SAAG Biennial Conference

Hogsback, Amathole Mountains

28-30 September 2023

Conference Organisers

Dr. Christel Hansen (University of Pretoria), Dr. Elizabeth Rudolph (University of the Free State), Laura Bannatyne (Rhodes University)
Contact the organisers at saageomorph@gmail.com.

Sponsors

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WELCOME MESSAGE

Welcome to the Southern African Association of Geomorphologists (SAAG) 2023 biennial conference, the first in-person conference since the Covid-19 pandemic. The conference, scheduled over 3 days, is held within the vicinity of Hogsback, located in the Eastern Cape of South Africa. The pre-conference excursion was held on Thursday 28 September, where participants were taken to the wetlands of the Elandsberg, and sampling was done to determine whether or not some of the wetlands found there consist of peat. The latter part of the day was spent on a visit to the scree deposits of Gaika's Kop. Importantly, our IAG grant recipients to the *Young Geomorphologist Training Program* took an active part in yesterday's activities.

Friday and Saturday are dedicated to academic presentations on geomorphological work done by our members. We have an exciting program for you. Spanning 6 sessions, chaired by our IAG grant awardees, we will have the opportunity to see work incorporating modelling approaches, and GISc, fluvial geomorphology, soil erosion, land degradation, as well as a session on science engagement.

On Friday morning (28 September) we are pleased to welcome Professor Sumner of the University of Fort Hare, who will give the **Plenary**. Professor Sumner will speak to '*Rock weathering: on trends and tenets – a southern African perspective'.*

Saturday after morning tea has been set aside for the **SAAG Biennial General Meeting**, followed by the **conference dinner** that evening where the new recipients of the Fellowship of SAAG will be announced.

We hope you enjoy the program on offer. We are also pleased to announce that the conference is registered with SACNASP for two CPD credits (validation number 2023-0681-002634)

We hope you will enjoy the conference! For any questions, please contact us at saageomorph@gmail.com.

Your 2023 Conference Organising Committee
Christel Hansen (University of Pretoria), Elizabeth Rudolph (University of the Free State), Renée Grundling (University of Pretoria) & Laura Bannatyne (Rhodes University)

SACNASP ACCREDITATION

The 2023 SAAG biennial conference was held 28-30 September 2023 in and around Hogsback, Eastern Cape Province of South Africa. The SAAG conference was held at The Edge in Hogsback and is registered for 2 CPD points with SACNASP under reference 2023-0681-002634.

PLENARY

Professor Paul Sumner from the University of Fort Hare will be giving the keynote address at our 2023 conference on 29 September. He will be talking on *'Rock weathering: on trends and tenets – a southern African perspective'.*

After completing high school in Eshowe, Paul Sumner studied for a BSc with majors in geography and chemistry at the University of Natal. An H.D.E. followed, also on the Pietermaritzburg campus, then Honours and the MSc degree in geography. Captured by university life, Paul took his first post as a temporary lecturer at the University of Fort Hare where he stayed for two years and then moved to a lectureship at the University of Pretoria in 1997. Paul was drawn to the mountains and worked on footpath erosion in the Drakensberg for the master's, and later on palaeo-landforms in Lesotho for the PhD at the University of Pretoria. Not afraid to digress, Paul also had an interest in rock weathering processes and studied these on Marion Island and in the Drakensberg. After working with colleagues and postgraduates in the sub-Antarctic, his interest shifted to more tropical climes where he co-led studies on erosion phenomena on Mauritius. He returned to the University of Fort Hare (UFH) in 2019, where SAAG celebrated three decades at the biennial event in that year. Paul has graduated 30 masters and doctoral candidates and published 54 journal articles. He is now Professor and Head of Department of the Department of Geography and Environmental Studies at UFH and holds a C rating with the NRF.

Awards and Grants

IAG Young Geomorphologist Training Program

With support of the International Association of Geomorphologists (IAG), SAAG was able to sponsor some of our Emerging Career researchers (ECRs) to the value of up to R 3,000.00 each, to attend the conference. Part of this is the participation in our IAG Young Geomorphologist Training Program.

The training program consists of two parts, of which PART I focuses on the pre-conference excursion. During this excursion, successful applicants learn about wetland degradation, rehabilitation, and wetland types of the Amathole Mountains. A significant portion of the training focused on peatlands, the identification thereof, and sampling of cores from wetlands for subsequent laboratory analyses.

PART II allows successful applicants to see the behind-the-scenes part of organising a conference. Before conference commencement awardees were involved in session descriptions, selection and ordering of abstracts, and scheduling of sessions. During the conference awardees help with logistical aspects, as well as chairing their sessions (together with an established researcher).

Successful applicants are Febe Jansen van Vuuren, Lukho Goso, Renée Grundling, Jason le Roux, Mthobisi Masilela, Thandeka Ndlela, Nkosingizwile Ndlovu, and Marike Stander. Each of the awardees will also present their work at the conference. Their talks are listed below.

Awardee	Talk	Date
Febe Jansen van Vuuren	Determining the composition of sediment in the Proses Spruit and Kromellenboog Spruit (Free State, RSA) using sediment fingerprinting	30 September, 15:30-17:00
Lukho Goso	Using Geographic Information Systems (GIS) to assess the biodiversity and protection levels of Africa's rivers	29 September, 15:30-16:30
Renée Grundling	Proposed anthropogeomorphological wetland classification system	29 September, 11:45-13:00
Jason le Roux	How degradation influences surface topography and hydraulic behavior of peatlands in the Maputaland Coastal Plain	29 September, 10:50-11:30
Mthobisi Masilela	Understanding the geomorphology of the Gobholo Granite Cave System in Eswatini	29 September, 16:45-17:40
Thandeka Ndlela	An assessment of land-use management-driven differences in the ecohydrology, physical and chemical composition of two peatlands in Eswatini	29 September, 11:45-13:00
Nkosingizwile Ndlovu	Assessing changes in the hydrological regime of lacustrine wetlands on the Maputaland Coastal Plain, South Africa	29 September, 10:50-11:30
Marike Stander	Apportioning soil types as source groups by using weathering indices as tracers	30 September, 15:30-17:00

SAAG would like to thank the IAG for their generous contribution, and the awardees for the hard work put into making the conference a success.

Esri South Africa Grant Awardees

Esri South Africa sponsored full conference attendance of two participating students. Each award has a value of R 5,500.00. A call was sent to students that had an accepted abstract at the conference. Any student that met the eligibility requirements listed below could apply.

Eligibility:

- Applicants must be students and have an accepted abstract to SAAG 2023.
- Applicants must be registered by the time of application, be a member of SAAG or a paid member of the SAYG.
- Applicants should use / have used the Esri suite of products in their work.

The two successful applicants are Lukho Goso, and Nkosingizwile Ndlovu. Lukho is presenting on 29 September in the 15:30-16:30 session on *Using Geographic Information Systems (GIS) to assess the biodiversity and protection levels of Africa's rivers*; Nkosingizwile is presenting on 29 September in the 10:50-11:30 session on *Assessing changes in the hydrological regime of lacustrine wetlands on the Maputaland Coastal Plain, South Africa*. SAAG congratulates both Lukho and Nkosingizwile for being selected for the Esri awards.

ECR Presentation Awards

The conference has many student submissions. All student presentations (those that take the format of a 12-minute student presentation), will be evaluated by selected SAAG members. The two best presentations will be awarded with book prizes.

The best two student presentations will receive either *Quaternary Environmental Change in Southern Africa*, sponsored by Professor Jasper Knight, or *Veld Management - Principles and Practices*, sponsored by Briza Publishing. SAAG thanks both sponsors for their generous contributions.

SESSIONS

Session	Description
Hydrological systems & regimes Friday 29 September, 10:45-11:40; 11:50-13:00; 14:00-15:00 *Convenors: Marike Stander & Febe Jansen van Vuuren*	Hydrological regimes and systems play a major role in shaping landscapes - even that of the economy - but people also play a role in shaping them. In this session, we look at the interaction between hydrological systems, the landscape, ecosystems, the climate, and humans. Firstly, the focus is on peatlands and wetlands, assessing their composition, degradation, hydrological regime, extent, and human impact. Secondly, the impact of floods on businesses is investigated, with the focus finally moving to fluvial systems. Rivers of Hogsback, the relationship between land use, riparian vegetation and channel geometry, and the mapping of channels over 80 years are presented.
Geomorphology & GISc Friday 29 September, 15:30-16:30 *Convenor: Mthobisi Masilela*	This session focuses on the application of GIS and Remote Sensing in the assessment of geomorphic and environmental processes to better understand and manage our landscapes and their ecosystems. Talks range from assessing biodiversity and river protection in Africa to assessing the rehabilitation of degraded hillslopes and modelling energy expenditure in nature reserves. With DEMs extensively used in terrain and surface modelling, the impacts of the choice of the DEM selected for geomorphic analysis are evaluated.
Modelling approaches in geomorphology Saturday 30 September, 09:50-10:30 *Convenor: Jason le Roux*	This session focuses on hydrological modelling, with a specific focus on the Soil and Water Assessment Tool (SWAT). It begins with a presentation on a newly developed open-access database containing baseline input data needed to run the model, as well as the results of modelling streamflow and sediment outputs at national and catchment scales with this data set. The succeeding presentation investigates the effect of DEM data resolution on SWAT model performance for analysing the hydrological response to land cover and land use (LULC) changes in the Swartkops River catchment. The session concludes with SWAT being applied to determine the effects that plantations could have on wetlands in the eastern Free State.

