.

Charl de Villiers in an environmental assessment practitioner in **Cape** Town with an interest in agroecosystem governance.

SWAZILAND LANDSCAPE-BASED MANAGEMENT PLANNING ASSESSMENT

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ABSTRACT

Landscape/ecosystem approach aims at achieving sustainable use of ecosystem services in order to sustain human livelihoods and human well-being. UNDP-Swaziland through the Strengthening National Protected Areas Systems (SNPAS) is working towards increasing Protected Areas (PAs), and improving their operations. Swaziland's formal PAs only cover approximately 4% of the country's total land area. Despite their global significance on biodiversity, the PAs are small, patchy and vulnerable; inadequately representing the countries varied ecosystems and biodiversity. This study aimed at interrogating the processes of a landscapes planning and management approach, and how it would contribute towards improving biodiversity conservation in the country. It sought to establish the social and land resources in different chiefdoms, and to develop three landscape management plans for the SNPAS project. Community mobilization approach was used and the global positioning system (GPS) was used for baseline data collection. The baseline data was then used to develop social and land resources maps, as well as land use, soil and land suitability maps. The results showed that rangelands were overgrazed, overstocked, highly eroded (especially along routes leading to dip tanks), and were highly infested with Invasive Aline Plants Species (IAPS). The results also showed that wetlands and waterways were destructed. Major causes of the destruction included that wetlands were being used for crop farming, livestock farming, infrastructural development and human settlements. Major conclusions included that chiefdoms have areas that can be dedicated to biodiversity conservation and the present land use plans for the chiefdoms need to be revised. It was also concluded that robust works on IAPS control, wetland ecosystem protection and sustainable land management approaches should be employed.

Keywords: Protected areas, biodiversity, degradation, invasive alien plant species, landscape management plans.

Gcina Dlamini is the Strengthening National Protected Areas Systems (SNPAS) Project Manager at UNDP-Swaziland.

GEOMORPHOLOGICAL HETEROGENEITY AND BIODIVERSITY IN SWAZILAND

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ABSTRACT

This study examines the inter-relations between the geomorphology of Swaziland and its biodiversity, with special attention given to vegetation. The overall aim is to explore the relationship between relief forms and the biodiversity using data-driven Bayesian networks and geographic information systems. Bayesian networks graphically reveal how geomorphological variations influence soils and climate which are key determinants of vegetation types. The findings have implications on understanding the dynamics of landscape change processes as governed by land use and climatic changes.

Keywords: geomorphology, vegetation, biodiversity, Bayesian networks

Wisdom Dlamini is an environmental scientist with research interests in earth observation (remote sensing), applied data mining and predictive modelling for environmental applications. He holds a PhD in Environmental Science, an MBA, an MSc in Tropical Resources Ecology, a Diploma in International Environmental Law, a Postgraduate Diploma in Wildlife Management and a BSc in Physics and Environmental Science. His scientific and administrative experience spans a wide variety of areas such as biodiversity conservation, climate change, natural hazards analysis, remote sensing, spatial data science, environmental law and policy.

SOUTHERN AFRICAN DUST SOURCES

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ABSTRACT

Southern African dust sources have been identified using a variety of remotely sensed products including Handheld Space Photography, TOMS, SeaWifs, MODIS true colour and Deep Blue products. This presentation will focus particularly on the 10 year observation record from the Meteosat Second Generation (MSG) using the 8.7, 10.8 and 12.0 µm bands. Atmospheric mineral dust is known to have an impact beyond the immediate source area since it may also play a role in climate forcing and ocean productivity. Satellite sensors have been able to highlight the varied sources of Southern African dust, which include large interior dry lake basins in Botswana and Namibia as well as west coast salt pans and dry river valleys of the Namib. Areas of active surface mining and agricultural are among the most important anthropogenic sources in the region. Source point identification from remote sensing has guided field based measurements and allowed for the detailed examination of surface characteristics, dynamics and mineral dust release mechanisms as well as dust chemistry. Remotely sensed data has also identified the seasonality and synoptic drivers of the most prevalent source areas and established prevailing dust trajectories of the region. Given the inaccessibility of some of the world's major sources in northern Africa the southern subcontinent is well placed in advancing ground based knowledge in our understanding of such global scale processes. Remote sensing plays a key role in targeting field observations.

Keywords: Mineral dust, South Africa, Meteosat

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COMPARING WETLAND PROBABILITY MAPS FOR THE KRUGER NATIONAL PARK, SOUTH AFRICA

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ABSTRACT

Wetland mapping involves not only the mapping of landscape features, landform characteristics and processes (geomorphology) but also the presence or movement of water (hydrology). Generally, remote sensing and Geographical Information Systems are used in the mapping of wetlands. Two semi-automated mapping approaches used to map wetlands in the Kruger National Park, are compared. The first approach identified potential wetlands from various Landsat 5, 7 and 8 imagery, which were mapped as such where they occur within the valley-bottom landscape unit derived from a terrain (morphological) units. An interactive mapping process was done with using ancillary data e.g. geology, vegetation types, soil types and high resolution imagery. The second approach is based on the assumption that wetlands will develop in the lowest part of the landscape pending certain conditions. For this approach, the study area was subdivided into homogenous mapping regions based on relief, rainfall and generalized geology. Flow accumulation (ArcGIS) and percentile filter maps (Whitebox) were created and areas to be mapped as wetland (i.e. the valley-bottoms) are indicated by setting threshold values for the aforementioned maps. Both approaches used the Shuttle Radar Topography Mission DEM (SRTM; 30 m).

The aim of this study was to compare the results (1:50 000 scale wetland probability map) of the two approaches by doing an accuracy assessment of wetlands associated with the valley-bottom terrain unit (i.e. channeled and unchanneled valley-bottoms, seeps, rivers, valley-plains &, floodplain wetlands). Verified GPS points of wetland and non-wetland occurrences as identified along main and secondary roads were used for this purpose. Both studies added substantially to the wetlands of existing land-cover maps as well as the current National Fresh Water Priority Area wetland layer. The results also provided percentage statements on valley-bottom wetlands in the Kruger National Park. This supports wetland rehabilitation plans and prioritization in the Kruger National Park by considering the conservation status and level of impact. Furthermore, the presentation evaluates and discusses the strengths and limitations of two wetland probability maps for the Kruger National Park to inform future mapping efforts at creating an improved national wetland inventory for South Africa.

Keywords: Wetlands, Mapping, DEM, remote sensing, Kruger National Park

Althea Grundling is a senior researcher: wetlands at the Agricultural Research Council - Institute for Soil, Climate and Water and a research fellow at the Applied Behavioural Ecology & Ecosystem Research Unit, UNISA. Her research interests are wetland mapping, processes and impacts.

MANIPULATING THE GEOMORPHOLOGY OF WETLANDS IN MINIMISING THE IMPACTS OF EROSION: A SOUTHERN AFRICAN WETLAND REHABILITATION CASE STUDY

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ABSTRACT

Wetlands are not uncommon features in the southern African landscape. However, they are not always recognised due to their seasonal and ephemeral nature in the drier parts of the sub-continent. This often results in their degradation as they are not considered in land use change or development planning. Classic examples often resulting in erosion of wetlands include overgrazing in rural areas and infrastructure development around cities.

Geomorphology and hydrology are two key processes determining the character and functioning of wetlands and it is often these processes that are altered during impacts on wetlands, resulting in stream flow concentration and subsequent erosion. This study focuses on the manipulation of geomorphological features in wetlands in order to arrest erosion and modify altered flow patterns through implementing various rehabilitation measures. These include amongst others hard structures such as weirs to change the slope of the thalweg, trap sediment and rewet the wetland. Geotextiles were applied in soft options creating chutes to arrest erosion and silt fences to trap sediment in gullies.

A key objective of this study was to determine the cost benefit of the various intervention types. The results will be presented and discussed.

Keywords: Wetlands, Geomorphology, Erosion, Rehabilitation

Piet-Louis Grundling has been involved in wetland research since 1987 and was appointed in 2002 as the first National Coordinator of the Working for Wetlands Programme in South Africa. His dedication to wetland rehabilitation and capacity building earned him the South African Vley Lily award at the 2002 National Wetland Action Group Conference (now known as the National Wetland Indaba). He was nominated for the 2013 Stewardship National Wetland Award. He has served on numerous wetland related forums and Water Research Commission (WRC) committees in South Africa and various international organisations such as the International Mire Conservation Group (IMCG) and CC-GAP of Ramsar. He is currently serving on the Main Board of the International Mire Conservation Group (IMCG) and as chair of the South African Wetland Society. He has initiated short wetland courses (with the University of Pretoria in 2004 and in 2011 with the University of the Free State where he is presently a research associate) focusing on wetland management and rehabilitation.

SHORT-TERM AND HIGH-FREQUENCY DIURNAL FROST OBSERVATIONS FOR VESLESKARVET, ANTARCTICA

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ABSTRACT

Ground thermal and moisture regimes have been recorded for the Northern Buttress of the Vesleskarvet nunataks, Antarctica, since 2008. The ground freezing index (GFI), calculated on an annual basis, is an indicator of the annual frost regime and determined by the Finn method. This method is most applicable to very cold regions with long freezing seasons. Vesleskarvet is found in a continuous permafrost zone with annual ground freezing index (GFI) exceeding 5500. For near surface temperatures, the winter freezing index (FI) continuously exceeds 2000, with the summer thawing index (TI) approaching zero. Vesleskarvet is characterised by annual frost with limited seasonal thaw and a paucity of diurnal freeze-thaw cycles (92 verified cycles since data collection began). In the top 2 cm of the ground, less than 3% of the time shows any thawing; at a depth of 15 cm this reduces to only 0.1%. The active layer for this area is 16 cm thick, with little annual variability observed. Diurnal frost penetration is calculated to be 8 mm. Permafrost extends to a depth of 550 m and average permafrost temperature is -16 °C. Similarly, average near surface temperatures are -17 °C.

