



Preconference excursion 12-15 September 2019



Soil erosion in the Tsitsa River Catchment, Eastern Cape

Details of contact person:

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Use SAAG2019 excursion as the subject

Notes:

The excursion is a self-travel, self-accommodate, self-cater (ad)venture, in the Tsitsa River Catchment; There are no pre-excursion fees but you need to make your own travel, accommodation and food arrangements. Academic talks will be given at current study sites in the Tsitsa River Catchment, including one of the largest gullies in South Africa, as well as two very large (remote) waterfalls (Tina and Tsitsa Falls). Talks will focus on, but not limited to:

- Rainfall erosivity, soil erodibility, soil erosion (natural and accelerated) and the measurement thereof,
- Hydrological and sedimentological connectivity,
- Catchment restoration including the importance of ecological infrastructure such as wetlands.

In an attempt to meet basic societal needs, the Department of Water and Sanitation is planning water resource development on the Tsitsa River, nested within the Mzimvubu River Catchment (the only large river network in SA without a dam). The problem is large parts of the catchment are severely eroded due to the presence of highly erodible soils. Not only are the gully erosion features spectacular (several kilometres long and over 100 m wide), gully erosion feeds massive amounts of sediment into the river network. Due to limited resources it will not be feasible to rehabilitate these gullies with large and costly structures. In order to implement resources and investments optimally, it is important to prevent further erosion by protecting areas that are not eroded. One of the research aims is to map susceptible/gully-free areas that are hydrologically connected. These susceptible areas, although gully-free, are hydrologically connected and consist of dispersive duplex soils that are highly erodible. Another approach currently used is unmanned aerial vehicle (UAV) technologies, utilizing photogrammetric payloads and freeware coupled structure-from-motion (SfM) photogrammetric software. Gullies are mapped in detail, including the extent of source areas where sediment is generated, as well as the spatial extent of storages where connectivity is reduced. More details will be given in the final programme. During the excursion, there will be ample opportunities to discuss the implications and challenges of research in the Tsitsa River Catchment.

- **Dates:** arriving in Maclear on 12 September in the afternoon and departure to Chintsa East on 15 September in the morning. However, you may join the excursion at any stage, e.g. delegates flying in to Mthatha and hiring a vehicle.

- **Accommodation:** three nights (12-14 September). The recommended option is at Bob's Place Guest Farm (15 km's outside Maclear). Choices of accommodation at Bob's Place range from single room, twin room, and camping (all self-catering).
See website www.bobsplacemaclear.com.
Contact: Colleen Viedge.
Email: colleenviedge@gmail.com
Additional accommodation is also available in the town of Maclear, for example: Alpine B&B; Declan's B&B, Maclear Manor, Woodcliff.
Links to booking sites are provided on <https://saageomorph.wixsite.com/saag/accommodation>
- **Talks** by academics and students begin at a lookout point of the Tsitsa River on the R396 from 09h30 Fr 13 Sep and we will travel in convoy to other sites thereafter.
- **Entrance fees** to the Mhlontlo Nature Reserve are for your own expense (R20pp).
- **A WhatsApp** group for communication purposes will be created later for the excursion.
- **Avoid driving at night** due to road conditions (pot holes, stray animals, poor visibility due to mist etc.).
Expect delays due to roadworks and twisty/sloping roads.

Itinerary

Thu 12 Sep (arrival at Bob's Place Guest Farm from 14h00)

Book into room or put up tent, followed by self-catering braai.

Fr 13 Sep (09h30-16h00): Tsitsa River lookout point above Sinxako; then drive to Tsitsa River Bridge for self-catering lunch; then drive to rehabilitation sites near Ugie.

Talk #	Title	Presenter
1.1	Trends and characteristics of rainfall in the Drakensberg	<i>Werner Nel</i>
1.2	River evolution along the eastern seaboard	<i>Kate Rowntree</i>
1.3	The natural/baseline erosion rates/land denudation rates for this landscape	<i>Heinz Beckedahl</i>
1.4	Measuring sediment with the assistance of Citizen Technicians	<i>Laura Bannatyne and Bennie van der Waal</i>
1.5	Community based natural resource management planning: the role of geomorphology	<i>Bennie van der Waal</i>
1.6	Restoration of the severely gullied Tsitsa River Catchment: where to begin?	<i>Johannes Theunissen</i>
Self-catering lunch at the Tsitsa River Bridge, Sinxako.		
1.7	Current wetland rehabilitation and restoration works in the Tsitsa River Catchment	<i>Piet-Louis</i>
1.8	Sediment dynamics of floodplain wetlands in the Tsitsa River Catchment	<i>Pippa Schlegel</i>
1.9	Wetland resilience in the Tsitsa River Catchment	<i>Jessica Tavener</i>
Self-catering braai at Bob's Place Guest Farm		

Sat 14 Sep (09h30-16h00): Tsolo gully and surrounds; then drive to Tsitsa Falls, then Tina Falls.