Session	Description
Open theme Friday 29 September, 15:30-17:00 *Convenor: Renée Grundling*	This session covers a wide range of topics. It starts by introducing the South African sub-antarctic region of Marion Island where lithology dating methods and virtual tourism of the region will be discussed. The session will then shift to discussing granite weathering in the creation and geomorphology of the Gobholo caves in Eswatini. Finally, the session will return to South Africa and close with a discussion of small-scale farmers in the Eastern Cape, their yields and the factors influencing them.
Science engagement Friday 29 September, 09:20-10:30 Saturday 30 September, 09:00-09:50 *Convenor: Thandeka Ndela*	This session showcases the different ways geomorphology contributes to geography education of different stakeholders from students, scientists from different disciplines, policymakers, government, communities, as well as private business owners. Various ways of doing this are discussed, such as improving research infrastructure, the use of virtual reality, as well as adopting social-economic-ecological pathways in geomorphological research. The session further highlights the opportunities for tackling complex geomorphological concepts, by using Southern Africa as a natural laboratory.
Soil erosion & land degradation Saturday 30 September, 14:00-15:00; 15:30-17:00 *Convenors: Lukho Goso & Nkosingizwile Nldovu*	Soil erosion and land degradation are pivotal challenges that ripple across ecosystems, impacting agriculture, water resources, and our environment. They are the silent culprits reshaping our landscapes. This session is not a mere presentation; it's a dynamic, immersive exploration. In Friday's session, we begin our journey with a focus on rural Mpumalanga, South Africa, where unpaved roads intersect with environmental degradation. We'll tell the story of gully and rill erosion, intricately linked to agricultural landscapes and community well-being. As these converge, themes emerge, shining a light on the multifaceted challenges. We'll uncover the consequences of poor management, the interplay of topography and climate, and the profound role of community perceptions. During Saturday's session, our expedition starts in the upper Caledon River Catchment, revealing planosols and acrisols' intricate sediment contributions. Tracing the UPL agrochemical spill and Jagersfontein Tailings Facility collapse, we'll dissect the progression from triggers to the journey of rehabilitation. Ascending Amathole Mountains, the Machine Learning Random Forest algorithm deciphers gully erosion secrets, unveiling dynamic forces. The session concludes with the Jagersfontein Tailings Facility's aftermath through sediment fingerprinting, decoding the long-lasting ecological and agricultural impacts.

PROGRAM

SUMMARISED PROGRAM

Colour key	Administrative	Official	General session	Excursion	Refreshments

<table>
<tr><th>Time</th><th>28 (Thu)</th><th colspan="2">29 (Fri)</th><th>30 (Sat)</th></tr>
<tr><td>8:00</td><td rowspan="16">Preconference Excursion</td><td colspan="2">Final registration</td><td>free time</td></tr>
<tr><td>8:30</td><td rowspan="2">Opening session</td><td>Uploading of presentations</td></tr>
<tr><td>9:00</td><td>Science engagement</td></tr>
<tr><td>9:30</td><td rowspan="2">Science engagement</td><td rowspan="2">Modelling approaches in geomorphology</td></tr>
<tr><td>10:00</td></tr>
<tr><td>10:30</td><td colspan="2">Tea</td></tr>
<tr><td>11:00</td><td rowspan="4">Hydrological systems & regimes</td><td rowspan="4">SAAG BGM</td></tr>
<tr><td>11:30</td></tr>
<tr><td>12:00</td></tr>
<tr><td>12:30</td></tr>
<tr><td>13:00</td><td colspan="2">Lunch</td></tr>
<tr><td>13:30</td><td colspan="2"></td></tr>
<tr><td>14:00</td><td rowspan="2">Hydrological systems & regimes</td><td rowspan="2">Soil erosion & land degradation</td></tr>
<tr><td>14:30</td></tr>
<tr><td>15:00</td><td>Tea</td><td>Tea @ own expense</td></tr>
<tr><td>15:30</td><td rowspan="2">Geomorphology & GISc</td><td rowspan="3">Soil erosion & land degradation</td></tr>
<tr><td>16:00</td></tr>
<tr><td>16:30</td><td rowspan="2">Open theme</td></tr>
<tr><td>17:00</td><td></td></tr>
<tr><td>17:30</td><td>Registration</td><td colspan="2">free time</td></tr>
<tr><td>18:00</td><td>Meet & greet</td><td>Dinner @ own expense</td><td>Conference dinner</td></tr>
</table>

DETAILED PROGRAM: DAY 1

Colour key	Administrative	Official	Geomorphology & GISc	Open theme	Soil erosion & land degradation	Hydrological systems & regimes	Science engagement	Modelling approaches in geomorphology

Time	Friday 29 September
8:00	**Final Registration & Uploading of Presentations**
8:20	Opening (Laura Bannatyne, SAAG President)
8:30	Keynote speaker: Professor Paul Sumner *'Rock weathering: on trends and tenets – a southern African perspective'*
9:20	**Break**
09:20-10:30	* South African Polar Research Infrastructure (SAPRI): an introduction and science engagement, Abuyiselwe A Nguna * Old scopes to new goggles: implementing virtual reality in the South African lecture room, Elizabeth Rudolph * The use of VR technology as an alternative to real-world field trips: a study in the geomorphology classroom, Christel Hansen
10:30	**Tea**
10:45-11:40	* How degradation influences surface topography and hydraulic behavior of peatlands in the Maputaland Coastal Plain, Jason le Roux * Assessing changes in the hydrological regime of lacustrine wetlands on the Maputaland Coastal Plain, South Africa, Nkosingizwile Ndlovu
11:40	**Break**
11:50-13:00	* Quantifying changes in the extent of wetland types of the Maputaland Coastal Plain using remote sensing: implications for restoration and conservation, Philani Apleni * Proposed anthropogeomorphological wetland classification system, Renée Grundling * An assessment of land-use management-driven differences in the ecohydrology, physical and chemical composition of two peatlands in Eswatini, Thandeka Ndlela * Rivers of Hogsback in a changing environment, Kate Rowntree * Examining land use and riparian vegetation relationships on channel geometry: implications for the hydrologic regime of the Baakens river catchment, Nelson Mandela Bay Municipality, Luneshri Odayar *Mapping changes to fluvial channels in the Delumhlwazini and Injisuthi River Valleys, uKhahlamba-Drakensberg, between 1935 and 2023, Ian Meiklejohn
13:00	**Lunch**
14:00-15:00	* Using Geographic Information Systems (GIS) to assess the biodiversity and protection levels of Africa's rivers, Lukho Goso * What is the impact of the choice of Digital Elevation Model (DEM) in geomorphological analysis? Examples from South Africa, Jussi Baade * Using GISc for modelling energy expenditure when traversing paths in nature reserves of the City of Tshwane, South Africa, Christel Hansen * Analysing rehabilitation success of *Pportulacaria afra* on degraded hillslopes of Steytlerville: a remote sensing and landscape function analysis approach, Aobakwe Tsheloane
15:00	**Tea**
15:30-17:00	* Constructing a digital Marion Island using Unreal Engine 5 to examine its use for virtual tourism and geo-conservation, Bjorn Boyes * Determining the formation ages of the lithologies on sub-Antarctic Marion Island, Sibusiso Sinuka * Understanding the geomorphology of the Gobholo Granite Cave System in Eswatini, Mthobisi Masilela * Karst geomorphology and associated environmental problems within the Southern Africa Region, Heinz Beckedahl
17:00	***Day 1 concludes. Dinner @ own expense.***

DETAILED PROGRAM: DAY 2

Colour key	Administrative	Official	Geomorphology & GISc	Open theme	Soil erosion & land degradation	Hydrological systems & regimes	Science engagement	Modelling approaches in geomorphology

Time	Saturday 30 September
8:30	**Uploading of Presentations**
09:00-09:50	* Between a rock and a hard place. Opportunities for geomorphic inquiries in Southern Africa, Frank Eckardt * Geomorphology as a component of the social economic ecological framework, Laura Bannatyne
09:50-10:30	* Southern African soil, land cover and weather generator file databases for SWAT applications, Jay le Roux * Modelling the impacts of forestry on wetland hydrology using the Soil Water Assessment Tool, Colby L. Weiss
10:30	**Tea**
11:00-13:00	**SAAG Biennial General Meeting**
13:00	**Lunch**
14:00-15:00	* Assessing soil erosion and sedimentation risk in relation to land use in contributing drainage areas of impoundments in the Upper Keiskamma Catchment, Bachazile Vilakati * Soil erosion and rainfall erosivity in a Karoo badland - an eleven year record, Kate Rowntree * Gully erosion topographic preferential zones on the high-water yield Amathole Mountains, Eastern Cape, South Africa: insights to coupling and sediment connectivity, Sive Mlamla
15:00	**Tea**
15:30-16:30	* Determining the composition of sediment in the Proses Spruit and Kromellenboog Spruit (Free State, RSA) using sediment fingerprinting, Febe Jansen van Vuuren * Apportioning soil types as source groups by using weathering indices as tracers, Marike Stander * Understanding the role of geomorphological processes in anthropogenic disasters: the UPL and Jagersfontein disaster case studies – from cause to rehabilitation, Piet-Louis Grundling
16:30	***Day 2 concludes. Join us for the Conference Dinner at 18:00.***

ABSTRACTS

Analysing rehabilitation success of P*ortulacaria afra* on degraded hillslopes of Steytlerville: a remote sensing and landscape function analysis approach

Aobakwe Tsheloane

Department of Geosciences, Nelson Mandela University, Gqeberha, South Africa

S220049424@mandela.ac.za

Student presentation, Geomorphology & GISc session

Land rehabilitation is a continuously growing practice aiming to remediate land degradation on countless landscapes and ecosystems in the Karoo, Eastern Cape, South Africa. *Portulacaria afra* (Spekboom) was introduced on extensively degraded rangelands of Steytlerville linked to extreme weather conditions and injudicious land use activities such as historical overgrazing, to rehabilitate the degradation, mitigate potential desertification and revive landscape functionality. The effectiveness of any rehabilitation efforts needs to be monitored and understood. Since the implementation of the Spekboom rehabilitation programme, the hillslopes' secondary vegetation cover succession and landscape functions are poorly understood quantitatively. The aim of this study was to analyse rehabilitation success of *Portulacaria afra* on degraded hillslopes combining remote sensing and landscape function analysis (LFA) approach. Degraded hillslopes, rehabilitation sites of early growth stage Spekboom and matured Spekboom, vegetation condition were mapped using the Normalised Difference Vegetation Index (NDVI) for photosynthetic activity and the Normalised Difference Moisture Index (NDMI) foliar moisture content. On each site, 50-m long transects (n = 3), landscape function was determined by analysing patch-interpatch attributes to derive the Landscape Organisation Index (LOI) to understand recovery from hillslope dysfunctionality to functionality. Results show a positive correlation between the NDVI, NDMI and the LOI on the young and mature Spekboom sites. The young and mature Spekboom sites were characterised by high NDVI, NDMI and LOI denoting high vegetation health, foliar moisture and well-connected patches, which are signs of well restored vegetation activity. Therefore, mature and young Spekboom exhibit signs of positive rehabilitation and reduced levels of degradation. The study further proves the efficacy of remote remotely sensed data for monitoring rehabilitation efforts success at similar spatial scales.