Data are recorded at hourly intervals, adhering to ANTPAS and GTN-P standards. While these intervals allow for long-term monitoring of the permafrost and active layer, the diurnal environment is not well-presented, requiring increased-frequency monitoring. To this effect, high-frequency (one-minute or five-minute) data collection has been implemented for the Austral summer months since 2011, with camera monitoring of ground heave implemented in January 2017. High-frequency monitoring coupled with digital image collection allows for a more accurate evaluation of the diurnal frost environment at this site and data show a previous underestimation of the extent of the diurnal environment. While the thawing depth is restricted to the upper few centimetres of the ground, heave related to diurnal freezing and thawing is recorded. Latent heat release is evident in a "zero-curtain" effect on freezing; latent heat absorption is observed as a drop in ground temperature during melting. Heave of 2.5 cm is recorded for fine material and larger clasts of more than 10kg are observed to move during diurnal freezing and thawing events.

Keywords: diurnal frost cycles, Antarctica, high-frequency monitoring, frost heave

Christel Hansen is a Doctoral student at Rhodes University under the NRF/SANAP-funded project 'Landscape Processes in Antarctic Ecosystems'. Her work focuses on high-altitude and -latitude frost environments.

UNMANNED AERIAL VEHICLES (UAVS): APPLICATIONS FOR GEOMORPHOLOGICAL RESEARCH AND USE IN SOUTH AFRICA

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ABSTRACT

Unmanned aerial vehicles (UAVs) have revolutionised surveying by providing high resolution imagery and spatial data. UAVs can also provide high resolution remote sensing data for ecological stress analyses, making the data extremely useful and accessible for researchers from various fields, including geomorphology. Improvements in the technology associated with UAVs, the reduction of costs associated with UAVs and improvements in processing software have now made this technology accessible to many researchers. This presentation highlights the potential of UAVs for geomorphological research and addresses the requirements for their operation in South African airspace that is governed by the South African Civil Aviation Authority.

Keywords: geomorphology; unmanned aerial vehicle; spatial data

David William Hedding is an associate professor at UNISA and his research focuses on cold climate geomorphology.

EARTHWORKS AND SELECTED PLANTS USED TO RESTORE MARGINAL AGRICULTURAL LAND

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ABSTRACT

Berg en Dal is situated outside Ladismith, Klein Karoo, in the catchment area of the Klein Swartberg. The farm was purchased in 1999 by an NPO and members have developed a range of regenerative homestead model sites in a challenging context of limited water supply, alkaline and saline soils and extreme winter and summer temperatures.

This presentation will examine the efficacy of runoff management techniques, erosion management strategies and the use of mostly indigenous plant species in landscape regeneration. The areas intensively focused on were degraded agricultural land and land considered marginal, with an intention to bring them into food, fruit, medicine and food production on a homestead scale. Broad scale areas have mostly been worked to prevent further erosion.

The impact of these approaches is very interesting in terms of soil building, increased biomass and the production of microclimates and niches for human production.

Keywords: Erosion management strategies; landscape regeneration; soil building; increased biomass; generation of microclimates

Alex Kruger has been a Permaculture practitioner for 20 years, working in urban and rural contexts.

LANDUSE CHANGE AND SEDIMENTATION ON WATER RESERVOIR IN UPPER RUNDE SUB-CATCHMENT, ZIMBABWE

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ABSTRACT

Some one percent of the world's reservoir capacities are lost to sedimentation annually. This study aims to assess Upper Runde Catchment landuse changes from the year 2000 to the present and the rate of sedimentation and potential siltation on Gwenhoro dam. Coupled with secondary data from Zimbabwe National Water Authority (ZINWA); sediment samples (December 2016 to April 2017) were obtained using the grab sampling method after storm events to determine the sediment load. Changes in landuse were detected using satellite images from the years 2000 to 2017. The findings reveal that Gwenhoro dam is not within the designated sediment sampling points of ZINWA. However, data from other catchment sampling points with similar landuse were used to determine the rate of sedimentation for Gwenhoro dam by proxy. It was revealed that ZINWA was still using a 1957 baseline class of a low erosion catchment for Upper Runde (3000mg/l) to estimate sediment load. However, findings from field measurements show an average sediment load that is above 7000mg/l. In terms of landuse changes, upper Runde catchment experienced significant changes in landuse from the commercial and generally forested to a largely communal lands class as a result of the Fast Track Land Reform Programme (FTLRP). The paper recommends frequent monitoring of landuse changes and sediment loads in order to obtain accurate dam capacities for water planning purposes and security.

Keywords: landuse change, sedimentation, potential siltation, upper Runde sub-catchment

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WETLAND PROBABILITY MAP FOR SWAZILAND

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ABSTRACT

Worldwide wetland inventories are important, not only to report on wetland pressures and threats in catchments but also to prioritize wetlands for conservation and for identifying wetlands in need of rehabilitation. Similar to South Africa, there is a need for a proper wetland inventory for Swaziland; the existing map (1979) only accounts for wetlands within protected areas. A proper wetland inventory for Swaziland is also a requirement of the RAMSAR convention, which Swaziland ratified in 2013. The aim of this study was to use a semi-automated approach in mapping areas where wetlands could occur. The South African National Biodiversity Institute (SANBI) is currently improving the national wetland inventory for South Africa using a DEM based approach derived from the Shuttle Radar Topography Mission (SRTM; 30 m). It was decided to follow the same mapping approach and wetland classification used for the South African wetland inventory for Swaziland. The approach only maps wetlands in valley-bottoms including valley-floors, valley-plains, seeps associated with valley-bottoms and rivers. It excludes depression wetlands and dams.

The study area is subdivided into homogenous mapping regions based on relief and generalized geology. Flow accumulation (ArcGIS) and percentile filter maps (Whitebox) are created for the study area. Areas to be mapped as wetland are indicated by setting threshold values for the flow accumulation and percentile filter maps for each of the mapping regions. The 2008 SPOT images were used as a backdrop coupled with 81 known wetland points (from an independent dataset) to inform the thresholds determination. The end product is a 1:50 000 scale wetland probability map. An accuracy assessment was done using verified GPS points of wetlands occurrence identified along main and secondary roads.

The result is a new wetlands map for the entire Swaziland which provides a base for future improvement and supports the Swaziland government's obligation to report on the country's wetland status in terms of the RAMSAR convention, as well as current research on the geomorphology of selected wetlands in Swaziland in line with wetland health assessment.

Keywords: Wetlands, Mapping, DEM, Swaziland

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PERCEPTIONS ON LAND DEGRADATION IN SOUTH AFRICA: A NATIONAL OVERVIEW

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ABSTRACT

Land degradation is a global problem. In the recent decade, countries have become more and more aware of the threat of degradation processes like soil, water, biological and chemical degradation to the provisioning of ecosystem services and the resilience of socio-ecological systems. Land degradation processes are well understood, but addressing the problem successfully and sustainably in the long term, is more complicated. Many countries who are signatories to the United Nations Convention to Combat Degradation (UNCCD), voluntarily become involved in global initiatives to assist in progress at national level in the fight against land degradation. These include the UNCCD 'Land Degradation Neutrality by 2030 (LDN 2030)' and continental initiatives such as 'Africa restoring 100 million hectares of deforested and degraded land by 2030' (Afr100 initiative). Both these initiatives require a national target setting process to decide where to invest limited resources to comply with country wide and continental targets. To effectively address land degradation problems and ensure long term sustainable impact of Sustainable Land Management measures, a thorough understanding of the different degradation processes involved, the underlying causes, drivers and impacts of land degradation is necessary. Eventually countries will need to know where they can prevent degradation, where (and how) to reduce the negative impact of degradation if the degradation process has already started, or where more serious levels of degradation should be rehabilitated. This paper will use the National Assessment Data from the Land Degradation Assessment in Drylands (LADA) Project in South Africa as a basis to indicate the severity and extent of land degradation in the country. The research demonstrates through selected case studies how the data inform a better understanding of the real causes of land degradation and lastly, indicate through the formulation and use of both a Degradation Index and Sustainability Priority Index, how to determine priority areas for intervention. Since the LADA National Assessment data is semi-qualitative in nature and based on perceptions of contributing specialist collected during a series of Participatory Assessment Workshops (together with ground-truthing), the advantages and disadvantages of perception data for national level land degradation assessments, will also be discussed.