Talk #	Title	Presenter
2.1	Changes to the Tsitsa River geomorphology due to water infrastructure development	<i>Nick Huchzermeyer</i>
2.2	Avoiding degradation, the importance of soil erodibility	<i>Jay le Roux and Bennie van der Waal</i>
2.3	Capacity of ecological infrastructure and rehabilitation structures to retain sediment	<i>Bradley Vorster</i>
2.4	Measuring the effect of rainfall on the "mother" of gullies	<i>Ryan Anderson</i>
Self-catering lunch at Tsitsa Falls (entrance fee 20pp.)		
Visit Tina Falls (20km dirt road further)		
Self-catering braai at Bob's Place Guest Farm		

Sun 15 Sep: Travel to SAAG2019 conference at Arendsnes in Chintsa East.

En route to Chintsa, stop at a view point near Mtatha (-31.446523, 28.424976). The organizers will depart early for Chintsa, without the group, and will not be able to join talks or visits planned on this day.

Preconference excursion abstracts

(Received on 06 September 2019)

Restoration of the severely gullied Tsitsa River Catchment: Where to begin?

Johannes Theunissen and Jay le Roux

Erodible duplex soils in the Eastern Cape has resulted in the formation of thousands of gullies within the Tsitsa River Catchment. The accelerated growth of these gullies is threatening the feasibility of current water resource development in the catchment, as well as the livelihoods of local communities. With limited resources and time, it is not feasible for the Tsitsa River Project to rehabilitate such a large group of gullies. The study aims to prioritize gullies within the catchment for rehabilitation according to geomorphological and socio-economic aspects. These aspects include sediment delivery, sediment connectivity, and known communal needs and perceptions. Especially gullies that have a large sediment yield potential and those which threaten the livelihoods of communities within the catchment. This aim will be achieved by the following objectives: Prioritizing gullies according to potential sediment delivery; Prioritizing gullies according to sediment connectivity; Prioritizing gullies further with respect to communal needs and perceptions; Identifying key focus areas in the catchment which provide critical ecological services (infrastructure) that can demonstrate short term advantages and have a large impact at a low cost. Sediment yield data and a digital gully map of the catchment will also be spatially interpolated with recent field measurements obtained. This will provide a comprehensive description of each gully's erosional processes. The resulting list of prioritized gullies will be used to identify key focus areas for rehabilitation within the catchment. Which, in turn, will help to increase the efficiency, and feasibility, of the rehabilitation effort in the Tsitsa River Catchment.

Johannes Theunissen and Jay le Roux: Department of Geography, University of the Free State.

Gatberg wetland restoration in the Tsitsa headwaters

Piet-Louis Grundling

The Gatberg wetland rehabilitation project is situated near the towns of Ugie and Maclear in the Eastern Cape Province and focus on the arresting of erosion in and rewetting of wetlands. These activities support the current objectives of the Natural Resource Programmes of the Department of Environmental Affairs to address land degradation in the Tsitsa catchment. Working for Wetlands has been involved with projects in this area since 2004, making it one of the oldest Working for Wetlands rehabilitation projects. An important motivation for work in this area is to maintain and improve current wetland ecosystem services particularly with respect to maintaining habitat for the threatened Grey and Crowned Cranes and the endangered Wattled Crane. The wetlands also provide important regulatory, cleansing and storage functions in terms of water supply, both to surrounding farms and towns and now also to the proposed downstream Ntabelanga dam. Due to the importance of the dam, there has been a recent focus on controlling sediment release in the headwaters of the dam's catchment.

The Weatherly wetland, just outside Maclear, will be visited during the pre-conference excursion where restoration activities focused on rewetting by the blocking of drains. The interventions used were mainly small earth plugs. The results on rewetting will be discussed as well as the impact of the structures on the sediment dynamics of the system.

Piet-Louis Grundling: University of Free State, Centre for Environmental Management; Department of Environmental Affairs, South Africa.