Keywords: land rehabilitation, Portulacaria afra, landscape function analysis, vegetation indices

An assessment of land-use management-driven differences in the ecohydrology, physical and chemical composition of two peatlands in Eswatini

Thandeka Ndlela[1*], Heinz Beckedahl[1,2], and Piet-Louis Grundling[3,4]

[1] Department of Geography, Geoinformatics and Meteorology, University of Pretoria, South Africa

[2] Department of Geography, Environmental Science and Planning, University of Eswatini, Eswatini

[3]Centre for Environmental Management, University of the Free State, South Africa

[4]Department of Forestry, Fisheries and the Environment, Regulatory, Compliance and Sector Monitoring, Pretoria, South Africa

*thandeka.ndlela@icloud.com

Student presentation, Hydrological systems and regimes session

The classification of peatlands is often based on several factors such as the source of peat, geomorphic features, vegetation, and climate. Hydrology has also been linked to specific peatland types and forms the basis of a peatland classification methodology with the source of water and source of nutrients identified as fundamental controls. This study, therefore, is an attempt at assessing and comparing land use management-driven differences in the ecohydrology, and physical and chemical composition of two peatlands in Eswatini. The first peatland occurs at a gazetted and protected area at Malolotja Nature reserve, while the second, occurs at Motjane community, and hence falls under Swazi Nation Land. A total of two and four monitoring transects were established at the Malolotja and Motjane peatlands, respectively. The decision on the number of transects to establish was made on the basis of the complexity of the sites (hydrology, topographic relief, vegetative communities, and soil types), the objectives of the monitoring project, as well as the size of the areas. On both peatlands, wells and piezometers were installed to monitor various hydrological parameters including water levels, electrical conductivity, and water temperature, as well as to sample ground and surface water for isotope analysis. Samples of peat and soil were also taken from all transects for the elemental analysis of carbon, nitrogen, hydrogen and sulfur, analysis of bulk density and major ions. Initial findings suggest a shallower and more stable water table at the Malolotja peatland. Additionally, the Malolotja peatland contains a higher percentage of the elements carbon and nitrogen in comparison to the Motjane community peatland. A long-term, detailed monitoring of the variables is still underway, and this will allow for the comparison of such results with similar parameters in Southern Africa and elsewhere.

Keywords: peatlands, land-use, ecohydrology, physical, chemical composition

Apportioning soil types as source groups by using weathering indices as tracers

MH Stander*[1], JJ le Roux[1], MAM Abd Elbasit[2], Gang Liu[3]

[1]Department of Geography, University of the Free State, Bloemfontein, South Africa,

[2]Department of Physical and Earth Sciences, Sol Plaatje University, Kimberley, South Africa

[3]State Key Laboratory of Soil Erosion and Dryland Farming on the Loess Plateau, Institute of Soil and Water Conservation, Northwest A&F University, Yangling, China

*duplessisMH@ufs.ac.za

Standard presentation, *Soil erosion and land degradation session*

The erodibility of duplex soils has made them the focus for research investigations where soil erosion is recognised as an environmental problem. Despite the well-known erodibility of them, the proportion sediment contribution of these soils compared to others, is undetermined. Locally, soil types as source groups are understudied and the use of specific chemical weathering indices as properties not yet tested. A catchment in the upper Caledon River Catchment provides an opportunity to apply sediment fingerprinting to soil types as sources by using trace and major elements, as well as weathering indices as tracers. This study aims to use these tracers to apportion and quantify the contribution of sediment from different soil types. The catchment has a pronounced gully on the midslope and footslope and that is developed primarily in the planosols that harbours a duplex soil texture. A total of 51 samples were taken from different soil types as well as sediment samples. All samples were analysed for trace and major elements, from where the chemical weathering indices were calculated. Various statistical analyses, including a mixing model (via the FingerPro RStudio package) were applied, using the commonly used two-step non-parametric H-test and discriminant function analysis. Results show that the planosols is contributing the majority of the sediment (57%), but that the acrisols that occur on the boundary of the footslope and steep midslope are also a major contributor (42%). The leptosols only contribute 1%. This study demonstrates that in this catchment, chemical weathering indices did not have discriminatory power to differentiate between soil types, but trace and major elements did. It is uncertain whether weathering indices would be universally ineffective as sediment tracers, or whether the application of this tracer is a function of soil grouping. Further research could elucidate the use of weathering indices as tracers.

Keywords: sediment provenance, geochemical fingerprint, sediment sources, sediment tracing, weathering indices

Assessing changes in the hydrological regime of lacustrine wetlands on the Maputaland Coastal Plain, South Africa

Nkosingizwile Bongiwe Ndlovu*[1], Heidi van Deventer[1,2], Christel Hansen[1] and Willem Landman[1]

[1]Department of Geography, Geoinformatics and Meteorology, University of Pretoria, Hatfield, South Africa

[2]Council for Scientific and Industrial Research, University of Pretoria, Hatfield, South Africa.

*U14383846@tuks.co.za

Student presentation, Hydrological systems and regimes session

The hydrological regime of wetlands plays a critical role in understanding the ecological functions and ecosystem services of these systems. It describes the spatiotemporal variation in water flow and storage within wetlands, including the inter- and intra-annual variations of water availability. Understanding the cycles of inundation of wetlands is useful to inform biodiversity typing and would be valuable for measuring the impact of climate change and anthropogenic pressures on wetlands. The Maputaland Coastal Plain (MCP) is a region located in the north-eastern part of KwaZulu-Natal, South Africa. Many diverse estuarine and freshwater ecosystems are found here, with extensive habitats highly dependent on the groundwater aquifer. Changes in the inter- and intra-annual hydrological metrics of lacustrine wetlands within the MCP, however, are poorly understood.

This study aims to assess whether any changes in the inter- and intra-annual hydrological regime of the MCP's lacustrine wetlands have occurred between 2016 and 2022. As a first step, the mean monthly rainfall data was collected from various organisations to determine inter- and intra-annual changes in rainfall patterns during this time. Subsequently, the Google Earth Engine platform will be used to extract the monthly extent of lacustrine wetlands from Sentinel-1 and -2 images at a 10-m spatial resolution to derive hydrological metrics, to see how surface water bodies respond to rainfall dynamics. The correspondence between the intra-annual, inter-annual and variation in the range of rainfall and the open water bodies, the lag between these, and changes over time will be quantified. The outputs are intended to inform biodiversity typing and monitoring of estuarine and freshwater wetlands of the MCP.

Keywords: goal A of the GBF, hydrological regime, lacustrine wetlands, Maputaland Coastal Plain, SDG 6.6.1a, wetland monitoring

Assessing soil erosion and sedimentation risk in relation to land use in contributing drainage areas of impoundments in the upper Keiskamma catchment

Bachazile S Vilakati* and Sive Mlamla

[1]Department of Geoscience in Nelson Mandela University, South Africa

*S2234431232@mandela.ac.za

Student presentation, Soil erosion and land degradation session

Soil erosion is one of the main environmental problems that endangers terrestrial and aquatic ecosystems mainly due to an interplay of environmental and anthropogenic factors. Generally, soil erosion leads to sedimentation which impact on the water quality and quantity of catchment which subsequently affect impoundments. The aim of this study was to assess the level of soil erosion, its relationship with land use and sedimentation risk on the contributing drainage areas of the Cata impoundment, in the upper Keiskamma river catchment, South Africa. Soil erosion and associated land use/cover types were mapped using Google Earth Pro and analysed in ArcMap. Fieldwork was conducted where erosion sites were randomly identified and measurements of gully length, depth, and width were recorded to permit soil loss estimation and the erosion classification scheme of the Southern African Regional Commission for the Conservation and Utilization of the Soil (SARCUSS) was used to analyse for sedimentation risk. The results reveal that the catchment is predominately susceptible to gullies, notably concentrated on the well vegetated grassland hillslopes and on gravel roadsides. On the former and the latter hotspots, soil erosion is attributed to cumulative impacts of lack of post road maintenance slope stabilisation /rehabilitation, downslope concentrated runoff from culverts and sub-surface erosion, respectively. The extensive gully erosion qualifies the catchment to severe erosion (SARCUSS G4), denoting high sedimentation risk to the Cata Dam. The high soil erosion occurrence echoes for land rehabilitation programmes to curb further degradation and dam sediment to protect rangelands and watercourses.