Keywords: land degradation assessment, severity and extent of land degradation, priority areas, causes and drivers, Degradation Index, Sustainability Priority Index

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A REVIEW OF EQUIPMENT AND OPERATOR PROTOCOLS FOR ROCK TEMPERATURE STUDIES

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ABSTRACT

Thermal fluctuations are generally accepted as being of critical importance in rock decay studies, but its exact effects are not well understood. A global database of rock temperatures for a variety of rock types and locations therefore has considerable value for quantifying the relationships between temperature fluctuation as a weathering driver and the subsequent rock structure alteration. However, there is currently very little experimental standardisation for the measurement of rock temperature. A review of current experimental methodologies is presented, with a particular focus on the equipment and data collection strategies. It is argued that there is currently very little standardisation between the various existing datasets, both from an equipment perspective and in terms of experimental design philosophy. This makes comparison of the various studies extremely difficult and obstructs any attempt to generate a consistent global rock temperature database. A call is made to develop a more consistent experimental protocol, so that datasets generated in future may be more easily collated and compared, in a similar manner to that in which permafrost studies are currently conducted. A protocol of this type has the potential to significantly expand our understanding of the role that temperature fluctuations play in the generation of rock structure shifts over time.

Keywords: Rock temperature, experimental protocols, rock decay

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LANDSAT-DERIVED LAND COVER MAPS AND CHANGE ANALYSIS FOR SWAZILAND

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ABSTRACT

Most of the Swaziland population is rural, many of who depend on a variety of forest products for their livelihoods. It is for this reason the Strengthening the National Protected Areas System of Swaziland (SNPAS) project aims at developing, expanding and effectively managing the capacities of Swaziland's protected areas (PAs) network in order to adequately protect the biodiversity. In order to carry out a comprehensive biodiversity assessment for the country, the SNPAS project, through this study, generated national land cover and vegetation type maps for four-time steps 1990, 2000, 2010 and 2015.

These datasets informed the assessments and land use planning, and provided insights on the trend of changes. Specifically, the study developed land cover map for the year 2015, which was validated using GPS points. Thereafter the same classification polygons used in the validated 2015 classification were then used to undertake a classification for the earlier years. From the resultant four classifications change was detected for the epochs 1990-2000, 2000-2010, 2010-2015 and 1990-2015. The study found that there has been a lot of land use change that has taken place in the country, with most such resulting in degradation. Natural forests had been heavily encroached by bushland, especially in the Middleveld, and so had been some grasslands in the transition zone between the Highveld and the Middleveld. Moreover, probably as a result of population increase, there was notable increase in the change of grasslands, natural forests and bushlands to agricultural land. All these changes have far-reaching effects on the geomorphology of our environment. The study highlighted the need for renewed efforts towards the protection and preservation of the nation's natural resources and biodiversity.

Keywords: Biodiversity, land cover change, Landsat, encroachment, degradation

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ASSESSING GEOMORPHOLOGIC DISTURBANCES OF A WETLAND ECOSYSTEM BY WILDLIFE AND TOURISM ACTIVITIES. A CASE STUDY OF DETE VLEI IN HWANGE DISTRICT

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ABSTRACT

Wetland degradation and loss due to agricultural activities has been observed to be rapid in communal areas of Zimbabwe. However, there is a dearth of empirical research that focuses on the state and drivers of wetland ecosystem change in protected state forests that form buffer zones between national game parks and communal areas. The study assesses wetland erosion caused by wildlife and tourism activities in Dete Vlei, located in Sikumi protected forest, Hwange district. The vlei is located close to Hwange National Park and is used for photographic safaris, a situation that has been resulting in many tourists visiting the wetland area to see different wildlife species that frequent the vlei for water and grazing, mainly during the dry season. A descriptive research design was used. Research data were collected through field observations, field measurements and semi-structured interviews with key informants such as Safari Operators, Owners or Representatives of a hotel and lodges along the vlei, Sikumi Forester and the Parks and Wildlife Management Authority Ecologist. The results of the study show that wildlife population and movements, footpaths formed by tourists, gravel roads along and crossing the vlei, storm drains along gravel roads, dams excavated in the vlei and illegal roads used by vehicles, to mention a few, have the potential to enhance soil erosion and sediment load in the vlei. Whilst the study recommends the introduction of tourism and wildlife related soil erosion control measures, further studies on the condition of the vlei's vegetation structure and composition and hydrology should be carried out to enhance a holistic understanding of wetland health.

Keywords: Soil erosion; Wildlife population; Photographic safaris; Wetland ecosystem, Catchment protection

A REVIEW OF SOIL EROSION AND ITS ENVIRONMENTAL AND SOCIO-ECONOMIC IMPACTS IN SWAZILAND

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ABSTRACT

Soil loss from the land surface by erosion is widespread worldwide and is one of the most serious environmental, agricultural and socio-economic problems facing the human society. Soil erosion has worsened over the years, not just in Swaziland but worldwide, and is threatening waterways and water bodies; the environment; sustainable agricultural production and food security; infrastructure and biodiversity. Soil erosion problems are compounded by increasing population pressure; increase pressure of livestock and the existing land tenure system including unsuitable land use and inappropriate land management practices. This is a review study that looks at the spatio-temporal patterns of erosion in the country. Most types of soils in Swaziland are highly susceptible to erosion, especially the highly weathered ferrosols, with a thin saprolite. A large body of the ferralsols are found in the highveld and upper middleveld. In the Middleveld of Swaziland most of the erosion has occurred on deep colluvial and saprolitic materias especially. Gully erosion is the main process. The infiltration rate of the clay-rich ferralitic soils is lowered by overgrazing and compaction along tracks and paths therefore promoting surface runoff resulting in the formation of rills. Over time the rills deepen and cut through the soil onto the underlying saprolitic materials resulting in the development of gullies. Presenting the state of soil erosion and land degradation is difficult in Swaziland especially in the absence of research and documentation on the extent of land degradation. Extensive research on the extent of soil erosion and land degradation, and mitigation measures to control soil erosion are required.

Keywords: Soil erosion, gullies, degradation, socio-economic impacts, environment

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AN ASSESSMENT OF GLOBAL RAINFALL EROSIVITY

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ABSTRACT

In the perspective of flood- and natural hazard prevention the modelling of rainfall erosivity is considered an important milestone. Past literature proved that rainfall erosivity is best estimated based on high temporal resolution rainfall data. This paper presents the findings from the global assessment of erosivity (GloREDA) project incorporating the work from 30 scientists all around the world which have collected high temporal resolution rainfall data from more than 100 data providers during the last 3 years. This extensive data collection resulted in the estimation of rainfall erosivity for 3,625 stations covering 63 countries by using the principles of the RUSLE model. This first ever Global Erosivity Database was interpolated using the Gaussian Process Regression (GPR) geo-statistical model to develop the global erosivity map at 30 arc-seconds (~1 km). Globally, the mean rainfall erosivity is estimated to be 2,190 MJ mm ha-1 h-1 yr-1, with the highest values (>5,200 MJ mm ha-1 h-1 yr-1) in major parts of South America and Caribbean countries, Central east Africa and South east Asia. The lowest erosivity are mainly found in Canada, Russian Federation, North Europe, North Africa and Middle East. The tropical climate zone has by far the highest mean erosivity followed by the temperate climate zone. The lowest mean rainfall erosivity is estimated in the cold climate zone.

Keywords: Rainfall Erosivity, RUSLE

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THE APPLICATION OF THE SWAT MODEL TO IDENTIFY KEY SEDIMENT SOURCES IN THE INXU CATCHMENT, SOUTH AFRICA

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ABSTRACT

The excessive supply and accumulation of suspended sediment leads to the degradation of fluvial systems such as rivers and dams. For purposes of protecting these systems, suspended sediment should be managed at catchment level and be catchment-specific. The Soil and Water Assessment Tool (SWAT) is a semi-distributed, hydrological model that can simulate water, chemical and sediment yields from large, ungauged catchments. It is a continuous time model that functions on a daily time step and accounts for variability of conditions specific to the catchment. SWAT has been applied previously in the Mzimvubu Catchment to answer questions about sediment yield. Results showed that areas of the catchment where the planned Lalini Dam will be located contribute a large amount of sediment. However, these modelled results need further validation and comparison to measured yields, and sources of suspended sediment need to be identified for catchment management plans. The current paper describes how SWAT was used to identify possible sources for suspended sediment in the Inxu Catchment, near Tsolo, South Africa. The results from SWAT were also, compared to measured suspended sediment yields of the Inxu's major sub-catchments. By focusing on the Inxu Catchment, the current study provided a more detailed representation of the spatial variability of potential sources within the Lalini Dam catchment, compared to the previously modelled results. As a result, the study was able to show that the areas that produce a significant amount of suspended sediment in the catchment have similarities in topology, land cover and soil type. The knowledge that has been generated from this study provides information on the quantity and provenance of suspended sediment which is fundamental for effective catchment management. This will aid in designing appropriate strategies that can manage key sediment production areas. With the planned Lalini dam along the Tsitsa River, knowledge of suspended sediment yields and sources proves to be critical if erosion sources are to be managed effectively.

Keywords: SWAT model, suspended sediment, sediment yield, sediment sources, catchment management

Namso Nyamela is a Master of Science student at Rhodes University and her research focuses on suspended sediment yield and provenance.

THE LINK BETWEEN THE PHYSICAL RIVER HABITAT TEMPLATE, AQUATIC ECOLOGY AND WATER QUALITY

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ABSTRACT

A fluvial system consists not only of the river channel networks, hydraulic habitat, bed and banks but also the riparian vegetation and floodplain, which are contained within a particular catchment. The result is that the river structure and function are intimately linked to the catchment they are a part of so that the river water chemistry, physical habitat template and biotic responses are all related. The ecological integrity of river systems can be linked to geomorphic influences as it is important in determining the variation and distribution of aquatic communities. The river substrate provides essential habitat to stream biota determined by particle size and stability and hydrological influences determined by variation in river flow regimes. Changes in either can result from natural or anthropogenic disturbances. River classification provides a means of relating physical instream processes to biological processes in order to assess ecological integrity. A hierarchical classification based on river longitudinal zonation, which identifies geomorphologically similar river reaches each having their own flow characteristics, sediment load and regional slope was used in the study. The classification system relates and compares changes in algal and macroinvertebrate communities down a longitudinal gradient in relation to chemical stream composition, their associated land uses and the physical river habitat template. The study provides insight into the environmental and physical-chemical-biotic interactions to further improve our understanding of the self-purifying capacity of a river.