Wetland classification and prioritization in the Tsitsa River Catchment, Eastern Cape Province

Jessica Tavener and Jay le Roux

Wetlands in South Africa have been subjected to high levels of modification, despite having economical and biological value. Likewise, several wetlands in the Tsitsa River Catchment have been subjected to modification, especially being susceptible to gully erosion due to overgrazing. Although some wetlands in the catchment are still intact, it is postulated that they are highly susceptible to erosion due to the erodible nature of wetland soils that are prone to the development of gully erosion. Soils derived from mudstone formations in the central part of the catchment are associated with duplex soils that are highly erodible with widespread gully erosion. Therefore, a spatial inventory is needed to classify wetlands and their erosion status to assist rehabilitation programmes in the near future. The classification of wetlands is difficult as a result of the connection between aquatic and terrestrial boundaries as well as the hydrological regime and various topographic settings. In this context, the research aim is to classify wetlands in the Tsitsa River Catchment according to the SANBI Classification System for Wetlands (Level 4: Hydrogeomorphic units) and the spatial extent of wetland erosion. Results will be used to provide options for rehabilitation of eroded wetlands in the catchment.

Jessica Tavener and Jay le Roux: Department of Geography, University of the Free State.

Avoiding degradation, the importance of soil erodibility.

Jay le Roux and Bennie van der Waal

The Mzimvubu River Catchment is the only large river network in South Africa without a dam, but proposals for water resource development in the Tsitsa tributary (at Ntabelanga and Laleni) have been put forward. However, the Tsitsa River Catchment consists of highly erodible soils with widespread soil erosion evident. Soils have a marked increase in clay content from the topsoil to subsoil and have an abrupt transition with respect to texture, structure and consistence. These soils limit intrinsic permeability since water does not move readily into the subsurface matrix, which leads to increased subsurface flow causing tunnel erosion. In addition, the subsurface matrix of duplex soils is often dispersive as a result of high sodium absorption. Rehabilitation structures in these soils will enhance subsurface accumulation of water and cause further erosion. Therefore, it is important to prevent further erosion by protecting areas that are not eroded. Areas that are not eroded need to be identified, especially areas that are susceptible to erosion. This study mapped areas that are susceptible to gully development but which are still gully-free. This was achieved by modelling drainage paths with a large contributing area and dispersive duplex soils in a GIS. The main outcome of this study is a map of gully-free areas that are susceptible to gully development in the Tsitsa River Catchment. More than 9 000 ha (5%) of the catchment is highly susceptible to further gully development. If not protected, these susceptible areas will contribute additional sediment loads to the river network.

Jay le Roux: Department of Geography, University of the Free State.

Bennie van der Waal: Department of Geography, Rhodes University.

Capacity of ecological infrastructure and rehabilitation structures to retain sediment

Bradley Vorster and Jay le Roux

Accelerated soil erosion is the leading cause of soil degradation. Techniques used to conserve soils differ from region to region depending on the type of soil, land use, terrain and climate. Furthermore, the lack of published literature on ecological infrastructure renders the decision of what type of rehabilitation or conservation action to use very difficult. Therefore, it is essential to focus on areas which are critical to ecological infrastructure and can demonstrate short term advantages with large impacts at a low cost. This study will focus on areas that have a good capacity to retain water and sediment. These areas include existing ecological infrastructure, existing infrastructure and future/planned rehabilitation structures. Firstly, the capacity of current ecological infrastructure will be illustrated by means of creating UAV-derived digital surface models (DSMs) at very high spatial resolution of 3 selected test gullies. Secondly, the capacity of current rehabilitation structures at the gullies will be monitored in the field and finally, the capacity of future/planned rehabilitation structures such as large permanent check dams within the gullies will be calculated in a GIS. The main outcome of this study will highlight the capacity of different ecological infrastructure to trap sediment at different locations. Although assessment of the trap efficiency of structures will be limited to 3 selected test gullies, the results will be applicable in other gullies. This will assist in the planning of appropriate interventions and designing innovations to reduce the amount of sediment that will enter into water bodies.

Bradley Vorster and Jay le Roux: Department of Geography, University of the Free State.

An interrogation of research on the influence of rainfall on gully erosion

Ryan Anderson and Jay Le Roux

Exploring research over the past decade on the influence of rainfall on gully erosion reveals some debate on the role of extreme rainfall on gully development, with some studies suggesting large influences of extreme rainfall, while others show limited impacts. Aspects such as antecedent moisture, periodicity of extreme rainfall events and others are highlighted as areas that should be expanded upon with focus on single- and multiple events over varying temporal scales, including ENSO (El Nino Southern Oscillation) on periods. Several recommendations are put forward to address these needs as studies of the rainfall factor begin to expand in gully erosion studies, especially under agricultural intensification and climate change. The use of new technologies in gully erosion research is also highlighted including applications of object-based image analysis, drone/UAV technology and photogrammetric/digital surface modelling. The advent of these technologies offer considerable potential to assess the influence of rainfall events on gully development, especially in data poor countries.

Ryan Anderson, Department of Geography, University of South Africa.

Jay Le Roux, Department of Geography, University of the Free State.