Keywords: gully erosion; sedimentation; land use/ land cover; impoundments

Between a rock and a hard place. Opportunities for geomorphic enquiries in Southern Africa

Frank Eckardt

Environmental & Geographical Science Building, South Lane, Upper Campus, University of Cape Town, Private Bag X3, Rondebosch 7701

frank.eckardt@uct.ac.za

Standard presentation, Science engagement session

In general, geomorphology encompasses a vast array of perspectives, including the planetary dimension, landscape evolution, palaeoclimatology, process studies, and applied geomorphology just to name a few. These span the entire range of spatial and temporal scales, from billions of years to the second, and from the global to the grain and molecular level. One could argue that the subject's origins and core are rooted in tectonics, denudation, quaternary climate, and erosion. Each also represents paradigm shifts that have not been addressed equally throughout the subject's history and certainly seem to favour some locations on the earth's surface over others. The human agent remains a negligible force until the modern era, nevertheless, the subject is now preoccupied with urgent climatic scenarios that require yet another specific type of enquiry. Above is a tentative list that undoubtedly textbooks would emphasize. It is argued here that the landscape of Southern Africa can contribute to many of these global themes, but that there are additional opportunities which merit further pursuit. This could include improving our understanding of mantle plumes, epeirogeny, mega fans, escarpments, and deep weathering, all of which are not systematically accounted for in textbooks or the broader scientific literature. Southern Africa represents a natural laboratory which challenges us to tackle and integrate process geomorphology and landscape evolution and embark on broader and more ambitious interdisciplinary collaborations that draw on structural geology, geophysics, evolutionary biology and geochemistry just to name a few.

Keywords: history of geomorphology, southern African geomorphology

Constructing a digital Marion Island using Unreal Engine 5 to examine its use for virtual tourism and geo-conservation

B Boyes* and EM Rudolph

University of the Free State

*2016237832@ufs4life.ac.za

Student presentation, Open session

The potential use of three-dimensional (3D) computer graphics game engines such as Unreal Engine 5 (UE5) has not yet been utilised fully in areas which can promote geo-conservation, education or virtual tourism. Marion Island, located in the south Indian Ocean, is a unique South African territory as it is a volcanic island situated in a sub-Antarctic environment. Within South Africa's geoheritage context, the island hosts a range of geomorphological and geological features found nowhere else in continental South Africa. The value of the island's geoheritage is not yet fully appreciated by the public due to its location and conservation status making it inaccessible to the public at large. This paper aims to utilise UE5 to digitally construct sub-Antarctic Marion Island and explore the viability of using the engine for virtual geo-conservation, education and tourism use. The main focus will be to use the ArcGIS compatibility of UE5 to create a geographically accurate digital island. Digital elevation data and landscape photographs from the island will be used to construct an accurate representation. The digital island will focus on the important geomorphological features of Marion Island such as scoria cones, glacial depositional features and peat lands. The final product will be compared to other current methods such as video and photographic tours used in geo-conservation and tourism.

Keywords: geoconservation, virtual tourism, geoheritage, Unreal Engine, Marion Island

Determining the composition of sediment in the Proses Spruit and Kromellenboog Spruit (Free State, RSA) using sediment fingerprinting

F. Jansen van Vuuren*, M.H. Stander and R. Hansen

Department of Geography, University of the Free State, South Africa

*febevv@gmail.com

Student presentation, Soil erosion and land degradation session

In September 2022, the Jagersfontein Tailings Storage Facility collapsed and spilled a vast volume of Kimberlite tailings into the environment. This affected the following river systems Proses Spruit, a river downstream of the tailings facility and a tributary to the Kromellenboog Spruit. Tailings washed down the Proses Spruit and passed the confluence with the Kromellenboog Spruit, transporting it even further downstream. Sediment influxes in river systems can have adverse effect on ecosystem functions, water quality and agriculture. The aim of this study is to determine difference in suspended sediment composition between the Proses Spruit and the Kromellenboog Spruit upstream and downstream of its confluence with the Proses Spruit. The Kromellenboog Spruit receives compromised sediment from the Proses Spruit and natural sediment from the upstream Kromellenboog Spruit. Downstream of the confluence, unknown proportions of these two types of sediment mix, resulting in sediment with an unknown composition. The sampling period will stretch over a twelve-month period to account for any seasonal variations in the river system. The two upstream sampling locations are approximately 200 m from the downstream sampling location. This ensures that there is minimal influence from external factors. Suspended sediment is sampled from the respective streams, up- and downstream of the confluence, by collecting large volumes of water. Samples are transferred to plastic-lined trays and dried in a closed oven at 40˚ C. X-Ray Fluorescence (XRF) and X-Ray Diffraction (XRD) analyses are conducted on the sediment collected from the trays to determine the sediment fingerprint of each sample. Results from the three locations are compared to determine the composition of sediment in the Kromellenboog Spruit and the severity of the long-term impact of the TSF collapse on the sediment quality of the river system.

Keywords: sediment fingerprinting, river confluence, tailings spill

Determining the formation ages of the lithologies on sub-Antarctic Marion Island

Sibusiso Sinuka

Department of Geography and Environmental Sciences, University of Fort Hare,

Alice, Eastern Cape, South Africa

sinukass@gmail.com

Student presentation, Open session

Determining the timing of the volcanic activity which led to the formation of sub-Antarctic Marion Island, located 2500km south east of Africa, is key to understanding the landscape dynamics (development and evolution) over geological time. Initial studies conducted on Marion Island were aimed at determining the maximum age of the Island and focused on the older Pleistocene grey lava sequences. However, little is known about the younger Holocene black lavas or red scoria material that make up the surface geology of the island.

The aim of this study is to:

1. Determine the formation ages of Marion Islands' Pleistocene grey lavas, Holocene black lavas and red scoria material which make up the current surface geology of Marion Island using Uranium Series Dating.
2. Clarify limits on accumulation of organic matter for peat development and maximum ages of ecological succession.

These aims will be achieved by: (i) sampling the three rock types that are found on Marion Island, (ii) mapping the individual lava flows, (iii) analysing the suggested relationship between Marion Island's volcanism and deglaciation which has been debated by Hall et al. (2011), (iv) reviewing the current knowledge of the lithologies of Marion Island (i.e. investigate the occurrence of sub-glacial volcanic activity), (v) assessing the influence of volcanics on landscape development and subsequent ecological succession and functioning, and (vi) determining the formation ages of glacial deposits to link deposits with sources.

Rock samples of up to 0.2kg will be collected from the Pleistocene grey lava, Holocene black lava and red scoria deposits at various locations around the Island. The samples were analysed using a Scanning Electron Microscope (SEM) to determine sample topography and structure. Samples then underwent heavy mineral separation, followed by X-ray Fluorescence (XRF) Analysis in which the mineral composition of each sample was identified. Age determination will be done using the Uranium Series dating method. The rock sample will then be inserted into an Inductively Coupled-Plasma Mass Spectrometer (IC-PMS) upon which Uranium and Thorium will be separated and their isotope abundances measured. Then the Uranium-Thorium ages are calculated to provide a relative age in which the Uranium was trapped in the rock sample. This will be done taking into account the disequilibria of Uranium/Thorium.

The age determinations of the different rock types will provide a more accurate account of the island's volcanic successions and will place the island in a more precise age bracket within the geological time scale**. (It is important to note that at the time of submitting this abstract, the rock samples are yet to be analysed and preliminary results should be available by the time the conference takes place).**

The result of the intended age determinations will provide precise ages of the lava flows found on the surface of Marion Island. This new information will enable a more comprehensive geological map of Marion Island, thus providing a more thorough assessment of the landscape evolution of the island as well as inform modelling of ecological succession and functioning.

Keywords: sub-Antarctic, Marion Island, uranium series dating, lithologies

Examining land use and riparian vegetation relationships on channel geometry: implications for the hydrologic regime of the Baakens River Catchment, Nelson Mandela Bay Municipality

Luneshri Odayar

Nelson Mandela University, Gqeberha, South Africa

s208048588@mandela.ac.za

Flash talk, Hydrological systems and regimes session

Riparian vegetation and land use/cover changes (LUCC) are controls that play a significant role in river channel modification. No previous studies have been done in this catchment examining the impacts of the above-mentioned controls. The present study aims to assess the relationship between riparian vegetation conditions and land use on channel geometry and fluvial regime implications in the Baakens River catchment. Riparian vegetation conditions and land use were mapped in IDRISI TerrSet via supervised image classification based on the implementation of Random Forest Machine Learning algorithm and Normalized Difference Vegetation Index (NDVI) on Sentinel 2A images (n = 2). Channel width and depth as well as in-situ vegetation cover estimates were made on the field at various reaches (n = 17). Results obtained revealed that riparian vegetation was intact over the entire river length denoted by NDVI values range of 0.6 – 0.8, with upstream, middle and lower sections dominated by trees and shrubs as well as herbs, respectively. Man-made modifications were predominantly evident downstream viz. channelisation, gabions, and bridges. No significant variation was noticed in relation to depth along the channel whereas width increased downstream, and particularly predominantly larger at modified reaches devoid of riparian vegetation. This study demonstrates that the upper catchment riparian zone is less impacted by urban development and unnatural hydrologic regimes compared to its lower reaches' counterparts.

The study concludes that channel geometry and fluvial regime in the Baakens River catchment is influenced by land use in the form of man-made structures and built-up areas and spatial variation of riparian vegetation.

Keywords: Baakens River Catchment, land use/land cover change, GIS, remote sensing, riparian vegetation, fluvial regime, modification

Geomorphology as a component of the social economic ecological framework

Laura Bannatyne*[1] and Margaret Wolff[2]

[1]Geography Department, Rhodes University, Lucas Avenue, Makhanda 6139; PO Box 94. Grahamstown, 6140

[2]Institute for Water Research, Rhodes University, Artillery Road, Makhanda 6139; PO Box 94. Grahamstown, 6140, South Africa

* ljbannatyne1@gmail.com

Standard presentation, Science engagement session

To quote our website: *Geomorphologists study the history, development and processes acting on the earth's surface materials and landforms that build these landscapes. Geomorphological expertise is applied in a wide variety of fields such as land degradation, natural hazard assessment, environmental management, environmental change, and palaeo-environmental research*.