Keywords: river ecological integrity, river geomorphology, biotic response

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GEOMORPHOLOGICAL SENSITIVITY EXAMINED IN A RECENTLY DEGRADED RIVER: INTEGRATING CONNECTIVITY AND PANARCHY TO UNDERSTAND CHANGE

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ABSTRACT

The study of river sensitivity to future human land-use activities and climate change is a fast growing field within the discipline of fluvial geomorphology. Broadly defined, river sensitivity relates to the nature and rate of channel adjustment to changes in water and sediment inputs from upstream. One way of defining river sensitivity is to investigate the degree to which water and sediment, hence disturbance responses, are transferred between different parts of a catchment (connectivity). Another means of defining river sensitivity is to investigate how a river has changed through time. The latter gives insight into the nature and rate of geomorphological cycling between processes of erosion and deposition as a river adjusts internal energy conditions and responds to different disturbances. These geomorphological cycles may be likened to adaptive cycles described within the concept of Panarchy. Panarchy attempts to explain cross-scale interactions of processes and structure in a system, which determines how the system behaves and responds to different types of disturbances. In this paper we argue that the concept of connectivity and Panarchy, when integrated, provide a useful means of understanding the sensitivity of different parts of a river system to disturbance events, and for predicting future geomorphological change. Connectivity and Panarchy are examined in the Baviaanskloof River catchment, Eastern Cape, where recent channel deepening and widening has taken place along the main stream and several connected tributary streams. We illustrate how a temporal and spatial understanding of river process, form and sensitivity to change may be applied to planning process-based river-floodplain rehabilitation in the Baviaanskloof.

Keywords: river sensitivity; connectivity; adaptive cycles; Panarchy; rehabilitation

Rebecca Powell is a project coordinator and researcher at Rhodes University. Her research interests include: wetland and river geomorphological history, sensitivity to human activities and rehabilitation, and more recently she has developed an interest in rehabilitation and sustainable land management of degraded rural landscapes. Rebecca coordinates a Global Environment Facility funded sustainable land management project being implemented in two rural landscapes of the Eastern Cape.

THE ROLE OF WORKING FOR LAND IN ADDRESSING THE TRIPLE CHALLENGES OF POVERTY, UNEMPLOYMENT AND SKILLS DEVELOPMENT

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ABSTRACT

The Department of Environmental Affairs through Environmental Protection & Infrastructure Programme (EPIP) instigated the implementation of projects aimed at conserving natural resources and protecting the environment, since 1999/2000. The programme has also grown from a budget of R28 million in the 1999/2000 financial year up to R R883 million in 2017/18.

The purpose of EPIP is to manage the identification, planning and implementation of projects throughout the country under the Expanded Public Works Programme (EPWP). EPIP creates temporary employments and skills development opportunities for unemployed people through the implementation of labour intensive under the auspices of EPWP targeting the unemployed youth, women, people with disabilities and Small Medium and Micro Enterprises.

The programme is comprised of seven focus areas and Working for Land (WfL) is one of them. WfL is focused on improving the quality of land that provides for and sustains its inhabitants. WfL addresses degradation of land due to desertification, overgrazing, soil erosion, poor storm water management and unsustainable farming practices. It's a biased towards degraded pieces of land that are communal and have a potential to impact badly to the livelihoods of communities.

Implementation of projects are encouraging sustainable land use practices, raising awareness and promoting resource conservation ethics. It promotes in empowering the greater community with rehabilitation of land by planting trees and making land available for agricultural purposes. Patterns of WfL are construction of gabion, planting of vetiver grass, storm water channels, education and awareness as well as curtailing bush encroachment.

It ensures that degraded ecosystems are restored to their original state in order to maintain or support the natural species. The impacts of land degradation are both environmental and socio-economic and are intricately linked to food security, poverty, urbanization and biodiversity. It also aimed at promoting the transition to sustainable and integrated management of land resources.

Keywords: Poverty alleviation Skills development Overgrazing Soil erosion Livelihoods of communities

Mahuma Ramashala is a Deputy Director at the Department of Environmental Affair. She is responsible for managing the identification, planning and implementation of Working for Land projects throughout the country under the Expanded Public Works Programme (EPWP). The purpose of Working for Land aimed at addressing degradation of land due to desertification, overgrazing, soil erosion, poor storm water management and unsustainable farming practices. It's a biased towards degraded pieces of land that are communal and have a potential to impact badly to the livelihoods of communities.

GEOMORPHOLOGY AND ECOSYSTEM PROTECTION: PUTTING GEOMORPHOLOGY INTO ENVIRONMENTAL FLOW ASSESSMENTS

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ABSTRACT

The importance of maintaining a flow regime in a river that is sufficient to protect ecological function is recognised worldwide. Methods to assess environmental flows have been driven largely by ecologists but geomorphology is increasingly incorporated as a necessary component of these assessments. Geomorphological processes determine the characteristic habitat for river fauna and flora and any change to geomorphic drivers can change habitat quality or even type of habitat available. In this paper I will demonstrate how geomorphology is integrated into the four different steps common to the environmental flow assessment (EFA) process. These are (1) classification and river typing, (2) ecoclassification, which measures the degree to which a river has been modified from natural, (3) determining the environmental flow requirements and (4) long term monitoring of the response to managed flows. Examples will be taken from South Africa and Tanzania (classification and river typing), The Mara River in Kenya (ecoclassification), The Mzimvubu River in South Africa (determining environmental flow requirements), The Rufiji Basin, Tanzania (monitoring). Challenges relating to the time and space scales over which geomorphological processes operate will be highlighted. These are often very different from those applied by ecologists who dominate EFA practice. The geomorphology must also consider how changes to the flow will affect sediment dynamics, adding further complexity to the assessment process.

Keywords: Mara River, channel change, incision, thresholds, floods, drought

Kate Rowntree is an Emeritus Professor in the Department of Geography at Rhodes University. Through her contribution to developing environmental flow assessment methodologies she has become acquainted with river systems throughout South Africa and in Kenya. She also has a keen interest in investigating land degradation processes with a view to implementing rehabilitation measures at the catchment scale. She has been active in promoting sediment tracing to identify sediment sources as a way of understanding catchment processes and guiding restoration efforts.

COSMOGENIC NUCLIDE SURFACE EXPOSURE DATING: PITFALLS AND CHALLENGES FOR ISOLATED FIELDWORK

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ABSTRACT

Sub-Antarctic Marion Island (46°54'S 37°45'E) exhibits evidence of Quaternary glaciation, but spatial and temporal constraints of the LGM are lacking. Recent advancements in cosmogenic nuclide dating techniques allow for a wider application of the methods to include a range of geological ages and composition. Marion Island, due to its relatively young basaltic substrate, now poses a unique opportunity for cosmogenic analysis to be applied to this geographical region. This paper reports on the suitability of glacial erosional and depositional features on Marion Island for surface exposure dating. In addition, a review of field methods used in April/May 2017 are provided, where conventional extraction techniques have been adapted to overcome the limitations of access and suitability of sampling point locations. A summary of pitfalls and challenges are provided for future application of these techniques in similar contexts.

Keywords: cosmogenic nuclides, surface exposure dating, Marion Island

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GEOHERITAGE AND GEOCONSERVATION AS A TOURISM POTENTIAL IN SWAZILAND

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ABSTRACT

The expansion of tourism is for many developing countries one of the major incentives to advance their economic sustainability. In Africa, apart from cultural resources, living organisms in form of nature and game reserves have in this context played a significant role.

Geosites represent a third anchor that may contribute in supporting tourism in future. The term "geosites" is applied for geological sites with specific geoscientific values or sometimes for entire regions. Geosites represent locations where the internal and external dynamics of the Earth and the resulting geomorphological features are exceptionally well demonstrated, or are apparent in the form of beautiful land sceneries. Additionally, former mining sites with all their preserved utensils, are also incorporated in the definition of geosites, and lastly, locations of exceptional fossils, minerals and certain rock types may as well as archaeological sites be added.

Swaziland, located along the south-eastern African continental plateau, is characterized by its highly diversified landscapes and eco-regions, among which the following major types of geosites can be categorized (below are for each type only a few examples identified):

- Landscapes:

a) Mahamba gorge near Nhlangano: Quartzites of the Mozaan Group, about 2.9 Ga, an impressive scenery suitable for ecotoursm.
b) Sibebe monolith near Mbabane: A rather homogeneous porphyritic granite forming part of the Mbabane pluton, about 2.7 Ga, suitable for ecotourism.

- Specific mineral and rock sites:

a) Pigg`s Peak road cut: Gneisses and migmatites, probably the oldest dated rocks in Africa, about 3.6 Ga.
b) Gobholo cave near Mbabane: A large, only recently discovered cave embedded in granite rocks exhibiting rare flowstones (speleothems).