Impact of proposed dam construction on channel geomorphology with specific reference to the influence of sediment on river habitats and biota in the Tsitsa River, South Africa

Nicholaus Huchzermeyer

Fluvial systems are dynamic systems in which variables in a catchment and river channel affect the morphology of river reaches. South African rivers are increasingly being exposed to stresses from a combination of factors, one of the most prevalent being the impacts of damming rivers which result in varying downstream sediment fluxes and flow regimes. The sediment load combined with flow characteristics for respective river channels provides the physical habitat for aquatic ecosystems. The damming of the Tsitsa River, through the construction of the Ntabelanga Dam, will change the overall downstream geomorphology. A baseline survey of the present geomorphology and associated instream habitats of the selected reaches was set up by conducting cross-sectional surveys of channel topography, water slope surveys, discharge measurements and visual and quantitative assessments of substrate. Loggers were installed at each site to collect continuous data on variations in water depth and temperature. Monitoring surveys, in terms of fine sediment accumulation, were conducted to characterise dynamic habitat arrangements and macroinvertebrate community composition. In addition a taxa related physical habitat score for the Tsitsa River was created. The relationship between the physical and ecological characteristics of the Tsitsa River is used to discuss likely changes that will occur to channel geomorphology with specific reference to the influence of sediment on river habitats and biota after the dam has been constructed.

Nicholaus Huchzermeyer, Department of Geography, Rhodes University, South Africa.

Sediment dynamics in floodplain wetlands in the Tsitsa Catchment: implications for floodplains in southern Africa

Pippa Schlegel

Wetlands have been identified as important natural sediment sinks and buffers in the Tsitsa River Catchment, South Africa. In-depth mapping of the upper Tsitsa Catchment showed over 2 800 wetlands covering an area of approximately 7 600 hectares. These wetlands range from large valley bottom wetlands to small hillslope seeps. A changing climate, high anthropogenic pressures, lack of sustainable landscape management and duplex, highly erodible soils increase the vulnerability of functioning wetland systems and have increased sediment loads into the Tsitsa River. Wetlands and floodplains are the most crucial natural buffers occurring along the drainage system in terms of sediment conveyance. According to Kotze et al. (2009), floodplain wetlands have been characterised as having the potential to provide the following ecosystem services: sediment trapping, flood attenuation, erosion control, and phosphate, nitrates and toxicant assimilation. However, research is needed to answer specific questions on geomorphic processes pertaining to these services. The objectives of this research are to understand the rates and processes of lateral erosional and depositional processes within the channel and the connected vertical sediment accumulation across floodplains; what type of sediment is being accumulated and how long is this sediment stored on the floodplain. The aim of this research is to determine the rate of sediment and nutrient cycling within meandering floodplain wetland systems.

Pippa Schlegel, Department of Geography, Rhodes University, South Africa.

The natural, baseline erosion rates for the middle veld landscapes of the Transkei region of the Eastern Cape Province

Heinz Becketdahl

Soil erosion in this landscape is driven by a combination of both physical and geochemical processes and is therefore highly variable, reflecting the complex interplay inter-play on the prevailing forcing mechanisms. Murgatroyd (1979) estimated the regional geological erosion rates to vary about an approximate mean of some 8t/ha/a, derived from rough calculations of the material lost since the continental breakup of Gondwana. This value contrasts significantly with the rates of 12-15 t/ha/a, determined by Le Roux and Roos (1986) for runoff plots in a conservation area in the Free State during the 1970s and 80s. By contrast, the preliminary work to quantify the sediment lost by processes of sloughing off the gully sidewalls in dispersive soils by different researchers have pointed to rates varying between 2 t/ha/a and 10 t/ha/a. This contrasts sharply with the highly variable rates of 4 t/ha/a up to >100t/ha/a obtained from estimates at both Inxu drift and the Mabeleni forest region. This large variability is explained by the variability of highly individualized processes during dispersion. The dynamism of the erosion processes is highlighted by the *in situ* find of the pelvic bone of a small plains zebra in the KuLozulu gully a short distance upslope from the Inxu Drift site. This material was found 1,5m below surface in the gully sidewall, and was dated by Louis Scott from the National Museum in Bloemfontein as 168yrs BP in 1988. This implies that the animal died in a depression some 200 years ago, which was then infilled and more recently re-excavated. Although the fundamental erosion processes are understood, the details of the processes of dispersion (and the interaction of this with mechanical erosion processes and, more recently, anthropogenic forcing) is poorly understood, which in turn is reflected in the generally poor performance of existing erosion models in the region.

Heinz Becketdahl, Department of Geography, Environmental Science and Planning, University of Eswatini, Swaziland, and Department of Geography, Geoinformatics and Meteorology, University of Pretoria.