This definition mentions history and development, but it side-steps the impact *on* and *of* the social-economic-ecological framework in which our research takes place while saying nothing about communication before, during, and after a study. We often, as academics, bound our projects and apply our own blinkers to partition the landscape and focus on what some may consider "pure" geomorphology. Using the example of the Tsitsa Project, which took place from 2014 – 2023 in the Tsitsa River catchment in the Eastern Cape, and the ongoing Sustainable Drainage Systems (SuDS) project in Stanley Village, near Sunderland, UK, we highlight the necessity of framing geomorphological research within a social-economic-ecological context. We highlight the importance of co-creating knowledge with stakeholders, of ensuring a common understanding, and of appropriately sharing research outcomes with *all* social-economic-ecological stakeholders. We draw on work from a range of disciplines to show how this can be done, and to demonstrate the benefits that accrue to researchers, communities, practitioners, and decision-makers. We encourage you to look beyond the boundaries of geomorphology in scoping your research, since many of today's early career researchers are the consultants and practitioners of tomorrow, working on projects that will demand rather than request this approach.

Keywords: social-economic-ecological framing; Tsitsa; SuDS; geomorphology research; development consulting

Gully erosion topographic preferential zones on the high-water yield amathole mountains, eastern cape, south africa: insights to coupling and sediment connectivity

Sive Mlamla

Geosciences Department, Nelson Mandela University, Gqeberha, South Africa

Sive.Mlamla@mandela.ac.za

Standard presentation, Soil erosion and land degradation session

Soil erosion is a wide-spread environmental problem accounting for significant loss of topsoil, rangelands, and downstream sedimentation into aquatic systems and artificial water storage impoundments. The phenomenon is evident on the strategic water source area of the Amathole Mountain, South Africa. Its topographical underpinnings remain undocumented, and these may reveal insights to sediment delivery to rivers and impoundments. The present study sought to spectrally detect gully soil erosion, investigate its topographic preferential zones and implications for sediment coupling using Machine Learning Random Forest algorithm on high resolution (10 m) Sentinel-2A in GEE and a 20 m DEM in ArcMap, respectively. Results reveal that gullies are the dominant erosion forms in the catchment and are spatially distributed mostly in the middle to lower slope positions of the hillslopes along drainage line exhibiting coupling and direct sediment delivery to the impoundments. The ML Random Forest algorithm and geospatial analyses are recommended for mapping soil erosion in rural catchments and analysing topographical attributes relationship. To curb perpetual land degradation, rehabilitation of the affected hillslopes must be implemented.

Keywords: soil erosion, sediment connectivity, Amatole Mountains

How degradation influences surface topography and hydraulic behavior of peatlands in the Maputaland Coastal Plain

Jason P. le Roux*[1,2], Piet-Louis Grundling[2,3], Althea T. Grundling[1,2,4] and Heinz Beckedahl [5,6]

[1]Agricultural Research Council – Natural Resources and Engineering, Private Bag X79, Pretoria, 0001, South Africa

[2]Centre for Environment Management, University of the Free State, Bloemfontein, South Africa

[3]Regulatory, Compliance and Sector Monitoring, Department of Forestry, Fisheries and the Environment, Pretoria, South Africa

[4]Applied Behavioural Ecology and Ecosystem Research Unit, University of South Africa, Pretoria, South Africa

[5]Department of Geography, Geoinformatics and Meteorology, University of Pretoria, South Africa

[6]Department of Geography, Environmental Science and Planning, University of Eswatini, Eswatini

*Jasonleroux200@gmail.com

Standard presentation, Hydrological systems and regimes session

Peatlands are characterised by near surface saturation that prevents the aerobic decomposition of plant material, which subsequently accumulates as peat. The hydraulic properties of peat further contribute to a peatland's hydrology due to its water-holding capacity, which elevates the water table in conjunction with the further accumulation of peat, thereby maintaining near-surface saturation. When the water table of a peatland is lowered, peat begins to oxide, shrink, and compress, which alters its hydraulic properties and results in negative effects which amongst others include a reduction in permeability, the amount of water that a peatland can store, and more frequent water table changes. This results in further peat oxidation and an ongoing cycle of degradation, as well as an increased vulnerability to burning. Whilst pristine peatlands are naturally resistant to burning, dry peat is highly combustible due to its organic matter content. To date, 34 peatland sites have experienced peat fires across the Maputaland Coastal Plain, which contains 60% of South Africa's peatlands. This is a consequence of lowered water tables, attributed to water abstraction, widespread exotic plantation and climate variability.

To understand the effects that different stages of desiccation and burning have on the hydrological functioning of peatlands on the Maputaland Coastal Plain, hydrological investigations were conducted on three respective burnt peatlands. This includes Vasi Pan which is characterised by deep (+1 m) desiccation cracks and the Muzi Swamp, a calcareous peatland, which recently experienced peat fires, as well as a historic peat fire in the Mfabeni Mire, which was previously dated at 12 430 BP, and contains 4m of subsequently accumulated peat. Hydrological transects, comprising of well and piezometer nests, were installed and monitored from 2020-2022 in the recently burnt peatlands to determine water table fluctuations in burnt and unburnt areas and how water movement influences degradational patterns. Peat at various stages of degradation were collected from all three sites and laboratory tests were conducted to determine differences in hydraulic properties. A detailed stratigraphy examination was conducted for burnt and unburnt sections in Mfabeni. Results of the water table analysis indicate that a reduction in surface elevation, as a consequence of desiccation cracks (Vasi Pan) and burning (Muzi Swamp and Vasi Pan), results in water tables being closer to the new surface elevations of the peatlands and more favourable conditions for the establishment of aquatic vegetation and the further accumulation of peat. The stratigraphy study in Mfabeni found that the patterns of desiccation and burning were similar to those at Vasi Pan and that subsequent peat development began inside desiccation cracks, which acted as preferential flow paths and favourable vegetation habitats. Laboratory tests found that peat which experienced extremely high levels of

degradation (i.e., secondary transformation) and burning exhibited more favourable hydraulic properties compared to degraded peat. This study found that primary peatland desiccation is detrimental to peat formation, whilst further stages of degradation produce more favourable conditions for ecosystem recovery. However, the initial degradation and the blatant loss of carbon cannot be ignored.

Keywords: peatland hydrology, peat degradation, peat hydraulic properties, peat fires

Karst geomorphology and associated environmental problems within the southern Africa region

Heinz Beckedahl[1, 2 *] and Mthobisi Masilela[1, 2 *]

[1]Department of Geography, Environmental Science & Planning, University of Eswatini, Kwaluseni Campus, Private Bag 4, Kwaluseni, Eswatini, M201
[2]Department of Geography, Geoinformatics & Meteorology, University of Pretoria, Private Bag X20, Hatfield, Pretoria, South Africa, 0002

* hbeckedahl@gmail.com

Standard presentation, Open session

There have been a considerable number of studies on karst terrain in southern Africa. Despite this, there is still a need for further research focussed in particular on the environmental challenges associated with karst in the southern African region. One such challenge is the lack of a regularly updated inventory of sinkhole incidents which continue to occur. A different consideration is that many of the aspects of the field are taken over by engineering, rather than geomorphology, even though a considerable proportion of the southern African landscape is karstic in nature. This where, by contrast, the southern Africa karst is in many ways distinct from that in other regions of the world by its chemical composition, a siliceous Ca-Mg carbonate, and the unique geological and climatic history of the region.

Southern African karst presents a range of both challenges and opportunities, as it contains some very important phenomena. The speleological, paleontological and archaeological record, continue to be a source of new scientific and educational information. Karst in the region is further important for the water supply, especially in the semi-arid and arid parts. Notwithstanding the volume of available research, southern African karst landscapes are under increasing threat from human activities such as mining and the associated de-watering of ground water compartments; urbanisation; construction and cement manufacture, and agriculture.

Human activities may frequently become environmental hazards, yet this is seldom quantified in impact assessments. One option to avert adverse environmental impacts, and to sustainably manage karst environments, is the Karst Disturbance Index (KDI), a comprehensive instrument used to quantify human disturbance in management karst environments.

The paper highlights that future land use on karst terrain will need to be informed by sound geomorphological research and insight and be strongly regulated in the future to address the continually increasing demand for karstic land within the region.

*Keywords**:** karst geomorphology; Karst Disturbance Index (KDI); human activities*

Mapping changes to fluvial channels in the Delumhlwazini and Injisuthi River Valleys, Ukhahlamba-Drakensberg, between 1935 and 2023

Ian Meiklejohn

Department of Geography, Rhodes University, Makhanda, South Africa

i.meiklejohn@ru.ac.za

Standard presentation, Hydrological systems and regimes session

River channels in floodplains of the Injisuthi and Delumhlwazini Valleys of the uKhahlamba-Drakensberg Park are amongst the most dynamic observed in the region. The floodplains result from sediment deposition, where the underlying geology and deep-seated paleo rotational mass movements constrict the valleys. Archived aerial photography from the Chief Directorate, National Geospatial Information was orthorectified and compared to recent Planet Labs and Maxar Technologies imagery to map the impact of significant flood events on river channels. The first detectable event was in the Injisuthi Valley before 1935 (no specific date can be determined). In September 1987, a cut-off low pressure that caused extensive flooding in KwaZulu-Natal modified both valleys, but "damage" was more extensive in the Injisuthi Valley. On 10 December 2020, a storm altered the course of the Delumhlwazini Valley. Changes were not as dramatic in the Injisuthi Valley. Several slope failures also occurred in the Inisuthi Valley below the confluence of the two rivers on 10 December 2020. Some of these failures were reactivated in April 2021. Controls on the alignment of the channels are the Geology, Geomorphology and river discharge. The localised nature of the flood impacts suggests that localised storms and the consequent high river discharges are significant contributors to the evolution of the valley-floor topography.

Keywords: River channels, Injisuthi, Delumhlwazini, uKhahlamba-Drakensberg Park, flood, mapping

Modelling the impacts of forestry on wetland hydrology using the Soil Water Assessment Tool

Colby L. Weiss* and Jay J. le Roux*

Geography Department, University of the Free State, Bloemfontein, South Africa.