- Fossil and archaeological sites:

a) Fig Tree Series in the Malolotja Nature Reserve: Cherts and shales of the Swaziland System, probably containing the oldest dated microfossils of Africa (>3.2 Ga).
b) Rock paintings in northern and western Swaziland. Among more than 10 known sites of Neolithic age are Nsangwini, Hholoshini and Sandlane the most prominent paintings and rock shelters, exhibiting painted animals, cattle and humans. Some of the Swazi sites are under threat of vandalism.

- Mining sites:

a) Ngwenya near Mbabane: Possibly the oldest iron ore mine in the world, exploitation tools (of Khoi-San?) were radiometrically dated at about 43 Ka.
b) Bulembu near Piggs' Peak: Former asbestos (chrysotile) mine, closed in 2001.

In neighbouring South Africa, tourism has been earmarked as a key sector with an excellent potential for growth. It is supporting currently one in every twelve jobs. This is not yet the case in Swaziland, but may be achieved by incorporating geosites as potential destinations. .

GEOMORPHOLOGY APPLIED: TYPING RIVER ECOSYSTEMS AND MAPPING RIVER CONDITION, NATIONAL BIODIVERSITY ASSESSMENT (NBA) 2018

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ABSTRACT

The exceptional biodiversity and high endemism in South Africa is matched by the country's high cultural diversity and its need for sustainable development. The challenging socio-economic setting combined with global change pressures make the assessment and monitoring of biodiversity and ecosystems an essential undertaking. The National Biodiversity Assessment (NBA) is a product of high scientific importance led by the South African National Biodiversity Institute (SANBI) in collaboration with several key partner organizations. Its primary purpose is to assess the state of South Africa's biodiversity based on best available science, with a view to understanding trends over time and informing policy and decision-making across a range of sectors. The NBA 2018 includes spatial as well as non-spatial elements covering terrestrial, freshwater, estuarine and marine components. The freshwater component deals with both wetlands and rivers. This presentation will focus on the river sub-component, specifically river ecosystem typing and river condition. Its purpose is to show how geomorphology can be applied in the biodiversity field. River ecosystem types represent the diversity of river ecosystems and are components of rivers with similar physical features (such as climate, flow and geomorphology). Under natural conditions, river ecosystem types are expected to share similar biological response potential. The 1: 500 000 river network was classified using Level 1 ecoregions, flow variability and geomorphological zones (i.e. four channel slope categories) to produce 223 distinct combinations of river ecosystem types for South Africa. River condition describes the extent to which a river has been modified by human activity. Ideally, those freshwater ecosystems that are currently considered to be of high integrity or in good condition should be selected for the purposes of conserving biodiversity. In the NBA 2018 the 2011 Present Ecological State (PES) dataset which is based on six underlying indicators (flow, water quality, instream habitat, stream bank/riparian habitat and, longitudinal and lateral connectivity) will be supplemented with modelled data (i.e. updated land cover). The PES aggregated ecological condition category reflects the degree of modification from natural (A) to critically modified (F). Data limitations and challenges will be discussed in detail.

Keywords: National Biodiversity Assessment (NBA) 2018; applied geomorphology, 1:500 000 rivers, river ecosystem typing and river condition

Lindie Smith Adao's research focuses on a number of related fields (e.g. fluvial geomorphology, aquatic ecology, conservation biology, water resources planning, spatial information technology involving GIS applications, etc.) under the broad umbrella of ecosystem management. Earlier research concentrated on freshwater biodiversity conservation planning. This discipline provides a means to halt and reverse freshwater ecosystem degradation by proactively and systematically identifying conservation priorities and options. Currently, she also focuses on landscape degradation and restoration as well as services that arise from healthy ecosystems.

SLOPES STABILITY IMPROVEMENT WITH VETIVER SYSTEM TECHNOLOGY

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ABSTRACT

The stability of upland natural slope, cut and fill slopes is based on the interplay between two forces, driving forces and resisting forces. Driving forces promote down slope movement of material, while resisting forces deter movement. When driving forces overcome resisting forces, these slopes become unstable.

Although gravity is the main driving force, it cannot act alone. Slope gradient, soil type, climate, and soil moisture contribute to its effect. The main resisting force is the material's shear strength and internal friction that opposes driving forces.

The ratio of resisting forces to driving forces is the safety factor (SF). If SF >1 the slope is stable. Usually a SF of 1.2-1.3 is marginally acceptable. Depending on the importance of the slope and the potential losses associated with its failure, a higher SF should be ensured SF of cut and fill slopes can be improved with earth shaping, conventional hard structures such as rock riprap, gabion, retaining walls etc., geotextile and vegetation, which improves the resistance of slopes to both superficial erosion and mass wasting mainly by increasing the shear strength of the soil via root reinforcement.

The removal of slope vegetation commonly causes slope failure. Specific hydro-mechanical mechanisms can be identified through which vegetation affects stability. The presence of vegetation also modifies the hydrologic regime by intercepting rainfall in the foliage and by extracting and transpiring soil moisture via the roots. The most effective restraint is provided where roots penetrate into residual soil or transition zone whose density and shear strength increase with depth.

Vetiver System Technology (VST) is based on the use of Vetiver grass, which has massive, long and penetrating roots, provides an ideal mechanism for slope stabilization. In addition to its unique structural contribution, VST improves the site both aesthetically (green and natural) and economically. Application of VST could reduce construction cost between 30-60%.

Besides infrastructure protection, VST has been shown to be effective in reducing or even eliminating many types of natural disasters, including landslides, mudslides and streambank and coastal erosion.

Case studies of VST applications in Africa, Asia, Australia and Latin America will be presented.

Keywords: Bioengineering, slope stabilisation, vetiver grass, soft measures

Paul Truong is the Technical Director of TVNI, Director for Asia and Oceania.

APPLICATION OF VETIVER SYSTEM TECHNOLOGY FOR STREAM BANK AND COASTAL DIKE STABILISATION IN VIETNAM

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ABSTRACT

Hundreds of hectares of land are lost annually ***throughout Vietnam*** due to ***riverbank and coastal*** erosion caused by strong current in the flood season, wave action by wind, ***sea dike failure by typhoons and storm surges.*** Rigid structural protection methods and soft structures are commonly used to stabilize riverbanks and to control coastal erosion. But these methods are either ineffective or too costly to implement.

Literature shows that due to its extraordinarily massive, deep and penetrating root system, Vetiver grass is extremely resistant to washouts from high velocity flow. Vetiver System Technology has been used successful in Australia, Asia and Latin America for riverbank and coastal erosion control.

Research in Australia showed Vetiver:

- Withstand flow velocity higher than 3.5m/sec in river under flood conditions and up to 5m/sec in a flooded drainage channel.
- Under shallow or low velocity flow, Vetiver acts as a barrier that reduces flow velocity and traps eroded sediment. It can maintain its erect stance in a flow as deep as 0.6-0.8m.

Research at Delft Technical University in Netherlands showed:

- *Cyperus rotundus* is commonly used to protect dikes from wave erosion by boats or wind. But it only thrives in fresh water. Although Vetiver cannot grow in full seawater, it has 60% of optimal growth in brackish water (9 ‰). Vetiver can be applied on dikes in fresh and brackish water.
- A physical model shows the amount of eroded material of cohesive soil (clay) on riverbank was approximately 8-10 times smaller using Vetiver grass
- A single hedge of Vetiver grass planted on the outer slope of a dike can reduce the wave run-up volume by 55%, in contrast with sod-forming grasses that give no reduction.
- The reduction of wave overtopping of more than 60% was measured when Vetiver is planted in front of the slope. Applying these results to a sea dike in Vietnam resulting in a reduction of 0.5m of the crest height, which corresponds to a reduction of 12.6% of the costs in case of two Vetiver hedges are planted on the outer slope.

Case studies of successful applications in river and canal banks, sea dikes and estuary dikes in Vietnam and Brazil will be presented

Keywords: Bioengineering, riverbank stabilisation, coastal dike stabilisation, vetiver grass, Vietnam

Paul Truong is the Technical Director of TVNI, Director for Asia and Oceania.

A BIBLIOMETRIC STUDY OF THE ROLE OF ARTIFICIAL INTELLIGENCE IN GEOMORPHOLOGY

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ABSTRACT

Although artificial intelligence (AI) has been applied within geomorphology since the 1990's, there is a lack of a review of its placement within mainstream research. A bibliometric study of the publications (consisting of 10 654 geomorphology articles) in three leading journals in the subject domain characterises geomorphology as having broad research interests. This manifests as a wide variety of keywords (19 532), most of which occurring only once, as well as little overlap in research foci between successive years. However, there is an overall emphasis on research related to erosion (keyword freq = 367), sediment transport (keyword freq = 230), climate change (keyword freq = 213), weathering (keyword freq = 204) and landslides (keyword freq = 195). Within this context AI can be considered a relevant part of the subject domain (keyword freq = 46). In particular, neural networks, support vector machines, genetic algorithms, fuzzy inference systems and machine learning are used within geomorphology and have the potential to make significant contributions to the main research foci of the subject. Given its application to studies involving the interaction of complex variables, AI is ideally suited to the complex systems encountered within the earth sciences.

Keywords: Artificial intelligence, Geomorphology, Bibliometrics

Barend van der Merwe is a lecturer at the University of Pretoria with research interests in statistical shape analysis of landforms and the application of artificial intelligence within geography.