*colbyweiss101@gmail.com

Student presentation, Modelling approaches in geomorphology session

Projected population growth is increasing the need and demand for timber production globally, increasing the risk of natural areas soon being converted to commercial plantation forestry. It is especially true for South Africa, where most timber comes from commercial plantations. The eastern Free State is currently unknown for forestry but can be a viable option. The environmental effects of such land use changes can be potentially devastating for wetland hydrology. This is based on the interference commercial plantations generally have on such areas. The study focuses on a 692 km^2 catchment (C81F) located in the eastern Free State, South Africa, near the town, Phuthaditjhaba, where the impacts of future commercial plantations on wetland hydrology are modelled. Implemented in this study for its usability in data-scare regions is the Soil Water Assessment Tool (SWAT+). The SWAT+ model is a hydrological model interfaced within QGIS, a Geographic Information System software, and requires a range of topographical and meteorological data. Datasets include a Digital Elevation Model (STRM 30m), land cover data from the South African National Land-Cover Dataset of 2020, soil data from the ARC land type database and meteorological data. Meteorological data from the Agricultural Research Council contained five years of data from the QwaQwa and Clarens stations. The model scenario compared the current state of the hydrology to the proposed change of grassland and shrubland to commercial plantation forestry. Results show a reduction in streamflow and groundwater flow, which will impact the wetlands in the catchment, possibly being environmentally detrimental to the region. These results are useful in determining the relative impact of forestry on catchment hydrology and, for comparative purposes, support efficient management strategies.

Keywords: commercial plantations, QSWAT+, wetland hydrology, LULC change

Old scopes to new goggles: Implementing virtual reality in the South African lecture room

Elizabeth M. Rudolph

Department of Geography, University of the Free State, Bloemfontein, South Africa
rudolphem@ufs.ac.za

Flash talk, Science engagement session

Lying in the dungeons of Geography buildings, under dust and dated topographical maps is the main ingredient to bring fieldwork back to the lecture room – stereoscopes! Stereoscopes have long been used to train students in interpreting landscapes from aerial photographs. Yet, for any student to effectively identify geomorphic features, they need an understanding of the physical context of these features and this often requires encounters with the natural environment. In a South African context, time and resource constraints, and increasing class sizes in undergraduate degrees, limit a (Geography) lecturer to what and how they can expose their students to in order to expand on or establish, encounters with the geomorphic environment.

I present here the possibility that, with the aid of a few pieces of cardboard (various templates available online), a stereoscope can be repurposed into a virtual reality goggle. Add a smartphone and campus Wi-Fi, *et voilà* – your students have access to whatever VR the internet provides. I use one example, VR Glaciers & Glacial Landscapes, which is a purposefully designed resource for virtual fieldwork. Students can visit sites from Switzerland to Yosemite where they are introduced to a range of geomorphic landscapes without ever leaving the lecture room. With these few, available, inexpensive elements, we might overcome (certainly not substitute) the dire need for field experience for our Geography students. Just hold on to those stereoscopes!

Keywords: virtual classroom, stereoscopes, virtual fieldwork, inclusive education

Proposed anthropogeomorphological wetland classification system

Renée Grundling*[1], Michael Loubser[1] and Heinz Beckedahl[2]

[1]University of Pretoria, Department of Geography, Geoinformatics and Meteorology

[2]Department of Geography, Environmental Science and Planning, University of Eswatini, Kwaluseni, Eswatini

*renee.grundling@gmail.com

Flash talk, Hydrological systems and regimes session

The influence of humans on the environment is becoming more pronounced as populations, particularly the urban population, increase. The imprint humans leave behind is so pronounced that a new geological epoch, the Anthropocene, has been created to accommodate human (i.e., anthropogenic) changes in the Holocene or recent geological timeline. Anthropogeomorphology is the study of how humans modify and create landforms and landform processes. Wetlands are generally seen as natural geomorphological features, but wetlands can be formed and modified due to human activities and may therefore be attributed to anthropogeomorphology.

This project analyses the variety of anthropogeomorphological wetlands, in the Gauteng Province, South Africa, using manual identification on platforms such as Google Earth Pro and in-field wetland delineation techniques such as basic soil, water and vegetation sampling and identification.

Based on the geomorphological variety, this project further aims to improve the current wetland classification system.

Keywords: wetlands, geomorphology, anthropogeomorphology, classification system

Quantifying changes in the extent of wetland types of the Maputaland Coastal Plain using remote sensing: implications for restoration and conservation

P. Apleni[1]*, H. van Deventer[1,2], L. Naidoo[3], and P. Tsele[1]

[1]Department of Geography, Geoinformatics & Meteorology, University of Pretoria, Pretoria, South Africa

[2]Council for Scientific and Industrial Research, Meiring Naudé Road, Brummeria, Pretoria

[3]Gauteng City-Region Observatory, 11 Jorissen Street, Braamfontein, Johannesburg

*u21846376@tuks.co.za

Student presentation, Hydrological systems and regimes session

Wetland ecosystems play a vital role in biodiversity conservation and the provision of ecosystem services. Understanding the rate and extent of changes in wetland types is crucial for effective restoration and conservation efforts. The aim of the project was to quantify changes in the extent of wetland ecosystem functional groups (EFGs) of the Maputaland Coastal Plain (MCP) between 1990 and 2020. The Google Earth Engine (GEE) cloud computing platform was utilised to map seven wetland EFGs for seven years between 1990 and 2022. Two estuarine EFGs (Coastal salt marshes and Intertidal forests and shrublands) and five freshwater EFGs (Lacustrine, Large macrophytes, Permanent marshes, Seasonal marshes, and Subtropical-temperate forested wetlands) were mapped for seven years in the 22-year period, using the random forest classification algorithm. Landsat images were employed for typing EFGs for 1990, 2000, 2006, and 2013, whereas Sentinel-1 and Sentinel-2 were used to create cloud-free median composites for 2018, 2020, and 2022. A digital elevation model was generated from 5-m interval contours and 1:10 000 spot heights and used in the classification of the EFGs. Changes in the extent of the wetland EFGs were then used to calculate the rate of change and estimated year of potential collapse.

The results showed that the average percentage extent of wetlands is 14.8% of the MCP, and the average rate of change was -0.5% between 1990 and 2013 and -2.92% between 2018 and 2022. Suggesting a more rapid decline between 2018 and 2022 compared to earlier years (1990 to 2013). Over the years, wetlands have shown changes predominantly to two categories, including cultivated wetlands and Croplands. Cultivated wetlands occurred across the estuarine-freshwater ecotone, totalling approximately 8.2 km². In the iMfolozi/uMsunduzi Estuary, approximately 11.3 km² of subtropical-temperate forested wetlands underwent conversion to cropland, posing risks to wetland ecosystem functions and the provision of ecosystem services. These sites could be considered for restoration to meet the 30% extent of the GBF's target 2.

Keywords: Global Biodiversity Framework (GBF), Google Earth Engine (GEE), IUCN global ecosystem types, Landsat, Random Forest, Sentinel

Rivers of Hogsback in a changing environment

Kate Rowntree

Department of Geography, Rhodes University, Grahamstown, South Africa

kate.rowntree@me.com

Standard presentation, Hydrological systems and regimes session

The rivers of Hogsback and the surrounding Amatole Mountains comprise an important component of the local landscape. Numerous waterfalls, including the iconic Madonna and Child, add scenic value that attracts tourists to the area; the mountain streams and their wetland sources provide important habitat for wildlife; they contribute to water supply options used by Hogsback residents and visitors. Downstream, below the Amatole escarpment, Hogsback Rivers provide a water supply to inland villages, towns (Alice) and Hamburg on the coast. Mountain streams typically have a high ecological quality, being minimally impacted by anthropogenic activity, but the rivers of Hogsback area have been significantly impacted due to this upland area having been settled since the mid-19th century. Although the indigenous forest that dominates the south-facing escarpment slopes is largely intact there has been a major transformation to the upland grasslands due to the establishment of grazing lands, forestry and gardens in the residential areas. This presentation provides an overview of the characteristics and drivers of these mountain streams, before examining past, present and future threats to this aquatic ecosystem, especially those that affect sediment loads. Key threats are identified as climate change, land cover transformation and land management practices. Specific threats are changes to rainfall patterns, fire risk, alien vegetation and plantation forestry.

Keywords: Hogsback, river condition, environmental impacts, sediment

Soil erosion and rainfall erosivity in a Karoo badland - an eleven year record

Kate Rowntree

Department of Geography, Rhodes University, Grahamstown, South Africa

k.rowntree@ru.ac.za

Standard presentation, Soil erosion and land degradation session

Soil loss rates have been monitored in a Karoo badland at an elevation of 1400 m.a.s.l. using erosion pins since April 2012. Eleven sets of five pins were located on a range of topographic features within the badland area: planar slopes (six), rills (two) and interfluves (three). Pin extension was measured at approximately six monthly intervals to cover the summer rain and winter dry seasons. A tipping bucket rain gauge located within 500 m of the site recorded rainfall at 5 minute intervals. Rainfall per monitoring period ranged from a winter low of 30 mm to a summer high of 405 mm. Maximum rain per rain day ranged from 5 mm to 99 mm (December 2022).

The average annual soil loss from all eleven sites over the eleven year period was 3.21 mm. This compares to 3.1 to 8.5 mm reported by Boardman et al. (2015) for a number of sites in the vicinity of Compassberg Mountain at elevations of around 1700 m.a.s.l. Slopes recorded the greatest average annual loss at 5.60 mm, rills the lowest at 1.25 mm. Interfluves recorded an average loss of 2.39 mm. Slopes recorded a net soil loss at all six sites over all but two monitoring periods, when a small net deposition was recorded. Both rills had clumps of vegetation growing within the channel so that net deposition occurred during a number of monitoring periods, with a tendency for deposition to increase with increased rainfall. The December 2022 event, however, caused significant erosion that washed out previously deposited soil. The interfluves recorded low rates of soil loss or deposition that was not related to rainfall amounts, with the exception of the steepest interfluve that recorded significant erosion during the last two monitoring periods.