PRINCIPLES FOR DEVELOPING A CATCHMENT REHABILITATION STRATEGY: THE CASE OF THE NLEIP IN THE TSITSA CATCHMENT, SOUTH AFRICA

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ABSTRACT

The Ntabelanga and Laleni Ecological Infrastructure Project (NLEIP) has been instigated by South Africa's Department of the Environment (DEA) in response to concerns over the potential rapid sedimentation of two dams planned for the ~4000 km2 Tsitsa catchment. The DEA has committed R450 million over ten years to fund a catchment scale rehabilitation programme that aims to reduce sediment input into the two dams while also increasing the ecological potential to support rural livelihoods. The purpose of this paper is to present principles to guide the rehabilitation strategy based on sound scientific principles and pragmatic constraints. In order to optimise the use of funds, the strategy needs to identify both spatial priorities based on source provenances as well as source types, which include surface erosion, gullies, roads and tracks. Consideration needs to be given to sediment source types in order to recommend the most effective remediation measures. A particular problem in the area is the presence of dispersive soils which are highly vulnerable to piping and gullying but for which control measures are not well established. The strategy must also take account of the needs of people living on the land and their commitment to becoming involved in implementing and sustaining the rehabilitation measures. Different scales need to be addressed, from setting priorities at the broader catchment scale to the local catchment scale appropriate for village-based action.

Keywords: Rehabilitation, Tsitsa catchment, soil erosion, degradation, guiding principles, NLEIP

Bennie van der Waal is a Research Associate at Rhodes University. His research is centred on monitoring sediment dynamics and developing an appropriate adaptive management and restoration plan for the Tsitsa River catchment. Other work include impact assessments of proposed developments on river geomorphology.

INTEGRATING EROSION MODELLING INTO MINE REHABILITATION DESIGN

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ABSTRACT

Erosional stable post closure landforms are a key requirement for mine closure. The objective of erosion modelling is to provide optimum final rehabilitated topography for various cover materials and vegetation cover conditions combinations in support of rehabilitation design and costing. The modelling approach involves integrated erosion and landform evolution modelling. The models are coupled as such to address the limitations of each model. The erosion model is applied to predict erosion rates from site specific seasonal distribution in rain erosivity and cover material erodibility, slope gradient-length-shape scenarios and effect of cover conditions as affected by rock cover, seasonal vegetation cover and tillage practices that can be parameterised in detail. The landform evolution model is applied to simulate the three dimensional topographic changes over time as determined by surface erosion, locations of gully initiation and development and sediment depositional areas along slopes. Consequently, problem areas of unacceptable high erosion rates and gully development can be identified for the engineer to optimise designed topography, based on site and post closure specific conditions.

The integrated erosion and landform evolution modelling form part of a larger modelling exercise to optimise the design and construction of rehabilitated land cost-effectively. The process is initiated with upfront landform design where the closure engineer develops an initial post-mining landform for the mined-out topography. Parallel to this process, a soil scientist will identify potentially suitable cover materials at site and accordingly determine a cover materials balance. The potentially suitable cover materials are then qualitatively rated for their suitability as growth medium, moisture ingress limiting cover material, as well as the long-term sustainable cover functioning and cover resilience. The cover material evaluation includes erosion related aspects such as susceptibility to soil dispersion, surface sealing and crusting, low rain infiltration and high runoff volumes and velocities, risk for lateral flows that could result in downslope gully initiation and development, and poor internal drainage in addition to detailed soil particle size distribution and organic matter contents.

The results from the erosion and landform stability study are a simulated best outcome for erosional stable post closure landforms based on site available materials and conditions.

Keywords: Erosion, landform stability, mine rehabilitation

Albert van Zyl is a registered professional soil scientist with 22 years experience in the environmental field. He has specialist skills in the application of numerical modelling to erosion and sedimentation, unsaturated flow and contaminant transport, liner leakage, seepage analysis and hydrologic models. His consulting assignments have included several assessments related to soil covers, erosion and sediment transport, seepage impact from contaminated land, tailings and waste facilities and contaminant fate and transport investigations. He also did research on the development of land quality indicators and monitoring systems, and the upscaling of erosion and sediment yield modelling from farm to catchment scale.

INTEGRATING SUSTAINABLE LAND MANAGEMENT INTO CATCHMENT MANAGEMENT STRATEGIES

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ABSTRACT

Erosion and sustainable land management are key aspects to be addressed in the management of rural catchments. The study objectives with regards to erosion were to (1) assess current status and potential future scenarios to identify potential risks and trade-offs, (2) develop a planning framework and analytical tools to evaluate potential options for implementation of catchment management strategy, and (3) develop catchment management strategies to water resource management and development at basin level.

The key issues identified from the situation assessment were that historic and current deforestation and cropland encroachment into steep head water and riparian areas are the major river sediment sources. Agricultural land is cultivated by hand and a combination of soil conservation practices are implemented; indicating that current sedimentation increase is due to improper land use and lack of land use planning rather than poor land management. Localised guidelines on soil and water conservation do exist and is implemented. Poverty levels are high.

The erosion elements that were considered for implementation of catchment management strategies were sediment production associated with soil loss at farmers' fields, sediment delivery and ingress into streams, and sediment transport in rivers. The study approach followed for the sediment production and delivery elements were to (1) identify spatial distribution of land capability in a catchment, (2) compare current land use to broad land capability classes to identify improper land use that requires a change in land use, and (3) predict impact and identify land management practices to minimise on-site soil loss and sediment ingress into streams.

The key catchment management options that were identified at a basin catchment level were that strategic land use planning must be incorporated into catchment management strategies, such as protecting steep, erodible non-agricultural land against deforestation and agricultural development; integrate existing soil conservation institutional structures into catchment management structures, including traditional authorities; use of existing farmer practices as basis to introduce improved conservation agricultural techniques rather than introducing new technologies that are unfamiliar, requires too much change and labour; and promotion of soil and water conservation techniques/practices must be based on directly improving rural livelihood and/or reduce labour requirements.

Keywords: Erosion, catchment management strategies, land use planning, sustainable land management

Albert van Zyl is a registered professional soil scientist with 22 years experience in the environmental field. He has specialist skills in the application of numerical modelling to erosion and sedimentation, unsaturated flow and contaminant transport, seepage analysis and hydrologic models. His consulting assignments have included several assessments related to soil covers, erosion and sediment transport, seepage impact from contaminated land, tailings and waste facilities and contaminant fate and transport investigations. He also did research on the development of land quality indicators and monitoring systems, and the upscaling of erosion and sediment yield modelling from farm to catchment scale.

IMPLEMENTATION OF 10-BE AND 26-AL AMS AT ITHEMBA LABS AND FIRST MEASUREMENTS FOR AN EROSION STUDY

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ABSTRACT

Accelerator Mass Spectrometry (AMS) is the method of choice for a number of cosmogenic radionuclides applied in geomorphology. The most widely used of these are 26-Al and 10-Be, which are formed in quartz upon exposure to secondary cosmic radiation. We have recently implemented the AMS methods for these 2 isotopes at iThemba LABS, have setup a crushing/milling laboratory for the processing of rock to extract the quartz and have now inaugurated a dedicated chemistry laboratory for the extraction of 26-Al. The AMS system has been tested with runs of standard samples. In a first test with real project samples for a study on denudation rates at the Rising Star Cave site near Johannesburg in South Africa were successfully analysed for 26-Al in comparison with the established AMS laboratory in Cologne, Germany, thus verifying our AMS system for 26-Al. For 10-Be we use a new, innovative method of eliminating the interfering stable isobar 10-B. We have successfully tested this method with standards samples and blanks. This method will allow us to measure 10-Be with better efficiency than almost all other AMS laboratories. We are currently working on 10-Be extracts for an inter-comparison on the same samples that have been analysed for 26-Al.

Keywords: cosmogenic isotopes, accelerator mass spectrometry, erosion

Stephan R. Winkler (MSc University of Vienna, PhD Australian National University) is the research scientist responsible for the Accelerator Mass Spectrometry system at iThemba LABS.

UNDERSTANDING THE RELATIONSHIPS BETWEEN LAND COVER DYNAMICS AND SOIL EROSION IN FORMER HOMELANDS OF LIMPOPO, SOUTH AFRICA: A REMOTE SENSING PERSPECTIVE

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ABSTRACT

Reliable and up-to date information on the status of natural landscapes is critical for continued harnessing of ecosystem services. These landscapes sustain wildlife/livestock and crop production which is crucial for the rural poor. Moreover, the stability of natural landscapes is critical not only in the provision of ecosystem services, but also in regulating global land-surface processes and water and carbon cycles, maintaining biodiversity, improving soil fertility, and maintaining regional hydrological balance. Previous studies, have demonstrated that these natural landscapes experiences severe degradation, due to changes in climate conditions, global warming and poor land management practices. However, limited research work has been done to establish the validity of this assertion. This information is therefore critical in developing appropriate land management practices and conservation efforts. The aim of this research was therefore to map and assess the link between land cover changes and soil erosion in former homelands of Limpopo, South Africa, using high spatial resolution remotely sensed data. The results of this study have shown that areas with less vegetation cover are strongly associated with severe degradation. We can therefore conclude that application of remotely sensed data provide crucial spatial information that can support monitoring land degradation and hence aid rehabilitation and assist environmental authorities to determine vulnerable areas.

Keywords: land degradation, spatial extent, monitoring, vulnerable areas, former homelands

Timothy Dube is a lecturer at the University of Limpopo and his research focuses on remote sensing applications in geomorphology.