A correlation analysis between soil loss rates and rainfall erosivity indices identified maximum rain per rain-day as the variable having the highest correlation across all sites (all sites R = 0.76, slopes R = 0.68, rills R = 0.42, interfluves R = 0.63). Strong correlations were also found between the product of total rainfall and the maximum rain per rain-day and soil loss from all sites and from slopes (all sites R = 0.79, slopes R = 0.77). Cumulative storm energy over the monitoring period was estimated using equations from Hudson (1961), Stocking et al. (1988), Reynard (1997), van Dyk (2002). The strongest correlations for all sites combined and slopes, significant at the 0.001 level and less, was found for the Hudson (0.68 & 0.71 respectively) and Stocking et al. equations (0.82 & 0.81 respectively); weak insignificant (at the 0.05 level) correlations were found between soil loss on rills or interfluves and all energy measures. Thus while variables based on daily rainfall gave significant relationships for soil loss over the relevant monitoring period for all sites, the two measures of erosivity developed by Hudson (1961) and Stocking et al. (1988) for southern Africa were the best soil loss predictors for all sites combined and the badland slopes.

Keywords: soil loss rates, Karoo badlands, erosion pins, rainfall erosivity

South African Polar Research Infrastructure (SAPRI): an introduction and science engagement

Abuyiselwe A. Nguna

South African Polar Research Infrastructure, Martin Hammerschlag Way, Foretrust Building, Foreshore, Cape Town, 8002

aa.nguna@saeon.nrf.ac.za

Standard presentation, Science engagement session

The Department of Science and Innovation officially launched the South African Research Infrastructure Roadmap (SARIR) in 2016. The SARIR initiative is a high-level strategic and systemic intervention to provide research infrastructure across the entire public research system, building on existing capabilities and strengths, and drawing on future needs. The overall objective of SARIR is to provide a strategic, rational, and medium to long-term framework for planning, implementing, monitoring, and evaluating the provision of research infrastructures necessary for a competitive and sustainable national system of innovation (NSI). Three of the Research Infrastructures are currently managed by the National Research Foundation, i.e., the Shallow Marine and Coastal Research Infrastructure (SMCRI), the Expanded Terrestrial and Freshwater Environmental Observation Network (EFTEON) and the South African Polar Research Infrastructure (SAPRI).

The vision of SAPRI is to enable balanced and transformed research growth across the multiplicity of polar disciplines, and to maintain and further expand the world-class, long-term observational research infrastructure and datasets already established within South Africa polar and oceanographic research. This will benefit the governmental strategies for Antarctica and the sub-Antarctic islands and assist decision makers to formulate appropriate environmental policies that lessen the risk and vulnerability of global climate change on the regions which impact South Africa, but also which South Africa are custodian to.

The SAPRI mission is to transform the access to, and perception of, South African polar research for technicians, engineers, scientists of all disciplines, learners and students, government, private business and civil society and to further accelerate the implementation of the pan-African Science, Technology, and Innovation agenda. In doing so SAPRI will create a co-designed, sustainable, and responsive Research Infrastructure which produces Big Science stimulating innovative research and Intellectual Property generation that is of global relevance, and services the needs of all.

Keywords: polar, marine, infrastructure, engagement, pan-African, big science

Southern African soil, land cover and weather generator file databases for SWAT applications

Jay le Roux*[1], Johan van Tol[2], Ndifelani Mararakanye[1], Leushantha Mudaly[3], Harold Weepener[4], Michael van der Laan[4]

[1]Jay le Roux, Department of Geography, University of the Free State, SA.
[2]Johan van Tol, Department of Soil, Crop, and Climate Sciences, University of the Free State, SA.
[1]Ndifelani Mararakanye, Department of Geography, University of the Free State, SA.
[3]Leushantha Mudaly, Department of Plant and Soil Science, University of Pretoria, SA.
[4]Harold Weepener, Agricultural Research Council – Natural Resources and Engineering, SA.
[4]Michael van der Laan, Agricultural Research Council – Natural Resources and Engineering, SA.
*Lerouxjj@ufs.ac.za

Standard presentation, Modelling approaches in geomorphology session

One of the biggest challenges to set-up and run the SWAT model in Southern Africa is to obtain appropriate input data, especially soil data. This study interprets/formats multiple geo-spatial datasets at a multinational scale for use as baseline input to run ArcSWAT or QSWAT in Southern Africa. The input datasets consist of more detailed and higher resolution soil data than the Global databases. The input database is stored in the Water Research Observatory (WRO) data portal: https://www.waterresearchobservatory.org/data-and-resources/hydrological-data-and-modelling.

The portal provides geo-spatial input datasets including the following:

- SWAT catchment outline data (tertiary and quaternary) including the hydrologically corrected SRTM DEM of Southern Africa at 90 m resolution;
- Land cover maps at 30 m resolution including South African National Land Cover (2014; 2018; 2020) and Finer Resolution Observation and Monitoring of Global Land Cover for Africa version 2 (2020) linked to SWAT land cover codes;
- Soil maps with SWAT attribute data derived from pedotransfer functions of the Land Type Database of South Africa useable at a scale of 1:250,000, as well as Soil and Agronomy Data Cube for Africa at 30 m resolution;
- Weather statistics (WGN) files for 12 weather stations obtained from the Agricultural Research Council in South Africa.

Performance of the Southern African baseline data was determined by comparing streamflow and sediment outputs with previous modelled catchment data models, as well as comparison of the hydrological accuracy against measured streamflow data. Although the catchment data models were slightly superior compared to the national data models, the national datasets were capable of modelling streamflow and sediment dynamics at a catchment scale. The next step will be to expand the Southern African datasets to the African continent, assisting researchers to set up and run the SWAT model anywhere in Africa. Modellers will be able to use the input data 'as is', or alternatively supplement, improve and/or replace the input data with their own recent/sophisticated data. Such an input dataset is an important step forward in the application of SWAT to assist soil and water management in Africa.

Keywords: ArcSWAT, QSWAT, input data, data portal, open-source, Southern Africa

Understanding the geomorphology of the Gobholo Granite Cave System in Eswatini

Mthobisi Masilela* and Heinz Beckedahl

Department of Geography, Environmental Science & Planning, University of Eswatini, Kwaluseni Campus, Private Bag 4, Kwaluseni, Eswatini, M201

Department of Geography, Geoinformatics & Meteorology, University of Pretoria, Private Bag X20, Hatfield, Pretoria, South Africa, 0002

*mmasilela@uniswa.sz

Standard presentation, Open session

Although less common in comparison to their karst counterparts, granite caves are some of the well-known types of caves found around the world. These caves have formed in most of the continents, and in regions of granitic geology due to the different geomorphic processes of pseudokarst nature that are active in these environments. Of the World's renowned granite caves, and extending some 60 m below ground, and with explored lengths of more than 1 500 m, the Gobholo cave system in Eswatini is one of the largest granite cave systems documented in the scientific literature. The cave system is found in the Gobholo Valley which is located approximately 10 km east of Mbabane, the capital of Eswatini. The Gobholo Valley is located on the Mbabane granite pluton, a formation made up of the Mswati granites of 2,7 Ga. in age. The pluton is a porphyritic granite of coarse grain which forms part of the Kaapvaal Craton, an old yet stable landscape composed primarily of granitoids, gneiss, and other metamorphosed volcanic and sedimentary rocks varying in age between 2.5 – 3.6 Ga. The research focuses on the structure and composition of the granitic bedrock, and compares its mineralogy with the geochemistry of the water of the Gobholo River. Remote sensing and GIS are used to map the spatial arrangement of landforms, geological structure, and digital modelling of the terrain. These are further used to explain the geomorphic processes of the study area. The analysis and modelling of the Gobholo Valley is of key importance in this research, as it informs the discussions and conclusions on the genesis and dynamics of the Gobholo granite cave system. From these analyses, it was ascertained that the study area shows evidence of remarkable tectonic activity. This is demonstrated by the network of NNE-SSW and NW-SE fault lines and lineations, which account for the deep dissecting and near perpendicular valleys, with the Gobholo Valley being one of these. A notable feature of this cave system, compared with other granite caves reported in the literature, is that it has elements of both solutional-depositional systems, as well as the ‘typical’ boulder systems in which the interstitial fines have been washed out between large, buried scree-slope boulders.

Keywords: Granite, Gobholo, Eswatini, weathering

Understanding the role of geomorphological processes in anthropogenic disasters: the UPL and Jagersfontein disaster case studies – from cause to rehabilitation

Piet-Louis Grundling

Department of Forestry, Fisheries and the Environment, Regulatory, Compliance and Sector Monitoring, Pretoria, South Africa

Centre for Environment Management, University of the Free State

pgrundling@dffe.gov.za

Standard presentation, Soil erosion and land degradation session

Geomorphological processes are primary drivers in the formation, ecology and functioning of watercourses. These processes are more pronounced in drier landscapes such as the southern African plateau where erosion and deposition events along elevation gradients result in watercourses, such as wetlands, declining as other develop elsewhere in the landscape. The nature and rates of these processes affecting watercourses are influenced by human interventions within catchments and range from, amongst other, large scale urbanisation causing stormwater flows to landscape scale agriculture driving surface flow and wind erosion respectively. These examples are often resulting in gradual degradation of the natural environment which are mostly only noted when exacerbated during extreme rainfall events and prolonged intense droughts.

However, within the anthropogenic landscape, poorly designed, maintained and /or inappropriate developments may cause catastrophic events with disastrous outcomes for humans and nature alike. Two such event occurred recently in South Africa with major impacts on watercourses and loss of human life: The UPL agrochemical spill into the Ohlanga tributary and estuary on 12 July 2021 after an arson attack; and the Jagersfontein Developments Tailings Facility dam burst into the Proses Spruit and downstream environment on 11 September 2022.