WETLAND GEOMORPHOLOGY: EROSION PROCESSES SHAPING THE MAGNOLIA DELL PARK

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ABSTRACT

Management of low-lying fluvial systems in developed landscapes are important for flood control, often resulting in engineered channels and flood control basins that alter the sediment loads and related geomorphic processes. The management of these systems is becoming increasingly import to minimize potential flood risk. The aim of the study is to investigate the geomorphology and hydrology of the Magnolia Dell Park and to understand the contribution of urbanization, recreational activities and man-made structures to the erosion in Magnolia Dell Park, Pretoria. In this study the geomorphology, history and surroundings of the Magnolia Dell Park were defined with a specific focus on general geomorphic setting and impacts caused by infrastructure and access routes to the Park; as well as recreational impacts. The gradient and drainage of the Walkerspruit were studied by using 1 m contours and a high resolution colour aerial photo (2013) of the study area. This also helped to spatially examine the urbanized environment and impacts associated with it. It can be concluded that the Magnolia Dell Park is a remnant of a larger wetland now confined between a steep eastern slope, restaurant, and road network in the east with urban development up and downstream of the in- and outflow. Frequent flooding occurs because of the poor design of the upstream stormwater drainage systems, thus resulting in the Walkerspruit overflowing its banks. This has proven to be problematic for the restaurant and subsequent human interventions of paved parking and channeling. The flow has further impacted the Park by increasing surface runoff, soil compaction, damaged vegetation and foot paths causing erosion and flooding downstream. Stagnant water becomes a problem after flooding and occurs in certain low-lying areas of the degraded wetland. Pollution is another problem especially in urbanized areas. Various measures have been taken to prevent and manage erosion, including concrete weirs and gabion retaining walls. This is, unfortunately, inadequate and the study recommends measures to decrease the amount of energy in the system by amongst others: widening the channel; decreasing the steep channel gradient by adding more weirs; slowing down the stream velocity by increasing the channel length and by introducing larger meanders.

Keywords: Floodplain, geomorphology, hydrology, urbanization, impacts, erosion

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SOIL EROSION PREVENTION IS BETTER THAN CURE, IN SOUTH AFRICA'S ONLY LARGE RIVER NETWORK WITHOUT A DAM

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ABSTRACT

The Mzimvubu River Catchment is the only large river network in South Africa without a dam, but proposals for water resource development in the Tsitsa tributary (at Ntabelanga and Lalani) have been put forward. However, the Ntabelanga Dam Catchment consists of highly erodible soils with widespread soil erosion evident (approximately 4 000 gullies, affecting an area of approximately 3 000 ha). Due to limited resources it will not be feasible to rehabilitate these gullies with large and costly structures at the catchment scale. Furthermore, structures in the erodible dispersive soils will enhance subsurface accumulation of water and cause further erosion around structures (worsening the problem). Therefore, in order to implement resources and investments optimally, it is important to prevent further erosion by protecting areas that are not eroded. This was achieved by mapping gully-free areas susceptible to gully development in the catchment, by mapping areas that have the same DEM-derived topographical variables and parent material-soils interactions than gullied areas but which are still gully-free. The main outcome of this study is a map of gully-free areas that are susceptible to gully development in the Ntabelanga Dam Catchment. More than 9 000 ha (5%) of the catchment is highly susceptible to further gully development. These areas consists of gentle slopes in zones of saturation along drainage paths with a large contributing area, erodible duplex soils derived from mudstones. If not protected, these susceptible areas will contribute additional sediment loads to the river network. Soil erosion prevention will not only reduce the sediment yield and increase dam life expectancy, but will also benefit the local communities by preventing further soil degradation of their land.

Keywords: gully erosion, susceptibility, prevention, GIS, catchment scale.

Jay le Roux is a senior lecturer at the Geography Department, University of the Free State in South Africa. He was previously employed in the Soil Health and Remediation Programme at the Agricultural Research Council – Institute for Soil, Climate and Water. His research projects are related to hydrological and soil erosion modelling and mapping using GIS and remote sensing techniques. His most recent project modelled the flow and sediment yield in the Mzimvubu River Catchment that made it possible to estimate future dam life expectancies. Other research focus areas include sediment transport and hydrological connectivity, using hydrological models such as the Soil and Water Assessment Tool that are interfaced in a GIS.

GEOMORPHOLOGY OF THE GRANITE CAVES OF GOBHOLO, SWAZILAND

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ABSTRACT

While the most common types of caves are Karst caves which form on soluble rocks such as limestone and dolomite, granite caves are a special class of caves which form on granitic or granitoid rock (non-karst or pseudo-Karst), with totally distinct geomorphological processes responsible for their genesis. Granite (consisting primarily of quartz, feldspar, mica, and pyroxene) is normally water insoluble, unlike limestone, dolomite and gypsum. Consequently, chemical weathering and gravitational collapse of the scree material are the main processes identified as being responsible for granite caves. However, on rare occasions on cooling magma sometimes leaves hollows within it, which may later be classified as primary granite caves. Extending more than 40m below ground, with lengths of more than 1200m, the Gobholo caves in Swaziland are one of the largest granite caves ever reported. The caves are found in the Gobholo valley, lying about 10km east of Mbabane, the capital city of Swaziland and between the Gobholo and Msunduza mountains. Through the valley flows the Gobholo River which flows under the cave system for more than 1.8km. The Gobholo caves are now used as a tourist attraction site by a local adventure company in the country, but very little is known about the geomorphological genesis of this granite heritage system. This ongoing research on the cave system seeks to enhance the scientific understanding of the development of the caves and to enhance the sustainable management of this site of cultural significance. In order to achieve the aim of this research, mapping of the Gobholo caves, geochemical and bio-geomorphological analysis of the host rock and surrounding environments will be conducted. Further, data on geomorphological processes including chemical weathering, flowstone formation as well as gravitational collapse of host rocks will be collected to model the processes which have led to the development of the caves. A hydrological and bio-geomorphological study of the Gobholo River will also be conducted to investigate its influence on the development of the caves. Ultimately, conclusions will be drawn about the development of the Gobholo caves and sustainable management practices, based on the findings of the studies, will be proposed.

Keywords: Geomorphology, Psedo-karst, Granite caves, Gobholo

Mthobisi Masilela is a teaching assistant at the University of Swaziland and currently developing his proposal for PhD research in physical geography where he will study the gnesis and morphology of the granite cave system in Gobholo, Swaziland. The co-authors, Heinz Beckedahl and Paul Sumner are professors in geography at the University of Swaziland and University of Pretoria respectively. They are supervising the PhD research as pursued by the main author.

GULLY EROSION RATES IN THE TSITSA RIVER CATCHMENT, EASTERN CAPE PROVINCE

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ABSTRACT

Gully erosion is one of the most prevalent forms of soil degradation in South Africa and is a process in which water concentrates in narrow flow paths and removes soil, resulting in deep incised channels that range from 30cm to 30m deep. The assessment of gully erosion rates in severely gullied catchments, however, remains a major challenge. The aim of the study is to assess the gully erosion rates in a severely gullied catchment known as the Tsitsa River Catchment in the Eastern Cape Province. This will be achieved through the mapping of gully expansion of representative gullies at different time scales; assessing the gully depths and their different volumes in the field, and by ultimately determining the erosion rate of the catchment. Sequential mapping techniques will be used to map gully development/expansion of representative gullies. The study will utilize the most recent multi-temporal and high resolution imagery that are available, including SPOT 5 satellite imagery and National Geospatial Information (NGI) aerial photos. The study will measure current gully depths in the field and determine their volumes, followed by estimations of the current gully erosion rates in a GIS. First estimates indicate that gullies continue to expand, most probably due to overgrazing and because of highly erodible duplex soils in the area. These causal factors work in tandem, decreasing infiltration rates which in turn leads to increased (channelized) runoff and the formation of gullies in the Tsitsa River Catchment.

Keywords: Gully erosion, rates, expansion mapping

Lefa Morake is a Geography honours student at the University of the Free State.

AEOLIAN PROCESSES AND SEDIMENT FLUX ON SUB-ANTARCTIC MARION ISLAND

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ABSTRACT

Recent observations have recognised the increasing role of aeolian processes as a geomorphic agent on sub-Antarctic Marion Island. Thus, this study presents the first data on intra-annual variations in the rates of aeolian sediment flux at Mesrug (46° 56' 41"S; 37° 49' 59"E) Marion Island. Marion Island has a hyper-oceanic climate, with cold and wet conditions and consistently strong wind velocities throughout the year. An intensive and high resolution environmental monitoring campaign was conducted at the study site. Aeolian transported sediments were collected using Big Spring Number Eight (BSNE) sediment traps at four different heights above the ground (i.e. 0.05, 0.25, 0.45, 0.65 m) on a monthly basis. The study also investigated the relationships between; aeolian sediment flux and wind speed, maximum wind gusts, and rain-free days to ascertain what the drivers of aeolian sediment movement rates are on sub-Antarctic Marion Island. Local meteorological conditions were monitored at 0.8 m above the surface at five-minute intervals using Pace Scientific XR5 data loggers and sensors. The experiment suggest an annual sediment flux of 1.37 kg cm-2 y-1 exist at the study site while it was estimated that aeolian sediment movement appears to cease at 0.93 m above the ground. A notable limitation of the study is the incomplete dataset of environmental parameters. As such, no single environmental parameter can be correlated with aeolian sediment flux. This study advocates further long-term monitoring of aeolian processes on Marion Island and that the link between aeolian processes and synoptic climate must be established. In addition, research on wind as a means to disperse genetic material on Marion Island should be investigated.