This presentation discusses the role of geomorphological processes in the progression of these disastrous events, the role of flow mediums and landscape characteristics. Moreover, the disregard of the receiving environments' geomorphic characteristics in the implementation of containment measures and the resultant secondary contamination are highlighted. Lastly, various interventions options are considered with geomorphology integrated in the rehabilitation framework.

Keywords: geomorphological processes, anthropogenic disasters, contamination, rehabilitation

The use of VR technology as an alternative to real-world field trips: a study in the geomorphology classroom

Michael Loubser and Christel Hansen*

Department of Geography, Geoinformatics and Meteorology, University of Pretoria, Pretoria, South Africa

* christel.hansen@up.ac.za

Standard presentation, Science engagement session

Theoretical knowledge and practical application in any field or discipline are correlated, and it is important that the teaching environment highlights such links. Teaching Earth Sciences like geomorphology is no exception. For example, while a student may understand the theory of gully formation or periglacial processes, actually standing in a gully and observing the effects of soil erosion firsthand, or observing a periglacial landscape and seeing sorted stripes and polygons directly, deepens the grasp of the mechanics involved. Traditionally, this link was established via field trips, in which the theoretical information discussed in the lectures was demonstrated in real-world conditions. However, in recent years, undergraduate field trips have become more difficult to arrange, due largely to a combination of increasing student numbers, distance, time, expense, scale, safety, and the increasingly hybrid environment following the COVID-19 pandemic.

Virtual reality (VR) and virtual field trips (VFTs) offer the opportunity to address some of these issues, in particular since start-up costs are fairly low. 360° cameras are widely available and cheap to obtain (for example a GoPro MAX can be acquired for around R10 000), and the footage that they shoot can be viewed with almost any standard smartphone that contains an internal gyroscope. Additionally, the combination of a free cell phone app and a cheap VR holder allows for the creation of a rudimentary VR setup that allows the user to view the footage simply by turning their head, which increases the immersion factor considerably. VR and VRTs are thus increasingly being considered as an effective form of teaching to either supplement or replace actual field trips.

This paper explores the use of VR and VRTs at the undergraduate and postgraduate levels for courses taught at the University of Pretoria. The undergraduate study comprised students learning in an exclusively online environment; the postgraduate study employed contact teaching. The undergraduate study was unsuccessful, ascribed to the online environment and high bandwidth requirements for 360° videos. The postgraduate study was successful. Students universally enjoyed the experience, and stated that it was an excellent preparatory exercise for the real field trip.

Feedback indicates that VFTs cannot replace actual field trips, that bandwidth requirements are problematic for students of poorer backgrounds, that load shedding has a significant impact, that access to suitable VR headgear is a limiting factor, and that some students experience vertigo when taking part in VFTs. Regardless, VR and VFTs provide students with an immersive experience that can help them understand landforms and processes without the need for them to physically visit the location.

Keywords: virtual reality, virtual field trips, hybrid teaching, theory and practice through VR

Using Geographic Information Systems (GIS) to assess the biodiversity and protection levels of Africa's rivers

Lukho Goso[1], Heidi van Deventer[2,1], Christel Hansen[1] and Lindie Smith-Adao[2]

[1]Department of Geography, Geoinformatics and meteorology, University of Pretoria (UP), South Africa.
[2]Council for Scientific and Industrial Research (CSIR), South Africa.

*u22018591@tuks.co.za

Student presentation, Geomorphology & GISc session

The negative impacts of anthropogenic and climate changes on Africa's river ecosystems have become a growing concern, yet the biodiversity of these systems is poorly understood. To enable reporting on targets 1 (degradation), 2 (restoration), and 3 (protection) of the Global Biodiversity Framework (GBF), it is important to do river ecosystem typing at a continental scale, something that has not been done yet. This study assesses the biodiversity and protection levels of Africa's rivers using GIS.

Firstly, the 10 Major Habitat Types (MHTs) and 85 Freshwater Ecoregions of the World (FEOWs) regions in Africa were combined with the RiverAtlas version 1 lines. This allowed for the calculation of the six Longitudinal Geomorphic Zones (LGZs). The Global Intermittent Rivers and Ephemeral Streams (GIRES) version 10 dataset was used to differentiate between permanent, seasonal, and episodic flows. These datasets were integrated to categorise African rivers based on the International Union for Conservation of Nature (IUCN) global ecosystem types at the Ecosystem Functional Types level. Secondly, the River Ecosystem Types (RETs) were overlaid with the World Database on Protected Areas (WDPA) to determine the extent of their protection in meeting the 30% of target 3 by 2030 outlined in the GBF. The assessment used the protection level categories formulated based on the GBF, namely; exceed target protection (≥30%), protected (≥15%<30%), and only half protected (≥0%<15%). The number of RETs meeting the GBF protection level category is reported.

The regions, flows, and LGZs information produce 141 coarser-scale (using the MHTs) and 892 finer-scale (using the FEOWs) RETs. A total of 7 273 728.2 km of rivers are found in Africa, with 139 MHT RETs (<10% extent), making up 71% of the total extent and possibly range-restricted areas. At a coarser scale, the analysis revealed that 15 RETs (or 10% of the MHT RETs), covered 75% of Africa and predominantly seasonal flow within the tropical and subtropical floodplain rivers and wetlands MHT regions. The LGZs—upper foothills, lower foothills, and lowland rivers were uniformly distributed across the continent. While 126, or 90% of the MHT RETs, covered 25% of Africa and predominantly permanent flow, with a roughly even distribution across all MHT regions and LGZs. The results indicate that only 11.3% of the 141 RETs exceed target protection, 35.5% are protected, and 53.2% are only half protected. Further work is underway to assess the ecological condition of the RETs to inform both the threat status and protection levels.

Keywords: continental scale; Global Biodiversity Framework (GBF); global ecosystem types (GETs); red listing of ecosystems; river ecosystem types; target 3 of GBF

Using GISc for modelling energy expenditure when traversing paths in nature reserves of the City of Tshwane, South Africa

Christel Hansen* and Melandrie Smit

Department of Geography, Geoinformatics and Meteorology, University of Pretoria, Pretoria, South Africa

* christel.hansen@up.ac.za

Flash talk, Geomorphology & GISc session

The Sustainable Development Goal (SDG) 11 aims to "make cities and human settlements inclusive, safe, resilient and sustainable". Urban green spaces (or open spaces) are used by citizens for recreational purposes, including physical activity. Target 11.7 of this SDG in turn aims to "provide universal access to safe, inclusive and accessible, green and public spaces, in particular for women and children, older persons and persons with disabilities". SDG 11, thus, includes making urban spaces accessible and provision for their effective use.

The City of Tshwane (CoT), located in the Gauteng Province of South Africa, currently has 19 nature reserves accessible to the public. These reserves function as green spaces where citizens engage in recreational activities, including walking, hiking, and trail running. While trails are delineated for some of the open spaces, none of the current nature reserve maps assign a difficulty level to any of their trails. This impacts the experience of citizens with reference to these open spaces. Furthermore, the lack of mapped trails, or maps only being available online makes these open spaces less accessible and their access less equitable. This is counter to the aim of Target 11.7.

Here energy expenditure for designated walking/running trails (in terms of average energy expenditure per gender) of nature reserves of the CoT are modelled using Geographic Information Systems (GIS) and the application of known functions, such as the Modified Hiker function, Epstein's function, and Pandolf's metabolic rate function. Based on modelled results, a grading system adapted from Hugo is applied to each trail. This grading system is based on e.g., difficulty, time spent, trail gradient, and expected energy expended per trail. Crucially, geomorphological aspects such as the percentage of steep slopes and other aspects of the terrain are included. Modelled results are verified via fieldwork using Garmin Forerunner 55 and Samsung Galaxy Active2 smartwatches, as well as using Volunteered Geographic Information (VGI) obtained from an online survey (https://arcg.is/D1L950).

Results are presented in the form of an interactive online resource (map), and a series of infographics for each nature reserve, detailing the characteristics of each trail (difficulty, time, distance, expected energy expended, and equivalence of food item required to match energy expended). This allows for improved usage of these spaces for the CoT's citizens, contributing to Target 11.7.

Keywords: energy expenditure modelling, SDG 11.7, urban park accessibility, online mapping, infographics

What is the impact of the choice of Digital Elevation Model (DEM) in geomorphological analysis? Examples from South Africa

Jussi Baade[1], Kevin Zoller[1], and Jay J. le Roux[2]

[1]Department of Geography, Friedrich Schiller University Jena, Jena, Germany
[2] Afromontane Research Unit, Faculty of Natural and Agricultural Sciences, University of the Free State, South Africa

*jussi.baade@uni-jena.de

Standard presentation, Geomorphology & GISc session

Over the past years a number of open access, high resolution Digital Elevation Models (DEM) representing the surface of the Earth have been made available facilitating the calculation of geomorphometric indices for large areas. Many scholars are aware that these DEM derived from remote sensing data represent Digital Surface Models (DSM) inducing some noise when it comes to the representation of the terrain. Further, it is well known that the resolution of a DEM affects the calculation of geomorphometric indices. But few might be aware that the choice of a specific DEM can induce further uncertainties in the quantification of landscape metrics. Here, we present results on the differences when calculating the LS-factor of the RUSLE for SALDi sites based on six different DEM with 30 m and 90 m resolution. This covers the ASTER GDEM V03 (30 m), derived from stereo pairs, the 30 and 90 m Copernicus DEM based on TanDEM-X acquisitions between 2011 and 2015, the 30 and 90 m editions of the SRTM DEM acquired in February 2000 and the 90 m MERIT DEM, which represents an improvement of the 90 m SRTM DEM. When comparing the calculated mean LS-factor for individual sites the overall difference in values reaches 50 % and when considering the 30 m resolution data only, the difference is about 25 %. The findings highlight the need to consider the applied DEM as a source of uncertainty and an influencing variable in calculating geomorphometric indices, like the RUSLE LS-factor.

Keywords: geomorphometric indices, RUSLE LS-factor, ASTER, SRTM, TanDEM-X, Copernicus Global DEM

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