Keywords: Marion Island, Hyper-oceanic, sediment flux, aeolian features

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THE EFFECT OF BENEFICIAL MICROBES ON PLANT AND SOIL HEALTH

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ABSTRACT

The physical, chemical and biological constraints associated with mining overburdens presents different reclamation problems. For restoration and rehabilitation efforts to be successful, the establishment of a self-sustaining ecosystem, as well as a permanent vegetation cover is required. Interactions between plants, especially plant roots and soil biota can be seen as the "biological engine of the earth" which drives processes such as ecological niche establishment, the cycling of nutrients and the maintenance of soil structure. Soil microbes thus influence ecosystem processes such as nutrient acquisition and nutrient cycling as well as pedogenesis. However, the impact of these soil microbes on plant productivity and diversity is not well understood.

This study aimed to investigate the effect of two fungal inoculants on plant growth and soil health. A live microbial bio-fertilizer as well as a beneficial plant growth promoting fungi were applied to contaminated soil from a gold mine tailing. Co-inoculations consisting of the microbial bio-fertilizer and the plant growth promoting fungi were applied. Plant species selected for this study were Sunflower (Helianthus annuus), Amaranthus (Amaranthus cruentus) and Scutch grass (Cynodon dactylon) as these mentioned species are suitable for use in the rehabilitation process. Preliminary plant performance was evaluated in terms of the number of plants that germinated. Fluorescein Diacetate Hydrolysis (FDA) tests were also done to measure the total microbial activity in the soil as an indication of soil functionality. Further plant performance tests will include plant height, root to shoot ratios, root and shoot weights and photosynthetic ability.

The results of this study indicate that the treatments had different effects on germination as well as soil microbial status. Soil microbes have the potential to increase the uptake of toxic metals such as aluminium which is abundantly present at low pH conditions. It has already been proven in previous studies that soil microbes can increase plant growth in uncontaminated soil. Thus, it is proposed that soil amendments be applied to the contaminated soil before the application of microbes, in order to prevent toxicity in plants due to a low soil pH. Beneficial microorganisms inoculants may thus have an impact on the renewal of self-sustained ecosystems which in turn have the potential to influence the success rate of rehabilitation of disturbed/contaminated mining sites.

Keywords: Soil microbes, microbial activity, soil functionality, plant growth, rehabilitation

Dinè Pretorius is a BSc Honours Environmental Rehabilitation student at the University of the Free State. Her research project aims to investigate the effect of beneficial soil microbes on plant growth and soil health as a potential measure to increase the success rate of mine rehabilitation.

ASSESSING THE INFLUENCE OF VALLEY SETTING AND SPECIFIC STREAM POWER ON RIVER FORM AND PROCESSES IN MOUNTAINOUS, SEMI-ARID CATCHMENTS, EASTERN CAPE, SOUTH AFRICA

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ABSTRACT

The study investigated two catchment-scale controls on river forms at the Baviaanskloof, Kouga and Kromme (BKK) catchments: valley confinement and valley specific stream power. The delineation and characterization of primary controls on river forms are crucial in the assessment of the geomorphological components of river systems. These catchments are characterized as semi-arid, mountainous, meso-scale catchments.

Most rivers flow in valleys where the bedrock material exerts some degree of lateral or vertical confinement. As result, river characteristics accompany variations in the valley width. Valleys can be broadly classified as confined or unconfined, with highlighted differences in their vegetation structure, topographic gradient and groundwater-surface water interactions. Stream power has been used to estimate sediment transport and channel patterns. It is a function of discharge, slope and channel width. These variables have a tendency to systematically change along a river's longitudinal profile as geologic and climatic controls influences their distribution and pattern. The study initially employed an automated method for determining valley confinement and specific stream power using Valley Confinement Algorithm (VCA). The algorithm mapped the extent and shape of unconfined valley bottoms using readily available spatial data such as Digital Elevation Model (DEM) and a stream network as an input. Unconfined valley bottom polygons were delineated by the algorithm and areas along streams but outside of the polygons are considered confined valleys. Metrics such as centerlines and valley width were consequently generated for calculating valley specific stream power.

Additionally, a terrain analysis method was developed to calculate specific stream power on heterogeneous landscapes for the three sample catchments. The study used a 5m resolution DEM to determine the slope, flow accumulation for each catchment and weighted this flow accumulation grid with Lynch's gridded surface of long-term rainfall statistics (1900-2000) as a discharge proxy. The method substitutes channel width by valley width because specific stream power is primarily constrained by valley width in semi-arid systems with highly variable flows. The results provided a quantitative, typological spatial variation of the mechanistic descriptors of the controls on fluvial styles. Further statistical analysis can be applied to predict and classify different fluvial styles in a catchment.

Keywords: Geographical Information Systems (GIS); Hydrogeomorphology; river classification; integrated river catchment management

Siviwe Pamela Sekese is a MSc Environmental and Water Science student at the Department of Earth Sciences, University of the Western Cape. Her research is focused on fluvial geomorphology in particularly, developing a catchment-linked framework for classifying different fluvial styles. The current thesis forms part of a bigger project which is aimed at developing a participatory hydrological model for the exploration of water resource protection, restoration and water use management options in the western Algoa WMA.

GULLY DEVELOPMENT AND LAND USE CHANGE IN THE TSITSA RIVER CATCHMENT, EASTERN CAPE PROVINCE

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ABSTRACT

Present day land-use and erosion have a far more complex relationship than what is seems at face value, often due to historical cases of land degradation. Gully erosion is a vital form of soil erosion which contributes significantly to soil degradation and loss in South Africa. Most of the gullies which are identified today are the result of a different form of land use between the present day and the past, therefore rendering the landscapes to be more vulnerable to gully incision. Research conducted in the Ngqushwa district, Eastern Cape, indicates that there is a very strong link between land-use change in the form of abandonment and badland gullying. However, there are no appropriate and standardized procedural measures to be taken with regards to erosion rates, monitoring and experimental studies of the irrigation and development of different gully types as well as their respective controlling factors.

Although land degradation within the Eastern Cape Province is a complex relationship between social, economic and environmental factors, land use change is usually coupled with land degradation including expansion of gullies in rural areas. It is postulated that gully erosion increased immensely in the late 1980's early 1990's when most of the fences in the Tsitsa River Catchment were removed. This study investigates gully development during latter-mentioned timeframe (when most fences were removed) using remotely sensed data (NGI aerial photos and SPOT 5 imagery).

Keywords: Gully erosion, Land use, Tsitsa River Catchment, Eastern Cape

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MAPPING AND MONITORING THE SPATIO-TEMPORAL VARIATIONS OF LAND DEGRADATION USING MULTISPECTRAL REMOTE SENSING DATA. A CASE STUDY OF SEKHUKHUNE DISTRICT

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ABSTRACT

Land degradation is one of the environmental problems particularly in South Africa that is severe and widespread. In South Africa, large degraded areas have been found within the former homelands, now communal areas. Many communal areas in the Limpopo, North West, Northern Cape, and Mpumalanga provinces are also severely degraded. Greater Sekhukhune District in Limpopo is among some of the areas which are badly degrading. The study aimed at assessing the utility of multispectral remote sensing technology in mapping and monitoring the spatiotemporal levels of land degradation in the Greater Sekhukhune District, Limpopo South Africa. Further, the study assessed if the observed soil erosion trends that existed in this area could be explained by biophysical factors relative to soil characteristics. . The results have shown that different levels of land degradation can be mapped from remotely sensed with accuracy around 60%. Overall the findings of this study underscores that the importance of free and readily available Landsat 8 OLI for continuous and landscape scale monitoring of land degradation and rehabilitation purposes.

Keywords: Former homelands; land degradation; remote sensing, soil erosion, supervised maximum likelihood classification

Terrence Koena Sepuru is a first year masters student in the department of Geography and Environmental studies. His research is based on the application of GIS and Remote Sensing data in monitoring and mapping soil erosion occuring over space and time.

THE EFFECT OF RAINFALL EVENTS ON GULLIES IN THE TSITSA RIVER CATCHMENT

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ABSTRACT

Soil erosion is a major challenge confronting soil and water resources in South Africa. One of the most detrimental forms of erosion in South Africa, especially in the Eastern Cape, is gully erosion. There are many processes and factors that contribute towards the development of gully erosion. Subsequently, research on gully erosion is challenging including several research gaps. Some of the main factors causing gully development include topographical characteristics, soil characteristics that are derived from certain parent materials, vegetation cover and land use interactions, as well as rainfall erosivity and runoff. One of the major causal factors is rainfall erosivity and runoff, especially during a rainstorm. Rainfall and runoff have been known to be a major driving factor in gully development - a prominent land degradation problem in the Tsitsa River Catchment, Eastern Cape. This study aims to investigate what influence rainfall events have on the development of gullies in the Tsitsa River Catchment. Rainfall data along with remotely sensed data over the periods of five and thirty years will be analysed and assessed. The first objective is to identify large rainfall events over the periods of five years and thirty years. The second objective of this study is to establish the extent of development for 10 test gullies over the same periods. Rainfall data from the nearby weather stations, along with aerial imagery are used to assess the extent of gully development, and in turn, the influence that rainfall events have on gully development.

Keywords: Rainfall; gully development; gully rates

Johannes M. Theunissen is a Honours Student at UFS and his research focus is on gully erosion.